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The Sphecidae (Hymenoptera) of Fennoscandia and Denmark

by
O. Lomholdt

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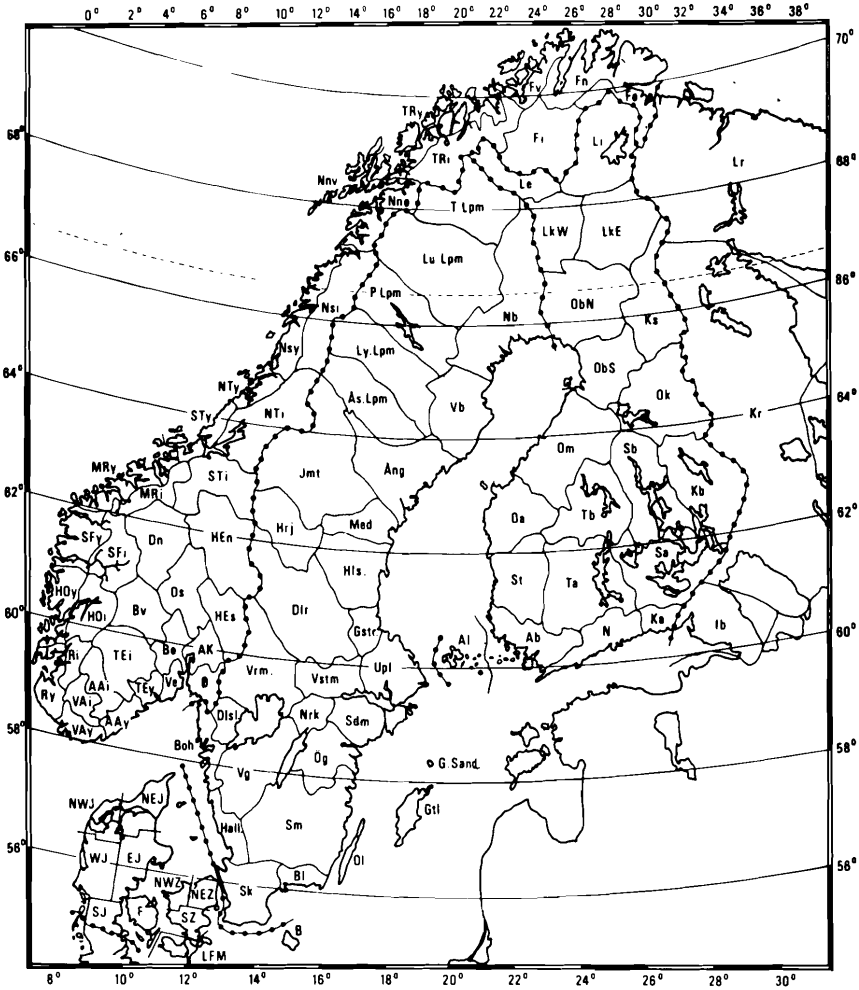

List of abbreviations for the provinces used throughout the text, on the map and in the following tables.

DENMARK

SJ	South Jutland	LFM	Lolland, Falster, Møn
EJ	East Jutland	SZ	South Zealand
WJ	West Jutland	NWZ	North West Zealand
NWJ	North West Jutland	NEZ	North East Zealand
NEJ	North East Jutland	B	Bornholm
F	Funen		

[redacted]

SWEDEN

Sk.	Skåne	Vrm.	Värmland
Bl.	Blekinge	Dlr.	Dalarna
Hall.	Halland	Gstr.	Gästrikland
Sm.	Småland	Hls.	Hälsingland
Öl.	Öland	Med.	Medelpad
Gtl.	Gotland	Hrj.	Härjedalen
G. Sand.	Gotska Sandön	Jmt.	Jämtland
Ög.	Östergötland	Ång.	Ångermanland
Vg.	Västergötland	Vb.	Västerbotten
Boh.	Bohuslän	Nb.	Norrbotten
Dlsl.	Dalsland	Ås. Lpm.	Åsele Lappmark
Nrk.	Närke	Ly. Lpm.	Lycksele Lappmark
Sdm.	Södermanland	P. Lpm.	Pite Lappmark
Upl.	Uppland	Lu. Lpm.	Lule Lappmark
Vstm.	Västmanland	T. Lpm.	Torne Lappmark

NORWAY

Ø	Østfold	HO	Hordaland
AK	Akershus	SF	Sogn og Fjordane
HE	Hedmark	MR	Møre og Romsdal
O	Opland	ST	Sør-Trøndelag
B	Buskerud	NT	Nord-Trøndelag
VE	Vestfold	Ns	southern Nordland
TE	Telemark	Nn	northern Nordland
AA	Aust-Agder	TR	Troms
VA	Vest-Agder	F	Finnmark
R	Rogaland		

n northern s southern ø eastern v western y outer i inner

FINLAND

Al	Alandia	Kb	Karelia borealis
Ab	Regio aboensis	Om	Ostrobottnia media
N	Nylandia	Ok	Ostrobottnia kajanensis
Ka	Karelia australis	ObS	Ostrobottnia borealis, S part
St	Satakunta	ObN	Ostrobottnia borealis, N part
Ta	Tavastia australis	Ks	Kuusamo
Sa	Savonia australis	LkW	Lapponia kemensis, W part
Oa	Ostrobottnia australis	LkE	Lapponia kemensis, E part
Tb	Tavastia borealis	Li	Lapponia inarensis
Sb	Savonia borealis	Le	Lapponia enontekiensis

USSR

Ib	Ingria borealis	Kr	Karelia rossica	Lr	Lapponia rossica

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Introduction

The present work is primarily based on classical faunistic treatments of the European and North American sphecid faunas. The following monographs represent the foundation of the book: Aurivillius (1904) treated the Swedish fauna of Sphecidae; Balthasar (1972) the Czech; Berland (1925) the French; de Beaumont (1964) the Swiss; Moczar and Bajari (1957 and 1959) the Hungarian; Muesebeck, Krombein,Townes et al. (1951), Krombein et al. (1958, 1967) the North American; Nielsen (1907) the Danish; Noskiewiecz and Pulawski (1960) the Polish; Oehlke (1970) the East German; Pulkkinen (1931) the Finnish; Saunders (1896) the British, and Schmiedeknecht (1930) the North and Central European fauna of Sphecidae. Recently Bohart and Menke (1976) published the most important: Sphecid wasps of the world, a generic revision. As appears from above, the treatment of this fauna in Denmark and Fennoscandia are the most ancient, and the changes, in some cases very extensive, in nomenclature and taxonomy made since then, have necessitated a modern revision of the Nordic fauna. The discovery of several new species within the area also helps to justify a revision. Furthermore, the existing knowledge of the biology, distribution etc. of the species has increased considerably.

I have found it very important to study material from as many localities as possible, and I ask the following institutions and private persons to accept my sincere thanks for invaluable help. My good friends, fil.lic.A.K.Merisuo and E.Valkeila, Finland, through discussions by letter over many years, rendered very valuable aid and inspiration during my work. By their extensive and comprehensive critical papers - dealing mainly with Finnish species - these two colleagues have made important contributions to the sphecid taxonomy, nomenclature, and biology; also they have willingly permitted me to borrow specimens from their unique private collections. To Lecturer S.E.Abrahamsen, Nr.Nissum, Denmark, I extend a special thanks for successful collaboration and for a great number of biological observations on several species, which have so far never been published.

I am also indebted to Dr.S.L.Tuxen and Dr.B.Petersen, Zoological Museum of Copenhagen, and Prof.J.Leclercq, Gembloux, Belgium, for loan of valuable material of Belgian Sphecidae for comparison. For loan of material I further thank Curator J.Andersen of Tromsoe Museum, Tromsoe, Norway; Fil.lic.H. Andersson, Lund, Sweden; Dr. J.Aubert, Lausanne, Switzerland; Prof. J.de Beaumont, Lausanne, Switzerland; Curator R.Danielsson, Lund, Sweden; Dr. S.Erlandsson, Stockholm, Sweden; Civil Engineer P.I.W.Gleie, Kirke Eskil-

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Finally, I extend sincere thanks to my friends H. Enghoff, O. Jensen and E. Rald, who often brought home valuable material from excursions in Denmark, Sweden and Finland, and I owe them a debt of gratitude for valuable criticism of my work.

Diagnosis of the Sphecidae

The Sphecidae constitutes a family within the Hymenoptera Aculeata, closely related to the bees. An autapomorphism for the Sphecidae is not expected to be existing since this family (or a subgroup within this) is regarded the more primitive of the two families, Sphecidae and Apidae (s. lat.), constituting the superfamily Sphecoidea (see also p. 33).

As the Sphecidae is impossible to define in terms of derived characters, the following combination of characters provides sufficient data for referring any Nordic specimen to this family:

Head orthognathous, i.e. mouthparts directed ventrally; eyes large, occupying most of the lateral and antero-lateral surfaces of the head; mandibles usual-

ly stout biting tools, often provided with strong teeth apically or internally; labiomaxillary complex usually short; antennae typically consisting of 13 segments in males and 12 in females; posterior margin of prothorax squarely truncate, in rare cases arcuate; scutum usually continuous with the drosal part of mesopleuron. resulting in a wide separation of the posterior margin of the humeral tubercles and the tegulae; mesothorax ventrally and laterally represented by the very large mesopleuron; propodeum usually forming a large, strongly convex, sculptured sclerite, whereby thorax becomes rather elongate; abdomen (gaster) usually consisting of seven visible segments in males and six in females; first abdominal segment, or parts hereof, often considerably elongate and narrow, forming a petiolus; last tergum in females often with a triangular, margined area with heavier sculpture (pygidial area); forelegs in females typically with a strong tarsal pecten; claws dentate only in rare cases; forewings typically with three cubital and two discoidal cells, but in several cases these numbers are reduced.

Morphology of adult Sphecidae

The general morphology of the adult Sphecidae is roughly similar to that of other Hymenoptera Aculeata. The following description is brief and only intended to elucidate the terms used in the keys and descriptions of genera and species.

HEAD (Figs. 1-3).

The head is large and very movable. A considerable large part of its surface is occupied by the compound eyes. These consist of a large number of ommatidia, whose size may vary considerably, even in an individual. Between the facets there are hair-like sensillae which in some species, e.g. Entomognathus brevis, may be visible with a pocket lens. Along the upper part of the orbit of the compound eyes many species have an elongate, either depressed or raised portion with different sculpture. This is called the facial fovea (fovea facialis) (Fig. 3). On the upper part of the vertex three ocelli are found, whose mutual position may be of great systematic value. In certain genera (e.g. Tachysphex) the two lateral (posterior) ocelli are highly divergent in appearance; they are depressed and elongate (Fig. 287).

Normally the antennae are inserted dorsal to the suture between clypeus and the lower part of the face (the epistomal suture) (Fig. 1). Their first segment is called the scape (scapus), the second, which is considerably smaller, the pedicel (pedicellus). The remaining part of the antenna is the flagellum. The antennae always consist of 12 "segments" in the females, and normally of 13 segments

in the males. Scapus is always the largest segment, and when this is relatively long, the antennae are said to be geniculate. Ventrally on the flagellum the males very often have a single or a pair of longitudinal pads (tyloidea) on each segment, whose morphology is often specifically distinct. The morphology of the flagellum, especially in the males, shows a considerable variation, since part of the segments may be excavated, depressed, dilated or provided with tooth-like processes.

The area between the anterior (median) ocellus and the epistomal suture is called frons (Fig. 1). Posteriorly on the head there is a large hole (foramen magnum) (Fig. 2), through which the internal organs (oesophagus, nerve cords etc.) pass from the head to the thorax. Round this hole runs, at a short distance, a carina (the postoccipital carina) (Fig. 2). Outside this there is a large horse-shoe-shaped area (occiput), which represents the posterior surface of the head. Laterally it is delimited by a usually sharp carina (the occipital carina) (Fig. 2). Anteriorly on the head, below the frons, a large plate, clypeus, is found (Fig. 1),

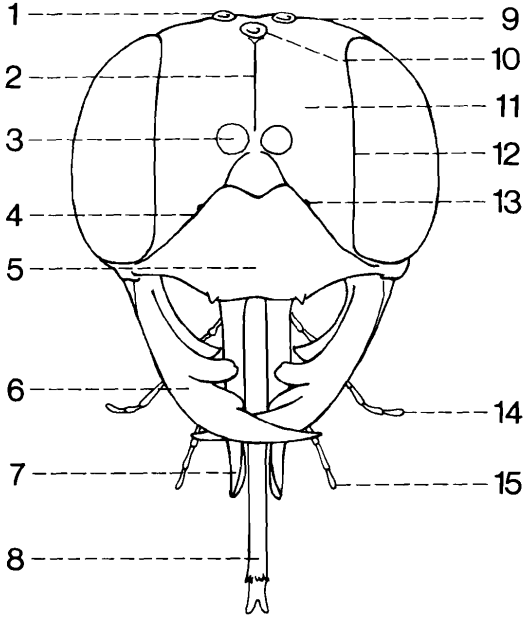


Fig. 1. Head of Ammophila sp. ♀ in frontal view. - 1: lateral ocellus; 2: frontal line; 3: antennal socket; 4: epistomal suture; 5: clypeus; 6: mandible; 7: galea; 8: glossa; 9: vertex; 10: anterior ocellus; 11: frons; 12: inner orbit; 13: anterior tentorial pit; 14: maxillary palpus; 15: labial palpus.

covering partly the mouth, partly the mandibles, when these are at rest. The anterior margin of the clypeus shows great variation, and this is frequently used in taxonomy. The labrum is articulated distally on the clypeus. Normally, the labrum is partly concealed by the clypeus, but in Bembix it is articulated with the anterior margin of the clypeus (Fig. 78). The mandibles are strongly developed, partly for biting, partly as digging tools. Their number of teeth, excavations etc. are useful taxonomic characters. Sexual dimorphism in the morphology of the mandibles is very common. Maxillae and labium are connected by membranes and function as a unity, the labio-maxillary complex, during intake of food. Generally the labio-maxillary complex is comparatively short in Sphecidae. A typical six-segmented maxillary palp is found in this family (Fig. 2). The labial palp (Fig. 2) normally consists of four segments.

THORAX (Figs. 4-5).

The thorax consists of three fused segments, however, the anterior segment

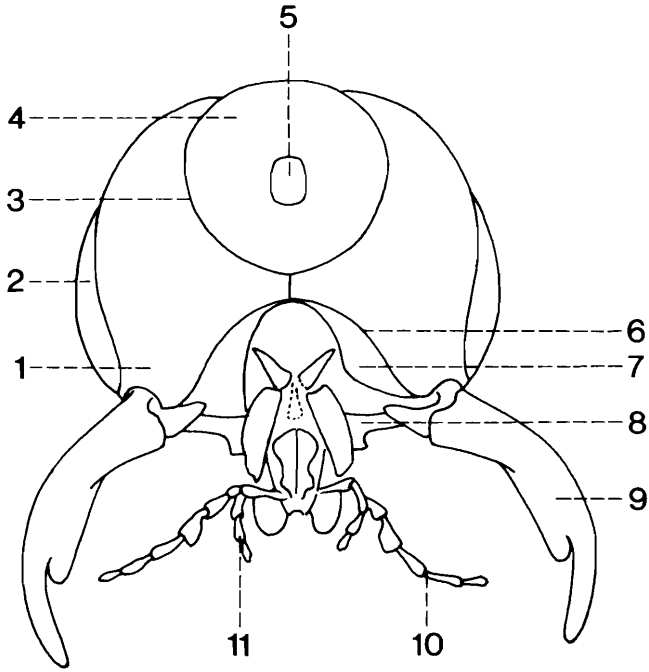


Fig. 2. Head of Ammophila sp. in posterior view. - 1: gena; 2: compound eye; 3: occipital carina; 4: occiput; 5: foramen magnum; 6: hypostomal carina; 7: hypostoma; 8: clypeus; 9: mandible; 10: maxillary palpus; 11: labial palpus (Redrawn from Bohart and Menke, 1976).

(prothorax) is ventrally rather loosely connected with the mesothorax. Prothorax is usually short (except in Sphecinae (Fig. 4), Ampulicinae and Alysson). Laterally it is protruded into a backward directed, sharply delimited lobe, the pronotal or humeral tubercle, which covers the mesothoracic spiracle (Fig. 4). The distance between the humeral tubercle and the base of the forewings is usually large so that the mesonotum achieves a broad contact with mesopleuron. Dorsally on the prothorax (pronotum) a sharp transverse carina is often present, which laterally may be protruded into tooth-like processes. The propleuron (pleuron 1) is rather loosely connected with the pronotum and appears as a segment belonging to the legs.

The mesothorax is by far the largest thoracic segment. Dorsally it is divided into two sclerites, scutum (Fig. 5) (mesoscutum) and scutellum (Fig. 5). On the scutum often one or several pairs of longitudinal furrows or carinae are found. Anteriorly are found two median scutal lines, and lateral to these run the prescutal carinae (Fig. 5). From the posterior margin of the scutum the parapsidal furrows run a shorter or longer distance forward. Often only a single pair of longitudinal lines is found lateral to the median scutal lines, and these are generally called parapsidal furrows, although this term is not strictly correct. A separate mesosternum is not found in Sphecidae, and the whole lateral and ventral part of the mesothorax is therefore usually called mesopleuron. The precoxal suture (Fig. 4) often protrudes sharply anterior to coxae 2, where it may develop as an angularly bent carina or be reduced to a small tooth-like process. The ventral midline is usually strongly depressed and is called the median sternal groove. From a sharp depression, just ventral to the base of the forewings

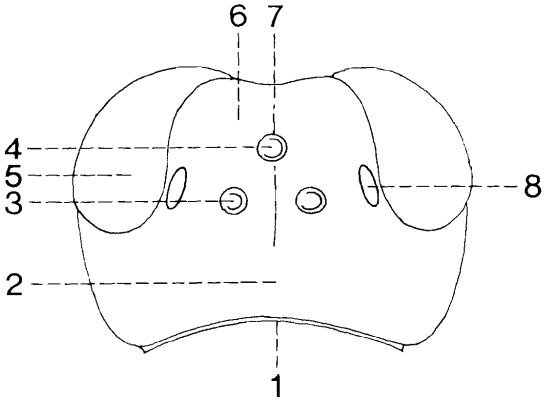


Fig. 3. Head of Crossocerus sp. in dorsal view. - 1: occipital carina; 2: vertex; 3: lateral ocellus; 4: anterior ocellus; 5: compound eye; 6: upper frons; 7: frontal line; 8: facial fovea.

(subalar pit), a coarsely pitted oblique furrow (anterior oblique furrow) often runs ventrally, where it may join or cross the epicnemial carina (Fig. 4). The area in front of the epicnemial carina is called the epicnemium (Fig. 4). In Mimumesa the epicnemial carina continues in the acetabular suture or crest (Fig. 75). The epicnemium is often smooth without sculpture.

The metathorax is short, dorsally represented by metanotum, laterally by metapleuron (Fig. 4). The sutures between scutum and scutellum are often strongly depressed, and may be divided into coarse, more or less quadrate pits.

ABDOMEN.

The first abdominal segment forms part of thorax as a functional portion of thorax, and is called propodeum. It is usually very large. Many species have dorsally a more or less heart-shaped area (area cordiformis or propodeal enclosure (Fig. 5)), whose sculpture often deviates considerably from that of the surrounding areas. The morphology of this area is of great taxonomic value, and its sculpture is extensively used in the definition of several species. In many genera the propodeum carries characteristic spines or teeth. Between the propodeum and the functional first abdominal segment a very pronounced constriction is found, whereby the abdomen becomes very mobile, mainly in the vertical plane. In the Sphecidae, usually the female abdomen consists of six visible segments,

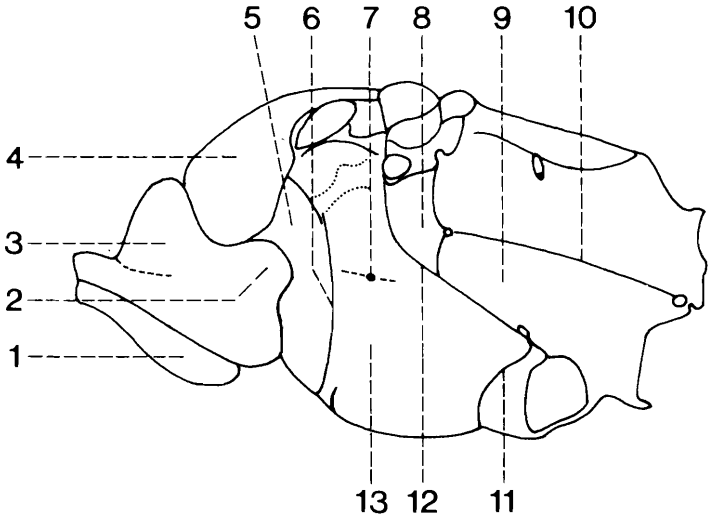


Fig. 4. Thorax and propodeum of Ammophila sp. in lateral view. - 1: propleuron; 2: humeral tubercle; 3: pronotum; 4: scutum; 5: epicnemium; 6: epicnemial carina or suture; 7: mesopleural scrobe; 8: upper metapleural area; 9: lower metapleural area; 10: metapleural suture; 11: precoxal carina or suture; 12: mesopleural suture; 13: mesopleuron (Redrawn from Bohart and Menke, 1976).

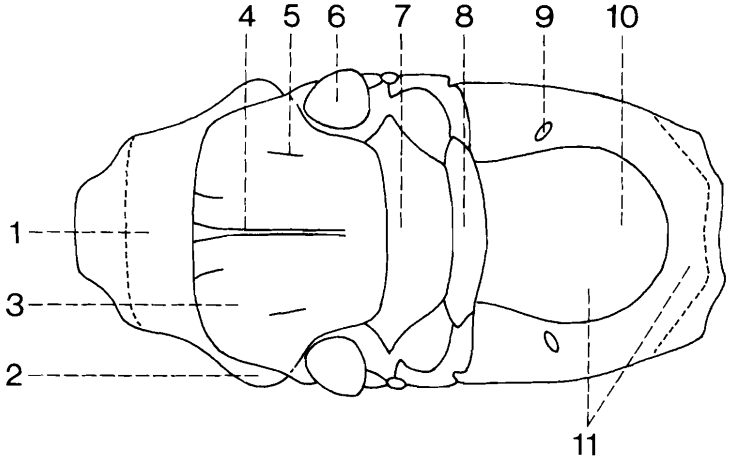


Fig. 5. Thorax and propodeum of Ammophila sp. in dorsal view.-1: pronotum; 2: humeral tubercle; 3: scutum; 4: median scutal lines; 5: parapsidal furrow; 6:tegula; 7: scutellum; 8: metanotum; 9: propodeal spiracle; 10: dorsal propodeal area or area cordiformis; 11: propodeum (Redrawn from Bohart and Menke, 1975).

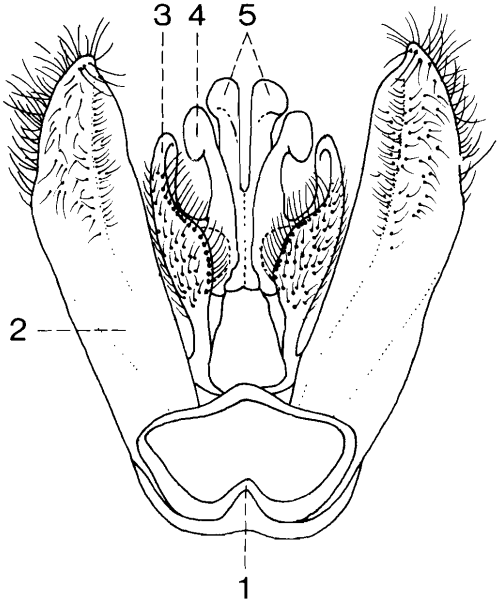


Fig. 6. Male genitalia of Chlorion aerarium Patton in ventral view. - 1: basal ring; 2: paramere; 3: cuspis; 4: digitus; 5: aedeagus (Redrawn from Bohart and Menke, 1963).

the male of seven. Segments VIII and IX are highly modified and form the sting apparatus etc. in the females, and the external genitalia in the males (see below). The anterior part of the abdomen may be considerably prolonged forming a petiolus, either by the first sternum alone or by first sternum + tergum. In the latter case it carries spiracles. On the last visible tergum in the females (VIth) a pygidial area is very often found, which usually is surrounded by a protruding carina. The morphology and pubescence of and round this area are very characteristic, and frequently used in taxonomy.

MALE GENITALIA (Figs. 6, 7).

The morphology of the external male genitalia is subject to great variation in the Sphecidae, and since, in some cases, they may be useful in the identification of closely related species, they are briefly described. The terms used in the following should be regarded as "trivial names" (cf. Snodgrass, 1941 and Smith, 1970). Proximally there is a ring-shaped sclerite (basal ring, gonobase, lamina annularis) (Fig. 6) with which some of the remaining sclerites are articulated. The large parameres (Figs. 6, 7), which morphologically are developed from gonocoxa and gonostylus, are situated laterally. These sclerites are, however, always fused, and the suture has disappeared. Medial to these, a proximal sclerite, volsella (lamina volsellaris) (Fig. 7) is typically present which distally carries the usually mutually movable cuspis and digitus (Fig. 6). In several species the volsellae are highly reduced and may be absent. Dorsally between the parameres the aedeagus (phallus) (Figs. 6, 7) is found, which is a paired structure, often with incisions, teeth etc., which may be used in taxonomy.

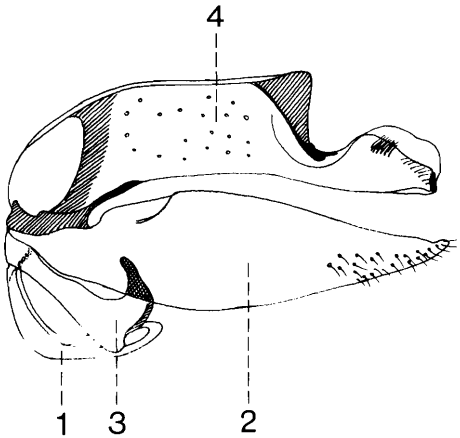


Fig. 7. Male genitalia of Nitela borealis Valkeila in lateral view. - 1: basal ring; 2: paramere; 3: volsella; 4: aedeagus.

LEGS.

In principle the legs do not differ from normal legs in Hymenoptera Aculeata. In the females the forelegs are very often modified for digging, thus the tarsi on the outer side may carry a row of stout, usually deflexed spines (tarsal pecten). Proximally on metatarsus (basitarsus) of the forelegs there is a deep emargination, which together with the apical spur on the tibia forms an antenna cleaner. A similar, but more weakly developed device, is found on the hindlegs. The legs or parts of them are very conspicuously developed in many males, e.g. within Crabronini, in which especially the tibia 1 and tarsus 1 may be much flattened, dilated or of different colour from the rest of the leg. It is probable that these highly modified forelegs are used to seize the female during copulation.

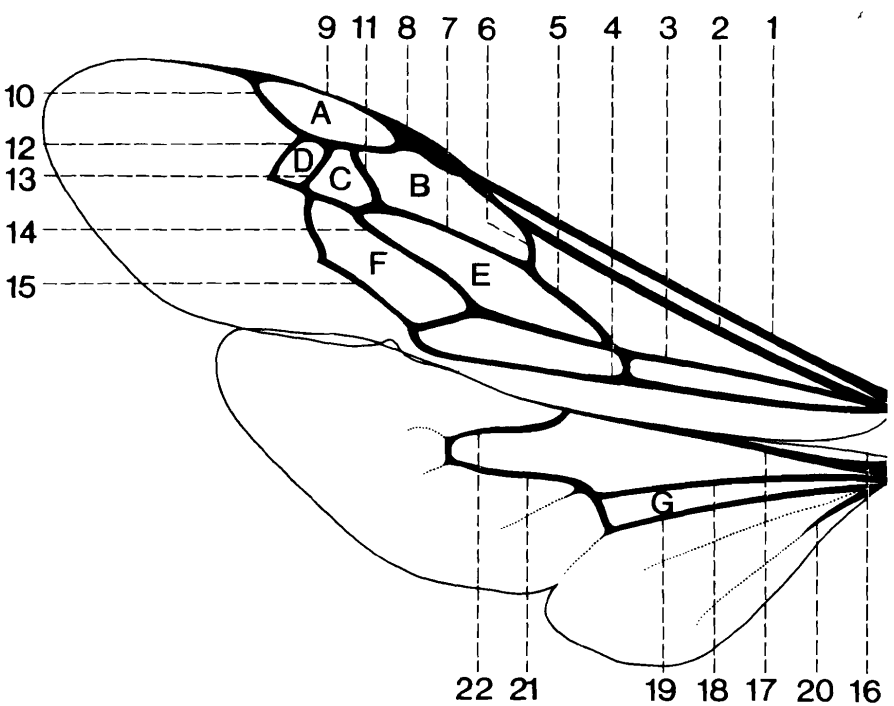


Fig. 8. Wings of Ammophila sabulosa (L.). - 1: costa + subcosta; 2: radius; 3: media + cubitus; 4: analis 1; 5: media; 6: radial sector; 7: radial sector + media; 8: pterostigma or stigma; 9: radius; 10 - 11: radial sector; 12: third cubital transverse vein; 13: second cubital transverse vein; 14: first discoidal transverse vein; 15: second discoidal transverse vein; 16: costa; 17: radius; 18: media + cubitus; 19: analis 1; 20: analis 3; 21: media; 22: radial sector. Cells: A: radial cell; B: first cubital cell; C: second cubital cell; D: third cubital cell; E: first discoidal cell; F: second discoidal cell; G: anal cell (Terminology adopted from Richards, 1956).

WINGS (Fig. 8).

The venation is best illustrated by a drawing (Fig. 8). The fore- and hindwings are coupled during flight by means of a number of hooks (hamuli) on the anterior margin of the hindwings. The hooks catch on to part of the reflexed posterior margin of the forewings.

Bionomics

The species of the Sphecidae are primarily solitary Hymenoptera. There are, however, important exceptions (see also Evans, 1964b): Microstigmus comes Krombein (Pemphredoninae) from Costa Rica shows "reproductive dominance" (division of labour) in females from the same nest. Apparently, no external morphological differentiation occurs (Matthews, 1968a, b). Trigonopsis cameronii Kohl (Sphecinae), occurring in Central and South America west of the Andes, shows a rather low degree of social development. Groups of females collaborate when constructing the nest. Theft without provocation of aggressive behaviour is common in this species (Eberhard, 1972).

In northern temperate zones adult Sphecidae are only active in the summer months, and the majority of the species produce only a single generation annually. The peak of the active period usually falls in June and July. Many species are, however, also on the wings during August and September, and a few may be met with in May. The maximum duration of life of the imagos is two to three months, dependent especially on climatic conditions.

The species frequently occur in habitats fully exposed to the sun, but a few, e.g. of Crossocerus, may breed in comparatively shady habitats such as woods. As to the placing of the nest, the Nordic Sphecidae may be divided into two main groups: (1) terrestrial species, which nest in the soil, and (2) arboreal species nesting in wood or hollow plant stems. The genus Nysson lives as predator on species of Gorytes, Argogorytes and Dienoplus (Nyssoninae), all of which construct their nests in the ground. It seems reasonable to assume that species belonging to group (1) represent the initial condition in evolution. In this connection it is interesting to note that both choices of habitat may exist within the same genus, e.g. Lestica and Crossocerus, but only exceptionally within the same subgenus, e.g. Crossocerus. In certain species the same entrance is often used by several females, suggesting an initial social behaviour (examples: Crossocerus elongatulus, C. megacephalus and Ectemnius cephalotes).

In Northern Europe there is a tendency for the fauna gradually to include more arboreal species northwards, and if comparison is made with more southern fau-

nas, especially with the French, this tendency becomes clear. See also the chapter "Distribution and zoogeography".

A good classification of nest types was given by Merisuo (1943), which is summarized as follows:

A. Nests constructed in wood and the like.

I. Nests constructed by the wasp itself.

a. In decayed wood, stumps etc. The system consists of a main tunnel and one to several lateral burrows. The cells are partitioned by sawdust.. ..... Ectemnius-type (Fig. 9)

b. In branches and thin stems. The tunnel system is branched or unbranched; the cells are arranged in a linear fashion. Partitions between cells consist of pith-dust or foreign substances ... Pemphredon-type (Fig. 10),

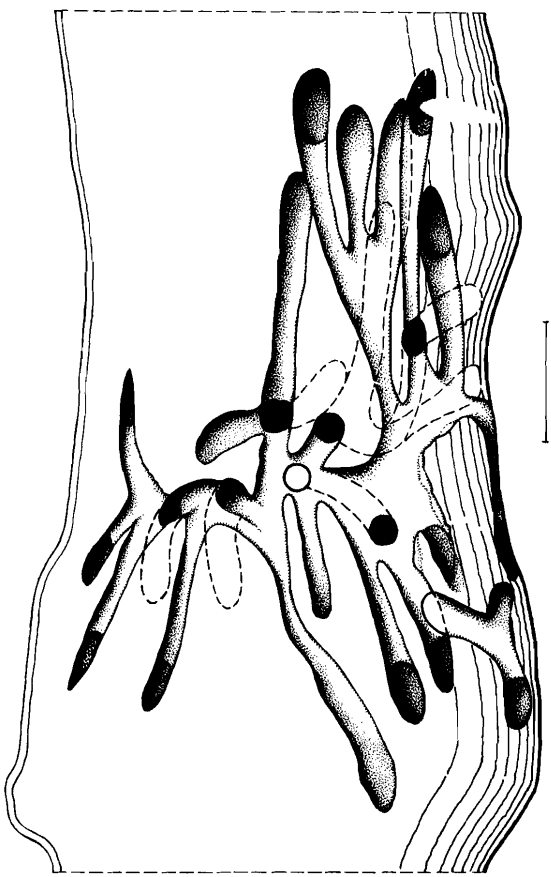


Fig. 9. Nest of Ectemnius cephalotes (Oliv.) in trunk of Betula sp. Scale: 2 cm.

II. Nest constructed in connection with tunnels made by xylophagous insects or old nests made by the same or other species of Sphecidae. Hollow plant stems are often used. The cells are arranged successively in branched or unbranched systems. The partitions between the cells consist of wood-dust or foreign substances ..... Passaloecus-type (Fig. 11)

B. Nests constructed in soil.

I. A single cell.

a. Containing one to five prey animals ..... Ammophila-type

b. Containing many prey animals ..... Bembix-type

II. Branched tunnel system with mass provisioning in each cell.

a. Cells placed in short lateral tunnels ..... Cerceris-type

b. Cells placed in long lateral tunnels ..... Gorytes -type

Other classifications are given by Abrahamsen (1972), Crevecoeur (1951), Minkiewiez (1933), and Tetens Nielsen (1936).

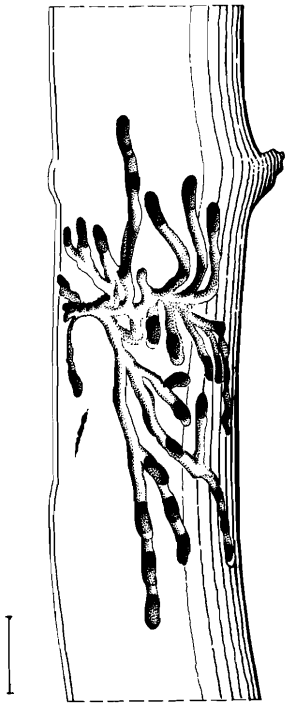


Fig. 10. Nest of Pemphredon lugubris (Fabr.) in branch of Quercus robur. Scale: 2 cm.

It is mentioned by Merisuo (l.c.) that the majority (about 75%) of the arboreal species in Finland are black or mainly dark coloured, while species constructing their nests in the ground usually have yellow and/or red markings (about 75%). Whether this is ascribable to camouflage seems rather uncertain.

Construction of the nest - as far as the terrestrial species are concerned - is mainly with the forelegs, whose tarsal segments usually bear a strong tarsal pecten on the outer side. A few genera (Dinetus, Podalonia and Belomicrus) have developed a psammophore, which consists of a row of long stiff hairs, partly on the inner side of femur 1 and partly along the ventral face of the head. When closed, these together constitute a kind of basket, in which material can be carried away. The mandibles play an important part in breaking up coarse-grained material. Arboreal species almost exclusively use the mandibles when constructing nests. The mandibles may be highly modified, e.g. in species of Passaloecus, which also use them for transporting and handling resin (Lomholdt, 1973).

The behaviour of the females in connection with the highly evolved care of the offspring may be divided into five main components:

A. Hunting
   1. Search for prey.
   2. Attack and paralyzation.
   3. Transportation of prey to a temporary storing place.

B. Construction of nest.
   1. Search for suitable nesting site.
   2. Excavation (eventually interrupted by periods where the temporarily deposited prey is inspected).

C. Transportation of prey to the nest and deposition in cell.
   1. Prey transported to nest.
   2. Nest examined.
   3. Prey pulled down into nest.

D. Oviposition.

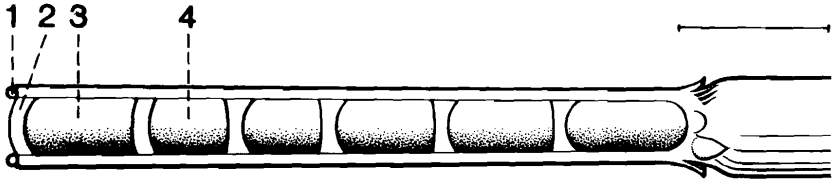


Fig. 11. Nest of Passaloecus eremita Kohl in stem of Phragmites communis. - 1: ring of resin droplets surrounding entrance; 2: terminal plug; 3: empty vestibular cell; 4: last provisioned cell. Scale: 1 cm.

E. Closing of nest.

1. Cell sealed.
2. Nest closed.

It is a general feature of the Sphecidae that the females undertake orientation flights in the immediate surroundings, both when a fully provisioned cell has been closed, and when the entrance is sealed. The above-mentioned schedule can be applied directly to the Ampulicinae and several Sphecinae, but should be modified if used for the description of the breeding biology of the "higher" Sphecidae. See the chapter "Phylogeny and Evolution".

The prey animals are mainly free-living insects and spiders, but several species of Podalonia seek terrestrial larvae of Noctuidae (Lepidoptera). The selection of prey shows that Diptera and Homoptera are preferred in Fennoscandia and Denmark. Usually the species seek their prey within a genus, order or suborder, but some species, e.g. Crossocerus quadrimaculatus and Lindenius albilabris use prey of several orders. Other species, e.g. Dolichurus corniculus, Philanthus triangulum, Argogorytes mystaceus and Belomicrus borealis have specialized on a single prey species.

Searching for prey often takes place far from the nest. In single cases (Passaloecus) the prey is sought in the same locality where the material for partitioning the cells is found. The prey consists of aphids living in pine and spruce.

In many species, especially those collecting Diptera, the large compound eyes play an important rôle in locating the prey. At short range (when the prey has been seized) the senses of smell and touch replace the vision. The species of Mellinus and Ectemnius are probably sharp-sighted at a distance of 15-20 cm. The hunting method of Mellinus can briefly be described as a slow stalking towards the prey to a distance of 2-3 cm. Thereupon the wasp seizes its prey with wide-open mandibles and spread forelegs. Ectemnius cavifrons and others, at the sight of a suitable prey, (often Syrphidae) will perform a hovering flight and make short jerky horizontal movements (estimate of distance), very slowly approaching the resting fly. With lightening speed it attacks the prey, seizes it with mandibles and legs, and paralyzes it. Such hunting technique is learned, and many unsuccessful attempts are made, before the technique is mastered. The adaptive radiation which has taken place with regard to the hunting methods within the Sphecidae has been briefly summarized in Table 2.

Paralyzation of prey is made almost exclusively by means of poison injected mainly ventrally in the thoracic region. The chemical composition of the poison is not known. In the honey bee it is produced in the acid gland, its active component being one or several neurotoxins (dialysable proteins) produced together with phosphatases and probably also acetycholine and formic acid (Wigglesworth, 1965).

The products from the alkaline gland are not supposed to have toxic action. It is known that Philanthus triangulum is immune to its own poison (Rathmayer, 1962). Tetens Nielsen (1935) described the effect of the poison on larvae of Ceranica pisi L. (Lepidoptera, Noctuidae), which were paralyzed by Ammophila. He found that especially in the metathoracic ganglion, but also in the brain (supraoesopharyngeal ganglion) considerable histological changes had occurred (evidence of degeneration). The nuclei were dissolved and the nerve tissue on the whole badly injured. Rathmayer mentions that in Apis mellifera paralyzed by Philanthus triangulum, especially the glia-cells in the thoracic ganglions were strongly affected. Sphecidae using highly sclerotized prey, e.g. Cerceris, Philanthus and Lindenius, inject the poison through the thin intersegmental membranes, especially near the base of the legs and through the cervical membrane, the poison thus, coming in direct contact with the powerful leg and wing musculature, where it probably acts on the neuromuscular synapses. In Pemphredoninae the sting - as far as known - is not used during paralyzation. On the other hand, the preyed aphids receive a number of strong bites (malaxation) in the neck region. This causes paralyzation of the locomotory musculature.

Depending on the size of the prey, this is dragged or flown to the nest (Table 2). Species using relatively small-sized prey have to collect an often considerable number, and Pemphredon lugubris provides with up to 40 aphids per cell.

The most common method to bring home paralyzed prey is to hold it with the middle legs during the flight. Thereby the forelegs are free and can be used to reopen the temporarily closed entrance to the terrestrial nesting site. Pemphredoninae, which are mainly arboreal species, transport their prey held with the mandibles, and Oxybelus carries it impaled on the sting. There is a single observation showing that the latter method may also be used by Crossocerus elongatulus (Tetens Nielsen, 1933).

The egg is attached ventrally on the thorax of the prey so that the newly hatched larva has no difficulty in finding its way through the soft segmental membranes at the base of wings, legs and head. The egg is usually placed on the last deposited prey, whereafter the nest (cell) is sealed.

Since males of Sphecidae, like many other Hymenoptera, are haploid, i.e. arise from the unfertilized eggs (haploid arrhenotoky or generative parthenogenesis), the females must be able to control fertilization of the eggs.

In the honey bee this control is made by means of four pairs of small muscles placed near the origin of the spermathecal duct near the receptaculum seminis (Snoddgrass, 1956). The haploidy of the males means that they cannot be bearers of recessive genes, and a consequence of this is that a favourably mutated gene will have a considerable chance to spread in species with generative parthenogenesis (Suomalainen, 1962). Another consequence of haploidy is that the males

cannot receive hereditary characters from their father, since they do not have one! (See also Whiting, 1945).

In species which construct their cells in a row, the innermost cell is first provisioned. In this cell is usually deposited a fertilized egg, which develops into a female. Dependent on the number and volume of the cells, fertilized and non-fertilized eggs are laid so that males develop in the outermost and often smallest cells. The eggs hatch in the course of one to three days and larval development normally takes two to three weeks. A cocoon is then spun and in this the larva hibernates. The pupal stage normally lasts two or three weeks. In the solitary Hymenoptera Aculeata it is very common that the males emerge earlier than the female. This is erroneously named proterandry. This is obviously necessary, since it would be a catastrophy if a newly hatched female from one of the innermost cells began to gnaw her way through the row of still unreared pupae.

Males of Sphecidae play a biologically important, though very brief, rôle, since their primary function is to inseminate the females. This occurs probably only once. Repeated copulation attemps often occur, but once the female is inseminated, she is completely unresponsive to further approaches. The males do not partake either in the hunting of prey or the construction of the nest.

ECOLOGICAL SIGNIFICANCE.

Most species of Sphecidae in the North do not occur in large populations, and even if rather large local aggregations are found, their relative importance in terrestrial ecosystems has never been studied in detail. It should, however, be remembered that Philanthus triangulum is completely dependent on Apis mellifera (the honey bee) as prey, and might act as a rather severe predator on this species, but such cases are rather exceptional. Otherwise it is hard to imagine which biotic factors could affect the populations of the species of Sphecidae to any considerable extent. The relatively non-prey-specific habits may be responsible for the high adaptiveness observed in several species.

It might be claimed that e.g. Cerceris and species of Passaloecus and Pemphredon might have some positive economic importance by preying on harmful species of Curculionidae (Coleoptera) and Aphididae (Homoptera), respectively, but the influence has never been investigated. It is my impression that Cerceris arenaria, when preying on Hylobius or Pissodes and occurring in large aggregations, may have a clear decimating effect on the weevil populations, but that any species of Passaloecus or Pemphredon might be useful in the biological control of noxious aphids is hardly credible, especially in the Nordic countries, where the wasps usually produce a single, short-living generation which most likely is not synchronized to the life cycle of any given aphid species.

The Sphecidae themselves of course are preyed upon, and predators are found even within the family itself (Nysson). It seems that mainly preimaginal stages are affected, and that predators are mainly composed of Hymenoptera and Diptera. The predatory stress is only elucidated in a few instances (Danks, 1971; Lomholdt, 1973). The value of Sphecidae as pollinators is undoubtedly insignificant, but exceptions exist in Argogorytes and Gorytes, but only in areas where the Fly Orchid, Ophrys insectifera, is common. The extreme adaptations found in these species as to "tempt" their pollinators is a reflection of Nature's most astonishing fancy (Kullenberg, 1961).

PREDATORS.

The carnivorous insects from which the Sphecidae suffer in their preimaginal stages, are commonly called parasites. This term should, however, be reserved for organisms which during their ontogenetic development are dependent at the cost of other organisms, without killing these. The insect larvae which can be found in nests of Sphecidae can live either (A) on the available provision, with the result that the "host larva" dies from starvation, or (B) on the whole content of the cell (egg plus provision), or (C) exclusively on the full-grown larva or pupa. These "foreign" insects should be grouped under the term parasitoids or cleptoparasites, of which the first term (Malyshev, 1968) is preferable. The group can be divided into four biological types:

I. Inquilines: The egg is laid on or near the "host egg". It hatches rapidly, and the young larva seeks and devours first the "host egg", then the provision. Gasteruption (Evaniidae) and some Chrysididae belong to this group.

II. Metaparasites: The "host larva" gets time to pass through parts of or the whole larval period, before it is attacked by the predator. Many Chrysididae, Chalcidoidea and Ichneumonidae belong to this group. The intraspecific size variation is often great in these species.

III. Orthoparasites: The predator does not lay its egg in the cell until the "host larva" has pupated. Some Chrysididae and Mutillidae belong to this group.

IV. Cleptoparasites: The larva feed exclusively on the provision. To these belong species of Diptera.

In the Coleoptera only a single predator, Megatoma undata L. (Dermestidae), has been established, the larva normally destroying several cells (Lomholdt, 1973).

The insect predators associated with the Sphecidae and other solitary Hymenoptera Aculeata seem to be host-specific only to a slight extent. However, a pronounced tendency exists in Hymenoptera "Parasitica" to seek Sphecidae nesting in wood, while the predatory Diptera seem to have specialized to a very great extent on terrestrial species. Within the Chrysididae, especially Omalus is a pre-

dominant predator on arboreal species, while Hedychrum and Hedychridium exclusively "parasitize" terrestrial species. In the Diptera the Sarcophagidae is the dominating predator group on Sphecidae nesting in the soil.

As predators should finally be mentioned birds, especially tits (Paridae) and woodpeckers (Picidae), which among other things feed on immature stages of arboreal Sphecidae.

Distribution and zoogeography

The digger wasp fauna in Fennoscandia and Denmark cannot be said to represent a unity. All the species occurring within this about 1.25 mill. sq. km large area are supposed to have their main distribution outside this. It is true that a few species were hitherto described as endemic, but they must be supposed also to occur, for instance, in West Russia, possibly in the Urals or Caucasus. The 171 species which at present can be reckoned to belong to the Nordic fauna have had extremely varied opportunities to colonize this in many respects "inhospitable" territory. If the numbers of species in the northern countries are compared (Table 1), it is clearly seen that areas with a stable, warm and dry climate in the summer months harbour a richer fauna, whereas areas with a rainy and cool summer climate have a numerically much poorer fauna.

The family Sphecidae mainly inhabits tropical and subtropical climates and is especially abundant in arid and semiarid areas. In the deserts and semi-deserts of the Tropics also occur the most "primitive" forms, both in morphological and biological respects. Towards the north the number of species decreases very considerably. In the Mediterranean subregion probably around 400 species occur, and Table 1 shows the rapid decline in the number of species towards the north. It should, however, be pointed out that (1) The relatively high number of species in Sweden and Finland should be correlated with the presence of a more stable continental climate in the summer, which favours immigration of both eastern and southern faunal elements. Several species with an eastern distribution have arboreal nesting habits and are associated with the trans-Siberian coniferous zone - the Taiga. This continues through North America, which makes the existence of Holarctic species possible. Southern and southeastern species often have terrestrial nesting habits but many are associated with the deciduous forest. (2) The number of species in Norway, especially in the western areas, is strikingly low. Here the influence of oceanic climatic conditions must be regarded as a seriously limiting factor. Unstable breeding conditions mean diminished reproduction and thereby reduced chances of survival in these areas.

TABLE 1.

Distribution of number of species in the North and adjacent areas.

Area		Number of species	% of arboreal species
France		292	28
Schleswig-Holstein		136	43
England		114	47
Denmark		123	48
Sweden		148	51
Norway		94	52
Finland		146	47
Karelia		120	43
Faunistic provinces of Fennoscandia and Denmark. See Fig. 13.	1	155	48
	2	153	37
	3	122	50
	4	27	41
	5	47	40
	6	72	50
	7	9	79

COMPOSITION AND DISTRIBUTION OF SPECIES.

An analysis of the fauna composition of the Sphecidae in the North was given by Lomholdt (1974), and here only the main features are mentioned. Fig. 12 shows how the number of species gradually declines towards the north and northwest through Fennoscandia. It is noted that there are large areas with strikingly low numbers of species, but this can probably be partly ascribed to low collecting activity. If distribution maps of several species are compared, faunistic provinces can be prepared (Fig. 13), but an analysis of whether these provinces denote communities (associations) gives the result (Fig. 14) that discontinuity does not exist between the regions. The fauna simply thins out gradually northwards. In describing the distribution of individual species, the provinces may, however, be useful, since they are also characterized on the basis of vegetation and climate.

ARBOREAL FORMS.

As a matter of fact, the family Sphecidae should be regarded as having developed from terrestrial forms, and consequently arboreal nesting habits can be conceived as an advanced feature. This has very often induced modifications in the body parts involved in constructing the nest. Another characteristic trait in the arbore-

al forms is their often comparatively small size and absence of yellow and red colour markings (Merisuo, 1943).

No less than 48% (82 species) of the species in Fennoscandia and Denmark occur also in easternmost Asia (Mongolia, China, Kamtchatka, Sakhalin), and most of these (62 species) are found also in Japan. 56% (46 species) have arboreal habits, and of these 72% (33 species) can be characterized as true Taiga species, either found breeding mainly in conifers and/or using coniferous resin as nest-building material. The majority of these species belong to Siberian fauna elements, and in Fennoscandia they have a pronounced eastern or north-eastern distribution (Fig. 15). Only a few of these species have been found in Denmark. A very considerable part (84%) of the total of 20 species with holarctic distribution are arboreal, but their distribution is often markedly disjunct.

TERRESTRIAL FORMS.

In Fennoscandia and Denmark the terrestrial Sphecidae mainly represent south-

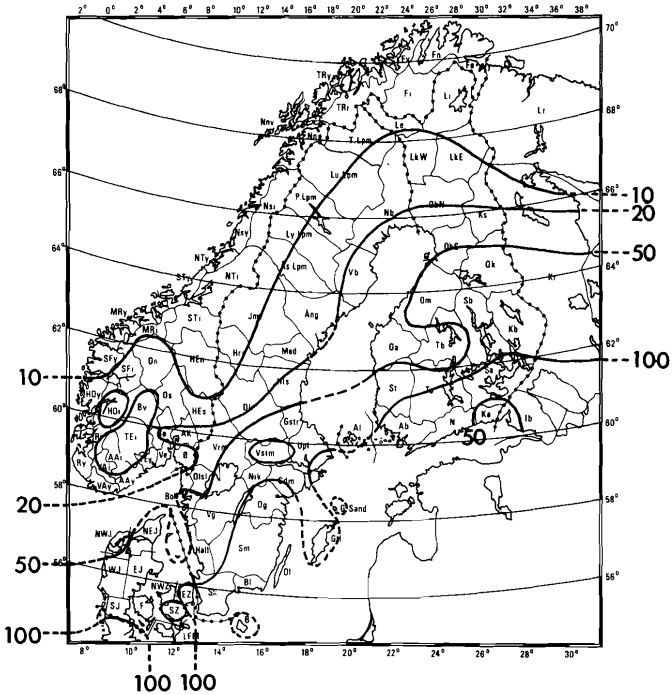


Fig. 12. Isopories for the approximate numbers of sphecid species in Fennoscandia and Denmark. Unexpectedly low numbers of species - probably due to low collecting activity - are found in SZ, B, Vstm., Oa and Tb.

ern fauna elements. On basis of recent works, especially those by Kazenas (1972), Gussakovski (1952) and Tsuneki (1971a, b; 1972a, b) it can be established that several of the terrestrial species are widely distributed throughout the steppe and desert areas of Asia. However, they rarely reach the far east as the arboreal species. The sub-Taigan species have their main occurrence in the area between the distribution-area of the terrestrial and the arboreal species in Asia. To this group belong a large number of species breeding in deciduous trees and hollow plant stems.

The majority of the terrestrial species in Fennoscandia and Denmark have their origin in the Mediterranean region, but a number of them has undoubtedly spread from eastern eremial centres. On basis of the - admittedly rather fragmentary - information on the fauna composition through southern Siberia it is difficult to give a definite statement on the distribution centres of a large number of species. Many arboreal sub-Taigan species have a pronounced disjunct occurrence, partly occurring in Europe, partly in East Asia. In many cases this may be explained by the absence of deciduous forest in large areas of Central Asia.

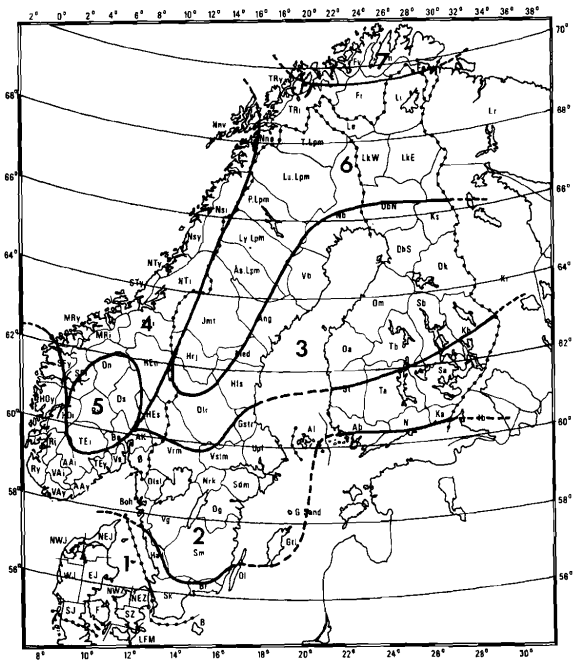


Fig. 13. Faunal provinces in Fennoscandia and Denmark constructed on the basis of the distribution pattern of Sphecidae.

The distribution pattern of the terrestrial sub-Taigan species also is often disjunct in Asia, but this may be ascribable to the often scattered collecting. That the arboreal species, in contrast to the terrestrial sub-Taigan ones, often have developed subspecies in Europe and East Asia respectively may be the expression of effective isolation of the two populations.

EXAMPLES OF DISTRIBUTION TYPES IN FENNOSCANDIA AND DENMARK.

Mediterranean fauna elements represent the main part of the fauna and constitutes 64-81% of the species in fauna provinces 1-6, but only 55% in fauna province 7.

As could be expected, this share is largest in the southern and western provinces and smallest in the northern and eastern. The distribution of the Mediterranean species in the North can be divided into two types, of which one comprises pronounced expansive species, which may occur north of the Gulf of Bothnia (Fig. 16). The other type comprises species which have their northernmost occurrence in Denmark, southernmost Sweden and Finland, and possibly in extreme southeastern Norway (Fig. 17).

The influence of Siberian (eastern) fauna elements is, as said above, mainly found in the boreal coniferous forest in Finland and Central Sweden (Fig. 18). To this type belong also species, whose southern distribution limit runs through Fennoscandia. These northern boreal species often have a disjunct boreo-mon-

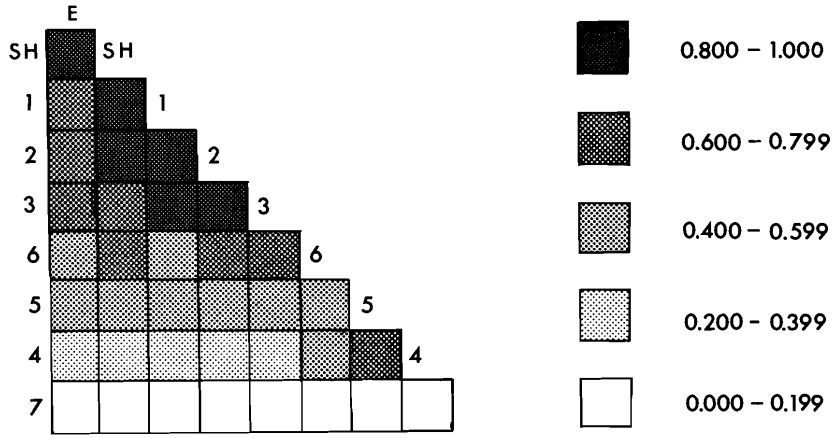


Fig. 14. Using Sørensen's quotient of similarity (QS = 2c/ a+b, where a = no. of species in the larger fauna, b = no. of species in the lesser fauna, and c = no. of common species in a and b), a Trellis diagram is constructed. The seven faunal provinces (Fig. 13) are compared mutually and with adjacent areas. No discontinuities are found, i.e. distinct associations probably do not exist. E=England, SH=Schleswig-Holstein.

tane (-alpine) distribution in Europe. Table 1 also shows that the influence of the arboreal species is relatively great in the provinces 3, 6, and 7.

In the Fennoscandian and Danish faunas - as said above - many species occur, whose distributional patterns may be difficult to explain. Several of these species are rare, and certain of them are only known from very few specimens. Pemphredon fennicus is hitherto only known from the two type-specimens (female + male) from the north boreal coniferous zone in Finland and Sweden. The species is interesting for its pronounced deviation from all palaearctic species of Pemphredon, but it exhibits considerable morphological affinity to the North American P. nearcticus. Of the remaining, apparently endemic species, should be mentioned Belomicrus borealis, Spilomena exspectata, S. curruca and Crossocerus lundbladi. Sphex rufocinctus, Tachysphex fulvitarsis, Crossocerus imitans and Podalonia luffii all have a very isolated occurrence in Fennoscandia and Denmark and might be regarded as postglacial thermophilous relics.

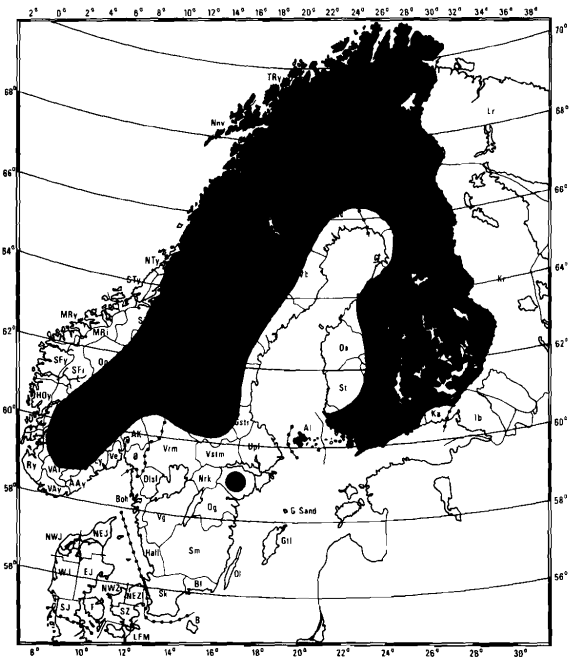


Fig. 15. The distribution of Crabro lapponicus Zett. in Fennoscandia. The species has a boreo-montane disjunct distribution in Europe.

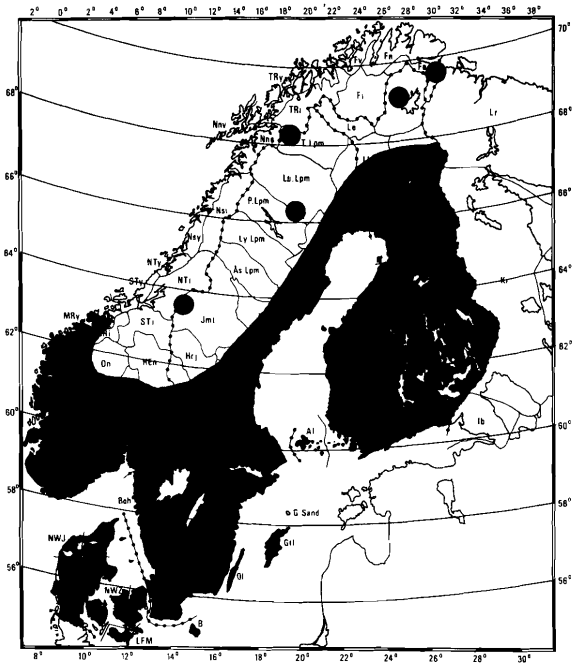


Fig. 16. The distribution of Ectemnius continuus (Fabr.) in Fennoscandia and Denmark. A holarctic species.

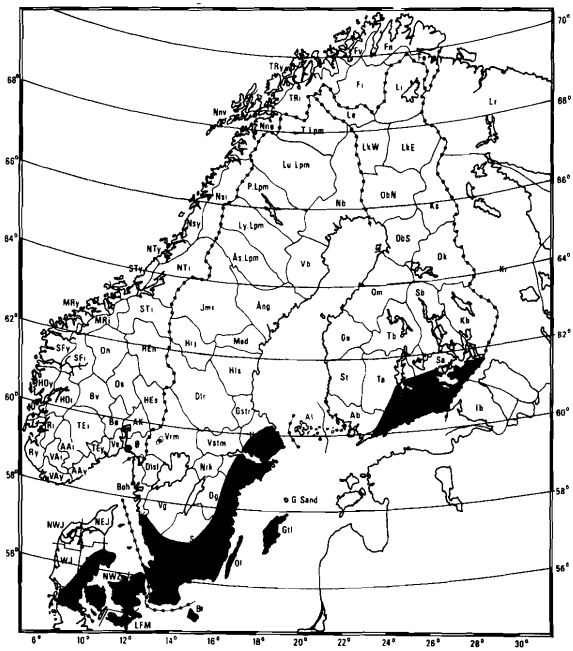


Fig. 17. The distribution of Philanthus triangulum (Fabr.) in Fennoscandia and Denmark. An example of a pronounced southern distribution.

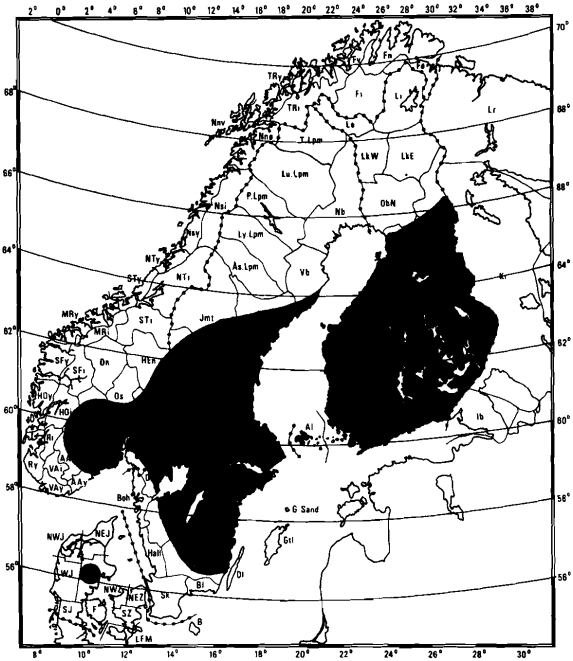


Fig. 18. The distribution of Diodontus medius Dahlb. in Fennoscandia and Denmark. A Siberian (eastern) species.

Phylogeny and evolution

The group Hymenoptera Aculeata forms part of the Hymenopteran suborder Apocrita. In the aculeate Hymenoptera the ovipositor is modified into a sting, having thereby lost its function in connection with oviposition. The aculeate superfamilies are as follows: Scolioidea, Bethyloidea, Formicoidea, Vespoidea, Pompiloidea and Sphecoidea.

Oeser (1961) mentions the following synapomorphic characters of the ovipositor of the Aculeata:

1. The presence of an incisura postarticularis (a deep incision proximally on 2nd valvifer). This is secondarily reduced in the Chrysididae (Bethyloidea).

2. The presence of a "furcula", a small V- or Y-shaped sclerite, situated dorsal to the 2nd valvulae. This is also called "detached notum" (Smith in Tuxen, 1970).

On this basis the Hymenoptera Aculeata should be regarded as a monophyletic unit. This view is also supported by Malyshev (1968), who discussed the phylogeny on the background of biological criteria, and Alten (1910), who elucidated phylogeny on the basis of the development of the central nervous system. Telen-

ga (1969) discussed the evolution of the Hymenoptera Aculeata on characters in the venation, thereby arriving at a diphyletic origin of the group. The Chrysididae are thus supposed to be derived from an evanioid ancestor, while the other Aculeata are proposed to have an ichneumonoid ancestor. This view is, however, not considered sufficiently founded to be accepted.

The Sphecoidea is here considered to include the Sphecidae and the Apidae (s. lat.) (Michener, 1944). The Apidae (s.lat.) represents a highly specialized subgroup and their close relationship with the Sphecidae would be considerably obscured, if the bees were placed in a separate superfamily. On p. 36 the most important diagnostic characters separating the Sphecidae and Apidae (s.lat.) are listed. It appears that these characters occur in their plesiomorphic state in the Sphecidae. The apomorphic conditions found in the Apidae (s.lat.) are often associated with the collecting of pollen and nectar. Virtually, all the 36 characters by Michener (l.c.) stated as primitive in the Apidae (s.lat.) are found in the same condition in the least specialized Sphecidae. Convergently evolved reductions occur in both groups, e.g. with regard to number of segments in the maxillary and labial palps, the number of cubital and discoidal cells in the forewing, the morphology of the volsella and the loss of the proximal tooth on the claws.

The family Sphecidae is here considered as comprising the following subfamilies: Ampulicinae, Sphecinae, Pemphredoninae, Astatinae, Philanthinae, Nyssoninae, Mellininae, and Larrinae.

The Ampulicinae and Sphecinae should be regarded as comprising the least specialized Sphecidae, not only as regards the morphology of the larvae (Evans, 1956, 1959a, 1959b) and the imagines, but also with regard to the ethology of the breeding biology (Table 2). In the least specialized subfamilies, i.e. the two previously mentioned, plus some Pemphredoninae, the volsellae carry a very well developed cuspis and digitus, and are usually large, isolated sclerites, which, however, may be mutually connected by a ventral sclerotized bridge (Snodgrass, 1941). The cuspis is often smaller than the digitus and may be absent, especially in very small species, or may be much reduced.

Within the more specialized Sphecidae there is a pronounced tendency to develop very large eyes. Concomitantly a differentiation of the size of the ommatida takes place so that those directed forwards become many times larger than those of the dorsal part of the compound eye. This phenomenon is especially pronounced in the Crabronini (Larrinae), and is probably related to the extra visual powers required to hunt fast-moving Diptera.

The evolution of the brood care within the Sphecidae can be divided into several phases as appears in the following scheme (slightly modified after Malyshev (1968)):

Evolutionary phases	Formula of brood care	Examples
I. Pompiloid phase	n (A+B+C+D+E)	Podaloria, Sphex
II. Sphecoid phase	n (B+A+C+D+E)	Dolichurus, A. sabulosa
III. Crabronoid phase	B+(AC) n+D+E	A. pubescens
IV. Bembicoid phase	B+AC+D+((AC) n) t+E	Philanthus, Bembix
V. Moneduloid phase	B+D+((AC)n)+E	Monedula (non-European)

A: hunting; B: construction of nest; C: transportation of prey; D: oviposition; E: closing of nest; n: number of prey; t: number of days for provisioning after oviposition.

It seems evident that there must be, and still exist, selective pressure towards development of forms which excavate the nest before hunting. This is obvious, because there is considerable risk that the paralyzed prey may be robbed by other predators during excavation of the nest. It is also characteristic that the species in groups I and II provision their nests with only a single or very few prey animals. These are so large that they cannot be flown, but must be dragged or carried the often long way to the nest. On the way the risk of attack is naturally greater than if they were transported by air (Table 2).

The delimitation and definition of the subfamilies Ampulicinae, Sphecinae, Pemphredoninae, Philanthinae and Mellininae is not difficult. Within the Larrinae the diversity of external morphology of the imagines is overwhelming compared with conditions within the other larger subfamilies, but a synapomorphism in this group, very specialized in several respects, is difficult to find. The presence of an oblique, sharp and very well defined crista on coxa 2 might be interpreted in this way. In several genera a remarkable character is developed in the mandibles, viz., a broad, often semi-circular emargination in the ventral margin, proximally delimited by a tooth of varying size. The presence of this character does not, however, seem to be restricted to the Larrinae, since similar structures are often found in males of Astata (Astatinae), although not nearly as distinct. In the Philanthinae, Mellininae and several Nyssoninae there is a broad concavity on the ventral margin of the mandibles, and it is questionable, therefore, whether this character should be regarded as synapomorphic of these groups. The species which excavate their tunnel systems in wood often have very broad and highly modified mandibles, often ending in a number of short, strong teeth (Pemphredon (Pemphredoninae) and Ectemnius (Larrinae)). In these the proximal concavity is absent. The Astatinae might perhaps be included as an inferior subgroup of the Larrinae, but the absence of the crista on coxa 2 is evidence to the contrary.

The loss of one spur on tibia 2 has taken place independently at least twice (in the Pemphredoninae and the Larrinae).

TABLE 2. Evolutionary trends in hunting and transporting prey in Sphecidae. (Partly after Evans, 1963).

Initial conditions as found in Ampulicinae and Sphecinae.	Derived conditions	Examples
Relatively prey-specific	Highly prey-specific	Philanthus
	Non-prey-specific	Crossocerus
Prey larger than wasp	Prey smaller than wasp	Most sphecid genera
Prey caught close to nest	Prey caught in highly varying distance from nest	Most sphecid genera
Prey dragged on the ground held with mandibles	Prey flown to nest held with mandibles	Pemphredoninae
	Prey flown to nest held with mid legs	Most Nyssoninae
	Prey flown to nest impaled on sting	Oxybelus

The presence of a sometimes very strongly V- or U-shaped incision in the inner orbits of the Trypoxylonini (Larrinae) and Philanthus (Philanthinae) should not be overestimated, since this character was probably evolved convergently within the two subfamilies. The significance of this incision remains problematic. In Philanthus and certain species of Trypoxylon the ommatids ventral to the incision are considerably larger than those dorsal to it. But as mentioned above, a strong differentiation of the size of the ommatids is seen, especially in the Crabronini, where there is no incision in the orbita.

Maintenance of the Nyssoninae as a monophyletic group is problematic, since the characters used in the definition seem to occur in their plesiomorphic condition (Beaumont, 1954).

The variation in venation, especially in the forewings, is very considerable and cannot be used in a classification at subfamily level (Kohl, 1896; Arnold, 1923). Primarily three cubital cells and two discoidal cells seem to be present, but particularly in small species, a considerable reduction of their number has taken place. Especially in the Astatinae and Mellininae a secondarily evolved division of the first cubital cell by a very faint vein has occurred.

RELATIVE AGE OF THE SPHECIDAE

It is probable that the phyletic line giving rise to the Sphecidae also lead to the Apidae (s.lat.) (Evans, 1958). The problem remains, whether a sister-group

relationship exists between the two entities or whether the family Sphecidae is to be regarded paraphyletic in terms of the Apidae (s.lat.). The origin of the Apidae (s.lat.) is probably correlated with the appearence of the Angiospermae, which apparently took place in Upper Cretaceous; the question remains open, however, whether the Bennettitales, which became extinct at the end of the Lower Cretaceous, had developed flowers which were pollinated by insects (Gothan and Weyland, 1964).

It was pointed out by Malyshev (1968) that striking similarities exist both in the construction of the nest and in the egg-laying behaviour between the primitive apid genera Prosopis and Colletes (Colletidae sensu Michener) and Psenulus (Pemphredoninae). In these genera the inside of the cells are lined with a pellicula, a parchment-like coating secreted as a fluid from the mandibular glands. The egg is placed directly on the collected provision. The ability to produce a pellicula may well be evolved convergently, but the placing of the egg must be interpreted as a symplesiomorphism. Nesting behaviour in most solitary bees is very similar to that of the Sphecidae, and it seems most convincing to accept that the bees were primarily soil-nesting insects.

Turning to the fossil record the following sphecid fossils have been described: Archisphex Evans, 1969 and Taimyrisphex Evans, 1973 from Neocomian, Lower Cretaceous and Conician-Santonian, Upper Cretaceous, respectively, do not contribute to the understanding of the phyletics since they seem to be too generalized to be classified as true Sphecidae. They might even be interpreted as scolioid or pompiloid wasps (Evans, 1973). Lisponema Evans, 1973 and Pittoecus Evans, 1973 both occur in the same geological formation as Taimyrisphex but are characterized as rather specialized Pemphredoninae. Judging from Lisponema and Pittoecus which are supposed to be wood-nesting, the Sphecidae underwent considerable evolution before the end of the Cretaceous, and perhaps the origin of the Sphecidae should be traced backwards to the Jurassic.

LIST OF DIAGNOSTIC CHARACTERS SEPARATING SPHECIDAE AND APIDAE (s.lat.)

	Sphecidae	Apidae (s.lat.)
Imagines	Body slightly hairy.	Body usually very hairy.
	Hairs simple.	Hairs, at least on humeral tubercle, plumose.
	Metatarsus 3 cylindrical.	Metatarsus 3 compressed.
	Metatarsus 1 in female often provided with a tarsal pecten.	Metatarsus 1 in female simple, without tarsal pecten.

	Labrum thin, often disc-shaped, without sculpture or pubescence.	Labrum thick, heavily sclerotised, often with strong sculpture and pubescence.
	Clypeus with anterior duplicature that covers labral articulation.	Clypeus without duplicature, labral articulation visible.
	Females collect animal provision.	Females collect vegetable food for the progeny.
Larvae	Mandibles smooth distally on the inner side. Margins usually strongly dentate.	Mandibles distally on the inner side usually with numerous small teeth. Margins with or without very small teeth.
	Salivary duct distally paired (except Ampulicinae and Sphecinae).	Salivary ducts fused distally.
	Maxillae with galea and palpus.	Maxillae without galea.

Immature stages

Ontogenesis in the Sphecidae does not differ from the general pattern in Hymenoptera Aculeata.

The egg is of the "hymenopteriform" type (Clausen, 1940), i.e. elongate, sausage-shaped, slightly curved. The larvae are of the "grub-like" type, i.e. practically unpigmented, blind and without limbs. They are adapted to a very protected life, usually in total darkness in cells. The period of larval development is short, lasting at most three weeks. Normally, the adult larva spins a complete cocoon, into whose surface material from the surroundings (food remains, sand grains, saw-dust and the like) is often incorporated. Especially within the Pemphredoninae the cocoon is very reduced, often to a thin wall just behind the partition between it and the next cell in front. At this stage probably all North European species hibernate. The prepupa (the pharate pupa) is "intermediate" between larva and pupa in many characters. Thus the developing rudiments of antennae, wings and legs are seen rather distinctly through the cuticula of the larva. After a moult the pupa appears: it is of the exarate type (free pupa). In many species within the Crabronini and Trypoxylon (Larrinae) the pupa, laterally on the abdomen, is provided with stout spine- or tooth-like processes (Fig. 19). In Pemphredon and closely related genera a curved, spine-like process is found above the lateral ocelli. The pupal stage normally lasts about 14 days, whereupon the imago emerges.

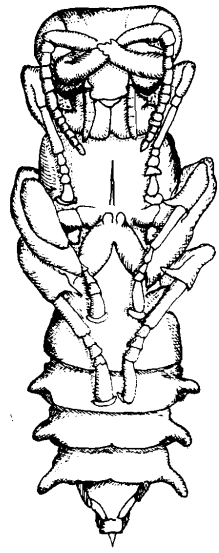


Fig. 19. Pupa of Ectemnius cavifrons (Thomson), ♂, in ventral view.

The study of the morphology and taxonomy of Sphecid-larvae is not at all an easy task, and only relatively few scientists have succeeded in developing and mastering an adequate technique. In this connection primarily Grandi (1961) and Evans, 1956-64) should be mentioned. I believe the most intricate work of describing sphecid larvae in detail at specific level is far beyond the scope of the present publication, and I have therefore chosen to present only an introductory description followed by a key to subfamilies and genera. Where descriptions of species exist, references are given throughout the text.

THE MATURE LARVA.

The head capsule is strongly sclerotized, but only slightly pigmented. In front view the head is usually almost circular (Fig. 20). Many species have a pair of obliquely running bands (parietal bands) anteriorly on the head. These are usually more strongly pigmented. The antennae are very short, one-segmented with three small sensillae distally, or the antennal papilla may be absent so that the three sensillae arise directly from the antennal orbits. The epistomal suture between the lower part of frons and clypeus may be absent. The labrum is very well developed, very mobile in relation to the clypeus, often slightly bi-lobed, and may be provided with a weak longitudinal furrow (Fig. 21). The labrum is richly provided with setae and sensillae, which often are of great systematic value. The ventral part of the labrum (epipharynx) is usually spinulose, and along the anterior border normally provided with a row of sensillae. The mandibles

are very strongly sclerotized and usually strongly pigmented. They are pronounced biting tools and have teeth on the inner side. The morphology of the mandibles shows good systematic characters. The maxillae are large and muscular, slightly sclerotized with two papillae distally. The lateral papilla (maxillary palp) is normally the largest, distally carying 3-4 sensillae (Fig. 21). The median papilla (galea) is distally provided with 2 sensillae (Fig. 22). The main part of the maxillae is composed of the stipes, which is without pronounced morphological characters. The medial part, "lacinial area" (Fig. 22), is strongly differentiated morphologically by the rough, often strongly spinulose surface. The labium consists of the very large postmentum and the smaller prementum. The latter carries the one-segmented labial palps, whose morphology is very similar to that of the maxillary palps. They often bear three sensillae distally (Fig. 22). Medially openings (the spinneret) for the silk-producing salivary glands are found. These terminate either in an unpaired, narrow "slit" or paired on more or less prolonged tubes (Figs. 20, 22).

The body shape is more or less cylindrical, usually slightly C-shaped curved, or more or less depressed, with convex sides. The thorax is without limbs. The abdomen consists of ten segments, of which the last may be slightly modified into a sub- and supra-anal lobe (Philanthinae). Laterally a row of well developed pleural lobes are found. The tracheal system is holopneustic with two pairs of

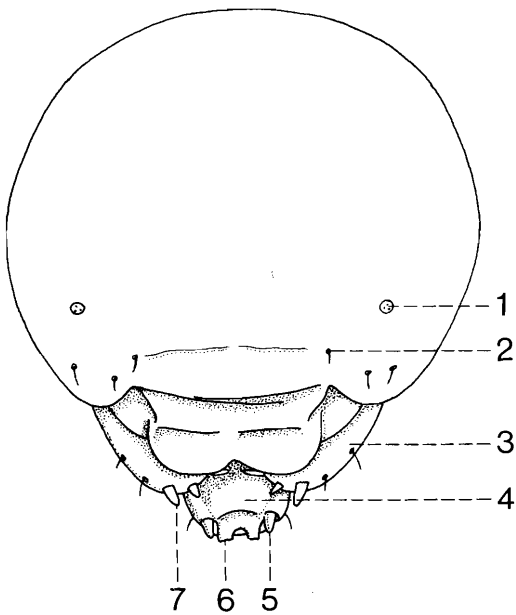


Fig. 20. Head of larva of Passaloecus eremita Kohl in frontal view. - 1: antenna; 2: anterior tentorial pit; 3: maxilla; 4: labium; 5: labial palpus; 6: spinneret; 7: maxillary palpus. Drawn after scanning electron micrograph.

thoracic and eight pairs of abdominal spiracles. The spiracle-bearing sclerite, peritremen, is more strongly sclerotized and more strongly pigmented than the remaining integument. The distal part of the tracheae is enlarged to two chambers, first a subatrium, and distally a jar-shaped atrium, whose walls are thick and strongly sclerotized. On the transition between these a ring of stout spines (collar spines) is usually found. The structure of the wall of the atrium provides good characters, of use in taxonomy.

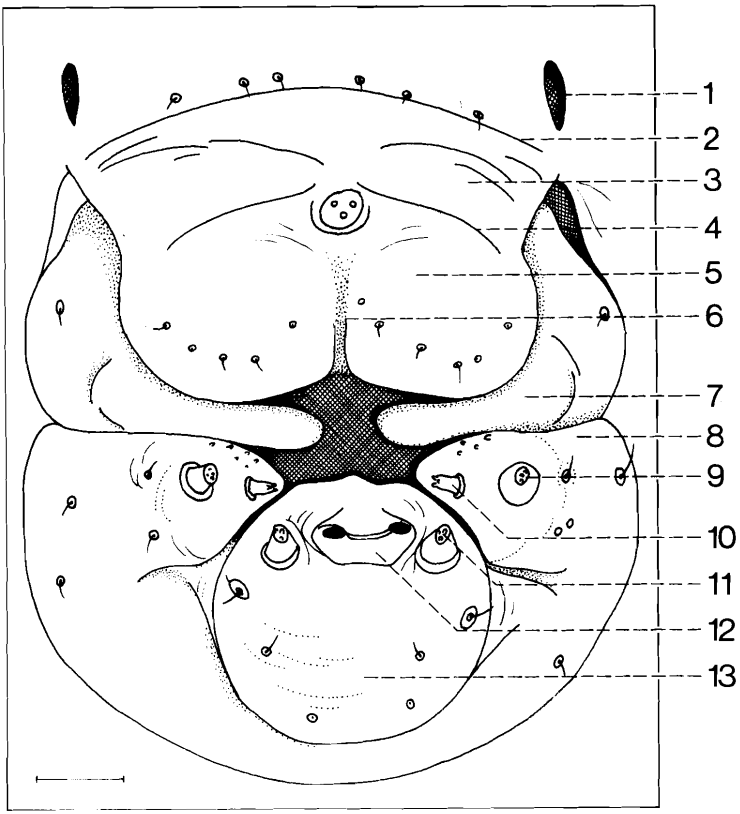


Fig. 21. Mouthparts of larva of Passaloecus eremita Kohl. - 1: anterior tentorial pit; 2: epistomal suture; 3: clypeus; 4: clypeo-labral suture; 5: labrum; 6: median labral line; 7: mandible; 8: maxilla; 9: maxillary palpus; 10: galea; 11: labial palpus; 12: spinneret; 13: labium. Drawn after scanning electron micrograph. Scale: 0.1 mm.

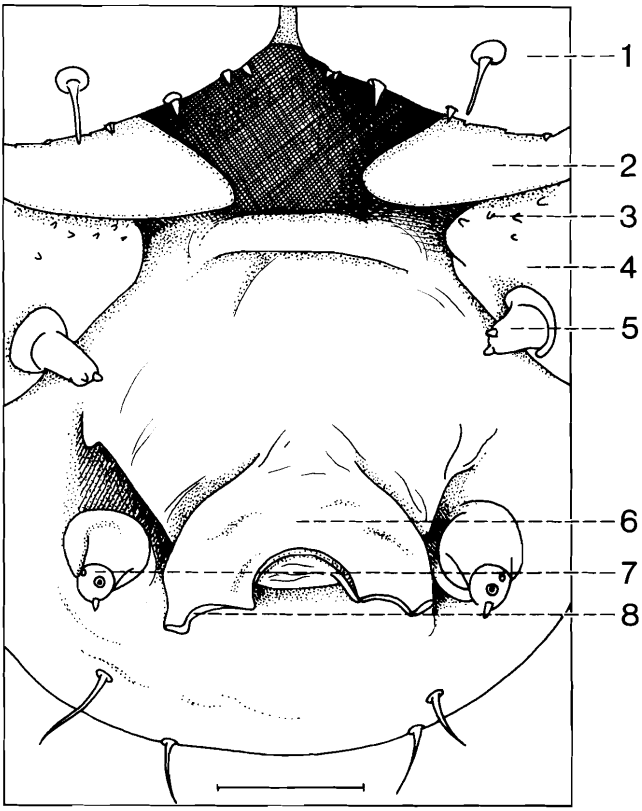


Fig. 22. Mouthparts of larva of Passaloecus eremita Kohl, enlarged. - 1: labrum; 2: mandible; 3: lacinial area (spinulose); 4: maxilla; 5: galea; 6: spinneret; 7: three sensillae of labial palpus; 8: salivary opening. Drawn after scanning electron micrograph. Scale: 0.1 mm.

Key to genera of Sphecidae, larvae

(The larvae of Dinetus, Didineis, Argogorytes, Dienoplus, and Lestica are unknown).

1 Apex of labium very broad, the spinneret a long, transverse slit (Fig. 23), with prominent raised lips 2

- Apex of labium more narrow, the spinneret paired, each opening at the end of a process of varying length (Fig. 24). Galea usually much shorter than maxillary palpi (absent in Spilomena) 5

2(1) Lips of the spinneret much more prominent laterally than medially. Labial palpus very short. Antennae with five sensillae ..... Dolichurus Latreille

- Lips of spinneret not more prominent laterally than medially. Labial palpus about as long as the maxillary palpus. Antennae with three sensillae 3

3(2) Mandibles stout and heavy, less than twice as long as their maximal width, without spinules on their upper surfaces ..... Sphex Linné

- Mandibles slender, more than twice as long as their maximal width, bearing minute spinules on their upper surfaces 4

4(3) Basal tooth of mandibles represented by a row of about seven minute denticles. (This character was used by Evans (1959) to separate the two following genera. However, small denticles are not present in P. affinis, Fig. 25) ..... Podalonia Spinola

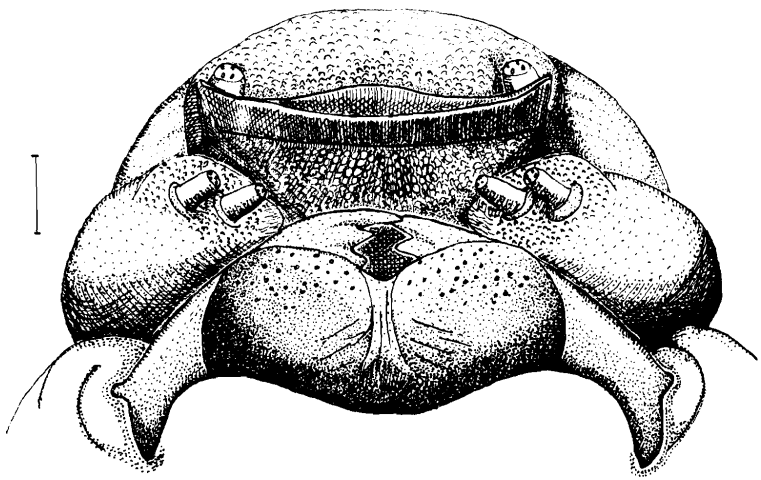


Fig. 23. Spinneret and other mouthparts of larva of Podalonia affinis (Kirby). Drawn after scanning electron micrograph. Scale: 0.1 mm.

- Basal tooth of mandibles simple or subdivided, but always protuding as a distinct tooth (Fig. 26) .... Ammophila Kirby

5(1) Anus directed caudally and situated at the apex of the abdomen or very nearly so (slightly preapical in Psenini, Pemphredoninae). Antennal papillae present (Fig. 27) (absent in most Pemphredonini) 6

- Anus directed ventrally and situated well before the apex of the abdomen, the anal segment forming a rounded or conical lobe beyond the anus. Antennal papillae absent, the sensillae arising directly from the membrane of the orbits (Fig. 28) 22

6(5) Maxillae with the apex directed somewhat mesally and closely associated with the labium and hypopharynx (Fig. 29). Epipharynx often spinulose laterally, but the spinules not or rarely reaching the midline 7

- Maxillae projecting apically as lobes which are free from the labium and hypopharynx (Fig. 30). Epipharynx spinulose (rarely papillose) over much of its

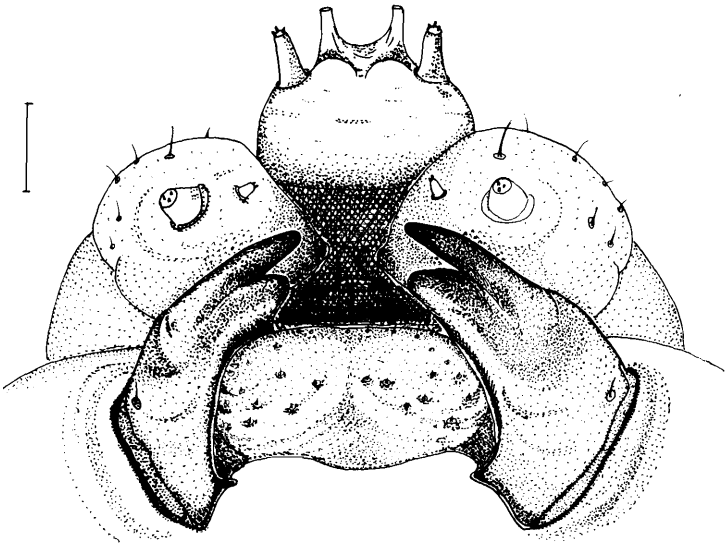


Fig. 24. Spinneret and other mouthparts of larva of Psenulus concolor (Dahlbom). Drawn after scanning electron micrograph. Scale: 0.1 mm.

surface. Antennal papillae always present. Soil-nesting. Cocoon present 17

7(6) Mandibles with a weakly pigmented area laterally near the base, this area bearing a considerable number of setae. Fourth abdominal segment humped dorsally. Parietal bands strong. Epipharynx strongly spinulose laterally. Soil-nesting. Cocoon present. (Astatinae) ..... Astata Latreille

- Mandibles with a single seta laterally near the base. Fourth abdominal segment not more humped than any other. Parietal bands absent or very weak. Epipharynx rather weakly spinulose antero-laterally (Pemphredoninae) 8

8(7) Antennal papillae absent, the sensory cones arising directly from the membrane of the orbit (Fig. 28) .. 9

- Antennal papillae present, usually long and stout, bearing the sensory cones distally (Fig. 27) 13

9(8) Integument spinulose at least antero-dorsally. Apical margin of labrum usually with a pigmented band. Wood-nesting 10

- Integument entirely naked. Apical margin og labrum usually not pigmented 12

10(9) Integument rather evenly spinulose anteriorly, including the thoracic dorsum. Cocoon absent. Cell-partitions entirely or partly made of resin .....Passaloecus Shuckard

- Integument spinulose only on parts of the sides and venter. Cell-partitions made of wood-dust 11

11(10) Mandibles short and stout, only slightly longer than maximal width basally, six-dentate, broadly convex internally, the apical tooth very large, projecting far beyond the marginal teeth. Cocoon present. ..... Ceratophorus Shuckard

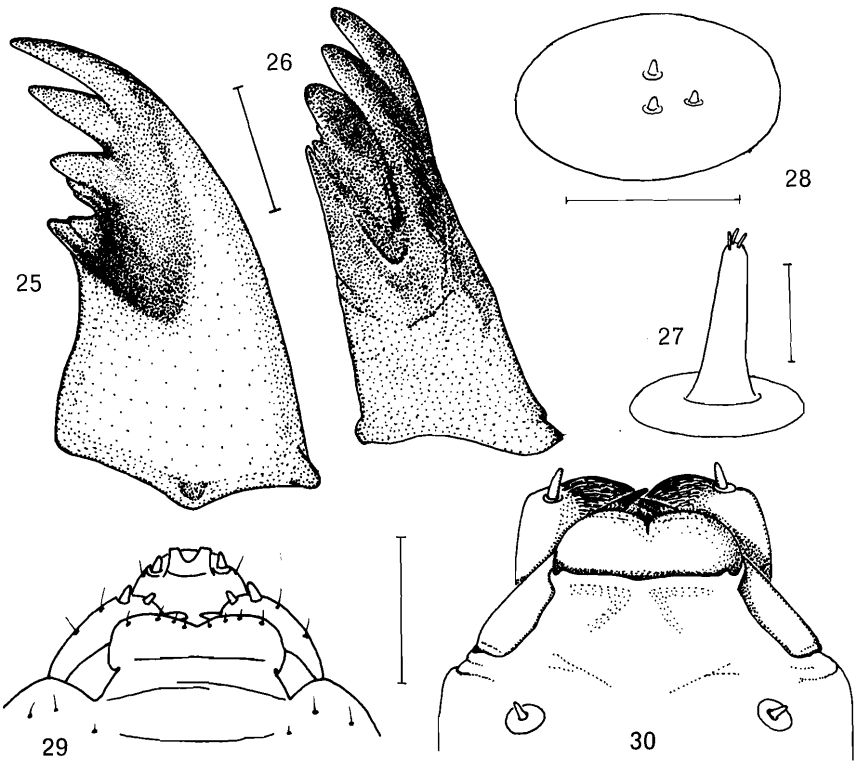
- Mandibles less heavily built, much longer than wide, never with more than five teeth. Cocoon absent in Nordic Species ..... Pemphredon Latreille

12(9) Body somewhat fusiform. Maxillae slightly roughened by small papillae or spinules. Soil-nesting. Cocoon present ..... Diodontus Curtis

- Body more cylindrical. Maxillae smooth. Wood-nesting. Cocoon absent ..... Stigmus Panzer

13(8) Head broader than high. Mandibles broad and short, terminating in four teeth which surround a strong concavity (Fig. 31). Spinnerets truncate apically (Fig. 32). Integument with sparse spinules. Wood-nesting. Cocoon absent ..... Psenulus Kohl

- Head as high as or higher than broad. Mandibles slender, the three or four apical teeth all in about the same plane. Spinnerets acute apically. Cocoon present 14



Figs. 25-26. Larval mandibles of 25: Podalonia affinis (Kirby); 26: Ammophila pubescens Curtis. Scale: 0.1 mm.
Figs. 27-28. Larval antennae of 27: Psenulus concolor (Dahlbom); 28: Passaloecus eremita Kohl. Scale: 0.04 mm.
Figs. 29-30. Maxillae and other mouthparts of larva of 29: Passaloecus eremita Kohl; 30: Cerceris rybyensis (L.). Scale: 0.4 mm.

14(13) Very small species, maximal length about 3 mm. Head entirely naked. Only distal tip of mandibles pigmented. Galea absent (Fig. 33). Wood-nesting. Cocoon present ..... Spilomena Shuckard

\- Species of normal size. Head with a few rather large setae. Larger part of the mandibles pigmented. Galea present as distinct papillae 15

15(14) Apical margin of labrum with a series of convexities, each bearing a small sensillum. Spinnerets long and spinelike. Soil-nesting ..... Psen Latreille

\- Apical margin of labrum with a row of very small nipple-like sensillae. Spinnerets shorter, slightly more exceeding than palpi 16

16(15) The penultimate tooth of the mandibles is replaced by a concavity. Soil-nesting ..... Mimesa Shuckard

\- Mandibles with two weak teeth on the inner margin. Wood-nesting ..... Mimumesa Malloch

17(6) Integument smooth or very inconspicuously spinulose. Opening between the atria and subatria of spiracles armed with a circlet of spines (except in Alysson) (Fig. 34). Last abdominal segment simple. Galea fairly strong, at least half as long as the palpi. (Nyssoninae) 18

\- Integument clothed nearly allover with densely set, small spinules. Opening between atria and subatria simple, unarmed. Posterior end of body modified for locomotion, either the supra-anal or sub-anal lobe protuberant, or the two lobes together forming a tubular process (Fig. 35). Galea much smaller than the maxillary palpi and may be hardly visible in certain species. (Philanthinae) 21

18(17) Frons with from one to six dark-tipped, nipple-like processes. Labrum with only minute setae, if any 19

\- Frons without dark-tipped, nipple-like processes. Labrum with strong setae 20

19(18) Frons with six nipple-like processes. Antennal papillae unusually long ..... Alysson melleus Say (No European species described. A. melleus is

a North American species, keyed by Evans & Cheng Shan Lin, 1956).

- Frons with one or three nipple-like processes. Antennal papillae short ..... Nysson Latreille

20(18) Sides of apical margin of labrum with at most a few weak, barely protuding spines. Lacinial area papillose ..... Gorytes Latreille

- Sides of the apical margin of labrum and the lacinial area roughly spinose (Fig. 36) ..... Bembix Fabricius

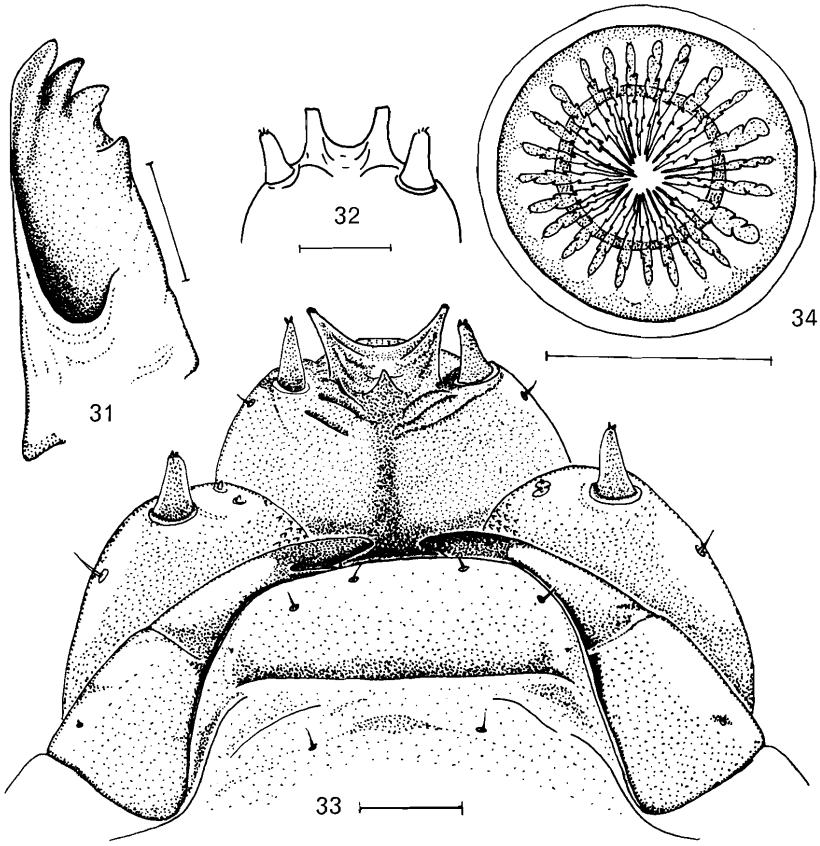


Fig.31. Larval mandible of Psenulus concolor (Dahlbom). Scale: 0.1 mm.
Fig.32. Spinneret of larva of Psenulus concolor (Dahlbom). Scale: 0.1 mm.
Fig.33. Larval mouthparts of Spilomena enslini Blüthgen. Scale: 0.04 mm.
Fig.34. Larval spiracle of Bembix littoralis Handlirsch. Scale: 0.1 mm.

21(17) Mandibles tridentate. Epipharynx with spinules over most of its surface ..... Philanthus Fabricius

\- Mandibles bidentate. Epipharynx with a considerable area medio-basally which is devoid of spinules or papillae..... Cerceris Latreille

22(5) Body with pleural lobes and a series of dorsolateral prominences conically produced, dark-tipped, and armed with numerous short, stout spinules (Fig. 37, 38). Mandibles without setae, on the inner margin with a strong concavity beyond which there are teeth connected by a blade-like portion. Oral surface of labium not spinulose. Soil-nesting. Cocoon present. (Mellininae) .... Mellinus Fabricius

\- Body without pleural lobes or dark-tipped, armed prominences. Mandibles with one (rarely two) setae laterally near the base, and otherwise not as above. Oral surface of prementum of labium at least partly spinulose. Cocoon present. (Larrinae) 23

23(22) Inner margin of maxilla with a large angular lobe arising from near the base (Fig. 39). Labrum with the inner margin mostly bristly, but with several strong setae set in the margin near the midline. Mandibles stout, terminating in four or five teeth which surround a strong concavity. Wood-nesting. ..... Trypoxylon Latreille

\- Inner margin of maxillae without angular lobe basally. Margin of labrum slightly to strongly bristly 24

24(23) Inner margin of maxilla with a weak to fairly strong apical or subapical prominence which is clothed with spinules or papillae. Pleural lobes of thorax often conically protuberant. Opening between atria and sub-atria of spiracles sometimes armed with a circlet of spines (Fig. 34) 25

\- Inner margin of maxilla simple, smoothly rounded, spinulose. Pleural lobes of thorax rounded (in diapausing larvae all the pleural lobes may be somewhat conical). Opening between atria and sub-atria always simple 27

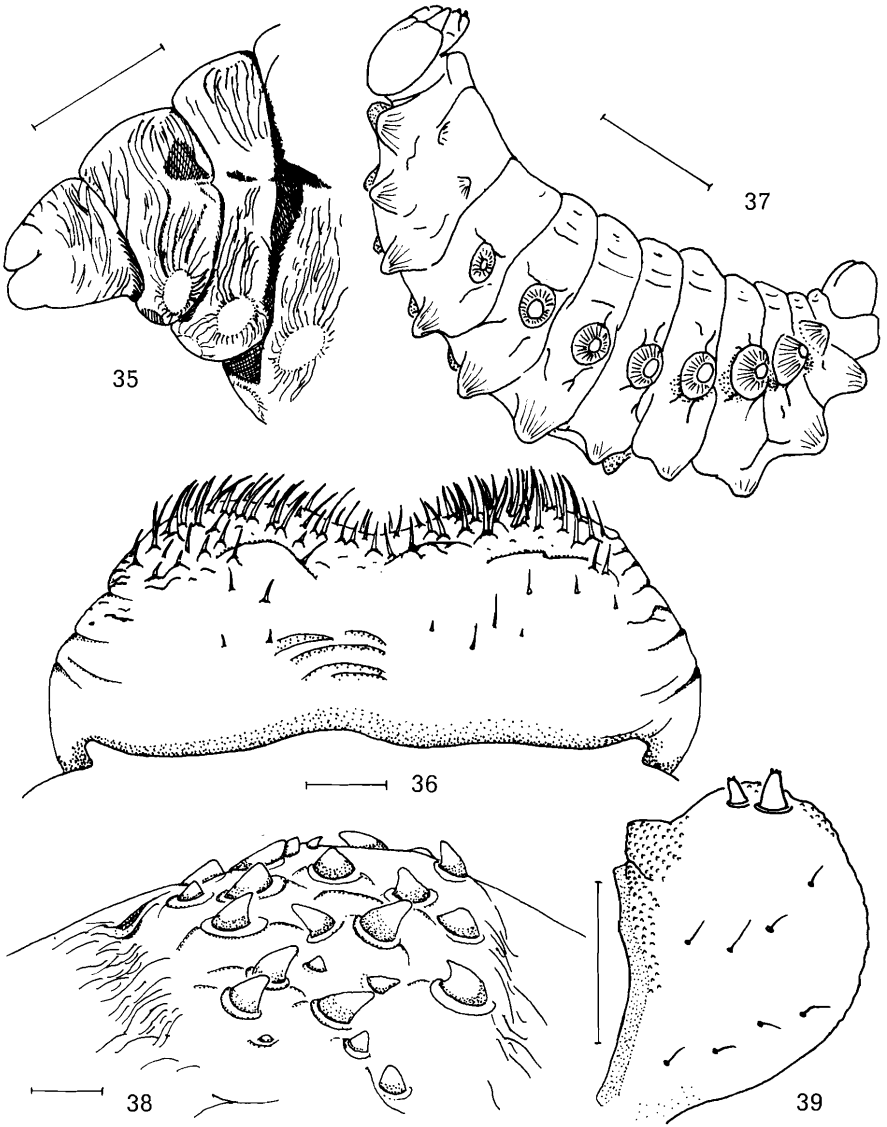


Fig.35. Posterior part of abdomen of larva of Cerceris rybyensis (L.) in lateral view. Scale: 1 mm.
Fig.36. Larval labrum of Bembix littoralis Handlirsch. Scale: 0.1 mm.
Fig.37. Larva of Mellinus arvensis (L.) in lateral view. Scale: 1 mm.
Fig.38. Spinules of thoracic prominences of larva of Mellinus arvensis (L.). Scale: 0.02 mm.
Fig.39. Larval maxilla of Trypoxylon figulus (L.). Scale: 0.02 mm.

25(24) Inner margin of maxilla prolonged into a sharp point. Soil-nesting ..... Miscophus Jurine

- Inner margin of maxilla not prolonged as above 26

26(25) The salivary openings at the end of very short processes. Antenna without sensory cones. Inner margin of maxilla with at most some elongate papillae. Wood-nesting ..... Nitela Latreille

- Each salivary opening at the end of a long process. Antenna with three sensory cones distally. Inner margin of maxilla densely spinulose. Soil-nesting .... Tachysphex Kohl

27(24) Mandibles slender, with three or four teeth in about the same plane, or the apical two one above the other, never with a distinct ventral, apical concavity 28

- Mandible stouter, usually with five, sometimes with only four teeth and a distinct ventral, apical excavation (Fig. 40) 31

28(27) Galea very short, not more than one third the length of the maxillary palpus. Soil-nesting Lindenius Lepeletier & Brullé

- Galea at least nearly half as long as the maxillary palpus 29

29(28) Oral surface of prementum of labium with a very dense covering of very short spinules. Soil-nesting. Entomognathus Dahlbom

- Oral surface of prementum with fewer and longer spinules 30

30(29) Apical two teeth of mandibles juxtaposed in such a way that the mandibles are strongly bifid in lateral view (Fig. 41). Soil-nesting species in the subgenera Hoplocrabro, Crossocerus, and Acanthocrabro ..... Crossocerus Lepeletier & Brullé

- Mandibles not bifid, all teeth almost in the same plane (Fig. 42). Wood-nesting ..... Rhopalum Stephens

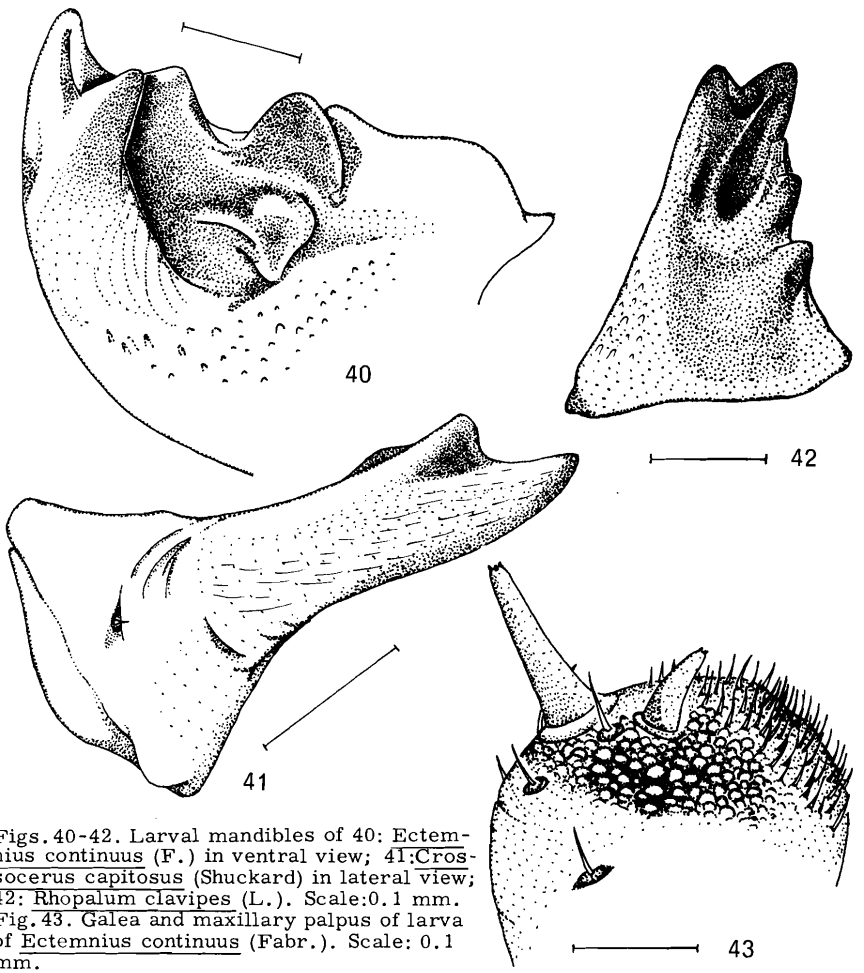
31(27) Epipharynx with a large area medio-apically which is devoid of spinules, either bare or papillose. Soil-nesting ..... Oxybelus Latreille

- Epipharynx spinulose medio-apically 32

32(31) Mandibular teeth strong; the ventral excavation also strong (Fig. 40). Galea about two-thirds as long

as the maxillary palpus (Fig. 43). Wood-nesting. Ectemnius Dahlbom

- Mandibular teeth slightly less prominent, the fifth (ventral, basal) tooth especially weak; the ventral excavation somewhat weaker than above. Galea slightly more than half as long as the maxillary palpus. Soil-nesting ..... Crabro Fabricius



Figs. 40-42. Larval mandibles of 40: Ectemnius continuus (F.) in ventral view; 41: Crossocerus capitosus (Shuckard) in lateral view; 42: Rhopalum clavipes (L.). Scale: 0.1 mm. Fig. 43. Galea and maxillary palpus of larva of Ectemnius continuus (Fabr.). Scale: 0.1 mm.

Key to genera of Sphecidae, adults

1 Forewings with one cubital cell (Figs. 55, 56) 2
- Forewings with 2 - 3 cubital cells 15

2(1) Inner orbits with a deep U-shaped emargination (Fig. 59) ..... Trypoxylon Latreille (p.263)
- Inner orbits without emargination 3

3(2) Cubital and discoidal cells fused (Fig. 55). Metanotum with two posteriorly directed projections (Fig. 60) 4
- Cubital and discoidal cells not fused. Metanotum without projections 5

4(3) Propodeum with a strong median thorn-like prolongation (Fig. 60) ..... Oxybelus Latreille (p.270)
- Propodeum at most with a tiny spine .... Belomicrus Costa (p.268)

5(3) Inner orbits diverging ventrally. Ommatidia of equal size ..... Nitela Latreille (p.259)
- Inner orbits converging ventrally. Ommatidia of very varying size 6

6(5) Abdomen with a long petiolus, segment 1 about twice as long as wide, apically distinctly expanded (Fig. 61) ..... Rhopalum Stephens (p.351)
- Abdomen without a distinct petiolus 7

7(6) Ocelli placed in an obtuse-angled triangle 8
- Ocelli placed in a right-angled or equilateral triangle 12

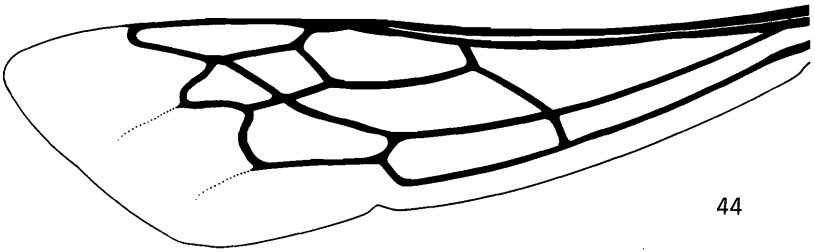
8(7) Mandibles single-toothed apically (Fig. 62). Both sexes have a pygidial area 9
- Mandibles apically with 2 - 3 teeth (Fig. 63). Only females have a pygidial area 10

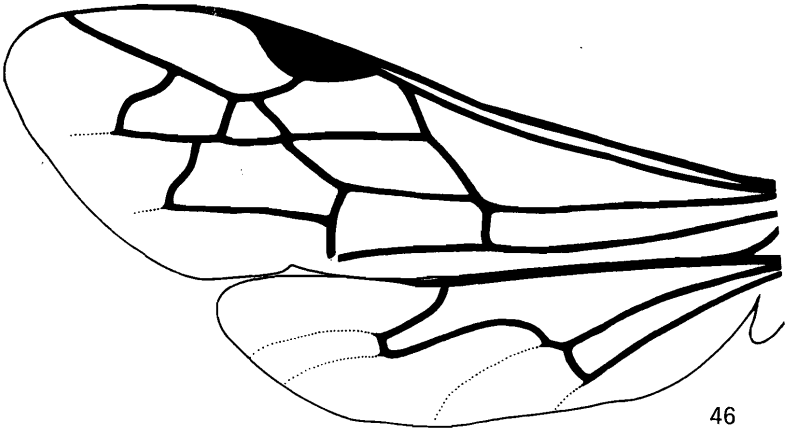
9(8) Eyes strongly pubescent. Mandibles proximally with a deep ventral emargination (Fig. 62) Entomognathus Dahlbom (p.344)
- Eyes naked. Mandibles without ventral emargination ..... Lindenius Lepeletier & Brullé (p.346)

10(8) Mesopleuron without precoxal carina in front of coxa 2. Males with 13 antennal segments. Tibia 1

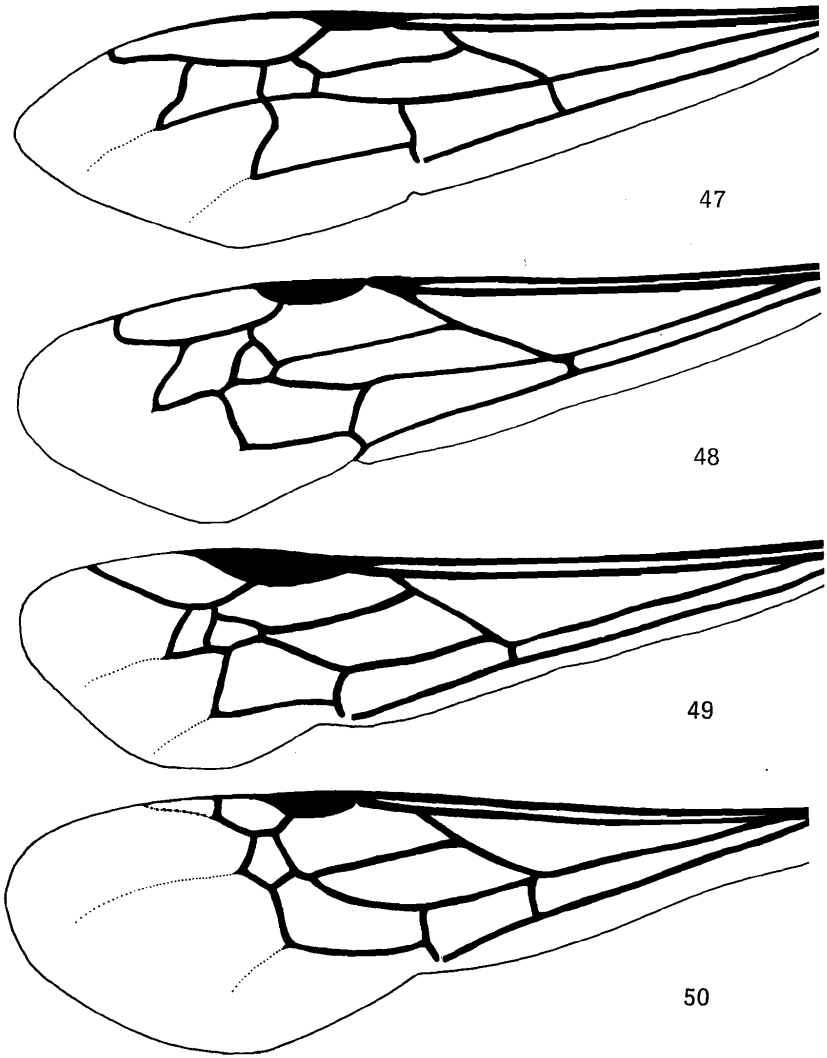
usually with large shield-like dilations. Pygidial area in females flat ..... Crabro Fabricius (p. 286)

- Mesopleuron with a short and sharp angular or arcuate precoxal carina (Fig. 64). Males with 12 antennal segments 11

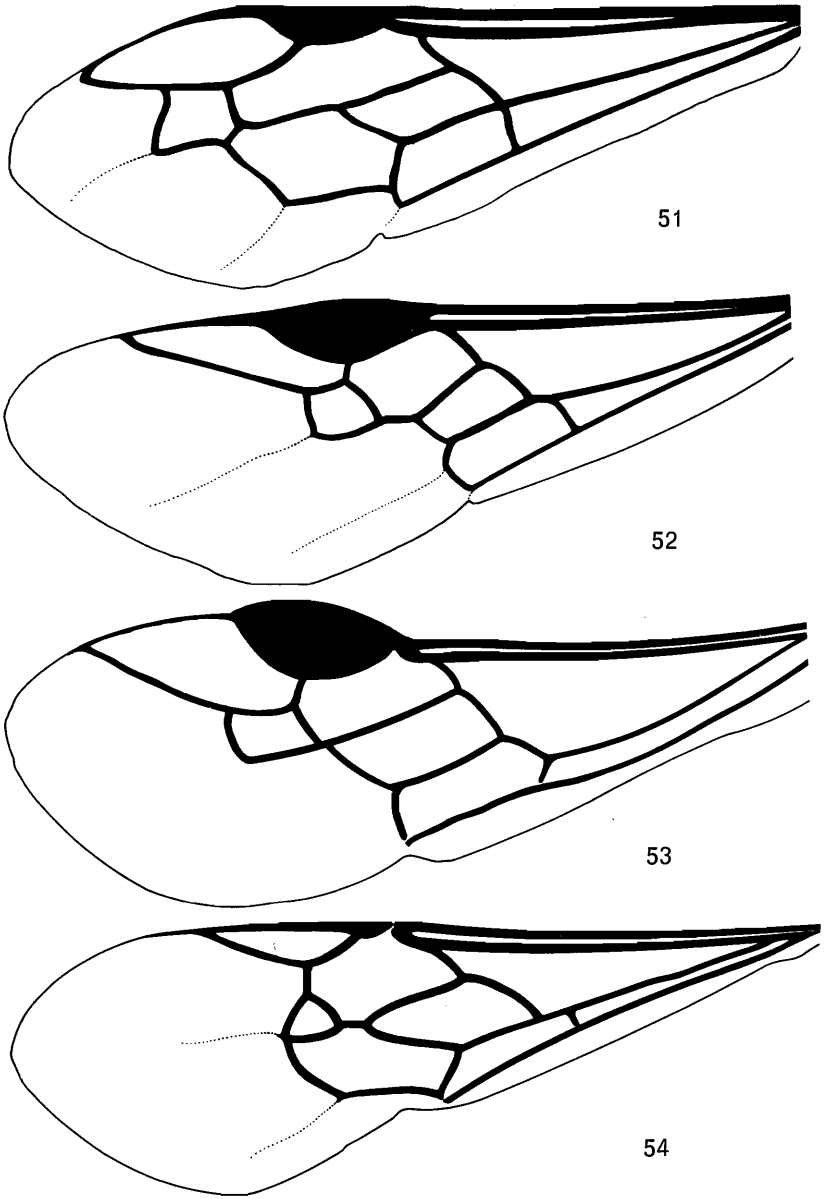




Figs. 44-45. Forewings of 44: Sphex rufocinctus Brullé; 45: Ammophila sabulosa (L.).
Fig. 46. Wings of Mimumesa sp. ?



Figs. 47-50. Forewings of 47: Mimesa sp.; 48: Cerceris sp.; 49: Alysson sp.; 50: Dinetus pictus (Fabr.).



Figs. 51-54. Forewings of 51: Pemphredon lugubris (Fabr.); 52: Stigmus sp. 53: Spilomena sp.; 54: Miscophus sp.

11(10) Terga very coarsely and deeply punctate. Facial fovea distinct. Pygidial area in females flat. Lestica Billberg (p.335)

\- Terga with sculpture very fine or almost absent. Facial fovea indistinct or missing. Pygidial area in females excavated in a groove apically, and surrounded by strong, golden bristles (Fig. 65) ..... Ectemnius Dahlbom (p.298)

12(7) Abdomen without yellow markings .... Crossocerus Lepeletier & Brullé (p.358)

\- Abdomen with yellow markings 13

13(12) Mesopleuron smooth, without carina, even, or with a small tooth anterior to coxa 2. Propodeum usually with a distinctly delimited area cordiformis which is smooth shining, and impunctate (Fig. 66). Males with 13 antennal segments . Crossocerus Lepeletier & Brullé (p.358)

\- Mesopleuron with a short and sharp angular or arcuate precoxal carina (Fig. 64). Propodeum without a delimited area cordiformis, the sculpture striate or rugose. Males with 12 antennal segments 14

14(13) Terga very coarsely and deeply punctate. Facial fovea distinct (cf. Fig. 377). Pygidial area in females flat ..... Lestica Billberg (p.335)

\- Terga with very fine or almost absent sculpture. Facial fovea indistinct or absent. Pygidial area excavated in a groove apically, and surrounded by strong, golden bristles (Fig. 65) ..... Ectemnius Dahlbom (p.298)

15(1) Forewings with two cubital cells (Fig. 51) 16

\- Forewings with three cubital cells (Fig. 45) 23

16(15) Second cubital cell petiolate (Fig. 54) ..... Miscophus Jurine (p.252)

\- Second cubital cell not petiolate 17

17(16) Petiolus much longer than wide 18

\- Petiolus not longer than wide 20

18(17) Forewings with one discoidal cell (Fig. 52) .. Stigmus Panzer (p.128)

\- Forewings with two discoidal cells (Fig. 51) 19

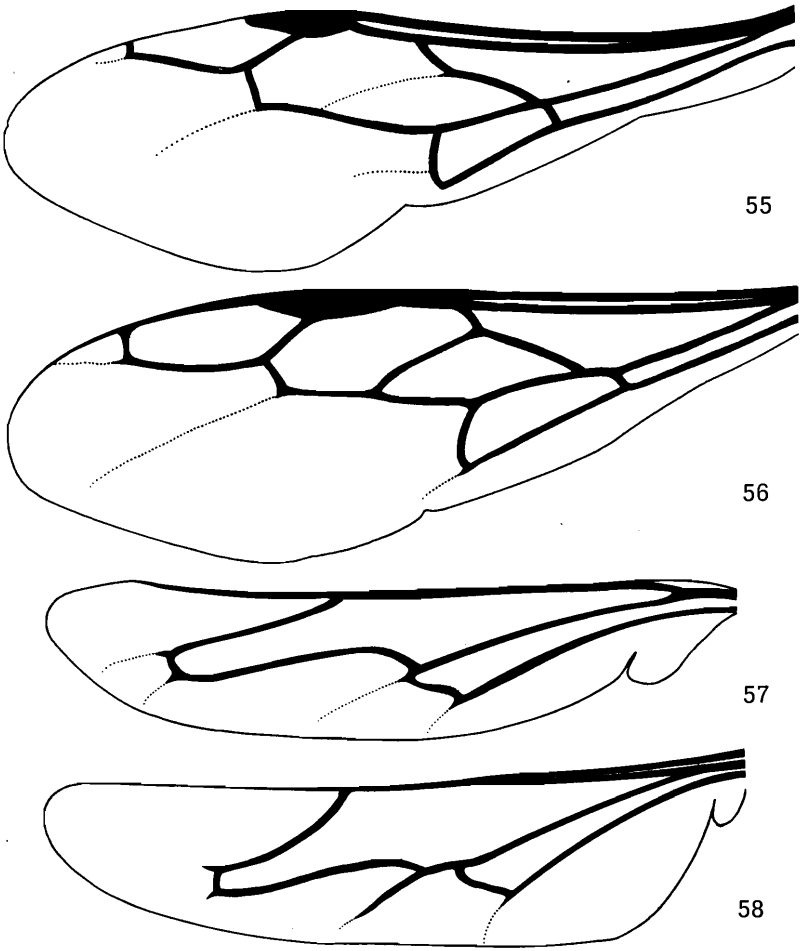
19(18) Frons between antennal sockets with a strong, obtuse horn ..... Ceratophorus Shuckard (p. 102)

- Frons between antennal sockets with at most a small spine ..... Pemphredon Latreille (p.81)

20(17) Forewings with only one discoidal cell (Fig. 53). Very small species ..... Spilomena Shuckard (p.132)

- Forewings with two discoidal cells 21

21(20) Inner orbits strongly diverging ventrally. Mandibles proximally with a ventrally directed rounded tooth



Figs. 55-56. Forewings of 55: Oxybelus sp.; 56: Rhopalum sp.
Figs. 57-58. Hindwings of 57: Gorytes sp.; 58: Dienoplus sp.

(Fig. 67). Radial cell short, with an accessory cell (Fig. 50). Body with extensive yellow markings ... . Dinetus Panzer (p.238)

- Inner orbits parallel or converging ventrally. Mandibles without ventral tooth. Radial cell long, gradually tapering towards apex (Fig. 52). Body black .. 22

22(21) Mesopleuron generally smooth, finely punctate, with one (sometimes double) vertical and one or two horizontal, coarsely pitted furrows (Fig. 68). Tibia 3 without spines. Females without pygidial area ..... Passaloecus Shuckard (p.113)

- Mesopleuron with rugose sculpture, without distinct furrows. Tibia 3 with small spines. Females with pygidial area ..... Diodontus Curtis (p.105)

23(15) Abdomen petiolate 24

- Abdomen sessile 31

24(23) Tergum 1 covering the whole dorsal face of the petiolus, posteriorly swollen (Fig. 69). Abdomen with yellow or yellowish-white markings ..... Mellinus Fabricius (p.223)

- Tergum 1 not covering the petiolus which is formed by the first sternum alone. Abdomen without yellow markings 25

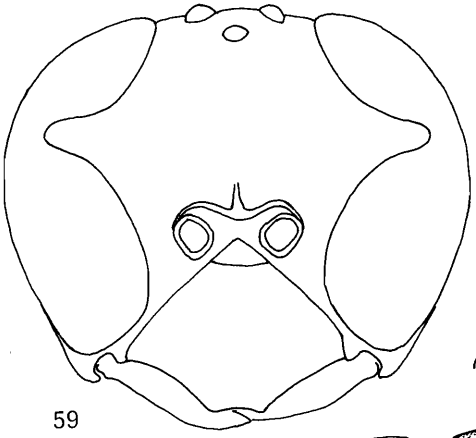
25(24) Petiolus sharply edged (Fig. 70). Antennae gradually thickened distally, last segment rounded apically. Females with very weak tarsal pecten 26

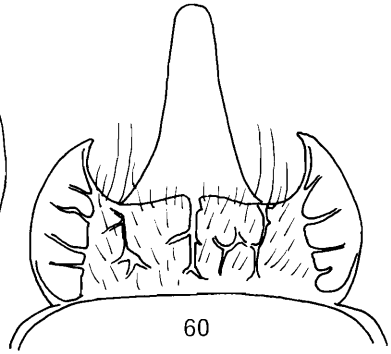
- Petiolus rounded in section. Antennae evenly filiform. Females with a very strong tarsal pecten (Fig. 71) 29

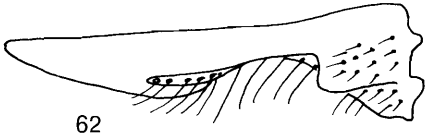
26(25) Media of hindwing leaves Media + Cubitus distally to anal cell (Fig. 46) ..... Psenulus Kohl (p.161)

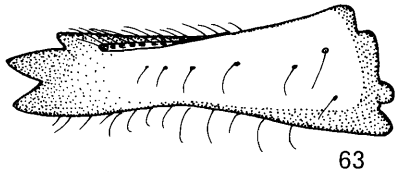
- Media of hindwing leaves Media + Cubitus proximally to apex of anal cell (Fig. 57) 27

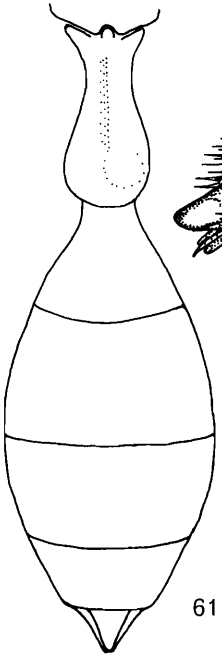
27(26) The first discoidal transverse vein joins the second cubital cell, and the second joins the third (Fig. 46). Frons with a small spine between antennal sockets. Antennal segments in male strongly excavate ventrally (Fig. 72). Petiolus very long, weakly margined ..... Psen Latreille (p.150)

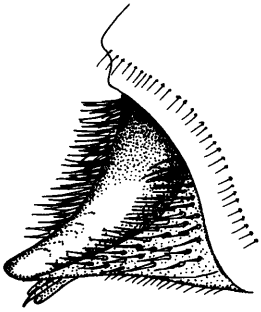












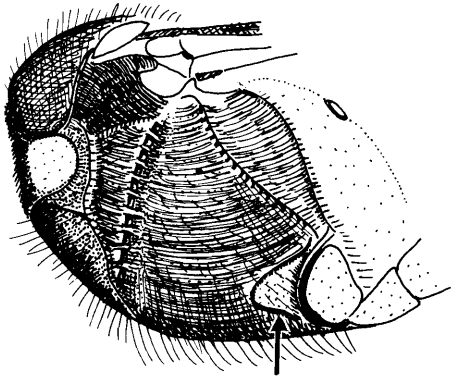


Fig. 59. Female head of Trypoxylon figulus (L.) in frontal view.
Fig. 60. Metanotal processes and propodeal spine of Oxybelus uniglumis (L.).
Fig. 61. Abdomen of Rhopalum coarctatum (Scop.).
Figs. 62-63. Mandibles of 62: Entomognathus brevis (v.d. Lind.); 63: Ectemnius cavifrons (Thomson), ♀.
Fig. 64. Precoxal carina of Ectemnius cavifrons (Thomson), ♀.
Fig. 65. Pygidial area of same, ♀.

- Both discoidal transverse veins join the second cubital cell (Fig. 47). Frons without spine, at most tuberculate between antennal sockets. Antennal segments in males not excavate, although occasionally with tyloidea. Petiolus strongly margined (Fig. 73) 28

28(27) Abdomen black. From the anterior ocellus a longitudinal carina goes foreword. This joins a doubly arcuate transverse carina below the antennal sockets (Fig. 74). Clypeus without a transverse pad. Mesopleuron smooth. The ventral part of the epicnemial carina continues as the acetabular suture (Fig. 75) ..... Mimumesa Malloch (p.152)

- Abdomen proximally red. The longitudinal and transverse carinae on frons very weak or absent. Clypeus in females usually with a transverse pad. Mesopleuron dull, microsculptured, distinctly punctate. The acetabular suture absent ..... Mimesa Shuckard (p.143)

29(25) Petiolus in lateral view as in Fig. 76, composed of both tergum 1 and sternum 1 ..... Ammophila Kirby (p.75)

- Petiolus only composed of sternum 1, in lateral view as in Fig. 77 30

30(29) First discoidal transverse vein joins the second the cubital cell, the second joins the third. Second cubital cell rhomboid (Fig. 44) ..... Sphex Linné (p.67)

- Both discoidal transverse veins join the second cubital cell, which is trapezoid (Fig. 45) .. Podalonia Fernald (p.70)

31(23) Labrum triangular, very strongly prolonged (Fig. 78) ..... Bembix Fabricius (p.202)

- Labrum not prolonged 32

32(31) Second cubital cell petiolate (Fig. 48) 33

- Second cubital cell not petiolate 36

33(32) Abdominal segments constricted (Fig. 235). Apex of radial cell truncate or rounded (Fig. 48) Cerceris Latreille (p.170)

- Abdominal segments not constricted. Apex of radial cell acute 34

34(33) Stigma very small. Propodeum short, with strong lateral teeth (Fig. 79). Inner orbits strongly converging ventrally. Head and thorax very coarsely

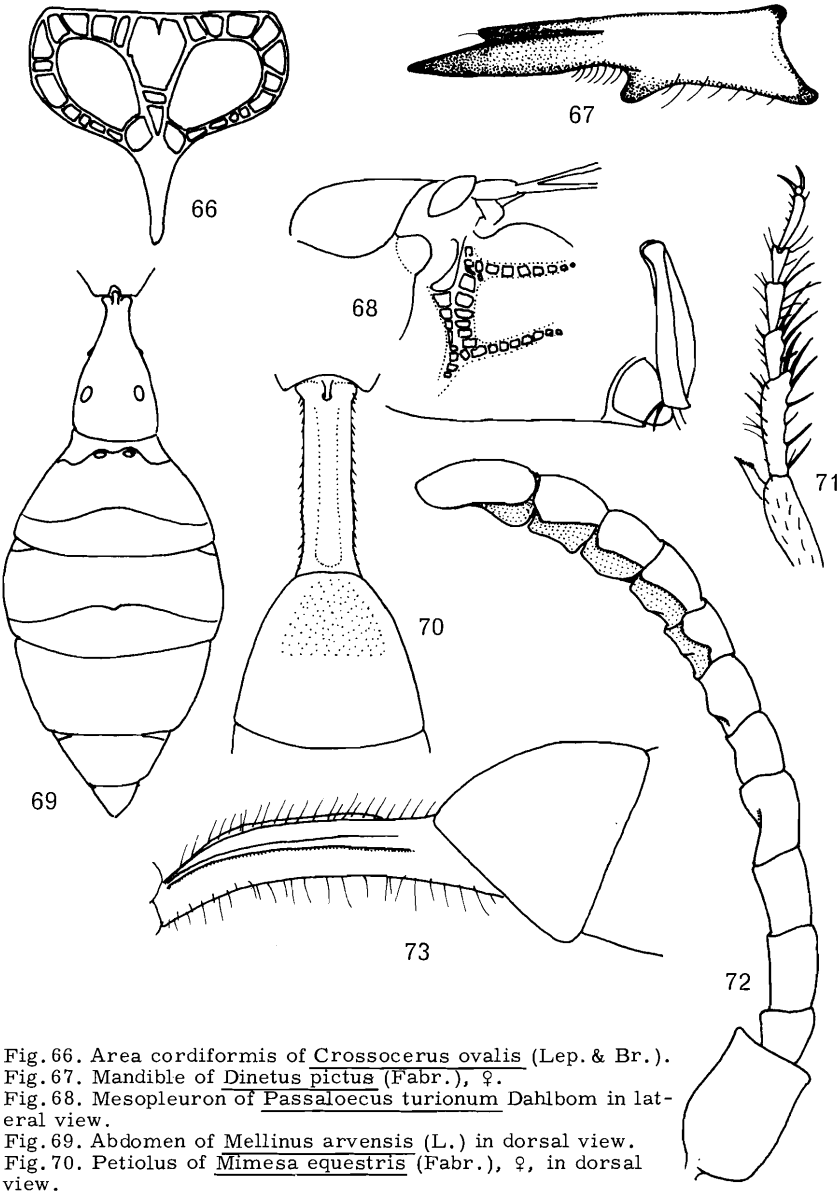


Fig. 66. Area cordiformis of Crossocerus ovalis (Lep. & Br.).
Fig. 67. Mandible of Dinetus pictus (Fabr.), ♀.
Fig. 68. Mesopleuron of Passaloecus turionum Dahlbom in lateral view.
Fig. 69. Abdomen of Mellinus arvensis (L.) in dorsal view.
Fig. 70. Petiolus of Mimesa equestris (Fabr.), ♀, in dorsal view.
Fig. 71. Tarsus 1 of Podalonia hirsuta (Scopoli).
Fig. 72. Antenna of Psen ater (Fabr.), ♂.
Fig. 73. Petiolus of Mimumesa atratinus (F. Morawitz) in lateral view.

sculptured ..... Nysson Latreille (p. 204)

- Stigma of normal size. Propodeum long, with or without very small lateral teeth. Inner orbits not or very slightly converging ventrally. Head and thorax superficially sculptured 35

35(34) First and second discoidal transverse veins join the second cubital cell (Fig. 49). Nervulus antefurcal. Abdomen with yellow spots. Last antennal segment in males normal ..... Alysson Panzer (p. 218)

- First discoidal transverse vein joins the first cubital cell, the second joins the second. Nervulus postfurcal. Abdomen without yellow spots. Last antennal segment in male C-shaped, antennal segment 12 distally with a small spine (Fig. 80). Didineis Wesmael (p. 216)

36(32) Both discoidal transverse veins join the second cubital cell 37

- First discoidal transverse vein joins the second cubital cell, the second the third 41

37(36) Inner orbits almost parallel or converging ventrally 38

- Inner orbits strongly diverging ventrally 40

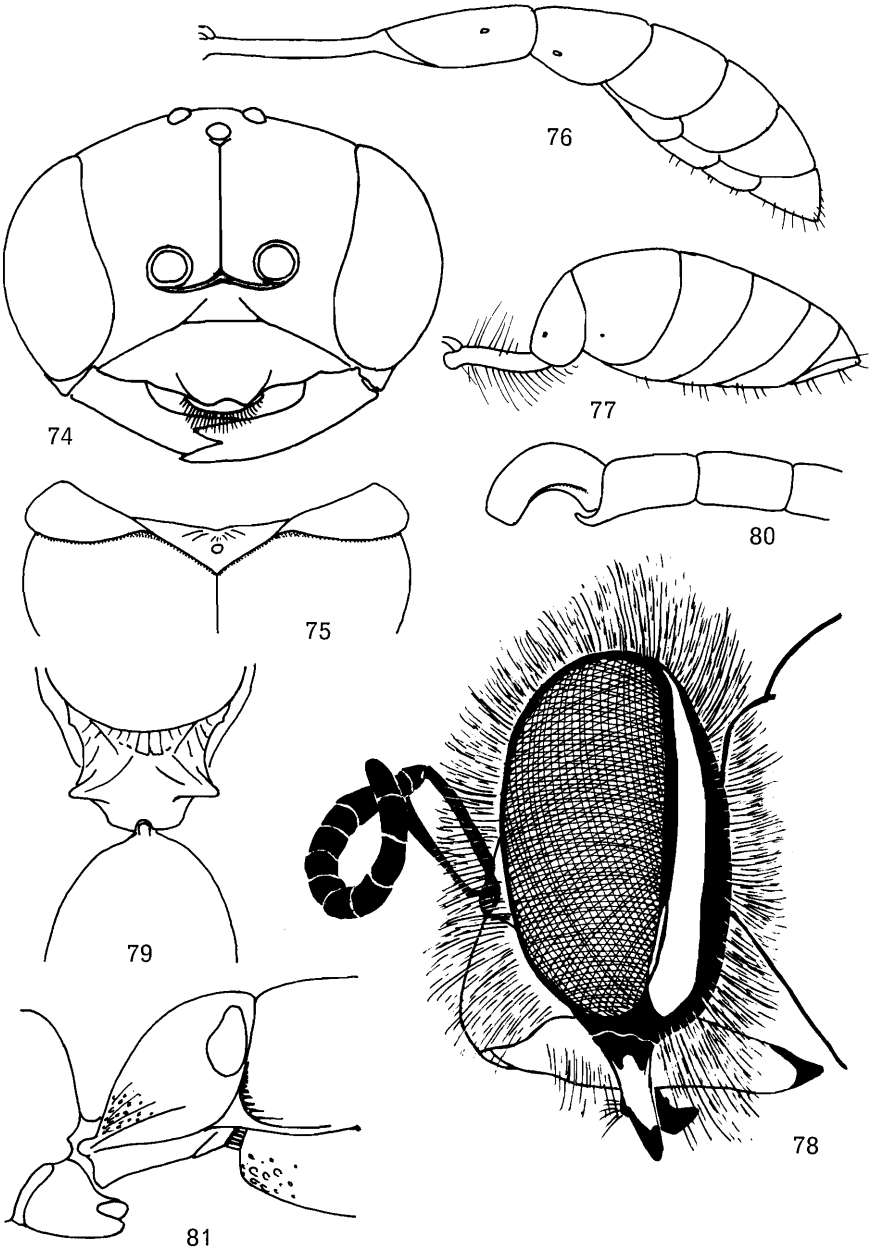
38(37) Abdomen with a strongly depressed furrow between the sterna 1 and 2, the latter strongly dilated, in lateral view as Fig. 81 ..... Argogorytes Ashmead (p. 187)

- Abdomen without a furrow between sterna 1 and 2, the latter not dilated 39

39(38) Media of hindwing leaves Media + Cubitus proximally to apex of anal cell (Fig. 57). Larger species with three or more yellow transverse bands on abdomen ..... Gorytes Latreille (p. 191)

- Media of hindwing leaves Media + Cubitus distal to anal cell (Fig. 58). Smaller species with whitish markings on abdomen ..... Dienoplus Fox (p. 199)

Fig. 74. Head of Mimumesa dahlbomi (Wesmael), ♀, in frontal view.
Fig. 75. Mesopleuron of Mimumesa dahlbomi (Wesmael) in ventral view.
Fig. 76. Abdomen of Ammophila sabulosa (L.), ♀, in lateral view.
Fig. 77. Abdomen of Podalonia hirsuta (Scop.), ♀, in lateral view.
Fig. 78. Head of Bembix rostrata (L.), ♀, in lateral view.
Fig. 79. Propodeum of Nysson spinosus (Forster) in dorsal view.
Fig. 80. Apex of antenna of Didineis lunicornis (Fabr.), ♂, in lateral view.
Fig. 81. Anterior part of abdomen of Argogorytes mystaceus (L.) in lateral view.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40(37) Tibia 2 with a single apical spur. The lateral ocelli elongate and very flattened ..... Tachysphex Kohl (p. 242)

\- Tibia 2 with two apical spurs. The lateral ocelli normal, circular and convex ..... Astata Latreille (p. 229)

41(36) Pronotum very long. Claws with a proximal tooth. Body almost entirely black ..... Dolichurus Latreille (p. 64)

\- Pronotum short. Claws without teeth. Body with yellow markings ..... Philanthus Fabricius (p. 182)

SUBFAMILY AMPULICINAE

The species of the subfamily Ampulicinae vary in size from 4.5 - 25 mm. Eyes elongate, situated laterally on the head, the inner orbits parallel or slightly diverging ventrally. Antennae filiform, 12-segmented in females, 13-segmented in males, inserted below a raised plate. Maxillary palpus 6-segmented, labial palpus with four segments. Prothorax elongate, the humeral tubercle extending posteriorly to the tegulae. Scutum usually with strong longitudinal furrows throughout its length. Propodeum large, strongly carinate dorsally, often with lateral prominences. Mesopleuron without epicnemium. Abdomen more or less petiolate (except in Dolichurus). Females without pygidial area. Forewings primarily with three cubital cells and two discoidal cells. Tibia 2 with two spurs. Claws dentate.

The larvae resemble those of Sphecinae, suggesting a close relationship (Evans, 1959b), but deviate in the following characters: the integument is devoid of spinules; the parietal bands are weak; the epipharynx is spinulose only laterally, and then very weakly; the mandibles lack the basal pores; the inner margins of the maxillae bear only short spinules; and the lips of the spinneret generally project farther laterally than medially.

The subfamily is mainly confined to the tropical regions, comprising six genera of which Ampulex is the largest. Only three species in western and northern Europe. The species nest in cavities both in the soil and in decayed wood near the ground. The prey consists of cockroaches.

Genus *Dolichurus* Latreille

Dolichurus Latreille, 1809: 387.
Type-species: Pompilus corniculus Spinola, 1808.

Genus easily recognizable by the long pronotum, and the very characteristic sculpture on scutum and propodeum (Fig. 82). Antennae long and slender. Coxa 3 very large. Femur 3 rather strongly dilated proximally. Claws with basal tooth. Abdomen has six visible segments in females; in the males the last three segments are telescoped and partly concealed within tergum 3. Females without pygidial area and without tarsal pecten on tarsus 1. Forewings with three cubital cells. First and second mcu join second and third cubital cells respectively.

The Ampulicinae are mainly distributed in the tropics, where the genus Ampulex is rather common. Dolichurus comprises about twenty species, of which two are found in Europe.

The nest is of simple construction, consisting of a single larval chamber, which often is only a pre-existing cavity in the ground. Larval provision consists of cockroaches (Blattodea), e.g. Ectobius.

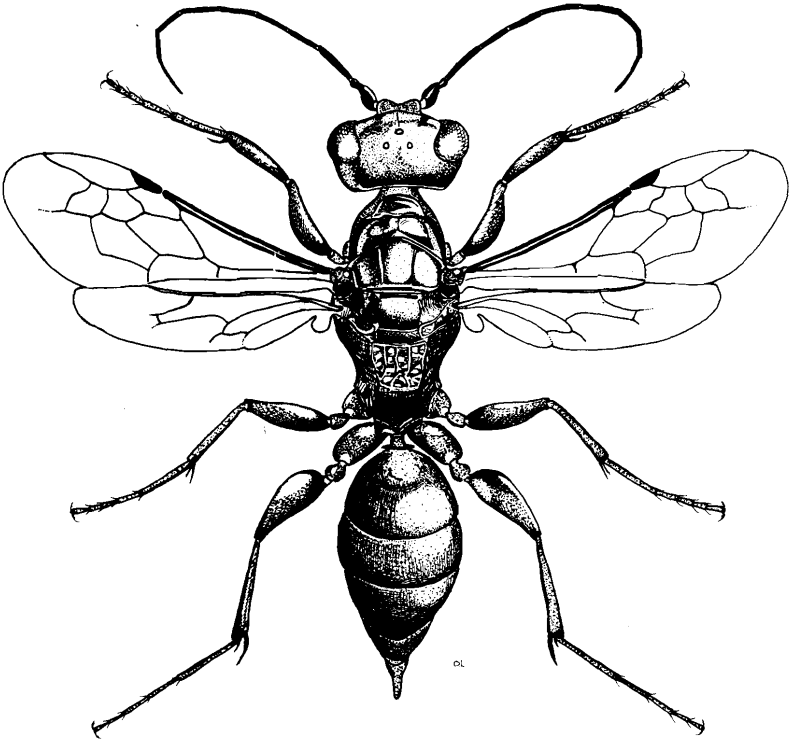


Fig. 82. Female of Dolichurus corniculus (Spin.). Length: 8-9 mm.

1. DOLICHURUS CORNICULUS (Spinola, 1808)
Fig. 82.

Pompilus corniculus Spinola, 1808: 52.

Female: 8-9 mm. Shining black. Head in front view almost circular. Clypeus strongly convex in the middle, with a faint longitudinal keel and 4-6 strong forward directed black bristles. Antennae long and slender, frontal face of scapus with an oblique longitudinal keel. Frons with irregular rugae. Scutum almost impunctate, with very well developed parapsidal furrows. Thorax dorsally with scattered, strong black bristles. Mesopleuron with coarse rugoso-punctation. Propodeum dorsally with four strong longitudinal carinae connected with each other by numerous transverse rugae. Posterior side of propodeum laterally with a backward directed spine. Abdomen smooth and shining with very fine and scattered punctation. Legs black, tarsi brownish. Tibia 2 with a distinct longitudinal furrow along anterior border.

Male: 7-8 mm. Clypeus with a whitish yellow spot on each side of the very strong longitudinal keel. Pubescence white, sparse. Sculpture of head coarse, consisting of shallow pits. Pubescence long and erect. Whole thorax rather densely punctate, with whitish pubescence. Punctation of mesopleuron rather strong. Propodeum as in female. Abdomen distinctly punctate, hairy with weak constrictions between the three first segments. Sterna strongly and densely punctate. Legs black, long and slender. Tibia 2 without longitudinal furrow.

Widely distributed and rather common throughout Denmark and Fennoscandia. - Sweden: northern distribution limit in Vrm. and Gstr. - Norway: a single specimen from AK, Bygdeø. - Finland: northern limit in Ok and ObS. In Soviet Karelia known from Ib. - Widely distributed in Europe, southwards to northern Africa.

The species prefers sandy areas: paths, fire breaks in coniferous forests, or areas along watercourses. The species does not dig a nesting-burrow, but uses pre-existing cavities in the soil. The food, which consists of the cockroaches Ectobius lapponicus L. and Phyllodromica megerli Fieber (=Aphlebia punctata Charp.), is treated in a very characteristic way, since the prey is only slightly paralyzed. Before it is carried to the nest, the wasp bites off two-thirds of each antenna of the prey. The very elongate egg is placed between coxae 2 of the prey and hatches in three to four days. The larva takes about ten days to develop. Larva described by Maneval, 1939.

Note added in the 1984-edition. Zanden (1977) recorded Dolichurus bicolor Lepeletier, 1845 from Finland: N, Helsingin Pitäjä, 1 ♂, 1.viii.1961. The gastral base is ferrugineous, the mandible has a yellowish white proximal spot. A very rare and sporadic species in Central Europe.

SUBFAMILY SPHECINAE

A well-defined, probably monophyletic unity, including the largest sphecid species known (52 mm). Head large, inner orbits parallel or converging ventrally, diverging only in rare cases. Antennae long, filiform, 12-segmented in females, 13-segmented in males, inserted relatively high up on frons. Maxillary palpus 6-segmented, labial palpus 4-segmented. Clypeus large. Mandibles very powerful, with strong teeth. Pronotum usually elongate, the humeral tubercles do not reach the tegulae. Thorax moderately sculptured. Mesopleuron with an epicnemial carina or furrow, epicnemium absent. Propodeum much elongated. Abdomen petiolate, the petiolus composed of either sternum 1 alone or in addition of tergum 1 and sternum 2 (postpetiolus). Pygidial area absent. Legs long and powerful. Tibia 2 with two apical spurs. Tarsus 1 of females with a strong tarsal pecten. Forewings with three cubital and two discoidal cells.

Larvae characterized as follow: integument spinulose or granulose; setae of head short or absent; parietal bands well developed; antennal papillae absent; labrum biconvex; mandibles stout, terminating in four teeth, galea as long as or longer than maxillary palpus; spinneret consisting of a transverse slit with prominent raised lips (Evans & Lin, 1956). The transverse spinneret is unique to the Ampulicinae and the Sphecinae among the Sphecidae.

The subfamily is mainly tropical and subtropical, comprising 19 genera of which only four occur in Europe. The Nordic species are all soil-nesters, whereas several exotic species either display arboreal nesting habits or construct their nests with mud (mud daubers). A few act as inquilines. The nests are provisioned with Orthoptera, Aranea, lepidopterous or (rarely) hymenopterous larvae.

Genus *Sphex* Linné

Sphex Linné, 1758: 569.
Type-species: Sphex flavipennis Fabricius, 1793.

Robust, medium to very large species (Fig. 83), very similar to the species of Podalonia, but the petiolus is much shorter (in the Scandinavian species), and also the thorax and legs are more powerful. Forewings with 3 cubital cells, of which the second and third receive the first and second recurrent veins respectively. The second cubital cell forms an equilateral rhomboid. Eyes large, strong-

ly convex, inner orbits parallel, slightly converging in males. The median ocellus is considerably larger than the lateral ones. Mandibles rather short, strongly curved and very powerful. Clypeus large, antennae inserted high up on frons. Tibiae very spiny, especially in females. Claws with two strong, rounded, basal teeth (Sphex s.str.). Females with highly developed tarsal pecten.

The genus is cosmopolitan and represented by a very large number of species, most of which occur in tropical and subtropical regions. To this genus belong some of the largest Hymenoptera.

2. SPHEX RUFOCINCTUS Brullé, 1832

Fig. 83.

Sphex rufocincta Brullé, 1832: 367.
Sphex maxillosa auctt., nec Fabricius.

Female: 16-23 mm. Head in frontal view slightly broader than high. The whole lower part of the face covered by a double pilosity consisting partly of dense, adpressed silvery hairs, partly of long and pale, very thick, erect bristles. Head also ventrally with long, pale hairs. Clypeus very large, strongly convex; the anterior border strongly depressed. Mandibles red-yellow or red-brown with black apex. The whole thorax very shallowly and sparsely punctate and mat due to the interstitial microsculpture. Propodeum dorsally with very fine and dense, sometimes indistinct transverse striae, with long and rather sparse, pale pubescence. Petiolus seen from above about twice as long as broad, black. Anterior half of abdomen red-brown coloured. First tergum with a black spot of variable size. Second tergum without black markings. Third tergum more or less extensively black coloured. Tibia 1 and tibia 2 and tarsus 1 and tarsus 2 with extensive rust-red or red-brown pattern. Foretarsi with numerous, very strong, compressed tarsal spines. Wings distinctly darkened. Third cubital cell triangular, since second and third cubital transverse veins join at the radial vein.

Male: 15-20 mm. Antennae long and slender, segments ventrally with two pairs of longitudinal carinae, between the medial ones is found an elongate excavation which is dull and flattened at the bottom. Inner orbits distinclt converging ventrally Clypeus and lower part of face with dense silvery pubescence. Anterior border of clypeus without depression, or slightly depressed. Sculpture and pubescence of thorax as in female. Propodeum dull, dorsally with fine granulate sculpture, occasionally with distinct transverse striation. Legs entirely black. Tarsus with quite short pecten. Black spot on first tergum usually larger than in female, and often an extensive black pattern on third tergum.

The species seems to maintain an isolated population on Gtl. (Ljungan, Irevik, and on Fårön) and might be considered a postglacial warm relict. The records from Vg. have not been verified. - The distribution area primarily covers the Mediterranean, Asia Minor and South-Siberian steppes.

At the end of a tunnel, about 15 cm long, a horizontal larval cell is constructed in the same way as in Ammophila and Podalonia, but there are reliable observations (Olberg, 1966), showing that several larval chambers were connected with the same entrance. While hunting takes place, the entrance to the nest is left open. The paralyzed nymphs of grasshoppers or crickets are carried or dragged to the nest. Each cell is provisioned with 3-5 specimens. The egg hatches after 3-4 days, and the larva is fully grown already after about 18 days. Recorded cleptoparasites are Metopia campestris Fallén and M. argyrocephala Meig. (Dipt., Miltogrammatidae).

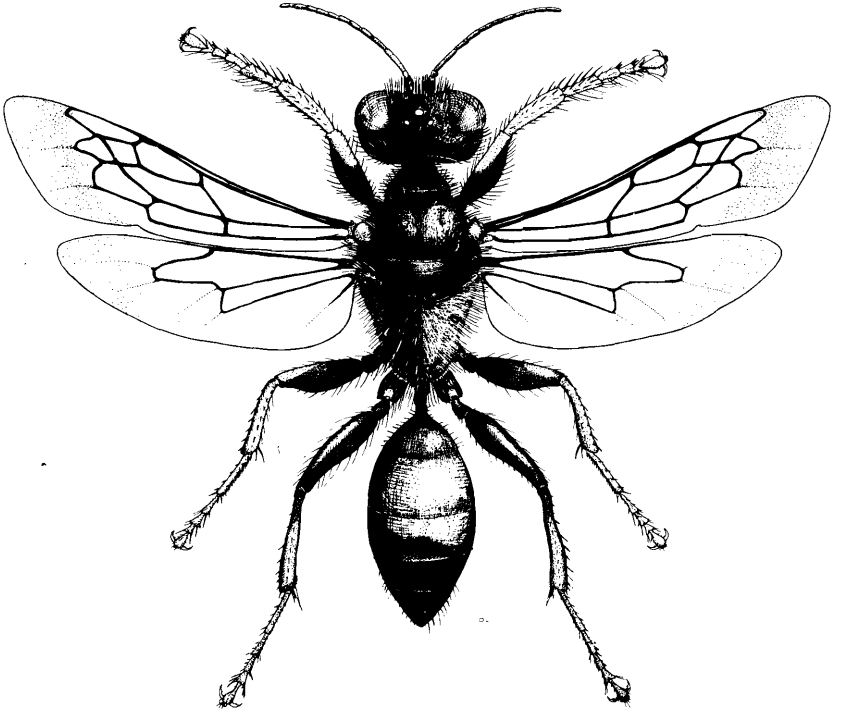


Fig. 83. Female of Sphex rufocinctus Brullé. Length: 16-23 mm.

Genus *Podalonia* Fernald

Podalonia Fernald, 1927: 1.

Type-species: Ammophila violaceipennis Lepeletier, 1845.

Large, robust, red-and-black wasps (Fig. 84). The genus is characterized by the rather short petiolus and by the first tergum seen in profile being fairly high and short (Fig. 86). There is no distinct constriction between this and the second tergum. The head in front view is short and broad, with dense, strong sculpture. The mandibles of the female are very long and powerful, with three teeth on the inner side. Those of the male are shorter and strongly curved, with only a single tooth on the inner side. The labio-maxillary complex is elongate in both sexes. Scutum with strong sculpture. Tarsus 1 of the female is strongly asymmetrically dilated, with very strong pecten. The pilosity of the head and dorsal thorax is long, strong and dense, especially in males. The males are otherwise considerably more slender than the females, with dense, bright silvery pubescence on the lower part of the face. Forewings with three cubital cells, of which the second is joined by both recurrent veins. Tibia 2 with two spurs.

The genus, which is represented by three species in Fennoscandia and Denmark, is distributed over large areas of the world. All species are associated with sandy biotopes, fully exposed to the sun. The nests are constructed in the ground, consisting only of a single larval chamber. The prey consists of soil-living larvae, e.g. of Noctuidae (Lepidoptera).

Key to species of Podalonia

1 Inner side of claws near base with a small sharp tooth. Propodeum dorsally with distinct diagonally striate sculpture ..... 4. affinis (Kirby)

\- Claws unarmed. Propodeum dorsally never distinctly diagonally striate, but with irregular wrinkled or pitted rugosity 2

2 (1) Female: Tarsus 1 strongly asymmetrically dilated, tarsal pecten very strong, the spines slightly dilated apically (Fig. 88). Metatarsus ventrally with or without a few very weak spines. Male: Mandibles with at least centre reddish-brown. Hairs on scutum silvery, sometimes with black base. Clypeus comparatively short and broad (Fig. 85)..... 5. luffii Saunders

- Female: Tarsus 1 except the metatarsus very slightly asymmetrically dilated. Tarsal spines tapering (Fig. 87). Metatarsus near ventral midline with a row of 3-4 strong spines. Male: Mandibles mainly black. Pubescence of scutum greyish-white. Clypeus comparatively narrow, its anterior border distinctly emarginate ..... 3. hirsuta (Scopoli)

3. PODALONIA HIRSUTA (Scopoli, 1763)
Figs. 84, 86, 87.

Sphex hirsuta Scopoli, 1763: 292.
Podalonia viatica auctt.

Female: 16-23 mm. Head and thorax with dense, very strong punctation and usual-

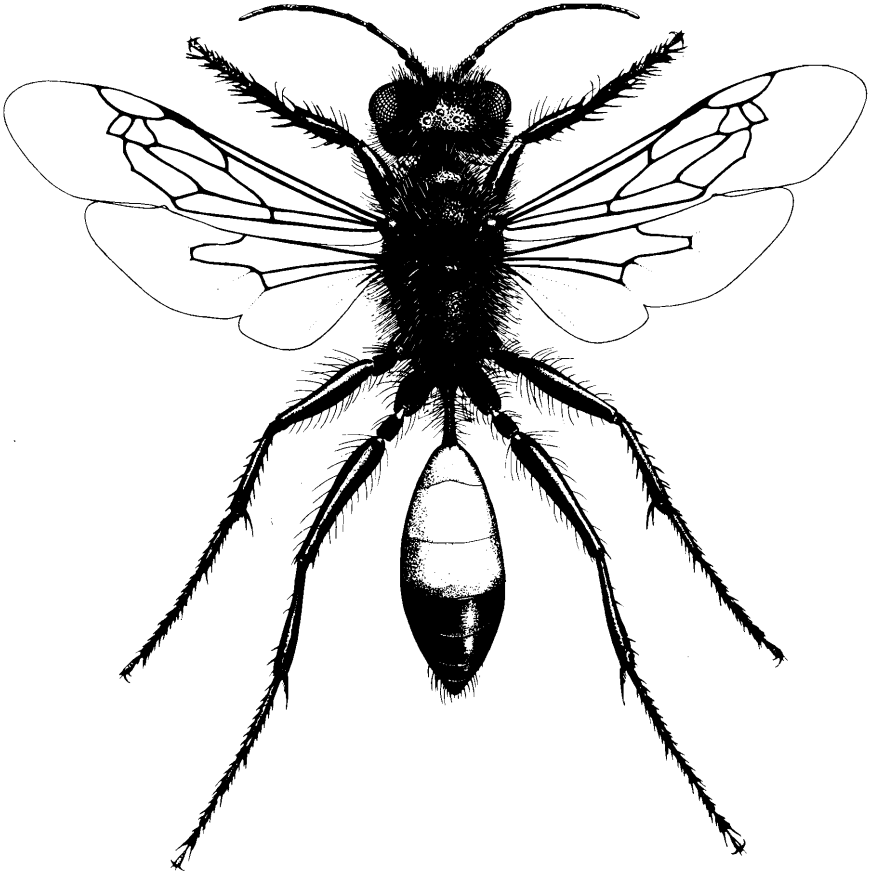


Fig. 84. Female of Podalonia hirsuta (Scop.). Length: 16-23 mm.

ly very long, strong pilosity, but this may be much reduced, especially in specimens from mountainous regions, both in Fennoscandia and Central Europe. Anterior border of clypeus with a slight central projection which often has almost right-angled corners. Propodeum dorsally with irregular, superficial pits or rugose, not distinctly different from the sculpture on the lateral parts. First and second tergum as well as basal part of third red or brownish-red. Tarsal segments of forelegs comparatively weakly dilated (Fig. 87). Pretarsus with a very small pulvillus. Claws without basal tooth.

Male: 14-20 mm. Head in front view distinctly narrowing ventrally, clypeus relatively long and narrow, almost plane. The long erect pubescence on head entirely black, on scutum consisting of a mixture of black and more or less greyish hairs. Sculpture of thorax and propodeum as in female. First, second and much of third tergum red. First tergum with at most a quite small, black, basal spot. Pulvilli of pretarsi large.

This is the most frequent Podalonia-species in northern Europe. - Denmark: common on dry, sunny soils throughout the country. - Sweden: northwards to Dlr. and Gstr. - Norway: only a few records, but probably common in the lowland areas in the south. - Finland: a south-eastern distribution, northwards to Kb. - Soviet Karelia: Ib and Kr. - Distributed through much of the Palaearctic region, eastwards to Inner Mongolia.

The nests are found in sandy areas: fire breaks and open areas near the coast, but may also be constructed in sandy slopes or gravel pits. The entrance-burrow is 6-7 cm long and runs obliquely down, where it is finally expanded to form a larval chamber. The sequence of the excavation and provisioning of the nest etc. is as follows: 1)Hunting and paralyzing of prey; 2) Excavation of nest; 3) Transportation of prey and egg-laying; 4) Closing and camouflaging of nest. It is noteworthy that the entrance is not temporarily closed as in Ammophila. The prey consists of naked larvae of soil-living Noctuidae, e.g. Agrotis, of which only a single individual represents the provision. It is stated (Adlerz, 1903) that while excavating the larva, the female "may be mistaken", instead digging out a larva buried and paralyzed by another individual. The larva is paralyzed by a number of stings, mainly in the thoracic locomotory ganglia, and carried to the future nesting place, where it is deposited temporarily in a tuft of grass or the like. Excavation takes place by means of the forelegs, the mandibles being used when pebbles and small twigs are being removed. The excavated material is scattered round the entrance. When construction of the nest is finished, the wasp retrieves the paralyzed larva dragging it into the nest. The egg is laid ventrally in the thoracic region. The entrance is closed with sand, which is stamped together, during which the wasp makes short buzzing sounds while its wings are folded. The vibrat-

ions probably help to pack the sand grains more tightly together. The egg hatches after 4-5 days. About ten days later the wasp-larva is fully grown and spins a pale brownish, rather solid three-layered cocoon. The imago usually emerges at the end of May, when also the hibernated females can be observed. Both males and females spend the night in cavities in the soil, often in slopes among roots of e.g. Ammophila arenaria (Marram Grass). Both males and females may be found sucking nectar from flowers of e.g. Jasione montana and Succisa pratensis. As parasite on imagines is recorded Paraxenos sphecidarum (Duf.) (Strepsiptera).

4. PODALONIA AFFINIS (Kirby, 1798)

Ammophila affinis Kirby, 1798: 205.

Female: 16-20 mm. Head and thorax dorsally with very sparse, often almost absent black hairs. Punctation on scutum weak and rather sparse, interspaces shining, with microsculpture. Anterior border of clypeus without projecting median lobe. Propodeum dorsally finely diagonally striate, dull with interstitial granulat-

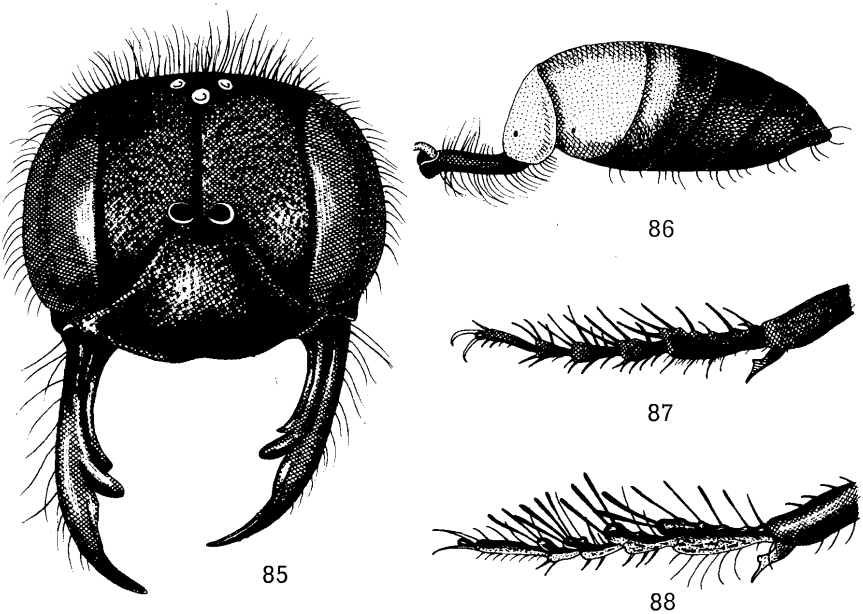


Fig. 85. Head in frontal view of Podalonia luffii Saunders, ♀.
Fig. 86. Abdomen in lateral view of Podalonia hirsuta (Scop.).
Figs. 87-88. Foretarsi of female Podalonia. - 87: hirsuta (Scop.); 88: luffii Saunders.

ion. Sides coarsely, somewhat irregularly striate. Second tergum entirely red or brownish-red. First tergum anteriorly with a black spot of varying size. Third tergum with narrow, black posterior border. Tarsal segments of forelegs comparatively strongly dilated. Pulvillus large. Claws with basal tooth.

Male: 13-18 mm. Clypeus comparatively short and broad, in profile distinctly concave behind anterior border. Area just in front of antennal socket not depressed as in hirsuta. The long pilosity on head and scutum is uniformly black, without admixture of pale hairs. Propodeum dorsally as in female with fine diagonally striate sculpture with interspersed granulation. First tergum with a black spot, which often covers the whole dorsal part. Second tergum usually entirely red, occasional specimens have an apical black, triangular spot. Posterior part of third tergum with a more or less extensive black area, which may extend forward in the shape of a triangular spot. Claws with distinct basal tooth.

A more southern species than hirsuta. - Denmark: rather common throughout the country. - Sweden: northern distribution limit runs through Vrm. and Gstr. - Norway: a few records from Ø, AAy and Ry. - Finland: very local, a few records from Ab and Sa. - In Soviet Karelia the species is known from Ib. - Widely distributed in the Palaearctic region.

The species often breeds together with hirsuta, but seems to be slightly more thermophilous. During excavation of the nest, small quantities of material are collected between the forelegs and the ventral side of the head. This material is carried some distance away from the entrance. As prey are used e.g. Agrotis-larvae (Lep. Noctuidae). In rare cases (small larvae) two are deposited in each cell.

5. PODALONIA LUFFII Saunders, 1903
Figs. 85, 88.

Podalonia luffii Sauders, 1903: 248.
Podalonia arenaria Lüderwaldt, 1897: 125.

Female: 16-20 mm. Closely related to hirsuta. Head (fig. 85) in front view very broad, approximately rectangular. Clypeus strongly convex, with rounded, slightly undulating anterior border. Mandibles reddish-brown, very long, reaching to or even beyond articulation of opposite mandible. Head and thorax sculptured as in hirsuta. Pubescence, especially on pronotum and anterior part of scutum, with strong admixture of silvery hairs. Propodeum dorsally on average somewhat more weakly sculptured than in hirsuta, and with white pubescence. First, second and more than half of third tergum red. Metatarsus, and adjacent segment very strongly dilated. Tarsal pecten (Fig. 88) very strong. Pulvilli well developed.

Male: 15-18 mm. Head in front view almost as in hirsuta, but clypeus distinctly shorter and broader. In large individuals clypeus is distinctly convex. Area just below antennal sockets with a depression. Hairs on scutum, and also some of those on lateral areas of mesopleuron, long and slightly curled, with rich admixture of silvery-tipped hairs. Propodeum dorsally more weakly sculptured than in hirsuta. Colour of abdomen as in female. In a few cases the claws have a tiny basal tooth.

Denmark: WJ, Skallingen and Gammelgab; NWJ, Hansted. - Sweden: restricted to the southern coasts; Sk., Vitemölla, Löderup, Klammersbäck and Åhus; Hall., Harplinge, and Gtl., Ljungarn and Fårön. - Recorded primarily from littoral localities in Europe, i.e. along the coasts of the Atlantic Ocean, the Channel, the North Sea and on the southern coast of the Baltic Sea. The species is also recorded from the steppes in eastern Europe and Kazakhstan.

The species seems to prefer coastal drift-sand areas, which are not occupied by the other two Fennoscandian species of Podalonia. It might be a postglacial relict in Fennoscandia and Denmark.

Genus *Ammophila* Kirby

Ammophila Kirby, 1798: 199.
Type-species: Sphex sabulosus Linné, 1758.

Large, very elongate, slender, red-and-black wasp (Fig. 89). Head large, wider than thorax, in anterior view often almost circular in females (Figs. 90, 91); distinctly elongate in males. Eyes very large, strongly convex. Antennae long, filiform. Clypeus large, its anterior margin evenly arched or slightly undulating. Its pilosity consists partly of long black bristles, which are most strongly developed in females, partly of a dense, silvery, felt-like pubescence, which is most developed in males. Mandibles long and powerful, inner side tridentate in females, shorter and more curved in males, with only a single tooth on the inner side. The labio-maxillary complex very elongate. Thorax and propodeum long and slender, propodeum dorsally with diagonally striate sculpture, often with interspersed granulation. Humeral tubercle, mesopleuron and posterior side of propodeum with white or silvery felt-like spots. Petiolus very long and thin, first tergum also very long (Fig. 92). Legs long and slender. Foretarsi of female asymmetrically dilated, with rather strong pecten. Tibia 2 with two spurs.

The species are associated especially with dry, sandy areas, where the nests are made in the ground. They consist of a short tunnel, which ends in a single

cell, and are provisioned with larvae of Lepidoptera or Hymenoptera Symphyta: Tenthredinidae.

Key to species of Ammophila

1 Third cubital cell sessile. Black colour on tip of abdomen with blue or greenish metallic sheen ..... 6. sabulosa (Linné)

- Third cubital cell petiolate. Black colour on tip of abdomen without metallic sheen 2

2 (1) Long hairs on head in both sexes black. Propodeum with fine diagonally striate sculpture and granulation between striae, therefore of dull appearance. Male: first sternum black, first tergum red or red-yellow with a black spot covering the whole dorsal area. Second tergum with a large triangular black spot ..... 7. pubescens Curtis

- Long hairs on head of female yellowish, in male white. Dorsal side of propodeum with coarse, diagonally striate sculpture, without distinct granulation between striae, and therefore shining. Male: first sternum black, first tergum mainly red or red-yellow, dorsal side with a black spot at base. Second tergum usually uniform red or red-yellow .. .. 8. campestris Latreille

6. AMMOPHILA SABULOSA (Linné, 1758)
Figs. 89, 90, 92.

Sphex sabulosus Linné, 1758: 269.

Female: 16-24 mm. Head in anterior view distinctly broader than high, inner orbits almost parallel. In smaller individuals the head is relatively narrower. Anterior border of clypeus, especially in large specimens, with a small tooth on each side (Fig. 90). The very short, dense pubescence on lower part of face vestigial, only rarely with silvery lustre. Pilosity of head otherwise brownish. Of the three teeth on the inner side of the mandibles the central one is squarely truncate (Fig. 90). Pronotum and scutum dull, shallowly and rather sparsely punctate with pale pubescence. The diagonally striate sculpture on propodeal dorsum very variable, the strong carinae often more or less irregular. Petiolus (Fig. 92) black, first tergum mainly black, second tergum completely black, and basal part of third tergum red-yellow or red-brown coloured. Tip of abdomen with faint bluish or greenish metallic sheen, this may be missing in specimens from the northern-

most parts of the range of the species. Metatarsus 1 strongly dilated on the outer side. Tarsal pecten strongly developed.

Male: 14-19 mm. Inner orbits strongly converging ventrally. Eyes very large and strongly convex. Long hairs of head black or brownish. A sparse admixture of pale hairs may occur occasionally. Thorax sculptured and hairy as in female, but lacking the strongly silvery felt-like spot on mesopleuron. The diagonally striate sculpture on dorsal area of propodeum sometimes very irregular and indistinct. First tergum with a dorsal dark longitudinal stripe. Second tergum likewise red, but with an elongate, oval, dorsal spot. Only the anterior fourth of third tergum red. Tip of abdomen black with faint greenish or bluish metallic sheen.

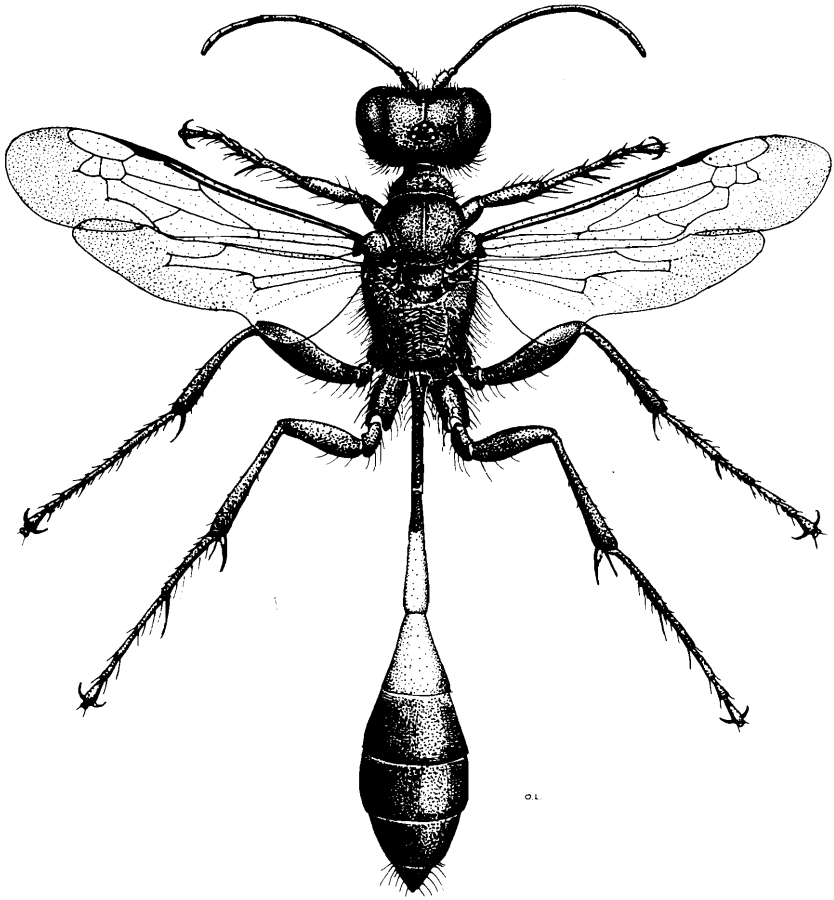


Fig. 89. Female of Ammophila sabulosa (L.). Length: 16-24 mm.

Very common in Fennoscandia and Denmark. Northern distribution limit runs through Nb. in Sweden, SFi in Norway and Ks in Finland. In Soviet Karelia recorc ed from Ib and Kr. - The species is widely distributed in the Palaearctic region, from northern Africa in the south, the Atlantic Ocean in the west, through southern Siberia to China, Kamchatka and Japan in the East.

The nests are usually constructed in a fairly horizontal, dry, sandy area, but steep, sandy or gravelly slopes may also be used. While the nest is being excavated, small quantities of sand or gravel are removed, carried between the ventral side of the head and the forelegs. Larger particles are released with the mandibles. The entrance of the nest attains a length of 5 to 20 cm and ends in a single larval chamber. The food consists of larger naked larvae of Noctuidae, Notodontidae or the like, e.g. Panolis piniperda Panz., Anarta myrtilli L. and Notodonta sp. Each cell most often contains only a single larva. The paralyzed larva is often carried more than 20 m across uneven ground. During the journey the larva, which is held with the mandibles, is sometimes dropped, while the wasp either climbs or flies up on top of a stone, twig or the like, evidently for better orientation. The return to the nest thus takes place exclusively be the sense of sight. For the last few centimetres the olfactory sense is presumably of rather great importance. When the larva is placed in the cell and the egg laid, loose sand is scraped down into the entrance by means of the forelegs. The sand is stamped firmly together, often with the anterior side of the head. Finally the hole is closed with a stone of suitable size. The place is camouflaged with fir needles, pebbles and the like.

The imago is met with from the end of May to often late in September. Males emerge up to one week earlier than the females. The species, especially in Central Europe, is the host of Paraxenos sphecidarum Duf. (Strepsiptera). Larva described by Iida, 1969.

7. AMMOPHILA PUBESCENS Curtis, 1829
Fig. 91.

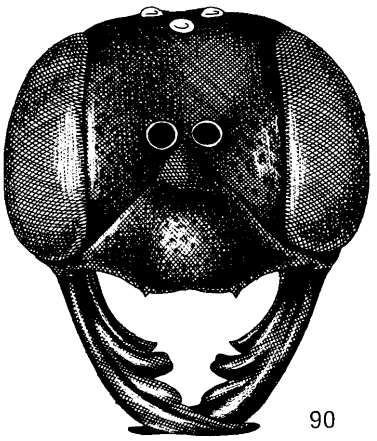
Ammophila pubescens Curtis, 1829: no.672.
Ammophila susterai Šnoflák, 1943: 1.
Ammophila adriaansei Wilcke, 1945: 277.
Ammophila campestris var. alpicola Beaumont, 1945: 468.

Female: 15-19 mm. Head in front view as in Fig.91. Clypeus with slightly projecting median lobe with rounded or obtuse-angled corners. Clypeus proper with distinctly silvery pubescence. Long hairs of head black. Median tooth of the three teeth on the inner side of mandibles rounded distally (Fig.91), the first tooth may be very weak. Diagonally striate sculpture regular dorsally on propodeum, striae

straight. Interspaces with distinct granulation. First tergum mostly, second completely, and anterior quarter of third, red. Black tip of abdomen without metallic lustre. Metatarsus 1 weakly dilated on outer side, trochanter and femur ventrally with a row of strong black bristles. Second and third cubital transverse veins joining at the radial vein or before it, i.e. making third cubital cell petiolate.

Male: 13-17 mm. Long hairs of head black. Silvery pubescence on anterior part of face often collected in small downward tapering bundles so that the underlying cuticula becomes visible. Area just below antennal sockets slightly excavate. Propodeal sculpture as in female, but often more irregular. Whole dorsal side of first tergum black. A black triangular spot occupying most of dorsal face of tergum 2. Dorsum of third tergum black except for two larger or smaller triangular, red spots anteriorly. Tip of abdomen without metallic lustre.

The distribution pattern of this species is rather similar to that of A. sabulosa, but it is a more southern species. The northernmost records from Sweden are from Gstr. and Med. - Only a few records exist from Norway: VAy, Mandal. -



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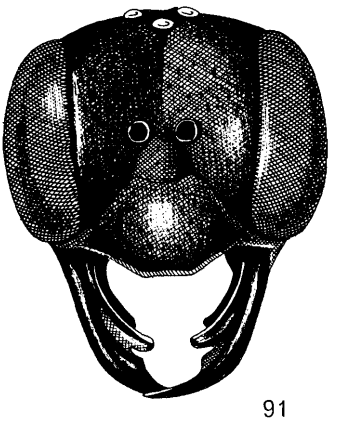

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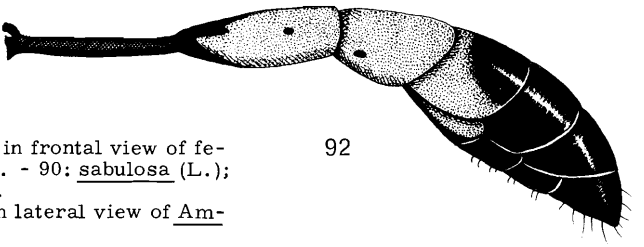

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Figs. 90-91. Heads in frontal view of female of Ammophila. - 90: sabulosa (L.); 91: pubescens Curt.
Fig. 92. Abdomen in lateral view of Ammophila sabulosa.

In Finland the northern distribution limit runs through Ok and ObS. In Soviet Karelia found in Ib and Kr. - The species is common through large parts of Europe, and also occurs in Mongolia.

The species may often be found nesting in the same localities as sabulosa. The female excavates the nest before hunting. Small quantities of material are collected and held between the forelegs and the ventral side of the head while being flown some distance away. When the larval cell has been finally provisioned, the entrance is temporarily closed with a loose sand plug. The prey usually consists of larvae of Geometridae (Lep.), but smaller larvae of Noctuidae may also be used. Exceptionally larvae of Tenthredinidae (Hymenoptera,Symphyta) are used. The prey is paralyzed and flown to the nest. Partly depending on the size of the prey each cell is provisioned with 3-10 larvae. The egg is deposited on the first placed prey, and the larva of the wasp may be far developed before the last prey has been deposited. The nest is carefully closed between each visit. The female will usually inspect her nest between each provisioning. Finally, the entrance is camouflaged with any available material. Metopia argyrocephala Meig. (Diptera, Miltogrammatidae) is recorded as inquiline, and Paraxenos sphecidarum (Duf.) (Strepsiptera) as parasite on imagines in South and Central Europe.

8. AMMOPHILA CAMPESTRIS Latreille, 1809

Ammophila campestris Latreille, 1809, 4: 54.

Female: 11-17 mm. Closely related to pubescens. Distinguished from this (besides the characters mentioned in the key) by the denser silvery pubescence on the clypeus and by the long pilosity being absent from the basal part of the petiolus.

Male: 11-16 mm. Easily distinguished from pubescens by the often completely red second tergum. The first tergum has a dark spot of variable size. The silvery pubescence on the clypeus is evenly distributed, generally not collected in bundles.

This species is widespread and rather common in Denmark. - In Sweden it occurs rather frequently in the south (Sk. and Sm.), whereas the records from Öl. and Dlr. are very few. - Not recorded from Norway. - Finland: a few records from N, St, Om and ObS. Soviet Karelia: Ib, Kr. - The species is widely distributed in the Palaeartic region, but does not seem to be as common as pubescens. Towards the east the species reaches the Pacific.

In contrast to the other Nordic species of Ammophila this species exclusively uses larvae of Tenthredinidae (Hym., Symphyta). Its larva was described by Grandi (1926).

SUBFAMILY PEMPHREDONINAE

A highly diverse subfamily, traditionally accepted to comprise two tribes, the Pemphredonini and the Psenini. The species vary in size from about 2.5 mm in Spilomena to 13 - 15 mm in some Pemphredon and Psen. It does not seem possible to point out an autapomorphism for the group which in several characters resembles the Sphecinae. The second apical spur on tibia 2 is, however, absent, and an oblique carina on coxa 2 is present. It is questionable, if an arboreal nesting habit is an original feature of the subfamily. The Pemphredonini must be considered the more primitive of the two tribes, and I agree with Evans (1959a) that the Psenini probably had a pemphredonine ancestor.

TRIBE PEMPHREDONINI

The Pemphredonini comprises the following Nordic genera: Pemphredon, Ceratophorus, Diodontus, Passaloecus, Stigmus, and Spilomena and is characterized as follows: Inner orbits parallel or slightly converging ventrally. Frons without longitudinal or transverse carinae. Antennae filiform, inserted relatively low on frons. Labrum large. Humeral tubercles reaching the tegulae only in Spilomena. Petiolus formed by sternum 1 alone (abdomen sessile in Spilomena). Females primarily with a pygidial area. Tarsal pecten strongly reduced. Forewings primarily with two cubital and two discoidal cells, but especially in small species these numbers might be reduced. The spinneret of the larva is distinctly paired, although the openings might be connected by a narrow slit. The openings at the tip of two prolongations. Maxillae directed medially, the galea smaller than the maxillary palpus and might be vestigial. Mandibles short and broad, with four to six teeth (fewer in small species). Antennal papillae usually absent.

Genus *Pemphredon* Latreille

Pemphredon Latreille, 1796: 128.
Cemonus Panzer, 1806: 186.
Dineurus Westwood, 1840: 81.
Type-species: Crabro lugubris Fabricius, 1793.

Entirely black, medium to rather small species (Fig. 43). Great morphological variation occurs mainly in the following characters: degree of development

of the head behind ocelli, clypeal pilosity, and number of mandibular teeth. As useful secondary sexual characters can also be mentioned the morphology of the pygidial area of the females and the morphology of the antenna and tarsus 2 of the males. Propodeum with species-specific, but extremely variable sculpture. The dorsal area is surrounded by a more or less strongly raised, broadly U-shaped pad, which may be invaded by the sculpture of the area cordiformis or of the lateral and posterior faces of propodeum. Usually this pad is dull and sculptured in Pemphredon s. str., whereas it often lacks sculpture in the subgenus Cemonus. Petiolus always distinctly longer than wide, with a strongly pitted, rugose or striate sculpture. Abdomen shining, as a rule without any sculpture. Tarsus 1 in females with at most a weak pecten. Forewings with two cubital cells, of which the first is about twice as long as the second.

Almost exclusively distributed in the temperate areas of the Holarctic region (Taiga-species). The genus comprises about 35 species of which about 15 occur in Europe.

The species nest in holes in wood, hollow plant stalks etc. The prey consists of Aphididae.

Due to the great intraspecific variation and rather complicated sculptural characters, which in many cases cannot be adequately described in words, correct identification of the species often presents great difficulties. However, in many cases the secondary sexual characters can be used as key characters. A rather large number of illustrations are included to faciliate the keys and aid identification. For identification of certain species it is highly desirable to have plentiful material for comparison. Traditionally the genus is regarded as comprising two well-defined subgenera, Pemphredon s. str. and Cemonus Jurine, but the taxonomical value of these is highly questionable.

Ceratophorus Shuckard is treated as a distinct genus, since morphological as well as biological characters clearly separate it from Pemphredon.

Key to species of Pemphredon (subgenera in brackets).

1 First discoidal transverse vein joins first cubital cell, second the second cubital cell (rarely interstitial). Third antennal segment 2.5 - 3 times longer than wide. Scutum usually dull, coarsely sculptured, anteriorly generally with distinct transversely rugose or striate sculpture (Pemphredon s. str.) .. 2

-	First and second discoidal transverse veins join first cubital cell. Third antennal segment at most twice as long as broad. Scutum usually shining with more or less distinct punctation (Cemonus Jurine)	9
2(1)	Females	3
-	Males	13
3(2)	Anterior border of clypeus with two incisions, whereby three toothlike projections are formed (Fig. 104). Petiolus much shorter than first tergum ..	4
-	Anterior border of clypeus with at most a single incision	5
4(3)	Pygidial area vestigial, or very narrow, with a sharp longitudinal keel (Fig. 118). Scutum shining, with scattered punctation ..... 11. lugens Dahlbom	
-	Pygidial area broad, surrounded by a projecting ridge or carina (Fig. 117). Scutum with distinct microsculpture, dull, finely and densely punctate. ..... 13. fennicus Merisuo	

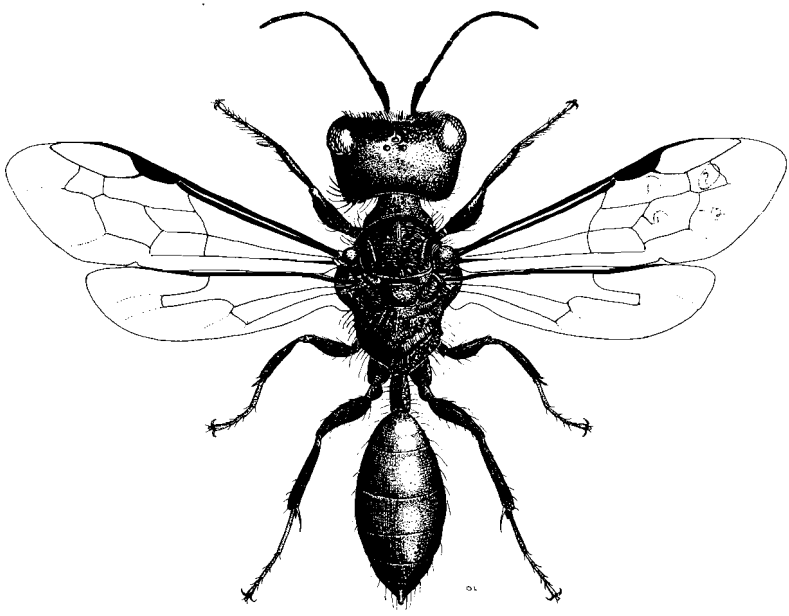


Fig. 93. Female of Pemphredon lugubris (Fabr.). Length: 9-12 mm.

5(3) The pad surrounding the irregularly rugose area cordiformis shining, with weak microsculpture. Pygidial area plane and delimited only by a weak carina (Fig. 114) ..... 15. balticus Merisuo

- The pad surrounding the area cordiformis distinct, often irregularly transversely rugose and dull. Pygidial area usually excavate apically and delimited by a sharp carina. If this is not the case (montanus), the anterior border of clypeus projects in an obtuse angle 6

6(5) Centre of clypeus with a deep semicircular incision delimited on either side by a small tooth (Fig. 106) Pygidial area narrow, excavated in a groove apically ..... 12. flavistigma Thomson

- Anterior border of clypeus without incision, squarely truncate, weakly convex or slightly angularly projecting 7

7(6) Pygidial area broad and flat (Fig. 116). Anterior border of clypeus angularly projecting (Fig. 102). Scutum with coarse fingerprint-like sculpture. 10. montanus Dahlbom

- Pygidial area narrower or groove-like, excavated at least apically. Anterior border of clypeus at most slightly convex. Sculpture of scutum weaker 8

8(7) Head behind eyes strongly narrowed (Fig. 94). Third antennal segment only slightly more than twice as long as broad (Fig. 124) ..... 14. beaumonti Hellén

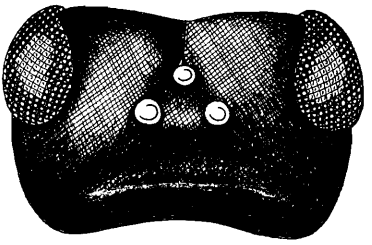
- Head strongly developed behind eyes (Fig. 96). Third antennal segment almost three times longer than broad (Fig. 122) ..... 9. lugubris (Fabricius)

9(1) Females 10

- Males 19

10(9) Anterior border of clypeus arcuate-emarginate in middle (Figs. 108, 109). Pygidial area excavated apically, sides slightly concave, sharply delimited, with two strong bristle-bearing pits subapically (Fig. 121). Space between these often takes the form of a small longitudinal keel 11

- Anterior border of clypeus either flat and trun-



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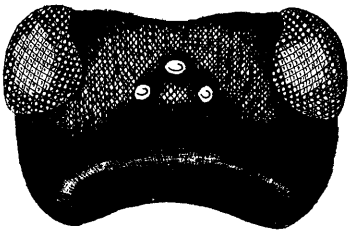

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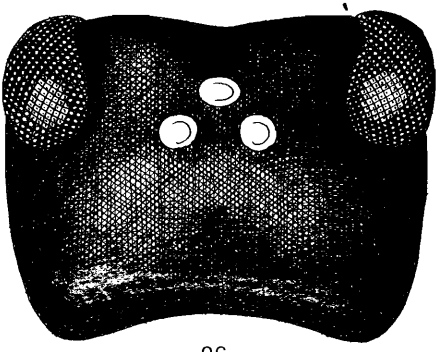

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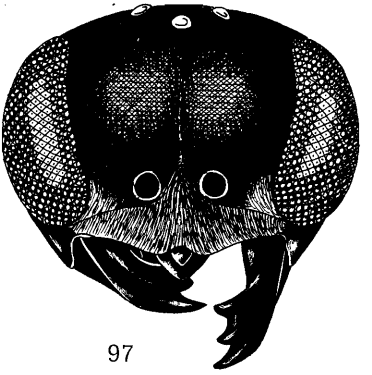

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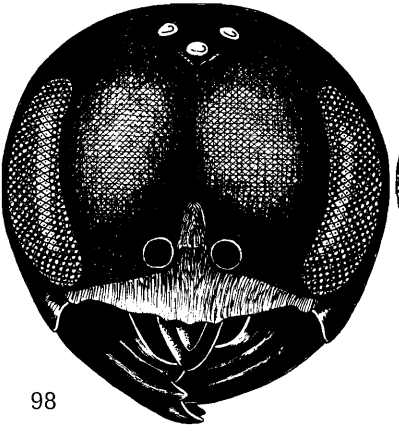

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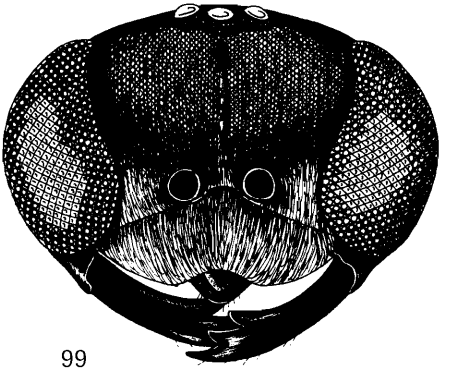

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Figs. 94-96. Heads in dorsal view of female Pemphredon. - 94: beaumonti Hellén; 95: balticus Merisuo; 96: lugubris (Fabr.).
Figs. 97-99. Heads in frontal view of Pemphredon. - 97: fennicus Merisuo, ♂; 98: same, ♀; 99: flavistigma Thomson, ♂.

cate or angularly convex medially (Figs. 111, 112). Pygial area with parallel sides, never with a subapical keel (Figs. 119, 120) 12

11(10) Anterior border of clypeus with a broad, semi-circular emargination delimited on either side by a truncate tooth (Fig. 109). At the bottom of the emargination is often a weak tooth ..... 16. mortifer Valkeila

- Anterior border of clypeus with a quite small to vestigial incision (Fig. 108) ..... 17. wesmaeli (A. Morawitz)

12(10) Clypeus squarely truncate, often with a small projection in the middle (Fig. 112). Scutum with irregularly rugoso-striate sculpture. Sculpture on lateral and posterier faces of propodeum fine, transition between this and the shining pad gradual . 19. lethifer (Shuckard)

- Clypeus convex, anterior border strongly projecting (Fig. 111). The reticulate-rugose sculpture on lateral and posterior faces of propodeum coarse, transition between this and the shining pad sharp ..... 18. inornatus Say

13(2) Metatarsus 2 strongly S-shaped curved (Fig. 135). Dorsal carinae of propodeum regular, almost straight ..... 12. flavistigma Thomson

- Metatarsus 2 at most weakly curved. Dorsal carinae of propodeum very irregular, often anastomosing (except in lugens, which is easily recognizable by the shape of clypeus) 14

14(13) Antennal segments 6 - 9 with strongly developed tyloidea, seen in profile as Fig. 126. Head and thorax with distinct microsculpture. Scutum with weak, sparse punctation. Propodeum weakly sculptured, pad shining ..... 13. fennicus Merisuo

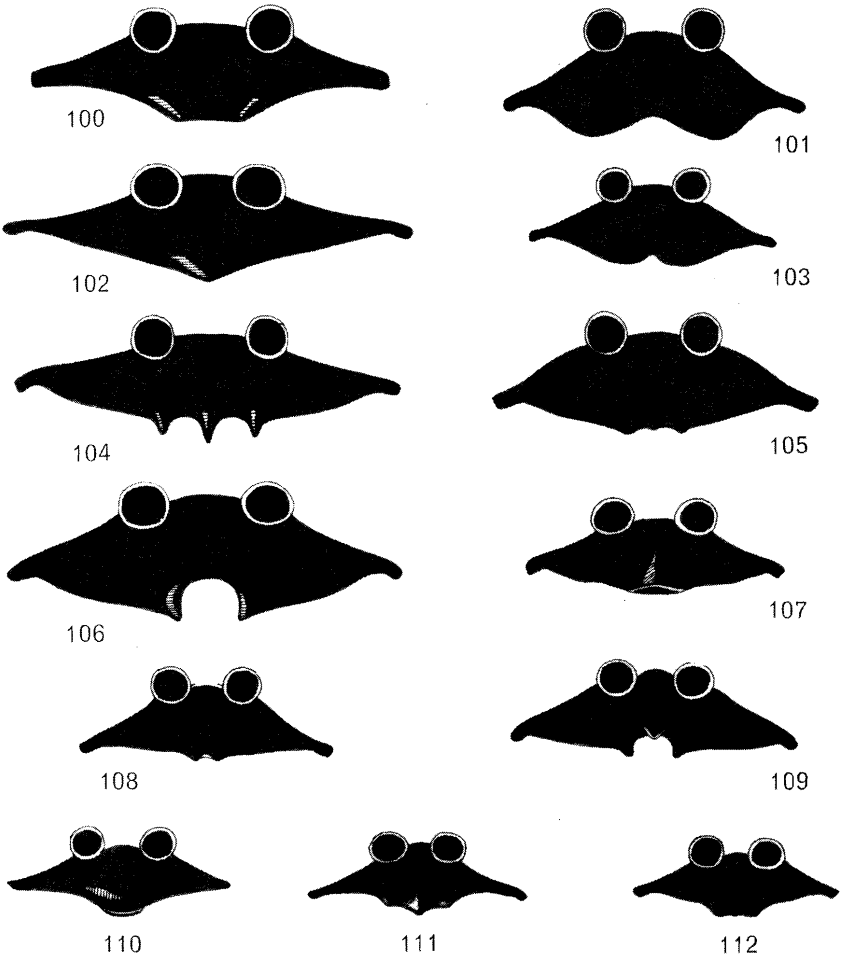
- Tyloidea considerably less distinct. Head and thorax at most with weak microsculpture 15

15(14) Pad surrounding area cordiformis shining, at most with indication of short rugae, with weak and scattered punctation (as in Cemonus). Third and fourth antennal segments of equal length (Fig. 127). Metatarsus 2 very slightly curved (Fig. 134) ..... 15. balticus Merisuo

- Pad surrounding area cordiformis dull, often

strongly reduced due to the dense transverse striae. Third antennal segment longer than fourth 16

16(15) Area cordiformis strongly and regularly striate. Anterior border of clypeus with three weak teeth (Fig. 105). Petiolus very short (Fig. 131) 11. lugens Dahlbom



Figs. 100-112. Clypeus of Pemphredon. - 100: lugubris (Fabr.), ♀; 101: same, ♂; 102: montanus Dahlbom, ♀; 103: same, ♂; 104: lugens Dahlbom, ♀; 105:same, ♂; 106: flavistigma Thomson, ♀; 107: balticus Merisuo, ♀; 108: wesmaeli (A. Mor.), ♀; 109: mortifer Valkeila, ♀; 110: beaumonti Hellén, ♀; 111: inornatus Say, ♀; 112: lethifer (Shuckard), ♀.

- Area cordiformis irregularly rugose. Anterior border of clypeus without teeth. Petiolus longer 17

17(16) Third antennal segment only slightly more than twice as long as broad (Fig. 125). Scutum shining, with strong punctation ..... 14. beaumonti Hellén

- Third antennal segment almost three times longer than broad. Scutum irregularly punctate and/or rugose 18

18(17) Anterior border of clypeus with a quite small arcuate emargination (Fig. 103). Outside of tibia 3 with row of pale spines. Metatarsus 2 very slightly curved, twice as long as second tarsal segment (Fig. 133) ..... 10. montanus Dahlbom

- Anterior border of clypeus very broadly emarginate (Fig. 101). Tibia without spines on the outer side. Metatarsus 2 straight, more than twice as long as second tarsal segment (Fig. 132) ... 9. lugubris (Fabricius)

19(9) Flagellum ventrally without sharply delimited tyloidea, at most with swollen areas. Scutum very finely and sparsely punctate ..... 18. inornatus Say

- Middle segments of flagellum with sharply delimited tyloidea. Scutum with coarser and denser punctation 20

20(19) At the bottom of the deep emargination in the anterior border of clypeus usually a small truncate tooth. Tyloidea as in Fig. 129 ..... 16. mortifer Valkeila

- Emargination shallower, evenly arcuate 21

21(20) Tyloidea distinctly convex longitudinally (Fig. 130); can be strongly reduced in small specimens. The shining pad surrounding area cordiformis broad, only slightly invaded by the rugae from the area cordiformis. Posterior face of propodeum densely and rather strongly pitted ..... 19. lethifer Shuckard

- Tyloidea sharp, narrow, almost linear (Fig. 128). The pad surrounding the area cordiformis strongly reduced due to the invading rugae. Lateral and posterior face of propodeum coarsely reticulate-rugose ..... 17. wesmaeli (A. Morawitz)

9. PEMPHREDON (PEMPHREDON) LUGUBRIS (Fabricius, 1793)
Figs. 10, 93, 96, 100, 101, 113, 122, 123, 132.

Crabro lugubris Fabricius, 1793:302.
Pemphredon luctuosus Shuckard, 1837:197.
Pemphredon pacificus Gussakovski, 1932:8.

Female: 9-12 mm. Head (Fig. 96) strongly developed behind eyes, seen from above approximately rectangular. Clypeus (Fig. 100) plane, sparsely and somewhat irregularly punctate. Anterior border slightly projecting, weakly convex, almost squarely truncate. Punctation in front of ocelli dense and fairly coarse, punctures longitudinally fusing into a rugose sculpture. Vertex with scattered punctures, shining, with extremely weak and irregular microsculpture. Pilosity of head long, whitish. Antennae (Fig. 122) long and slender, third segment about three times longer than broad. Scutum on either side with irregular arcuate striation and weak interstitial rugosity. Mesopleuron in front of coxa 2 with a rather strong transverse striation. Area cordiformis with strong, very irregular costae on shining background. Pad surrounding the area densely and rather finely, transversely rugose, with a rather dull appearance. Pygidial area (Fig. 113) narrow, apically rather strongly excavate, delimited by a sharp carina. Tibia 3 on outer side with a row of short, dark spines.

Male: 7.5-10 mm. Head in front view very broad. Eyes strongly convex. Seen from above head strongly narrowed posteriorly. Clypeus (Fig. 101) with strong, dense, silvery pubescence, which covers the broad emargination in the anterior border. Antennae (Fig. 123) long and slender, third segment almost three times as long as broad, distinctly longer than fourth segment. Median flagellar segments with narrow, sharply delimited tyloidea. Sculpture and pubescence as in female. Scutum shining, with scattered, irregular punctation, only very seldom forming distinct rugae. Mesopleuron with transverse striation in front of coxa 2. Pad surrounding the strongly rugose area cordiformis normally with transverse striation, but especially in small individuals this may be almost vestigial. These specimens therefore may be very similar to beaumonti or balticus (see key to species). Petiolus longer than first tergum. Tibia 3 without spines.

Common and widely distributed in Fennoscandia and Denmark. Denmark: not found in WJ, NWJ and SZ. - Sweden: northern distribution limit in Hrj. and Jmt.; a few specimens from Ly. Lpm. - Norway: the species is rather common in the southern districts. A few records from NTi, Nnø and TR. - Finland: very common up to ObN and Ks. - Soviet Karelia: Ib and Kr. - Wide-

ly distributed throughout the Palaearctic region, eastwards to the Pacific Ocean.

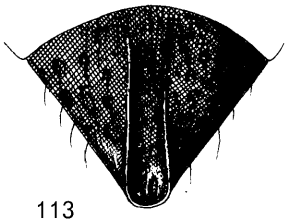
The nests (Fig. 10) are most often gnawed in decayed deciduous wood, often in connection with existing tunnels of e. g. xylophagous Coleoptera. The nest consists of a branched system, in which the cells are situated in rows. Prey consists of larger aphids (Aphididae), e. g. wingless specimens of Aphis sambuci L. of which about 40 are placed in each cell. In a few cases two or more females have been observed using the same entrance. It is, however, only the first few centimetres of the main tunnel which is common. The species hibernates as a fully grown larva (pre-pupa) and emerges at the beginning of June. As hymenopterous parasitoids Perithous mediator and P. divinator (Pimplinae) and Omalus violaceus and O. aeneus (Chrysididae) are recorded. The larva was described by Janvier (1961).

10. PEMPHREDON (PEMPHREDON) MONTANUS Dahlbom, 1845
Figs. 102, 103, 116, 133.

Pemphredon montanus Dahlbom, 1845: 262.
Female: 9-12 mm. Head seen from above strongly developed behind eyes (as in lugubris). Punctation in front of ocelli very dense, rather coarse, especially laterally coalescing into a striate sculpture. Clypeus (Fig. 102) shining, angularly projecting in the middle. Rest of head dull due to the well developed microsculpture. Scutum with indistinct, large punctures, dull, especially posteriorly with dense, distinct fingerprint-like sculpture on either side of the midline. Mesopleuron dull in front of coxa 2, with sparse, weak punctation. Area between base of forewings and the horizontally running coarsely pitted furrow on mesopleuron finely coriaceous. Pad surrounding the area cordiformis dull, densely and finely transversely rugose. Abdomen dull, with microsculpture. Pygidial area (Fig. 116) broad, almost plane and with distinct microsculpture. Surrounding carina only distinct apically.

Male: 8-10 mm. Very similar to lugubris, but distinguishable by the following characters: clypeus (Fig. 103) in the middle with a small arcuate emargination. Middle flagellar segments slightly swollen, ventrally with only short and indistinctly delimited tyloidea. Mesopleuron in front of coxa 2 without transverse striation. Petiolus distinctly shorter than first tergum. Metatarsus 2 weakly curved (Fig. 133).

Figs. 113-121. Pygidial areas of female Pemphredon. - 113: lugubris (Fabr.); 114: balticus Merisuo; 115: beaumonti Hellén; 116: montanus Dahlbom; 117: fennicus Merisuo; 118: lugens Dahlbom; 119: lethifer (Shuckard); 120: inornatus Say; 121: mortifer Valkeila.



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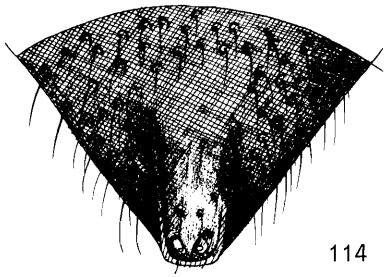

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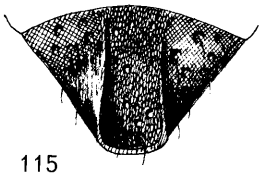

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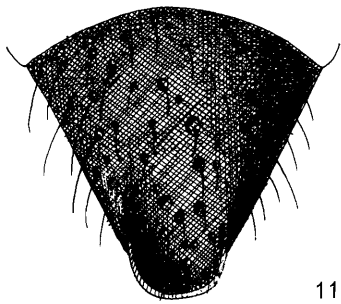

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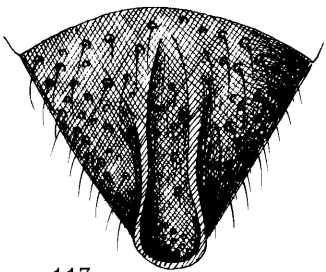

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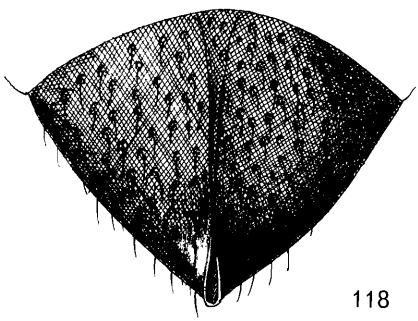

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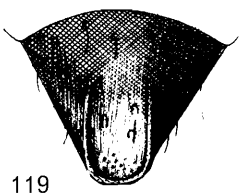

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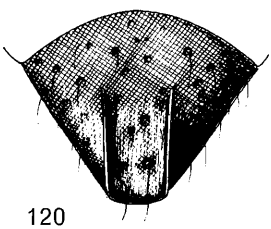

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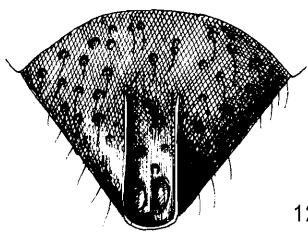

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Very common in Fennoscandia, but absent in Denmark. - Sweden: the species seems to avoid coastal regions, at least in the southern parts. A typical boreal species. Northern distribution limit in Ly. Lpm. and Lu. Lpm. - Norway: only found in the northern districts: Nnø, Fi and Fn. - Finland: very common throughout the country from Al to LkW and Li. - In Soviet Karelia recorded from Ib and Kr. - A Holarctic species. Like lugubris, this species is widely distributed throughout the Palaearctic region, eastwards to Japan.

The tunnel system is often very complicated, since several females may use the same entrance.

11. PEMPHREDON (PEMPHREDON) LUGENS Dahlbom, 1842
Figs. 104, 105, 118, 131.

Pemphredon lugens Dahlbom, 1842: 76.

Female: 9-12 mm. Very easily recognizable species. Clypeus (Fig. 104) plane, shining, with two semi-circular emarginations between three sharp teeth. Scutum rather shining, distinctly punctate, without striation. Striae strong in area condiformis, fairly regular. Pad very indistinct, considerably invaded by striae. Petiolus (Fig. 131) very short, hardly twice as long as broad. Last tergum without typical pygidial area, with a sharply projecting longitudinal keel (Fig. 118).

Male: 8-10 mm. Anterior border of clypeus (Fig. 105) with two weak emarginations and three obtuse teeth. Scutum superficially punctate, shining. Striation on propodeal dorsum strong and very regular, often completely concealing the surrounding pad. Petiolus at most twice as long as broad, considerably shorter than first tergum.

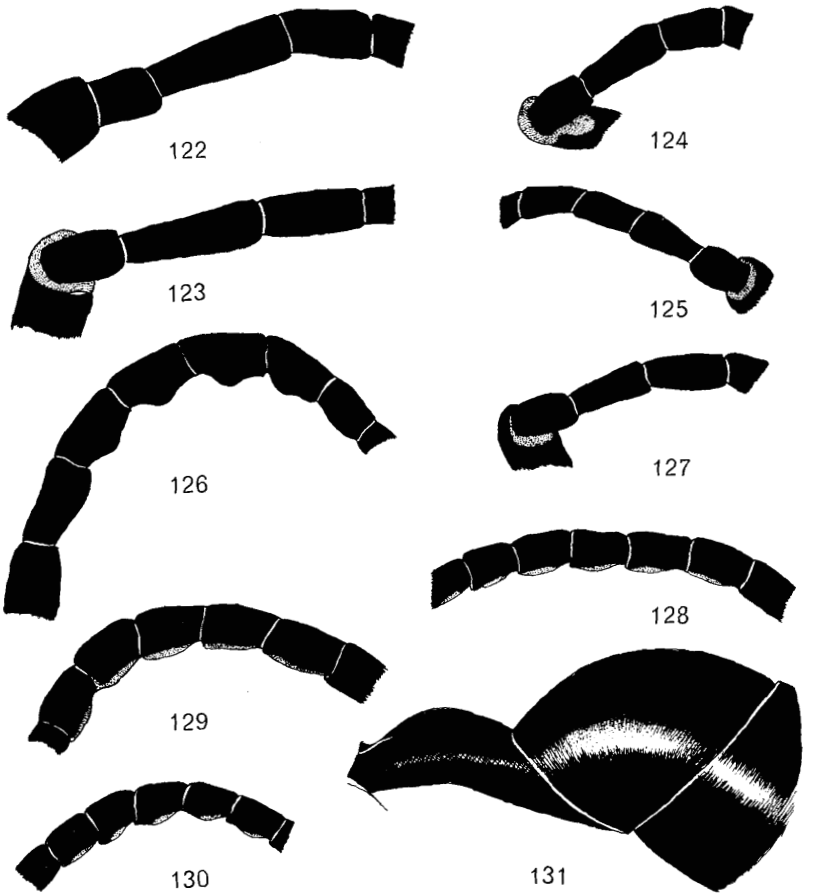
One of the most common Pemphredon species in Fennoscandia. - Found in most Swedish districts up to Nb. - Finland: almost the same distribution as lugubris and montanus, northern distribution limit in LkW. - In Soviet Karelia this species occurs in Ib and Kr. - Not recorded from Norway, although it probably exists there. - Predominantly a montane species in Europe, common in the Alps and the Pyrenees.

Nest often constructed in connection with deserted tunnels in decayed wood. Prey consists of Aphididae, e.g. Aphis sp., of which 28-31 constitute provision for the larva. Egg is attached to one of the midmost aphids. Larva described by Janvier, 1961.

12. PEMPHREDON (PEMPHREDON) FLAVISTIGMA Thomson, 1874
Figs. 99, 106, 135.

Pemphredon flavistigma Thomson, 1874: 192.

Female: 11-13 mm. Large, robust species. Head strongly developed posteriorly. Frons with fine sculpture, consisting partly of coalescing punctures. Vertex with scattered, rather coarse punctation and distinct microsculpture, surface thereby exhibiting a weak lustre. Clypeus (Fig. 106) rather shining, with deep, almost semi-circular emargination in the anterior border. Third anten-



Figs. 122-130. Antennae of Pemphredon. - 122: lugubris (Fabr.), ♀; 123: same, ♂; 124: beaumonti Hellén, ♀; 125: same, ♂; 126: fennicus Merisuo, ♂; 127: balticus Merisuo, ♂; 128: wesmaeli (A. Mor.), ♂; 129: mortifer Valkeila, ♂; 130: lethifer (Shuckard), ♂.
Fig. 131. Base of abdomen of Pemphredon lugens Dahlbom.

nal segment almost three times longer than broad. Sculpture of scutum coriaceous. Punctation rather superficial and irregular, posteriorly partly coalescing longitudinally. The microsculpture consists of fine lines, especially distinct anteriorly. Scutellum rather coarsely punctate with distinct reticulate microsculpture. Mesopleuron anterior to coxa 2 rather shining, finely and somewhat sparsely punctate, with distinct microsculpture. Area cordiformis with strong, somewhat irregularly radiating striae. Pad finely and densely transversely striate. Posterior face of propodeum finely rugose. Petiolus weakly sculptured, as long as first tergum. Abdomen dull, distinctly microsculptured. Pygidial area narrow, excavated in a groove with coarse punctures. Wings strongly infumate.

Male: 9-11 mm. Head (Fig. 99) in frontal view very broad, eyes strongly convex. Frons in front of ocelli with rugose or granulate sculpture, behind ocelli punctate with fine transverse lateral striation. Clypeus concave, anterior border with broad, shallow, arcuate emargination. Third antennal segment almost three times as long as broad. Flagellar segments ventrally with dull, oval tyloidea. Scutum dull, with superficial, somewhat irregular punctation. Scutellum densely punctate, interspaces densely rugose. Mesopleuron fairly shining with distinct punctation and fine microsculpture. Area cordiformis with strong radiating costae. Pad surrounding the area finely and densely transversely rugose. Posterior face of propodeum irregularly rugose. Petiolus irregularly and very superficially sculptured, as long as first tergum. Abdomen distinctly microsculptured. Metatarsus 2 strongly curved, slightly dilated distally (Fig. 135). Wings strongly infumate.

A rare species in Fennoscandia. - Sweden: from central Småland to Hls. and Jmt. - Finland: from Al to a little north of the Polar Circle in ObN, Rovaniemi . - Soviet Karelia: Ib and Kr. - Widely distributed in the more temperate, continental parts of the Palaearctic region, eastwards to Japan.

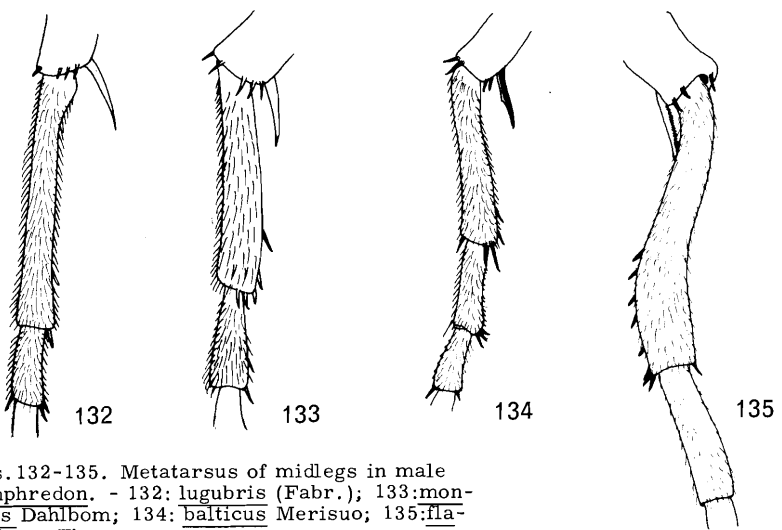
The nests are constructed in decayed wood, e. g. Betula (Finland) and Morus (Japan). The tunnel system is branched, the inside diameter varies from 4. 5 to 5. 7 mm. The length of the larval cells varying from 6. 5 to 14 mm, the partitions between the cells made of sawdust. 15-20 wingless aphids (Cinara sp., Tsuneki, 1952) constitute the provision. The species overwinters as a prepupa.

13. PEMPHREDON (PEMPHREDON) FENNICUS Merisuo, 1972
Figs. 97, 98, 117, 126.

Pemphredon fennicus Merisuo, 1972: 14.

Female: 10 mm. Head large, in front view as Fig. 97. Frons in front of ocelli punctate, without striation, interspaces with fine longitudinal lines. Area behind ocelli with distinct microsculpture, dull, punctate. Anterior border of clypeus with two weak emarginations, whereby three small teeth are formed (Fig. 97). Third antennal segment about 2.5 times longer than broad. Scutum and scutellum with superficial punctation, but strong microsculpture. The furrows on mesopleuron vestigial or absent. Mesopleuron otherwise weakly punctate, dull. Area cordiformis with fine, dense, transverse undulating striae. Pad surrounding the area broad, slightly convex, rather shining, with fine transverse rugosity. Petiolus dorsally with a deep longitudinal furrow, very weakly sculptured, distinctly shorter than first tergum. Pygidial area (Fig. 117) with a distinct delimiting carina only around apex, rather broad, only slightly concave, apically with a group of hair-bearing punctures.

Male: 8 mm. Frons in front of ocelli coriaceous, dull. Behind ocelli distinctly and rather sparsely punctate, with strong reticulate microsculpture. Just behind posterior ocelli is a small swelling. Clypeus (Fig. 98) in middle with a rather narrow arcuate emargination. Third antennal segment hardly twice as long as broad. Middle flagellar segments with very well developed tyloidea, in profile as Fig. 126. Scutum very superficially sculptured, rather shining, because the microsculpture is weak. Sculpture of area cordiformis considerably weaker than in remaining species of Nordic Pemphredon s. str.



Figs. 132-135. Metatarsus of midlegs in male Pemphredon. - 132: lugubris (Fabr.); 133: montanus Dahlbom; 134: balticus Merisuo; 135: flavistigma Thomson.

Pad surrounding area cordiformis shining, very slightly elevated. Posterior face and lateral parts finely granulate or coriaceous. Petiolus shorter than first tergum, dorsally with strongly depressed longitudinal furrow. Metatarsus 2 slightly curved, distinctly flattened on inner side.

This species is hitherto only known from the two type specimens (female and male), which both originate from the boreal coniferous forest zone in Lapland, Gargnäs, Ly. Lpm. in Sweden (male) and Suomussalmi, Ok in Finland (female).

Note. Fennicus is very closely related to the North American nearcticus Kohl. The variation within fennicus cannot be studied until more material is available, and the possible synonymy will not be discussed here. The distribution of the two forms suggests a separation during the glaciation in Pleistocene.

14. PEMPHREDON (PEMPHREDON) BEAUMONTI Hellén, 1955
Figs. 94, 110, 115, 124, 125.

Pemphredon beaumonti Hellén, 1955: 65.

Female: 7-8 mm. Head (Fig. 94) seen from above posteriorly strongly narrowed. Median lobe of clypeus thickened, rounded (Fig. 110). Frons in front of ocelli coarsely and densely punctate, and with indistinct longitudinal sculpture. Antennae (Fig. 124) short, third segment about twice as long as broad, only slightly longer than fourth segment. Scutum without actual punctation, but with coarse, irregular pit-like depressions, without striae. Scutellum likewise without striation. Mesopleuron in front of coxa 2 shining, with coarse punctures and very weak transverse rugae. The area cordiformis rather dull and very irregularly longitudinally rugose. The pad surrounding it with faint transverse rugae. Pygidial area (Fig. 115) comparatively broad, with distinct delimiting carina. Second and third sternum with scattered and rather coarse punctures. Metatarsus 1 ventrally with very short, weak and pale spines.

Male: 5.5-6.5 mm. Head densely and rather coarsely punctate. Clypeus with small, shallowly arcuate emargination in anterior border. Antennae (Fig. 125) short, third segment about twice as long as broad. Scutum shining, without striation but with dense, very coarse punctation. Mesopleuron in front of coxa 2 with very dense and rather strong punctation. Pad surrounding area cordiformis irregularly, transversely rugose. Petiolus short (as in balticus). Abdomen distinctly punctate. Metatarsus 2 on inner side and tibia 3 on outer side with a row of spines.

Very rare species in North and Central Europe, perhaps having a boreo-

montane distribution. In Fennoscandia a few specimens from Sweden: Gtl. and Finland: Ab and Sa. - In Soviet Karelia known from Ib.

Only a single nest has been recorded (Merisuo, 1972). This nest was found in a decayed pole, in which Calopus seraticornus L. (Col., Oedemeridae) was found. The nest produced 5 females and 2 males.

15. PEMPHREDON (PEMPHREDON) BALTICUS Merisuo, 1972
Figs. 95, 107, 114, 127, 134.

Pemphredon balticus Merisuo, 1972: 13.

Female: 8-11 mm. Very similar to small specimens of lugubris, but can be separated by the shining pad surrounding the area cordiformis. Anterior border of clypeus almost squarely truncate, rather strongly thickened, in front view forming a flat triangle (Fig. 107). Frons with fairly regular punctation with intermediate, very fine, oblique rugae. Head (Fig. 95) posteriorly distinctly narrowed. Part of scutum with irregular, rather coarse, pitted sculpture, part with fine, transverse, slightly arcuate rugae. Mesopleuron anterior to coxa 2 shining and smooth, with only few punctures and extremely fine transverse striation. Costae in area cordiformis irregularly undulating. Petiolus seen from above comparatively short. Pygidial area (Fig. 114) broad but rather indistinct, only apically with delimiting carina; its punctation weak.

Male: 6-10 mm. Very similar to small specimens of lugubris, from which it can be distinguished by the following characters: pad surrounding area cordiformis shining, only slightly invaded by costae from the latter. Third and fourth antennal segments of equal length (Fig. 127). Petiolus shorter than first tergum (1:1.1). Metatarsus 2 as Fig. 134, twice as long as second tarsal segment.

The species occurs very sporadic in Sweden: Hall., Sm., Ög. and Upl., and Finland: Al, Ab, N and Ta. - Otherwise very scattered in Europe (Poland, Germany, and Holland).

Known to breed in dead branches of Sambucus racemosa.

16. PEMPHREDON (CEMONUS) MORTIFER Valkeila, 1972
Figs. 109, 121, 129.

Pemphredon mortifer Valkeila, in Valkeila & Leclercq, 1972: 697.

Female: 8-10 mm. Head behind ocelli strongly developed. Anterior border of clypeus (Fig. 109) usually very characteristically shaped, since in the deep emargination there is a small tubercle or tooth. Emargination always broader

than width of scapus. Frontal keel very short or absent. Scutum with coarse, somewhat irregular punctation, which - especially in the anterior third - may have a tendency to form weak transverse rugae. Punctation on anterior two-thirds of scutum dense, interstices equal to or less than their diameter. Pubescence distinct over the whole surface. Area cordiformis distinctly depressed, rugae strong and slightly irregular, locally connected by transverse rugulae. Delimitation between shining pad and the coarsely reticulate-rugose sculpture on posterior face of propodeum sharp. Lateral margins of pygidial area (Fig. 121) slightly concave subapically, surface here with two large grooves, by which a more or less distinct median longitudinal keel is formed.

Male: 6-8 mm. Very similar to wesmaeli, but always recognizable by the shape of clypeus. The strong emargination is almost always provided with a small truncate tooth or tubercle. Median flagellar segments as Fig. 129. Frontal keel usually distinct. Scutum with coarse and rather dense punctation, occasionally with shining impunctate areas. Posterior face of propodeum coarsely reticulate-rugose. The shining surrounding pad occasionally reduced, owing to the very strong rugae of the area cordiformis. Second to fifth sterna with depressed apical margins.

Rather limited material exists from Denmark: NEZ, F and EJ. - Sweden: scattered occurrence from Sk. in the south to Ly. Lpm. in the north. - Not known from Norway and Finland, but occurs in Soviet Karelia, Ib and Kr. - The species is recorded from Central, East and North Europe. Additional material exist from Japan, Korea and Sakhalin; this material might constitute a separate subspecies.

The nests are constructed in timber and can have a complicated branching system. Each side branch normally terminates with a single cell, only in a few instances are there two in each of them. The number of cells varies considerably (max. 22), but it seems probable that the nest systems are composed of a number of smaller systems, constructed by several females (Tsuneki, 1952). The larva was described by Janvier, 1960. Omalus auratus (Linné) (Hymenoptera, Chrysididae) is recorded as a parasitoid.

17. PEMPHREDON (CEMONUS) WESMAELI (A. Morawitz, 1864)
Figs. 108, 128.

Cemonus wesmaeli A. Morawitz, 1864: 459.

Sphex unicolor Panzer, 1798: H. 52, T. 24 (preocc.).

Pemphredon scoticus Perkins, 1929: 55.

Female: 8-10 mm. Vertex strongly developed. Clypeus (Fig. 108) flat, anterior border with small arcuate emargination, at most as wide as scapus. Frontal keel short or absent. Punctation of scutum very variable, but always well developed. Punctures dense, coarser than those of vertex, often coalescing into transverse rugae anteriorly. Distance between punctures usually as great as or less than the diameter of these. Pilosity distinct, rather strongly developed, distributed over whole surface. Rugae in area cordiformis strong and irregular, especially centrally, where they partly invade the shining pad. Posterior face of propodeum coarsely reticulate-rugose. Transition to pad often sharp. Pygidial area slightly constricted sub-apically, here with two large pits, each containing 1-3 bristle-bearing punctures. Second sternum distincly punctate, punctures deeper than on following sterna.

Male: 7-9 mm. Can easily be confused with mortifer. Median flagellar segments with distinct tyloidea (Fig. 128). Emargination on anterior border of clypeus, however, always slighter, and always lacking the small tubercle at the bottom. The sculpture of scutum very variable, usually consisting of coarse punctures. Propodeum coarsely reticulate. The shining pad surrounding the very strong rugae of the area cordiformis often almost intersected by these in such a way that only a narrow margin is left. Posterior margins of second to fifth sternum distinctly depressed.

Denmark: a female from NEZ, Tisvilde Hegn. - Sweden: from Sk. in the south to Nb. in the north, not uncommon. - Norway: very little material from SFi, Flesje and Ri, Lerhang. - Widely distributed in Finland, from Al, Ab, and N in the south to Kb and Ks in the north. - Soviet Karelia: Ib and Kr. - Widely distributed in the temperate Palaeartic region.

The nests are constructed in decayed timber or pith-filled stems of e.g. Artemisia. The tunnel system is branched, often each side branch ending only with a single cell. Provision consists of Aphididae, e.g. Aphis, Myzus, Anuraphis, Macrosiphum or Atheroides. The larva was described by Janvier, 1960.

18. PEMPHREDON (CEMONUS) INORNATUS Say, 1824
Figs. 111, 120.

Pemphredon inornatus Say, 1824: 339.

Pemphredon shuckardi A. Morawitz, 1864: 460.

Female: 5-8 mm. Head seen from above comparatively short. Middle of clypeus (Fig. 111) strongly convex, anterior border angularly projecting. Punctation of scutum weak and sparse, on posterior two-thirds drawn out

into very weak longitudinal furrows. Pilosity thin, often only visible on anterior half of scutum. Punctation of scutellum likewise weak, extended into longitudinal furrows. Rugae of area cordiformis irregular. Often the stronger longitudinal rugae are connected by transverse rugulae. The shining surrounding pad well developed, often deeply invaded centrally by the rugae of the area cordiformis. Posterior face of propodeum coarsely reticulate-rugose. Transition between this and the shining pad very distinct. Pygidial area (Fig. 120) with parallel sides, with a few, weak, hair-bearing punctures apically. The surface itself shining, with only very few punctures. Second sternum very sparsely and finely punctate.

Male: 5-7 mm. Antennae without sharply delimited tyloidea, at most with slight swellings. In front of the anterior ocellus a sharp longitudinal keel often is found. Scutum smooth and shining with very scattered, fine punctation. Punctures much weaker than those of vertex. Scutellum with sparse but deeper punctures, and shining interstices. Propodeum as coarsely sculptured as in female. Posterior borders of sterna not depressed.

A common and widespread species in Fennoscandia and Denmark. Northern distribution limit not far from the Arctic Circle in Sweden and Finland. - Norway: a few records from Ø and AK. - Widely distributed throughout the Palaearctic region, eastwards to Mongolia, Japan and Kamchatka. In North America east of the Rockies.

The species breeds sometimes in branches and old wood, sometimes in galls of Lipara (Dipt., Chloropidae) on Phragmites. The prey consists of Aphididae, e.g. Phorodon, Aphis, Macrosiphum, Myzus, Thelaxes, Amphorophora, Anuraphis, Pterocomma, Chaitophorus, Pterocallidium, and Callipterus. Occasionally isolated individuals of a second generation are seen in the middle of September. As a hymenopterous parasitoid is recorded Perithous divinator Rossi (Pimplinae).

19. PEMPHREDON (CEMONUS) LETHIFER (Shuckard, 1837)
Figs. 112, 119, 130.

Cemonus lethifer Shuckard, 1837: 201.

Pemphredon littoralis Wagner, 1918: 143.

Pemphredon fuscatus Wagner, 1918: 143.

Pemphredon neglectus Wagner, 1918: 143.

Pemphredon minutus Wagner, 1918: 143.

Pemphredon brevipetiolatus Wagner, 1931: 232.

Female: 6-8.5 mm. Clypeus (Fig. 112) plane, only the anterior border proper slightly reflected, almost squarely truncate. Scutum with rather coarse, dense punctation, which rarely coalesces to form weak transverse rugae. The punctures sharply delimited anteriorly, posteriorly tapering into the interspaces, punctation almost as strong as that of vertez. Pilosity of scutum weak, visible only in anterior half. Sculpture of posterior face of propodeum dorsally continuing evenly into the shining pad surrounding the area cordiformis. Rugae of area cordiformis strong and regular, usually without transverse connections. Pygidial area (Fig. 119) with parallel sides, with 4-8 extremely small hair-bearing punctures subapically. Second sternum distinctly punctate.

Male: 5-8 mm. Antennae with characteristic tyloidea (Fig. 130). Keel in front of anterior ocellus very short or replaced by a weak longitudinal furrow. Punctation of scutum very variable, usually as in female. Occasionally the punctation is considerably sparser, but in that case more distinct. Propodeum as in female, but rugae of area cordiformis more irregular. Second sternum distinctly punctate. Posterior borders of sterna 2-5 distinctly depressed.

The species is common all over Denmark. - Sweden: rather common in the south, northern distribution limit through Vrm. and Gstr. - Norway: an isolated occurrence in the south-western part. - Finland: only found in the south-western districts. Soviet Karelia: Kr. - Distributed over large areas of the Palaearctic region, eastwards to Japan. Recently introduced to North America (Krombein & Burks, 1967).

The species prefers to nest in stems of different species of Rubus, sometimes also in wood, or in galls of Lipara lucens (Dipt., Chloropidae) in Phragmites. The construction is dependent partly on the diameter of the stem, thus in thicker stems a branched system may be made. The prey consists of various species of aphids (Aphididae), but each nest is mainly provisioned with a single species. The larva was described by Janvier, 1961; Grandi, 1961; Evans, 1964 and Iida, 1969. As a rule the species has only a single generation, but isolated individuals may have a second generation in September. It is scarcely possible for these to provision new nests. Several hymenopterous parasitoids are recorded (See Danks, 1971).

Note: The extensive list of synonyms suggests a considerable intraspecific variability. The variation is, however, rather continuous with respect to each character, and neither geographical nor biological criteria seem to indicate the existence, either of more species or of subspecies.

Genus *Ceratophorus* Shuckard

Ceratophorus Shuckard, 1837: 195.
Type-species: Pemphredon morio van der Linden, 1829.

The genus was long treated as a subgenus of Pemphredon, but I find it most appropriate to refer its only two species to a distinct genus on the ground of morphological and biological criteria.

Head in front view (Fig. 137) very broad, between antennal sockets a strongly projecting process. Clypeus (Fig. 138) with a very deep emargination, on either side delimited by a rounded tooth. Mandibles narrow, in female bidentate, in male tridentate. Antennae short, third segment only slightly longer than fourth. Labrum very large, projecting like a tongue. Scutum smooth and shining, only anteriorly with distinct punctation. Area cordiformis strongly rugose, surrounded by a shining pad. Petiolus very short, only slightly longer than broad. Females with almost plane pygidial area (Fig. 139, 140). Males lack the dense, silvery pubescence on clypeus. Forewings with two cubital cells, each of them joined by a discoidal transverse vein. The males can be extremely difficult to identify correctly.

The species breed in wood. In contrast to most Pemphredon-species the full-grown larva spins a complete cocoon. The prey consists of wingless aphids.

Key to species of Ceratophorus

1 Female: emargination in middle of clypeus evenly rounded (Fig. 137). Process between antennal sockets with distinctly concave sides, broadest subapically. Pygidial area distinctly excavate, delimited by a sharp carina (Fig. 139).
Male: larger, 6-7.5 mm. Head comparatively narrow ..... 20. morio v. d. Linden

– Female: emargination in middle of clypeus with weak projection (Fig. 138). Process between antennal sockets with parallel sides. Pygidial area very slightly excavate, its delimiting carina weak (Fig. 140).
Male: smaller, 4.5-5.5 mm. Head comparatively broad ..... 21. clypealis Thomson

20. CERATOPHORUS MORIO (van der Linden, 1829)
Figs. 136, 137, 139.

Pemphredon morio van der Linden, 1829: 82.

Ceratophorus anthracinus Smith, 1851: 126.

Pemphredon carinatus Thomson, 1870: 236.

Female: 7-9 mm. Head (Fig. 137) densely and strongly punctate. Punctures in front of ocelli coalescing into a rugoso-punctate sculpture. Emargination in anterior border of clypeus smooth at the bottom, without a tubercle. Frontal process strongly developed, its sides concave, apex often with a small emargination. Pygidial area longer than broad (Fig. 139).

Male: 6 - 7.5 mm. As female, but smaller. Emargination in anterior border of clypeus with a small tubercle in middle. Sterna with a rather dense fringe of yellowish hairs.

A rather sporadic species, locally often frequent. Denmark: only in North Zealand. - Sweden: several localities from Sm. in the south to Vg. in the north. - Norway: a single specimen from AK, Oslo. - Finland: from Al,

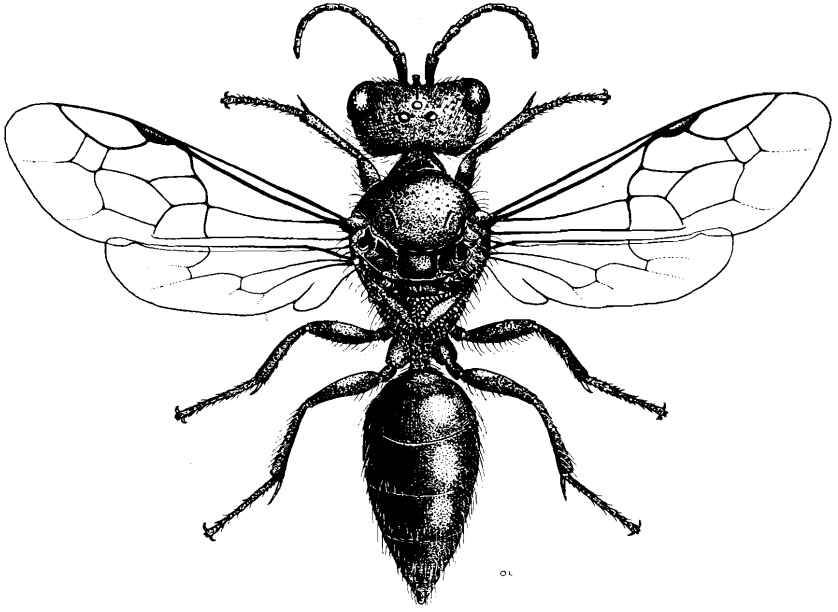


Fig. 136. Female of Ceratophorus morio (v. d. Lind.). Length: 7-9 mm.

Ab, and N in the south to ObS and Ks in the north. - Soviet Karelia: Ib and Kr. - Widely distributed in Europe.

The nests consist of a branched tunnel system, where each side branch ends in a cell. The provision consists of aphids, e.g. Amphorophora and Anuraphis. The egg is deposited on the ventral side of one of the first caught aphids. The full-grown larva spins a comparatively firm cocoon, in which there are no remains of aphids. See also Janvier, 1961.

21. CERATOPHORUS CLYPEALIS (Thomson, 1870)
Figs. 138, 140.

Pemphredon clypealis Thomson, 1870: 236.

Very similar to morio, and only separable from this by the characters mentioned in the key. The female occasionally lacks the small tubercle at the bottom of the emargination in clypeus (Fig. 138).

Not as common as morio, and even with a more sporadic distribution. - Denmark: a few specimens from F and NEZ. - Sweden: Sk., Gtl., Ög. and Upl. - Finland: local in the southern districts. Also material from Kb and Ks. - In the Soviet Karelia known from Ib. - Widely distributed in Europe.

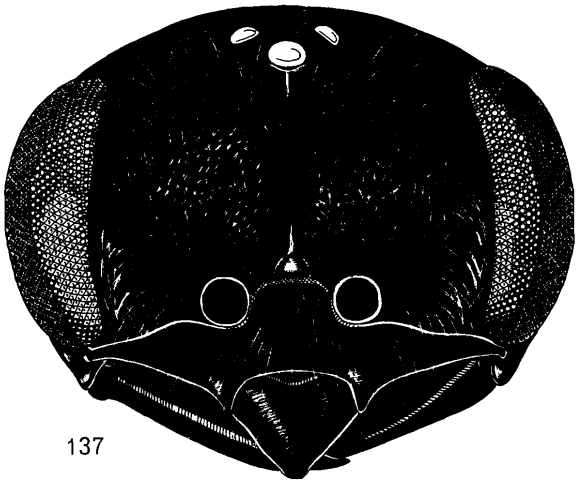

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Fig. 137. Head in frontal view of Ceratophorus morio (v.d.Lind.), ♀.
Fig. 138. Clypeus of Ceratophorus clypealis (Thomson), ♀.
Figs. 139-140. Pygidial areas of female Ceratophorus. - 139: morio (v.d.Lind.); 140: clypealis (Thomson).

Found breeding in a dead apple-tree, also in abandoned beetle tunnels in beams in a house (Lomholdt, 1973). Remains of aphids are often attached to the surface of the cocoon.

Genus *Diodontus* Curtis

Diodontus Curtis, 1834: 496.

Xylocelia Rohwer, 1915: 243.

Type-species: Pemphredon tristis van der Linden, 1829.

Medium to small species (Fig. 141), which in habitus and mode of locomotion can be very similar to the species of Passaloecus. The head is large and broad, in the female the distance between the mandibular articulations is greater than the distance between the eyes posteriorly, in the male considerably smaller. Clypeus of female shining, anterior border with two strong emarginations, whereby three sharp teeth are formed, the middle usually slightly weaker than the lateral ones. Clypeus of male covered by very dense, silvery pubescence. Emargination of anterior border simple. Forewings with two cubital cells, of which the first is more than twice as long as broad. The

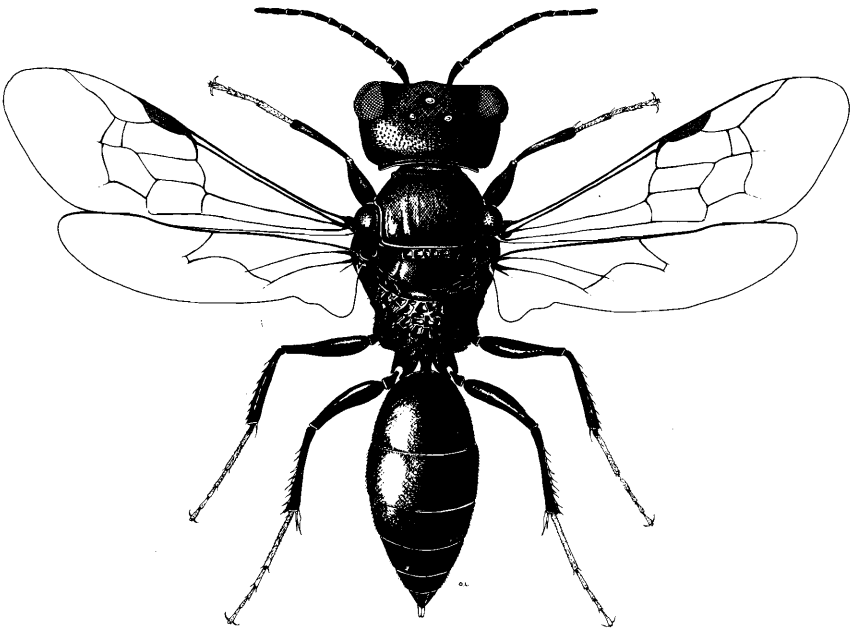


Fig. 141. Female of Diodontus tristis (v.d. Lind.). Length: 6-8 mm.

two discoidal transverse veins each join a cubital cell. Propodeum very coarsely sculptured. Petiolus very short. Tibiae 2 and 3 on the outer side with strong spines, which, however, may be very weak in males. Males as well as females with pygidial area.

The nests are constructed in the ground in sandy localities. The prey consists of aphids. The genus is distributed throughout most of the world. A great number of species occur in Central Asia (Tsuneki, 1972).

Key to species of Diodontus

Females

1 Along inner orbits runs a dull, impunctate furrow. Microsculpture between the dense punctures of frons consisting of irregular, weak rugae. Larger species 2

\- Along inner orbits runs a shining, impunctate, posteriorly more strongly raised, pad. Microsculpture between the sparse punctures of frons usually distinct, consisting of reticulate lines. Smaller species 3

2(1) Scutum densely, finely, uniformly punctate. Scutellum and metanotum also densely punctate. 26. medius Dahlbom

\- Anterior half of scutum very densely and rather coarsely punctate, punctures of unequal size. Posterior part shining with very scattered, rather coarse punctures. Scutellum and metanotum shining, with very scattered punctation ..... 25. tristis (v. d. Linden)

3(1) Mandibles and humeral tubercle black or brown-black. Tibiae black, tibia 1, however, with a pale line along anterior border ..... 24. luperus Shuckard

\- Mandibles and humeral tubercle yellow. Tibiae brown-yellow 4

4(3) Anterior border of clypeus as Fig. 142. Frons densely punctate. Ocelli form almost a right angle (Fig. 143) ..... 22. minutus (Fabricius)

\- Anterior border of clypeus as Fig. 144. Frons sparsely punctate, microsculpture rather weak. Ocelli form a distinct obtuse angle (Fig. 145) 23. insidiosus Spooner

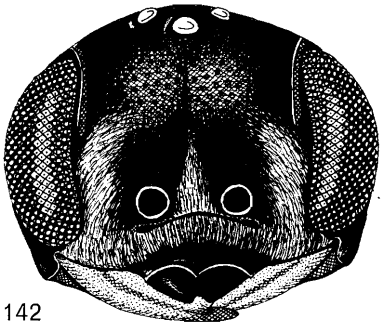
Males

1 Flagellum entirely dark, without excavations. Larger species 2

- Flagellum ventrally yellow-spotted or with slightly oblique excavations on 6th - 11th segments 3

2(1) Frons coriaceous. Punctation dense, interspaces with very fine, dense, slightly undulating rugae. Scutum, scutellum and metanotum evenly, rather densely and finely punctate ..... 26. medius Dahlbom

- Frons with coarse, dense, often coalescing punctures. Interspaces between punctures shining, with only indicated rugae. Scutum shining with scattered and coarse punctation. Scutellum and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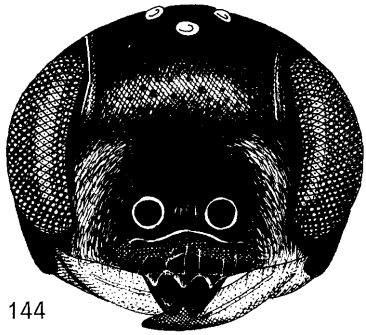
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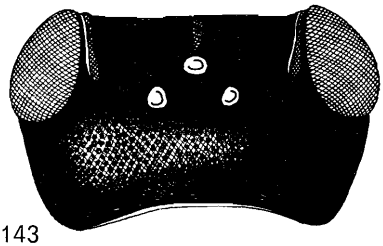
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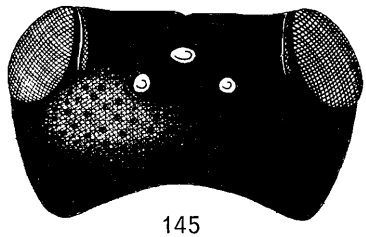
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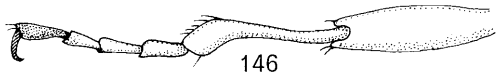
Figs. 142-145. Heads in frontal (142, 144) and dorsal (143, 145) views of female Diodontus. - 142, 143: minutus (Fabr.): (Fabr.); 144, 145: isidiosus Spooner.
Figs. 146, 147. Diodontus minutus (Fabr.). - 146: midtarsus; 147: foretarsus.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147

metanotum with only extremely fine, scattered punctation ..... 25. tristis (v. d. Linden)

3(1) Metatarsi 1 and 2 very long and slender, not dilated apically or S-curved. Terminal flagellar segments ventrally excavate. Mandibles red-brown 24. luperus Shuckard

- Metatarsi 1 and 2 curved or dilated apically. Flagellar segments with yellow spots ventrally. Mandibles yellow 4

4(3) Metatarsus 2 strongly dilated distally (Fig. 146). Metatarsus 1 very strongly curved (Fig. 147). Midmost antennal segments distinctly longer than broad ..... 22. minutus (Fabricius)

- Metatarsus 2 very weakly dilated distally. Metatarsus 1 almost straight. Midmost antennal segments as long as broad ..... 23. insidiosus Spooner

22. DIODONTUS MINUTUS (Fabricius, 1793)

Figs. 142, 143, 146, 147.

Crabro minutus Fabricius, 1793: 302.

Female: 5-6 mm. Head (Figs. 142, 143), scutum, scutellum and metanotum dull owing to the strong microsculpture, punctation fine, but rather dense. Mandibles yellow with red apex and brown base. Between antennal sockets a small acute spine. Pad along inner orbits appears more shining than remaining part of frons, due to the missing punctation, and almost lacking microsculpture. Clypeus as Fig. 142. Antennae black. Humeral tubercle usually yellow spotted. Mesopleuron above coarsely reticulate-rugose, ventrally with fine rugae or striae, like the remaining part of the animal with very sparse, short pubescence. Propodeum shining, with strong irregular ribs. Abdomen shining black. Pygidial area rather coarsely punctate, with distinct microsculpture. Femora black, tibiae red yellow.

Male: 3-4 mm. Lower part of face with dense silvery pubescence. Teeth, delimiting the deep emargination in anterior border of clypeus, truncate apically. Mandibles yellow. Terminal flagellar segments white-yellow ventrally, with very weak emarginations, middle segments distinctly longer than broad. Frons, scutum, scutellum and metanotum with strong microsculpture and scattered, rather fine punctation. Humeral tubercle yellow. Mesopleuron

above strongly and irregularly rugose, below punctate, with very distinct interstitial microsculpture. Femora black. Tibia 1 and tibia 2 yellow, tibia 3 brown with yellow base. Metatarsi 1 and 2 S-curved, metatarsus 2 dilated apically (Figs. 146, 147).

Common throughout Denmark. - Sweden: along the southern coasts of Sk. and on Öland and Gotland. - Not found in Norway. - Finland: distributed from Ab and N in the south to Kb, Sb and Tb in the north. - Soviet Karelia: Ib and Kr. - Recorded from Europe and large parts of Asia, eastwards to Mongolia.

The nests are found in small sandy walls and slopes. Usually several individuals breed in the same locality, often together with tristis. The prey consists of winged aphids, e. g. Thelaxes suberi Del Guericio (Thelaxidae), each cell being provisioned with about 30 specimens. The nests consist of a main tunnel about 10 cm long, ending in a cell. Along the main tunnel several side tunnels are excavated, which may themselves also branch. Altogether 10-15 cells may be constructed. Recorded parasitoids are Chrysis (Monochrysis) leachii Shuck. (Chrysididae) and Myrmosa melanocephala Fabr. (Mutillidae).

23. DIODONTUS INSIDIOSUS Spooner, 1938
Figs. 144, 145.

Diodontus insidiosus Spooner, 1938: 251.

Female: 4-5 mm. Head (Figs. 144, 145) shining with indications of microsculpture. Punctation anteriorly very scattered, but somewhat more deep than in minutus. Teeth of clypeus much more close together than in minutus, distance between the lateral teeth distinctly less than shortest distance between these and the lower margin of the eyes. Mandibles yellow with dark apex and base. Spine between antennal sockets vestigial. Antennae black. Pad along inner orbits as in minutus. Ocelli forming a distinctly obtuse angle (Fig. 145). Scutum shining, with scattered, faint punctation. Striation on mesopleuron and lateral faces of propodeum less pronounced. Microsculpture on pygidial area very weak. All femora, tibia 3 and tarsi black. Tibia 1 with pale front and brown back side. Tibia 2 with brown centre and pale base and apex.

Male: 3-4 mm. Punctation and pubescence of head as in minutus, but the punctures on upper part of frons usually stronger and more clearly distinguishable from the surrounding, rather weak microsculpture. Antennae short and strong. Flagellar segments about as long as broad, ventrally with yellow-grey spots. Mesopleuron distinctly punctate and rather irregularly micro-

sculptured ventrally. Humeral tubercle and mandibles yellow. Metatarsus 2 only very slightly dilated distally. Tibiae 1 and 2 yellow with faintly brown stroke on the inner side. Tibia 3 brown with a basal yellow or brownish ring.

A single female specimen from Finland: Om in coll. Valkeila. - Scattered in North and Central Europe. Originally described from material from the south coast of England.

Note. Insidiosus has a considerable similarity to the Mediterranean form, friesei Kohl, which may be considered a subspecies. Females of friesei generally has a more densely punctate face (although not nearly so densely as minutus) and scutum, and the microsculpture on the mentioned parts is somewhat stronger than in insidiosus. The pad along the orbits is often more strongly projecting, especially posteriorly. The tibiae are usually of uniform colour, as in minutus. Males are distinguishable by the absence of pale ventral spots on flagellar segments, and by metatarsus 2 being very slightly dilated distally.

24. DIODONTUS LUPERUS Shuckard, 1837

Diodontus luperus Shuckard, 1837: 186.

Female: 5-6 mm. Head with strong reticulate microsculpture and sparse, deep punctation. Clypeus shining, with only a few bristle-bearing punctures on posterior half. Without spine between antennal sockets. Mandibles black with slightly paler apex. Scutum with somewhat effaced microsculpture and scattered punctation, which becomes very weak in posterior half of the sclerite. Humeral tubercle black. Mesopleuron above with rather coarse, irregular rugae, ventrally indistinctly striate. Propodeum with strong ribs. Pygidial area as in minutus, with strong microsculpture mixed with punctures. Legs black with pale knees and tarsi. Tibia 1 with a pale streak along anterior edge.

Male: 4-5 mm. Head very densely and rather coarsely punctate with strong microsculpture. Lower part of face with dense silvery pubescence. Mandibles black or black-brown. Antennae long and slender, black. Terminal flagellar segments with slightly oblique ventral excavations. Punctation of scutum, especially on anterior half, forming longitudinal rows, microsculpture comparatively weak. Mesopleuron in front of coxa 2 distinctly punctate, with somewhat irregular, transverse microsculpture. Propodeum coarsely rugose. Legs black with yellow knees. Tibia 1 with yellow front side.

The species is rather common in Central Europe, and is found in England

as well as in northern Germany. It is distributed over large parts of Asia, eastwards to Kazakhstan and Mongolia.

The prey consists of Aphididae, e.g. Myzus and Macrosiphum. A single cell may contain 22 individuals.

Note. The species recorded by Pulkkinen (1931) from Finland: Ab, Uskela, is a male of medius Dahlbom (Hellén, 1954). Thus the species is not found in the north, but might possibly appear in southern Denmark.

25. DIODONTUS TRISTIS (van der Linden, 1829)
Fig. 141.

Pemphredon tristis van der Linden, 1829: 76.

Female: 6-8 mm. Head strongly and densely punctate. Punctures partly coalescing into small longitudinal rugulae. Microsculpture weak, consisting only of short longitudinal raised lines. Clypeus shining, median tooth strong. Mandibles black. Furrow along inner orbits half as broad as flagellum. Scutum shining, with only indications of microsculpture in anterior part. Punctures indistinctly delimited posteriorly. Scutellum almost smooth, with only few punctures along posterior margin of the coarsely pitted, depressed, anterior border. Humeral tubercle black. Mesopleuron in front of coxae 2 smooth and shining, laterally coarsely reticulate-rugose and striate. Propodeum dorsally with coarse, reticulate rugae. Abdomen with short, thin, adpressed pubescence. Pygidial area distinctly microsculptured, posteriorly with coarse punctures. Legs black.

Male: 5-7 mm. Frons shining with coarse, partly coalescing punctation. Genae very strongly striate, with long greyish pilosity. Occipital carina strongly raised. Antennae black, 7th to 10th flagellar segments with dull, oval tyloidea. Humeral tubercle yellow posteriorly. Scutum anteriorly very densely and rather coarsely punctate, posteriorly punctation becomes coarser and sparser. Scutellum shining, with few, evenly distributed punctures. Mesopleuron and propodeum sculptered as in female. Abdomen shining, almost naked, weakly constricted between first and second tergum. Femora black. Tibia 1 and tibia 2 brown with partly yellow inner side. Tibia 3 brown with yellow base and apex.

Common in most districts in Denmark, and fairly abundant in southern Sweden. Northern occurrence in Sweden in Upl. and Gstr. - Norway: a little material from AK and Ø. - Finland: very rare, a few specimens from Ka, Ta and Sa. - Common throughout Europe, in Asia recorded from Kazakhstan and Mongolia.

The nests are constructed in dry sandy soil, often in small slopes or walls. Not uncommonly found breeding in gravel pits and the like. The tunnel system may be very complicated, since main as well as side tunnels are often considerably branched. Number of cells varies from 2 to more than 20. Wingless aphids (Aphididae) are used as prey, e.g. Hyalopterus pruni Geoffr. The prey is paralyzed (killed) by powerful bites in the thoracic region. As far as known, the sting is not used. 20-40 aphids constitute the provision for each larva. The fully grown larva spins a firm cocoon, the outside of which is covered with attached sand grains. In Denmark the species occurs in two generations, of which the latter, in August-September, seems to be the richer in individuals (Nielsen, 1933). As parasitoids are recorded Myrmosa melanocephala Fabr. (Mutillidae) and Hammomyia albescens Zett. (Anthomyiidae). Concerning the latter, the statement must be regarded as misleading, since the family is exclusively herbivorous. On the other hand, it is probable that flies within the family Miltogrammatidae may be found parasitic on the species of Diodontus.

26. DIODONTUS MEDIUS Dahlbom, 1845
Fig. 18.

Diodontus medius Dahlbom, 1845: 249.

Diodontus dahlbomi A. Morawitz, 1864: 461.

Female: 7-8 mm. Frons very densely and finely punctate, interspaces anteriorly smaller than diameter of punctures, with very fine microsculpture. Between antennal sockets a small convexity. Clypeus shining in the middle, laterally densely and finely punctate, with thin, greyish pubescence. Median tooth truncate, considerably shorter than lateral teeth. Mandibles black with slightly pale apex. Furrow along inner orbits almost as broad as flagellum. Scutum more finely and densely punctate than in tristis. Humeral tubercle black or brownish. Mesopleuron in front of coxa 2 dull with distinct microsculpture and fine, scattered punctation. Lateral face of mesopleuron strongly striate, irregularly rugose dorsally. Abdomen black, with thin pubescence. Legs black, tibiae and tarsi lighter or darker brown.

Male: 5-7 mm. Frons dull, densely and finely longitudinally rugose, without distinct microsculpture in anterior part, punctation here finer and denser. Genae densely striate, with short hairs. Antennae black, 9th to 11th flagellar segment each with a very weak excavation. Scutum anteriorly with two pairs of short longitudinal carinae. Punctation of thorax as in female, but slightly stronger. No secondary sexual characters have been found in the morphology of the tarsi.

Denmark: EJ, Lisbjerg Skov, 1 ♀, 10. VII. 1964 (B. Overgaard). - Rather common in Sweden and Finland, especially in the central parts. Northernmost occurrence in Sweden in Jmt. and Ång., in Finland in ObS and Ks. - Norway: a few specimens from Ak, HEs and Bv. - A few records from northern Germany and the northern parts of European U. S. S. R.

Nests in sandy soil. A single nest was described by Adlerz, 1903: main tunnel about 10 cm long, ending with a cell. Four short side tunnels also ended with a cell each. Provision consists of large aphids, of which 7-9 are placed in each cell. Egg deposited on ventral side of prey.

Genus *Passaloecus* Shuckard

Passaloecus Shuckard, 1837: 188.

Type-species: Pempredon insignis van der Linden, 1829.

Comparatively small, slender, black species (Fig. 148). In nature they have a superficial resemblance to the smaller species of Crossocerus. Head short, flat anteriorly. Mandibles of female highly specialized: somewhat widened distally, on the inner side with an excavation, surrounded by a row of strong, erect bristles. Mandibles of male more simple. Clypeus of female with rather strongly projecting, usually straight or slightly emarginate central lobe; its pubescence usually sparse. In males the central lobe is less well developed, and the silvery pubescence very dense. Antennae of male usually with secondary sexual characters in form of tyloidea or assymmetrical segment. Mesopleuron with a, sometimes double, vertical, coarsely pitted furrow and one or two horizontal, also strongly pitted furrows. Propodeum long, reticulate. Abdomen with very short petiolus. Female without pygidial area. Apex of male abdomen with upward bent, sting-like appendage. Legs thin, foretarsi of female without tarsal pecten. Forewings with two cubital cells, the first more than twice as long as the second. The two discoidal transverse veins each join one cubital cell.

A cosmopolitan genus containing a great number of species; about 15 species occur in Europe.

The species nest in dry, usually pith-filled stems, abandoned insect tunnels in wood or in various galls (Fig. 11). For taxonomy of gracilis, turionum and borealis, see Yarrow, 1970.

Key to species of Passaloecus

1 Mesopleuron laterally with two horizontal, deeply pitted furrows (Figs. 148, 159). Area between these distinctly punctate, of shiny appearance, microsculpture reduced or absent 2

- Mesopleuron laterally with only one horizontal, deeply pitted, furrow. Area dorsal to this dull, very finely punctate, with distinct microsculpture 7

2(1) The vertical, deeply pitted furrow on mesopleuron is double (Fig. 149). Anterior border of clypeus with squarely truncate or slightly emarginate, anterior border. Male antennae with tyloidea 3

- The vertical, deeply pitted furrow on mesopleuron is single (Fig. 150). Female: anterior border of clypeus with three teeth.
Male: antennae with or without very few and indistinct tyloidea 6

3(2) Female: labrum very short, sides convex (Fig. 154) Anterior border of clypeus arcuately emarginate. Male: tyloidea distally sharply truncate, only slightly longer than half length of segments (Fig. 162)
30. brevilabris Wolf

- Female: labrum longer, sides concave subapically. Clypeus with straight or slightly concave anterior border. Male: tyloidea distinctly longer than half length of segments, evenly rounded distally 4

4(3) Scutum strongly sculptured; anterior corners, posterior border and the two deeply pitted parapsidal furrows are distinctly striate. Female: central lobe of clypeus narrower than labrum, its lateral corners rounded (Fig. 152). Inner orbits distinctly converging ventrally. Male: tyloidea strongly projecting, in profile as Fig. 160 ..... 27. gracilis (Curtis)

- Anterior corners and posterior border of scutum with or without weak striae. Parapsidal furrows weak, transverse carinae of these strongly reduced or completely missing. Female: central lobe of clypeus as broad as, or slightly narrower, than labrum. Inner orbits not or weakly converging

ventrally. Male: tyloidea slightly projecting, in profile as Fig. 161 5

5(4) Smaller (3.5-5.5 mm). Female: head in front view as Fig. 151. Anterior border of clypeus narrower than width of labrum. Male: antennae comparatively short, tyloidea on 8th-11th antennal segments distinctly shorter than length of segments (Fig. 161) ..... 28. turionum Dahlbom

- Larger (4.3 - 6.0 mm). Female: head in front view as Fig. 153. Anterior border of clypeus as broad as labrum. Male: antennae relatively longer, tyloidea on 8th-11th antennal segments as long as length of segments ..... 29. borealis Dahlbom

6(2) Frons between antennal sockets with very small spine. Female: clypeus shiny, plane, with sparse silvery pubescence (Fig. 156). Third antennal segment almost twice as long as broad. Male:

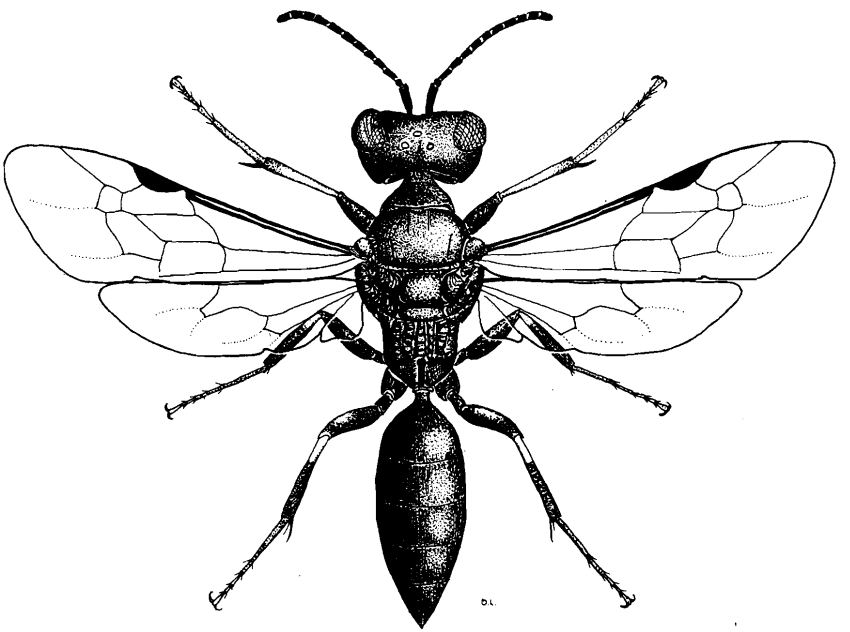


Fig. 148. Female of Passaloecus insignis (v.d.Lind). Length: 5-6 mm.

antennae relatively long, segments simple, pale ventrally ..... 31. eremita Kohl

- Frons between antennal sockets with strong, compressed spine. Female: clypeus dull, strongly convex, with dense silvery pubescence (Fig. 155). Third antennal segment only slightly longer than broad. Male: antennae comparatively short, 8th-12th antennal segments ventrally drawn out into a forwardly directed distal tooth (Fig. 165), dark ventrally ..... 32. corniger Shuckard

7(1) Abdomen with distinct constriction between first and second tergum. Dorsal face of propodeum longer than posterior face. Male antennae slender, tyloidea very indistinct. Relatively small and very slender species 8

- Abdomen without constriction between first and second tergum. Dorsal face of propodeum as long as posterior face. Tyloidea on more or less moniliform antennae of males, strongly developed. Medium-sized, rather robust species 9

8(7) Clypeus strongly projecting, rounded anteriorly (Fig. 158). Humeral tubercle with large whitish spot. Labrum short with slightly concave sides 36. clypealis Fæster

- Clypeus normally projecting, anterior border in female squarely truncate (Fig. 157), in male slightly concave. Sides of labrum distinctly concave (Fig. 157). Humeral tubercle black, sometimes very slightly paler in females. 35. singularis Dahlbom

9(7) Female: labrum, maxillary and labial palps whitish yellow (Fig. 159). Narrow depressed area along margin of lateral ocelli very indistinctly delimited. Upper part of frons with relatively weak microsculpture. Male: antennal segments in profile comparatively slightly dilated, tyloidea relatively short (Fig. 163) ..... 33. insignis v. d. Linden

- Female: labrum, maxillary and labial palps ligther or darker brown. Narrow depressed area along

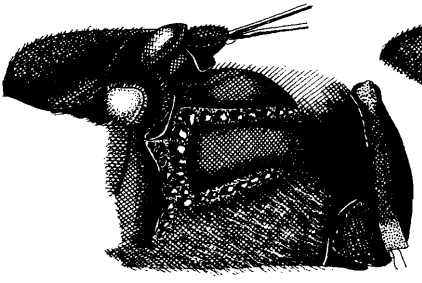
lateral ocelli laterally sharply delimited. Upper part of frons with relatively strong microsculpture. Male: antennal segments in profile strongly dilated, tyloidea usually as long as segments (Fig. 164)

34. monilicornis Dahlbom

27. PASSALOECUS GRACILIS (Curtis, 1834)
Figs. 152, 160.

Diodontus gracilis Curtis, 1834: 496.

Female: 4.5-5.5 mm. Head (Fig. 152) distinctly narrowing downwards towards mandibular articulation. Frons in front of ocelli dull, with distinct, comparatively strong punctation, interspaces equal to or less than diameter of punctures. Microsculpture relatively weak. Median lobe of clypeus distinctly narrower than labrum, usually narrowly depressed along anterior border, its corners rounded. Labrum usually with strongly concave sides subapically. Mandibles with large ivory coloured spot. Antennae short, median segments of flagellum only slightly longer than broad. Scapus usually with large ivory coloured spot along frontal side. Ivory coloured spot on humeral tubercle may be reduced or absent. Scutum comparatively strongly sculptured, punctation dense. Parapsidal furrows well-developed, with strong transverse striation. Especially laterally, but also basally on scutum, are short but strong carinae. Mesopleuron with double vertical and two horizontal, deeply pitted furrows; area between two last mentioned smooth and shiny, with or without extremely weak microsculpture. Punctation distinct.



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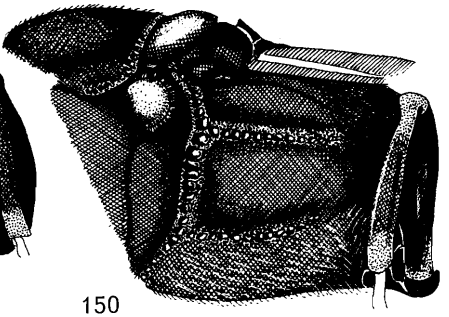

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Figs. 149-150. Mesopleuron in female Passaloecus. - 149: turionum Dahlbom; 150: eremita Kohl.

Male: 3.5-5.0 mm. Inner orbits very distinctly converging ventrally. Punctation of frons very dense, punctures sometimes coalescing transversely, whereby microsculpture is reduced. Antennae ventrally with well developed tyloidea, seen in profile distinctly convex (Fig. 160). Scutum with stronger sculpture than in female. The deeply pitted, transversely striate, parapsidal furrows often reach almost to posterior border of scutum. Mandibles, scapus and humeral tubercles often without white marks. Furrows on mesopleuron very well-developed.

The species is common and distributed over large areas in Denmark and southern Sweden, northwards to Boh., Vstm. and Upl. - Norway: a few specimens from AK, HOi and SFi. - Finland: an extreme southern distribution: Al, Ab and Ta. - A Holarctic species, but probably introduced to North America (listed as turionum Dahlbom by Krombein and Burks, 1967; corrected by Vincent, 1973, in litt.).

The nests may be found in dry plant stems, e.g. Phragmites and Sambucus, and in abandoned insect tunnels in old timber, also in agamic galls of Andricus kollari Htg. (Hym., Cynipidae) on Quercus spp. Larva described by Janvier, 1961. Prey consists of Lachnidae and Aphididae. Eurytoma nodularis Boh. (Hym., Chalcidoidea), Chrysis cyanea L. and Omalus aeneus (Hym., Chrysididae) are recorded as predators.

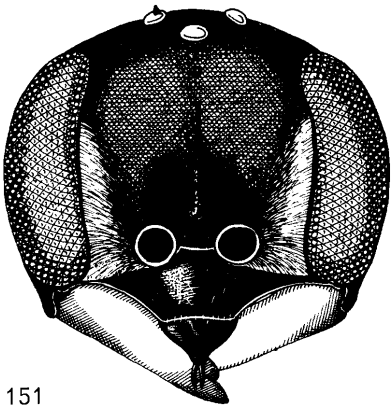
28. PASSALOECUS TURIONUM Dahlbom, 1845
Figs. 149, 151, 161.

Passaloecus turionum Dahlbom, 1845: 246.

Passaloecus brevicornis A. Morawitz, 1864: 462.

Female: 4.5-5.5 mm. Closely related to the preceding species. Head (Fig. 151) comparatively broader. Frons in front of ocelli shiny, punctation comparatively weak. Interstices equal to or greater than diameter of punctures. Microsculpture distinct. Middle lobe of clypeus usually narrower than labrum, anterior border distinctly arcuately emarginate, lateral angles sharp. Sides of labrum slightly concave subapically. Antennae longer than in gracilis. Scutum weakly sculptured, striation laterally, in the weak parapsidal furrows and basally, very reduced. Mesopleuron between the two horizontal furrows weakly and rather shallowly punctate.

Male: 4-5 mm. Punctation on frons weak, never fusing. Antennal segments longer than in gracilis, with flatter tyloidea (Fig. 161). Ivory coloured marks on mandibles, scapus and humeral tubercles only seldom reduced. Parapsidal furrows extend beyond central part of scutum, even in robust individuals.



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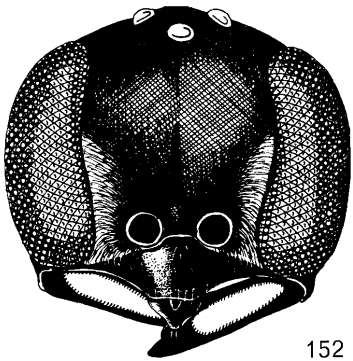

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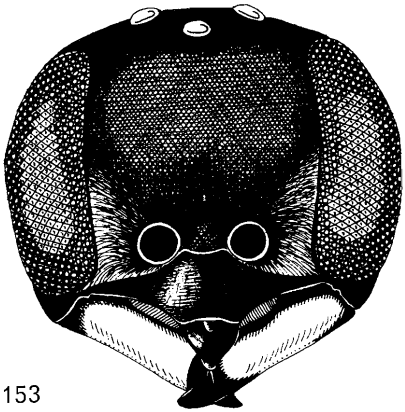

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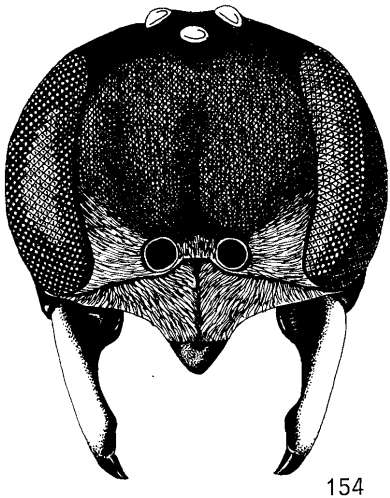

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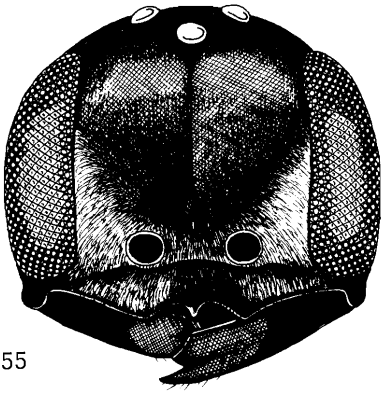

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Figs. 151-155. Heads in frontal view of female Passaloecus. - 151: turionum Dahlbom; 152: gracilis (Curt.); 153: borealis Dahlbom; 154: brevilabris Wolf; 155: corniger Shuckard.

Denmark: very sparsely distributed, predominantly in coniferous plantations in WJ, F, and NEZ. - Sweden: widely distributed from Sk. in the south to Dlr. and Ång. in the north. - Norway: a few records from AK, On and HOi. - Finland: common throughout the country. - Probably a boreo-alpine species in Europe.

The species has been found breeding in resin-galls of Petrova resinella L. (Lep., Tortricidae) on e.g. Pinus contorta and P. silvestris. As a nesting place the species probably also uses abandoned insect tunnels. Omalus biaccinctus (Buyss.) and O. aeneus F. (Hym., Chrysididae) are found as predators.

29. PASSALOECUS BOREALIS Dahlbom, 1845
Fig. 153.

Passaloecus borealis Dahlbom, 1845:247.

Female 5.5 - 6.5 mm, male: 5.6 mm. Recognizable by its considerable size. Head (Fig. 153) comparatively broader and antennae of males considerably longer than in turionum. Striation at base of scutum extremely weak or absent. Specimens from the Alps and the Pyrenees often lack the yellow proximal ring on tibia 3.

The distribution within Fennoscandia is very poorly known, since turionum auctt., nec Dahlbom (Merisuo, 1972) has been included in this species. - Denmark: a few specimens from NEZ. - Sweden: very local, known from Sm., G. Sand. (?), Jmt. and Ly. Lpm. - Norway: Nsy, Verdal (Dahlbom). - Finland: Al, Ab, Ta, Sb, N (Merisuo, 1973, in litt.) - Boreo-alpine distribution in Europe. The species also occurs in the Rocky Mountains in the U.S.A. (Vincent, 1973, in litt.), and in south-eastern Kazakhstan (Kazenas, in litt.).

30. PASSALOECUS BREVILABRIS Wolf, 1958
Figs. 154, 162.

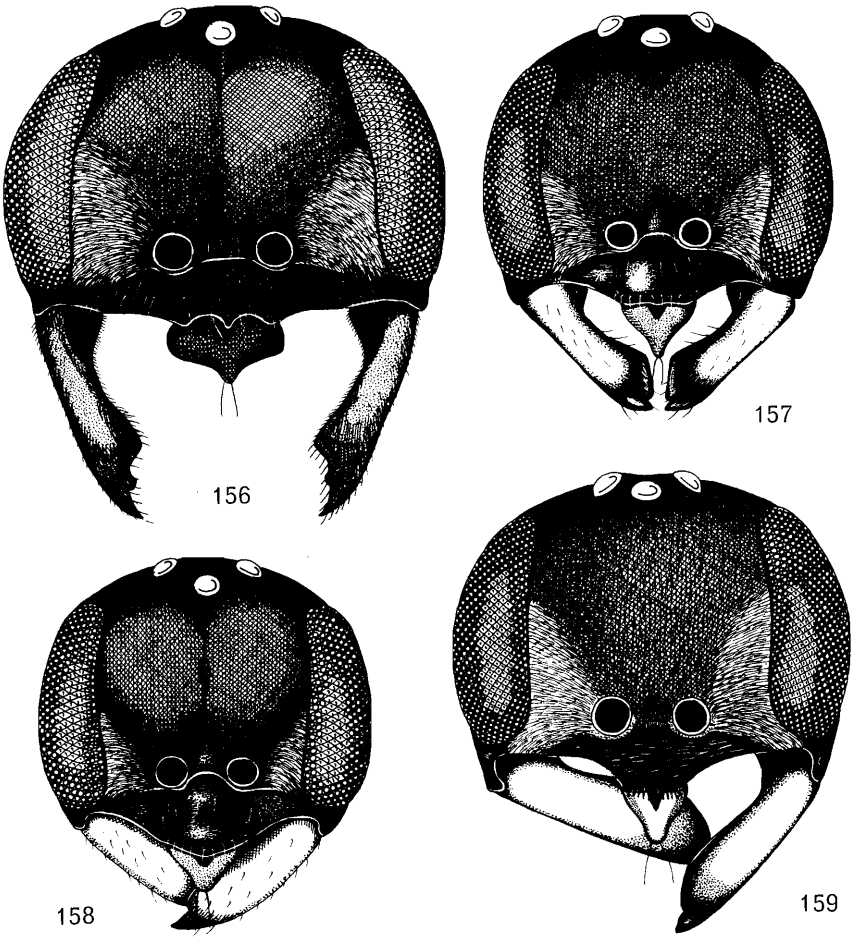
Passaloecus brevilabris Wolf, 1958: 15; Beaumont, 1963: 298.

Closely related to turionum. Female: 4.5-6 mm. Clypeus (Fig. 154) with dense and strongly developed silvery pubescence. Anterior border distinctly arcuately emarginate. Labrum very short, sides convex.

Male: 4-5 mm. Mandibles and scapus with very extensive yellow markings. Tyloidea very short, never longer than half the length of the antennal segments, and distally sharply truncate (Fig. 162).

Distribution in Fennoscandia limited to Central Sweden: Sm., Öl., Gtl., Ög., Sdm. and Gstr., and southern Finland: Al, Ab. - A boreo-alpine species in Europe.

31. PASSALOECUS EREMITA Kohl, 1893
Figs. 11, 150, 156.



Figs. 156-159. Heads in frontal view of female Passaloecus. - 156: eremita Kohl; 157: singularis Dahlbom; 158: clypealis Fæster; 159: insignis (v.d.Lind.).

Passaloecus eremita Kohl, 1893: 37.

Female: 5-6.5 mm. Head (Fig. 156) in front view very broad. Clypeus rather shiny, weakly convex, its anterior border with three rather weak teeth. Pubescence sparse, slightly silvery. Labrum short, very broad, distally abruptly narrowed, forming a truncate process. Frons between antennal sockets with or without a tiny spine. Colour of mandibles much varying, often with yellow longitudinal stripe. Cutting edge broad, in middle with broad angular projection. Antennae long and slender, all segments distinctly longer than broad, third segment about 1.5 times longer than broad. Scutum densely and finely punctate, parapsidal furrows indistinct. Mesopleuron with a single vertical and two horizontal deeply pitted furrows. Humeral tubercle sometimes with white-yellow spot. Tibia 3 with proximal white-yellow ring.

Male: 3.5-6 mm. Anterior border of clypeus with three very weakly indicated teeth, often concealed by the dense and well developed pubescence. Labrum, palpi, mandibles, scapus and humeral tubercles extensively yellow. Antennae long and slender, segments about 1.5 times longer than broad, yellow-brown ventrally. 11th and 12th segments with quite small shiny tyloidea. Sculpture of thorax as in female. Sixth tergum near posterior border with two small tubercular thickenings with long setae. Tibia 3 with white-yellow proximal ring.

The species occurs rather sporadically but may occur in large numbers locally. - Denmark: only recorded from NEZ. - Sweden: from Sm. in the south to Gstr. and Jmt. in the north. - Norway: 2 specimens from AK, Bygdeø. - Finland: widely distributed, from Al, Ab and N to Om and Ks. - Soviet Karelia: Ib. - Distributed all over Europe, but rare.

The species has been found breeding in very large numbers in roofs thatched with Phragmites in Denmark: NEZ. In one locality 173 nests were found in five meters of eaves. The number of cells varies with the length of the straws: on average 4-5 cells are constructed. A row of cells always terminates with an empty vestibular cell of varying length (parasite protection?). The partitions between the cells are made of conifer resin, which gradually hardens and acquires a whitish or pale yellow colour. The inhabited straws are easily recognizable by being sealed with a plug of resin. Usually a ring of small drops of resin is placed round the entrance, probably to prevent intrusion of cleptoparasites (Fig. 11). Very often earlier inhabited straws are used, even if these had housed species of e.g. insignis, singularis, corniger or e.g. Trypoxylon figulus, or Rhopalum coarctatum. The last constructed cells usually contain males, which are the first to emerge. The sex ratio

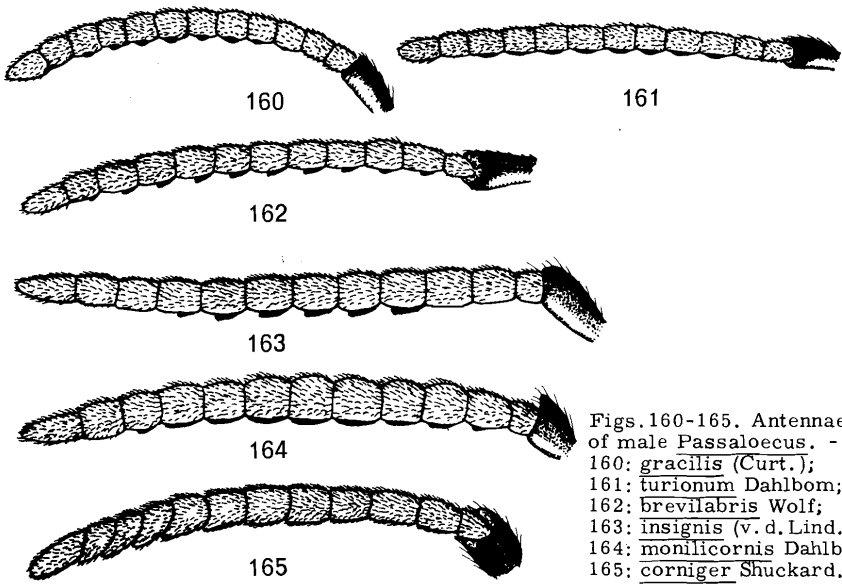
(females/males) lies round 1.4. In straws so thin that the animal cannot turn, the adult larva is orientated with its head facing the entrance (see Lomholdt, 1973). Prey consists of Homoptera, Lachnidae, e.g. Cinara pinea (Mordv.), which lives on Pinus. The nest may also be constructed in decayed wood, often in connection with abandoned insect tunnels. In wood the tunnel system may be branched. All nests are of linear type. The larva was described by Janvier, 1961.

As cleptoparasites are recorded Omalus aeneus Fabr., Chrysis cyanea L. (Hymenoptera, Chrysididae), Perithous mediator Fabr. (Hymenoptera, Ichneumonidae) and Megatoma undata L. (Coleoptera, Dermestidae). The larva of the latter usually destroys 2-4 cells.

32. PASSALOECUS CORNIGER Shuckard, 1837
Figs. 155, 165.

Passaloecus corniger Shuckard, 1837: 191.

Female: 5-6.5 mm. Head in front view (Fig. 155) comparatively long, inner orbits almost parallel. Clypeus strongly convex, with three strong teeth on anterior border, pubescence dense and strong, silvery. Labrum short and broad, with convex sides. Mandibles either uniformly dark or with small, whitish basal spot. Their cutting edge distinctly tridentate. Frons between



Figs. 160-165. Antennae of male Passaloecus. - 160: gracilis (Curt.); 161: turionum Dahlbom; 162: brevilabris Wolf; 163: insignis (v.d. Lind.); 164: monilicornis Dahlbom; 165: corniger Shuckard.

antennal sockets with strong, compressed spine. Eyes often with distinct setae. Antennae short and thick, segment in profile very slightly longer than broad. Yellow spot on scapus usually very reduced. Humeral tubercle with large whitish spot. Thorax sculptured as in eremita. Tibia 1 uniform red-brown, tibia 3 with red-brown proximal ring.

Male: 4.5-6 mm. Frons between antennal sockets with a strong, compressed spine. Labrum, palpi, mandibles and anterior face of scapus and usually also humeral tubercles yellow. Anterior border of clypeus with three small, rounded teeth. 8th-12th antennal segments drawn out into a ventral tooth (Fig. 165), ventral face dark. 6th tergum near posterior border with two very weak hairy thickenings. Legs with extensive red-brown markings.

The species is common in Denmark and Fennoscandia. Northern distribution limit in Sweden runs through Dlr. and Hls., in Norway through HOy and HEn. - A southern species in Finland. - Widely distributed in the Palaearctic region, through Asia to Japan.

As regards breeding biology, it closely resembles eremita, with which it often occurs. In addition, stated to breed in galls of Lipara (Diptera, Chloropidae) on Phragmites. Occasionally found breeding in old timber, including beams, in human habitations. Prey: Homoptera Aphididae, e.g. Aphis and Anuraphis. Larva described by Janvier, 1961. Parasites: Eurytoma nodularis Boh. (Hym., Chalcididae) and Chrysis cyanea L. (Hym., Chrysididae).

Note. The thorough observations by Corbet (1975) confirm the suggestion made by Chevalier (1923) that corniger does not catch aphids, it rather robbs provision from other Passaloecus-nests, even from conspecific nests. The evolution of conspecific robbery is difficult to explain in terms of positive selection, but such a behaviour is likely to be present only in crowded populations.

33. PASSALOECUS INSIGNIS (van der Linden, 1829)
Figs. 148, 159, 163.

Pemphredon insignis van der Linden, 1829: 79.

Passaloecus monilicornis Dahlbom, 1842: (p.p.).

Passaloecus roettgeni Verhoeff, 1890:383.

Female: 5-6 mm. Head (Fig. 159) in front view broad, inner orbits slightly converging ventrally. Lower part of face with rather sparse, but very distinct silvery pubescence. Hairs of clypeus with tips directed towards mid-

line. Anterior border of clypeus straight or weakly arcuately emarginate. Mandibles, labrum, palpi and scapus extensively white-yellow or ivory coloured. Marking on labrum V-shaped. Mandibles almost straight, only slightly and gradually dilated apically. The small cavity near lateral ocelli indistinctly delimited. Humeral tubercle with large white-yellow spot. Mesopleuron with a single vertical and only one horizontal, deeply pitted furrow; surface dull due to well developed microsculpture. Punctation very fine. Reticulation of propodeum rather coarse on shiny smooth ground.

Male: 4.5-5.5 mm. Mandibles short, slightly curved, their white-yellow markings may be greatly reduced. Median lobe of clypeus strongly convex, silvery pubescence well developed. Anterior face of scapus with larger or smaller white-yellow spot. 5th to 10th antennal segments slightly dilated, ventrally with strongly projecting, distally sharply truncate tyloidea (Fig. 163). Humeral tubercle often without pale mark. Thorax sculptured as in female. 6th tergum near posterior border with two backwardly directed, short spines, situated on small tubercular elevations.

Common in Denmark and in southern Sweden: from Sk. to Dls. and Upl. - A few specimens from southern Norway: AK. - Finland: not common, occurs sparsely in the south-western districts. - Distributed over large areas in Europe, eastwards through Asia to Japan.

The nests are found, often in large numbers, in old thatched roofs as described in eremita. Pith-filled stems of e.g. Sambucus or abandoned insect tunnels in decayed wood, often old beams in buildings, are also used as a breeding biotope. Sometimes, where the nests are constructed in long stems, the number of cells may be as many as 15-18. Each cell is sealed with a disc of resin. As prey are used Homoptera, Aphididae and Lachnidae, e.g. Anuraphis and Cinara. Nests of insignis are common in abandoned or commenced nests of other species of Passaloecus, Pemphredon inornatus Say (no. 18) and P. lethifer Shuckard (no. 19); Trypoxylon figulus (no. 106) and Rhopalum coarctatum Scop. (no. 140). Larva described by Janvier, 1961.

34. PASSALOECUS MONILICORNIS Dahlbom, 1842
Fig. 164.

Passaloecus monilicornis Dahlbom, 1842: 12.

Closely related to insignis, from which it can only by separated by the characters mentioned in the key.

The species is not yet recorded from Denmark, but occurs in all Fenno-

scandian countries. In Sweden it is rather common, being distributed from Sk. to Nb. - Norway: rather common in the southern districts, also a single specimen from Nnø. - Finland: common and widely distributed, northernmost record from Li, north of Lake Inari (about 69°N!). - A northern boreal species in Europe, which is not recorded, either from the Alps or the Pyrenees. The distribution extends eastwards to Mongolia, China, Japan, Korea and Kamchatka.

Breeding biotope in abandoned insect tunnels in dead wood. The tunnels are cleaned of wood dust and the like, and may be elaborated. The species is able to gnaw new tunnels in not too hard wood. The nest tunnels are often branched; the cells are, however, placed in rows. Number of cells may be as high as 22 (Tsuneki, 1955).

Note. The distribution pattern of P. insignis and of P. monilicornis in Fennoscandia emphasizes the view that the two taxa should be maintained at specific level (cf. Yarrow, 1970: 184).

35. PASSALOECUS SINGULARIS Dahlbom, 1844
Fig. 157.

Passaloecus singularis Dahlbom, 1844: 243.

Passaloecus tenuis A. Morawitz, 1864: 462.

Passaloecus gracilis auctt.

Female: 4.5-5.5 mm. Head in front view (Fig. 157) longer and narrower than in insignis. Clypeus rather shiny with weak, reticulate microsculpture, especially laterally. Anterior border itself slightly depressed, marked by a row of bristle-bearing punctures. Silvery pubescence very sparse and weak, hair tips directed ventrally. Labrum black or brown-black, distinctly constricted subapically. Mandibles slightly curved, black with brownish apex, with larger or smaller whitish spot in the middle. Anterior face of scapus with white-yellow spot. Humeral tubercle with or without light mark. Mesopleuron with a vertical and a single horizontal, deeply pitted furrow. Abdomen with distinct constriction between first and second segment.

Male: 3.5-4.5 mm. Very slenderly built. White-yellow pattern on mandibles and scapus very variable in extent, sometimes completely missing. Antennae long and slender, 5th to 10th segments ventrally with flat, broad, brownish tyloidea. Humeral tubercle usually black. Thorax and abdomen as in female, only a little more strongly sculptured. 6th tergum without spines or tubercles.

A common species in Denmark and Fennoscandia. - Sweden: from Sk. to Dlr. and Med. - Norway: a few specimens from AK. - Finland: widely distributed from Al, Ab, and N to Ok and ObS. - Soviet Karelia: Ib and Kr. - Known throughout Europe and distributed through Asia to Japan.

Nests usually in pith-filled stems, e.g. of Rubus, Ribes, Rhamnus, Sambucus and in Phragmites, or in empty galls of Lipara (Dipt., Chloropidae) in Phragmites communis. Nests are often constructed in abandoned insect tunnels in rotten wood, in association with human habitations. The nests of this species are easily recognized by the mixture of resin and small pebbles of 0.5-1 mm diameter used in the final sealing of the entrance. The length of the terminal plug may be up to 1 cm. The prey consists of wingless individuals of Homoptera, Aphididae, e.g. Aphis. Cleptoparasites are Perithous mediator Fabr., P. divinator Rossi (Hym., Ichneumonidae), Eurytoma sp. (Hym., Eurytomidae), Omalus auratus Fabr. and Chrysis cyanea L. (Hym., Chrysididae). Larva described by Janvier, 1961.

36. PASSALOECUS CLYPEALIS Fæster, 1947
Fig. 158.

Passaloecus clypealis Fæster, 1947: 204.

Passaloecus angustus Gussakovski, 1952: 215, syn. n.

An easily recognizable species (see the key), but closely related to singularis. Shape of clypeus (Fig. 158), the almost equilaterally triangular labrum, and the slender antennae are good specific characters. Male moreover easily recognizable by the very reduced tyloidea on 8th and 9th antennal segments.

A rare species. - Denmark: only known from WJ, F and SZ (type locality). - Sweden: a few specimens from Ög., Nrk. and Upl. - Not recorded from Norway. - Finland: the species occurs in very large numbers in Ab, Rymättylä (Merisuo, 1973); also known from Al, Ta, Sa, Kb and Om. - Widely distributed throughout central and northern Europe.

Only few observations exist of the nesting of this species (Janvier, 1961; Merisuo, 1973). The nests were found in stems of Lonicera and Phragmites. The partitions between the cells, and also the terminal plug, consisted of a mixture of resin (?) and small pebbles. It is also probable that empty Lipara galls in Phragmites may be used as nesting place, since the species has often been found associated with brackish and fresh water. Often occurs together with Rhopalum nigrinum (no. 141). Chrysis cyanea L. (Chrysididae) is probably parasitoid (Merisuo, in litt.).

Note. Recorded as P. augustus sp. n. by Gussakovski from several localities in western Russia, eastwards to Uzbekistan. Additional material from Kazakhstan (Kazenas, in litt.).

Genus *Stigmus* Panzer

Stigmus Panzer, 1804: H. 86, T. 7.
Type-species: Stigmus pendulus Panzer, 1804.

Small, slender species (Fig. 166) with or without very limited yellow markings. Head in front view broader than high. Vertex, especially in females, strongly developed. The forwardly directed ommatids are pronouncedly larger than those placed dorsally in the eyes. Clypeus in female shining, anteriorly produced into truncate teeth, which are separated by a U-shaped emargination (Fig. 163). In males clypeus is covered by a silvery shining pubescence; midpart of anterior border broadly rounded, squarely truncate or rather weakly arcuate-emarginate. Mandibles yellow with red apex, tridentate in females, bidentate in males. Antennae rather short, pale. Pronotum very short with a sharp transverse carina. Humeral tubercle reaching almost to articulation of forewings. The parapsidal furrows coarsely pitted. Mesopleuron in European species laterally with a strong, double vertical and two more or less distinct horizontal furrows crossed by carinae. Propodeum large, with coarse reticulation. Petiolus long; abdomen shining, smooth, with microscopic sculpture. Female with a quite small pygidial area. Tarsi long and slender, pale like tibiae. Metatarsus 2 with a single apical spur. Forewings with two cubital cells and a single discoidal cell. Stigma very large.

Only two species in Europe, genus otherwise with world distribution, only absent from Australia and New Zealand. The species nest in hollow or pith-filled plant stems, abandoned tunnel systems of xylophageous insects or in galls. Prey consists of aphids (Aphididae).

Key to species of Stigmus

1 Humeral tubercle with yellow or brown-yellow spot. Area below wing base reticulate. Male: anterior border of clypeus evenly arcuately concave (Fig. 168). Mesopleuron dull, with distinct reticulate microsculpture ..... 37. solskyi A. Morawitz

\- Humeral tubercle black or brown-black. Area below wing base with only weak rugae. Male: anterior

border of clypeus straight or weakly arcuately emarginate (Fig. 169). Mesopleuron ventrally shining, at most with indicated microsculpture ..... 38. pendulus Panzer

37. STIGMUS SOLSKYI A. Morawitz, 1864
Figs. 166-168.

Stigmus solskyi A. Morawitz, 1864: 462

Stigmus europaeus Tsuneki, 1954: 25.

Stigmus verhoeffi Tsuneki, 1954: 27.

Female: 3.5-5 mm. Frons anteriorly with weak longitudinal furrow, very finely and sparsely punctate with interstitial microsculpture. Antennal segments 4 and 5 of equal length. Clypeus shining, sometimes slightly transparent anteriorly; with long, sparse pubescence. Humeral tubercle pale. Scutum and scutellum dull with extensive microsculpture. Mesopleuron laterally, just below wing base, coarsely reticulate-rugose, whereby the dorsal of the two horizontally running furrows often disappears. Area in front of coxa 2 rather shining, with distinct, reticulate microsculpture.

Male: 3-4.5 mm. Head in front view very broad, eyes very strongly convex. Clypeus with broadly projecting median part, on either side delimited by

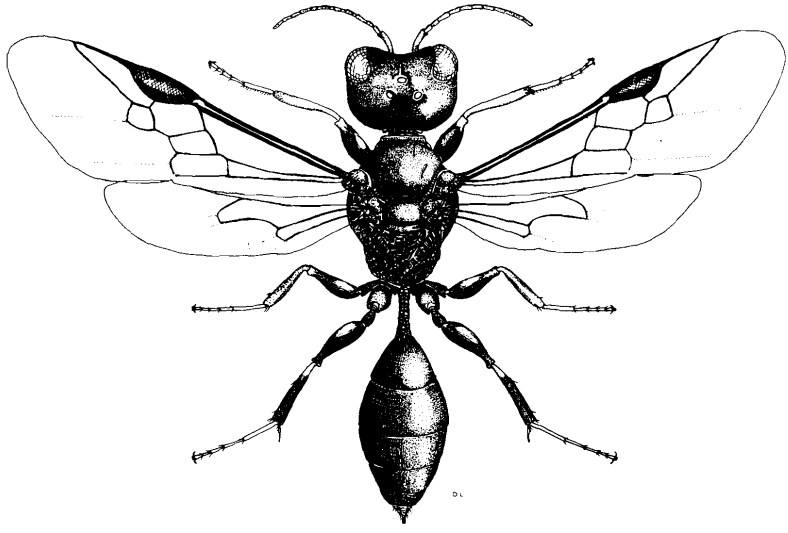


Fig. 166. Female of Stigmus solskyi A. Mor. Length: 3.5-5 mm.

a deep semi-circular emargination (Fig. 168). Frons between eyes with a trough-like depression, dull, strongly microsculptured. The furrow running parallel to the orbits posteriorly deeply excavate and with closely-spaced transverse carinae in the bottom. Thorax as in female, but with somewhat stronger microsculpture.

Not common, but widely distributed in Fennoscandia and Denmark. - Denmark: apparently absent from western and northern Jutland. - Sweden: sparse distribution through Götaland and Svealand. - Norway: a few specimens from AK and AAy. - Finland: distributed over large parts of the country; northern distribution limit in Kb. - Soviet Karelia: Ib and Kr. - The species is known mainly from Central and northern Europe, eastwards to Kazakhstan.

The species has been found breeding in branches, e.g. of Sambucus, Prunus and Malus, but also in abandoned tunnels of Anobium (Col., Anobiidae). When the tunnel system is constructed in stems with soft pith or in decayed wood, a great number of short side tunnels often proceeds from the main zigzag tunnel, each of them ending in a single cell. The prey consists of aphids (Aphididae), each cell being provisioned with 10-20 specimens. The larva was described by Janvier, 1962.

38. STIGMUS PENDULUS Panzer, 1804
Fig. 169.

Stigmus pendulus Panzer, 1804: H. 86, T. 7.

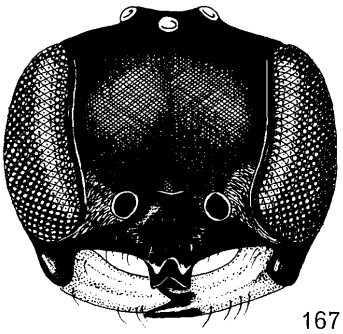
Female: 4-5.5 mm. The two teeth-like projections on anterior border of clypeus stronger and broader than in solskyi, whereby the emargination between them is narrower. Pubescence of clypeus distinctly sparser than in solskyi. Frontal furrow very well developed and deeply excavate. Antennal segment 4 distinctly longer than 5. Humeral tubercle black or brown-black. Scutum and scutellum shining, with only an indication of microsculpture. Area above the dorsal of the two horizontally running furrows on mesopleuron smooth, only rarely slightly rugose. Mesopleuron in front of coxa 2 shining.

Male: 3.5-4.5 mm. Head in front view (Fig. 169) relatively broader than in solskyi. Frontal furrow more strongly developed, on either side of this is a convexity. Anterior border of clypeus either squarely truncate or weakly arcuate-emarginate (Fig. 165). Microsculpture of head much weaker than in solskyi, whereby the surface is much more shiny. Orbits posteriorly with only an indicated division into cavities. Thorax shining, sculpture almost as in female.

This species has a remarkable distribution: in Sweden mainly in Götaland

and Svealand. - Norway: only known from AAy, Arendal. - Finland: very limited material from N. - Also found rarely in Europe. In Germany the species is found near Husum in Schleswig, and it might be expected to occur in southern Jutland.

The nest of this species may be found in stems, e. g. of Rubus fruticosus, where the main tunnel - if allowed by the thickness of the branch - runs like a spiral. The cells are usually constructed two in a line in short side tunnels, running parallel to the longitudinal axis of the branch close under the bark. Each nest may contain up to 14 cells. The fully grown larva was described by Janvier, 1962 and by Maneval, 1939. Provision consists of Aphididae, e. g. Myzus lythri (Schrank), of which about 25 are placed in each cell. Perithous mediator Grav., P. divinator (Pimplinae) and Diomorus armatus Boh. (Torymidae) are known as parasites.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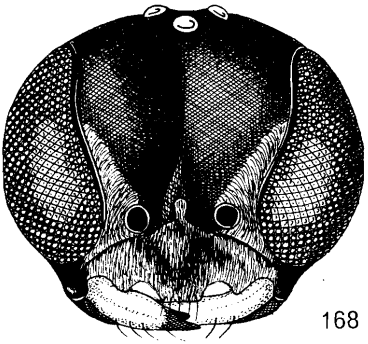
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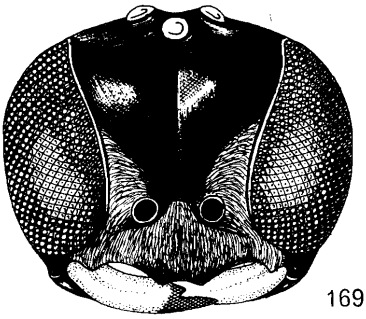
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Figs. 167-169. Heads in frontal view of Stigmus. - 167: solskyi A. Mor., ♀; 168: same, ♂; 169: pendulus Panz., ♂.

Genus *Spilomena* Shuckard

Spilomena Shuckard, 1838: 79.

Celia Shuckard, 1837, preoccupied.

Type-species: Stigmus troglodytes van der Linden, 1829.

Very small, slender species (Fig. 170), whose maximum length does not exceed 3.5 mm. Head in front view (Figs. 171-175) usually almost circular, eyes weakly convex. Clypeus narrow, its middle part strongly convex, the anterior border only slightly projecting. Mandibles bidentate. Antennae inserted far down on frons. Distance from antennal sockets to anterior border of clypeus less than diameter of sockets. Pronotum with strong transverse carina, often with a central, narrow interruption. Thorax, except propodeum, weakly sculptured, often rather shining, usually with distinct microsculpture. Area cordiformis usually with costae, generally on finely reticulate ground. Propodeum laterally and posteriorly usually with fine striae or rugae. Abdomen sessile, shining, with only extremely sparse pubescence apically. A true pygidial area is missing. Forewings with a very large stigma, two cubital and a single discoidal cell (Fig. 170). Tarsus 1 without pecten. Tibia 2 with a single spur. Tibia 3 without spines on the outer side. Face of males with yellow or whitish pattern.

Without material for comparison the species may be extremely difficult to identify correctly. This applies especially to small individuals and to the males of vagans and troglodytes. It is recommended to use times 100-150 magnification for identification.

The genus has a cosmopolitan distribution. Nine species in Europe. The species nest in pith-filled plant stems or abandoned larval tunnels of small xylophageous Coleoptera. The species may occur in great numbers locally.

Key to species of Spilomena

Females

1	Clypeus at least anteriorly with a longitudinal furrow (Fig. 171). Transverse furrow of scutellum deeply pitted	2
-	Clypeus without longitudinal furrow. Transverse furrow of scutellum smooth at bottom or with very weakly indicated transverse rugae	3

2(1) Head behind eyes strongly narrowed (Fig. 178) Ocelli form an acute angle ..... 39. differens Blüthgen

- Head behind eyes longer, more weakly narrowed posteriorly (Fig. 180). Ocelli form an obtuse angle 40. curruca (Dahlbom)

3(1) Head behind eyes strongly developed. Smallest distance from inner orbit to a lateral ocellus 2.5-3 times the distance between lateral ocelli (Fig. 182). Tergum 6 usually with two distinct, well separated longitudinal keels (Fig. 190) ... 41. enslini Blüthgen

- Head behind eyes shorter and more narrowed posteriorly. Smallest distance from inner orbit to a lateral ocellus at most 2 times the interocellar distance. Tergum 6 flat or with two very weakly marked longitudinal keels 4

4(3) Tergum 6 without keels. Sculpture of scutellum like that of scutum, with distinct microsculpture,

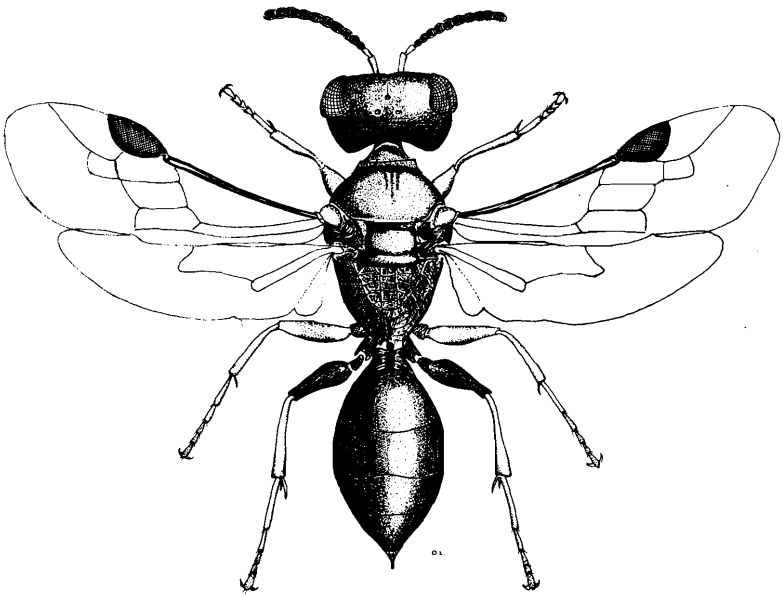


Fig. 170. Female of Spilomena vagans Blüthgen. Length: 2.5-3 mm.

including the central part. Mesopleuron dull, distinctly but finely rugulose. Propodeum dorsally shining, with coarse rugae ..... 42. exspectata Valkeila S. beata (s.141)

- Tergum 6 compressed, with one or two weak keels. Scutellum shining in middle, with or without very weak microsculpture. Mesopleuron smooth, strongly shining. Propodeum dorsally with weak rugae, interstices with finely but distinctly reticulate microsculpture 5

5(4) Transverse carinae between the two dorsal, longitudinal ribs on propodeum very weak or absent. Head seen from above very short (Fig. 187). Legs brown or pale brown-yellow, femora lighter or darker brown ..... 43. troglodytes (v. d. Linden)

- Transverse carinae between the two dorsal longitudinal ribs on propodeum distinct, varying in number from 5-6. Head seen from above longer (Fig. 185). Tibia 1 and tibia 2 strongly red-yellow, usually almost uniform coloured ..... 44. vagans Blüthgen

Males

1 Transverse furrow of scutellum with distinct transverse carinae, dividing it into a row of quadrate pits (Figs. 176, 177). Only anterior border of clypeus whitish (Figs. 172, 173) 2

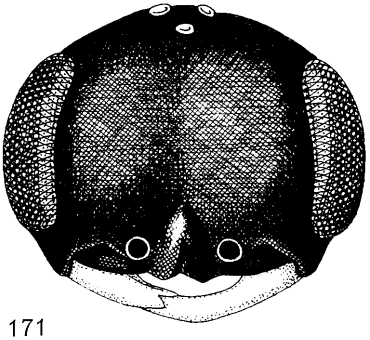
- Transverse furrow of scutellum at bottom smooth, without transverse carinae. Whole clypeus yellow or whitish 3

2(1) Transverse furrow of scutellum strongly pitted (Fig. 176). Head seen from above strongly developed posteriorly (Fig. 179), in front view comparatively broad (Fig. 173) ..... 39. differens Blüthgen

- Transverse furrow of scutellum with weaker pits (Fig. 177). Head seen from above shorter (Fig. 181), in front view somewhat narrower (Fig. 172) ..... 40. curruca (Dahlbom)

3(1) Vertex very strongly developed (Figs. 183, 189). Distance between posterior ocelli as great as or slightly greater than the diameter of an ocellus. 41. enslini Blüthgen

- Head shorter posteriorly, considerably more weakly developed. Distance between posterior ocelli considerably larger than diameter of an ocellus 4



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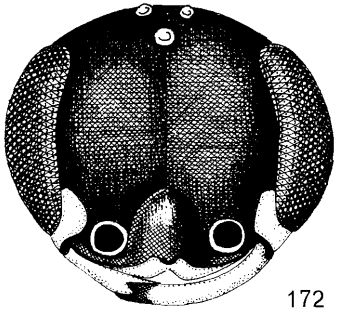

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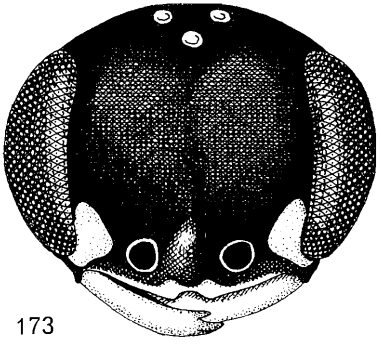

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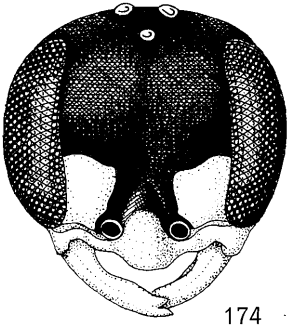

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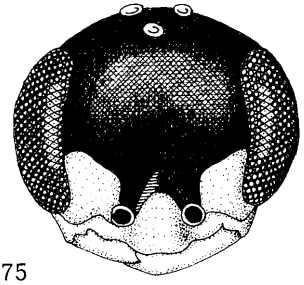

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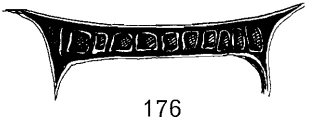

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Figs. 171-175. Heads in frontal view of Spilomena. - 171: curruca (Dahlbom), ♀; 172: same, ♂; 173: differens Blüthgen, ♂; 174: exspectata Valkeila, ♂; 175: vagans Blüthgen, ♂.
Figs. 176, 177. Transverse furrow of scutellum in male Spilomena. - 176: differens Blüthgen; 177: curruca (Dahlbom).

4(3) Legs and flagellum usually uniform red-yellow or yellow-brown. Median flagellar segments thickened, whereby flagellum obtains a moniliform appearance (Fig. 191). Head in front view broader than high (Fig. 175), seen from above as Fig. 186. Head around the mandibular articulations with a large yellow spot ..... 44. vagans Blüthgen

- All femora, and usually also flagellum, brown coloured. Flagellar segments not, or only weakly dilated. Head narrower, around the mandibular articulations usually without yellow spot 5

5(4) Head seen from above posteriorly very strongly narrowed (Fig. 188). Frons slightly convex. Flagellar segments slightly thickened ventrally. Habitus comparatively long and slender. 43. troglodytes (v. d. Linden)

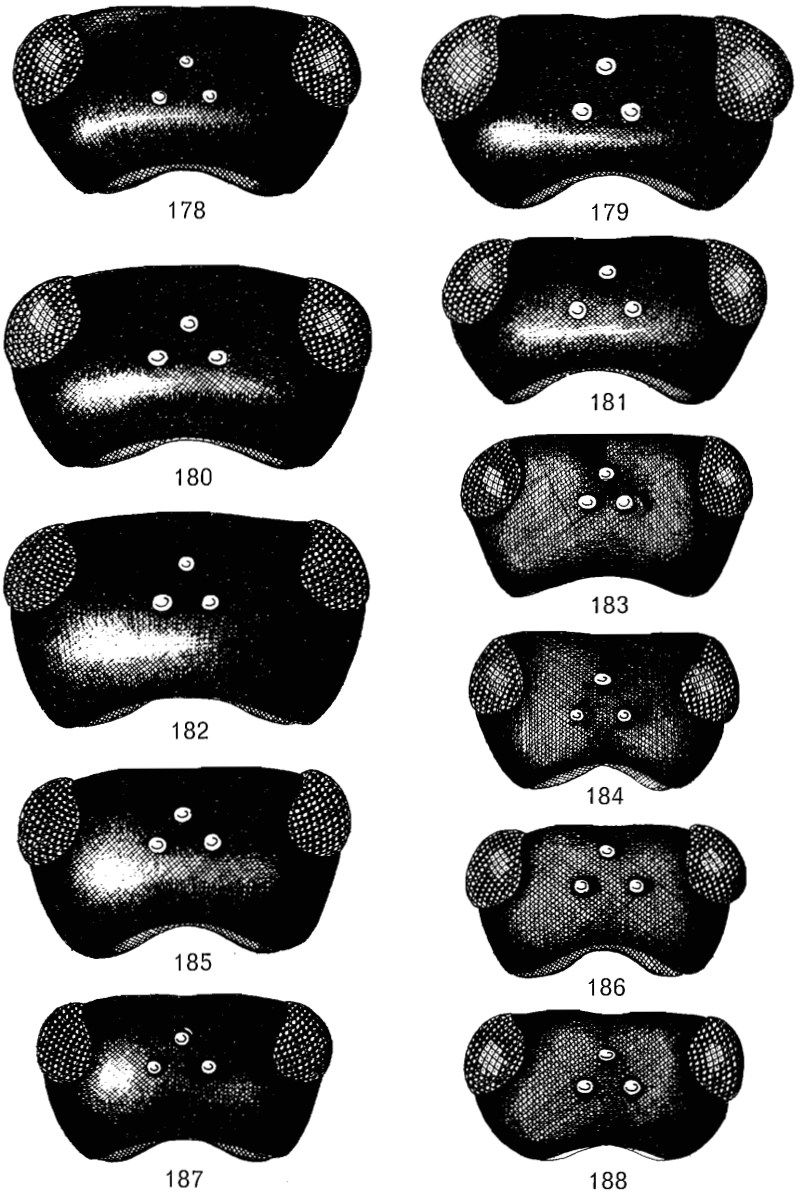
- Head seen from above as Fig. 184, frons almost straight. Flagellar segments very slightly thickened (Fig. 192). Habitus shorter and broader. 42. exspectata Valkeila → S. beata (s.141)

39. SPILOMENA DIFFERENS Blüthgen, 1953
Figs. 173, 176, 178, 179.

Spilomena differens Blüthgen, 1953: 173.

Female: 2.8-3.3 mm. Head seen from above as Fig. 178. Microsculpture on head and scutum weak, punctation very fine. Clypeus with distinct depressed midline and rather strong, angular emargination in anterior border. Mandibles and scapus brown, flagellum darker. Humeral tubercle posteriorly very slightly paler. Transverse furrow of scutellum divided into coarse, almost quadrate pits. Scutum posteriorly with very fine oblique rugae. Mesopleuron shining, smooth, with only indicated sculpture. Dorsal propodeal carinae usually distinct, the longitudinal ones usually somewhat irregular, not parallel. Anterior half of sides of propodeum plane, smooth, shining and without sculpture; posterior area with coarse, irregular rugae. Posterior face with distinct transverse carinae. Tergum 6 posteriorly with two slightly elevated longitudinal ribs, slightly diverging anteriorly. Femora dark brown, tibiae and tarsi paler.

Male: 2.5-3.0 mm. Only anterior border of clypeus whitish. Spots along lower orbits small, whitish. Mandibles and scapus yellowish (Fig. 173).



Figs. 178-188. Heads in dorsal view of Spilomena. - 178: differens Blüthgen, ♀; 179: same, ♂; 180: curruca (Dahlbom), ♀; 181: same, ♂; 182: enslini Blüthgen, ♀; 183: same, ♂; 184: exspectata Valkeila, ♂; 185: vagans Blüthgen, ♀; 186: same, ♂; 187: troglodytes (v.d. Lind.), ♀; 188: same, ♂.

Transverse furrow of scutellum with distinct pits (Fig. 176). Oblique rugae at the posterior border of scutum very indistinct. Mesopleuron as in female. Carinae of propodeum somewhat irregular. Legs light yellow-brown. Hind femora usually brown.

Not common, but widely distributed in the area. - Denmark: not known from Jutland. - Sweden: from Sk. in the south to Vrm. and Gstr. in the north. - Norway: a single female from AK, Bygdeø. - Finland: distributed mainly in the southern districts; northernmost localities in Kb. - Distribution area: Europe.

The nests are constructed in the same habitats as described under vagans, i.e. in abandoned tunnels of xylophagous insects, especially Anobiidae. There is only a single comparatively detailed description (Valkeila, 1957) with a statement of number of cells, branched tunnel system, prey (Thysanoptera) and separation of cells by means of compacted wood dust.

40. SPILOMENA CURRUCA (Dahlbom, 1843)
Figs. 171, 172, 177, 180, 181.

Celia curruca Dahlbom, 1843: 239.

Female: 2.5-3.0 mm. Closely related to differens, but besides the characters mentioned in the key, recognizable by the longer hairs on frons. Mesopleuron with very weak rugae and extremely fine punctation, pubescence more distinct. Pits in transverse furrow of scutellum rectangular. Tergum 6 with at most very weak longitudinal carinae. Legs of same colour as in differens.

Male: 2.3-2.8 mm. Only anterior part of clypeus whitish. The small spots along lower orbits also whitish. Head seen from above posteriorly strongly narrowed (Fig. 181). Very similar to differens, from which it can only be distinguished by the characters mentioned in the key, and by its somewhat more slender habitus.

This species is known only from Fennoscandia and Soviet Karelia. - Sweden: a few specimens from Sm. (Dahlbom), Ög., Nrk., Upl. and Vb. - Norway: NTi, Thynæss (Dahlbom). - Finland: N, Ta, Sa, Ok. - Soviet Karelia: Ib.

May be found nesting in old, partly decayed trees, e.g. Salix alba or in other wood-work (Valkeila, 1957).

41. SPILOMENA ENSLINI Blüthgen, 1953

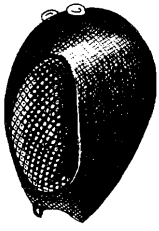
Figs. 182, 183, 189, 190.

Spilomena enslini Blüthgen, 1953:174.

Female: 2.8-3.3 mm. Very easily recognizable by the large, posteriorly strongly-developed head. Frons comparatively shining, microsculpture weak. Median part of clypeus almost plane, very weakly longitudinally striate. Anterior border distinctly angularly or arcuately incised, without longitudinal furrow. Mandibles brown. Antennae a little paler. Humeral tubercle black, only slightly lighter posteriorly. Microsculpture of scutum and scutellum hardly visible, punctation on the other hand distinct, but very fine. Transverse furrow of scutellum smooth at bottom. Mesopleuron with weak, reticulate microsculpture, which in front of coxa 2 is stronger, forming weak striation. Propodeum dorsally with rather strongly-projecting carinae and costae on an almost shining ground, as the microsculpture has practically disappeared. The longitudinal carinae usually somewhat irregular, slightly shortened. Striation of lateral and posterior faces of propodeum very fine, almost vestigial. Tergum 6 with two parallel, well-separated carinae (Fig. 190), surrounded by a weak, thin pubescence. Femora dark-brown, tibiae and tarsi paler.

Male: 2.4-2.9 mm. Characterized by the large vertex (Figs. 183, 189). Clypeus, mandibles, two big spots on lower part of face along inner orbits and scapus white-yellow. Flagellum pale yellow-brown or red-brown. Microsculpture on upper part of head and scutum comparatively weakly developed. Punctation indistinct. Costae in area cordiformis irregular, usually somewhat shortened. Legs light red-yellow, femur 3, however, distinctly darkened.

Locally rather common i Fennoscandia. - Denmark: nests in Sambucus only found in NEZ, (Brede). - Sweden: Sm., Öl., Ög., Vg., Nrk. and Gstr.



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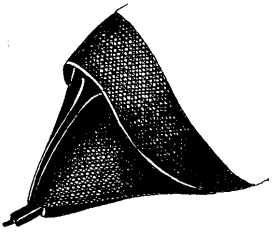

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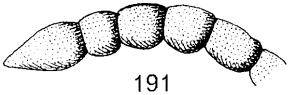

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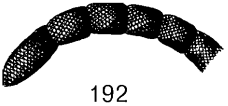

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Figs. 189-190. Spilomena enslini Blüthgen. - 189: head in lateral view of ♂; 190: apex of abdomen in lateral view of ♀.
Figs. 191-192. Antennae of male Spilomena. - 191: vagans Blüthgen; 192: exspectata Valkeila.

- Not recorded from Norway. - Finland: Ab, Ta, Sa and Kb. - Northern and Central Europe.

The nests are excavated in pith-filled stems of Rubus idaeus and Sambucus nigra. If there is sufficient space, a branched tunnel system is constructed. Mode of construction very similar to that of the species of Rhopalum. The diameter of the main tunnel varies between 1.2 and 1.5 mm. The diameter of the cells is almost constant, being 1.5 mm. Partitions between cells are made of dust more or less compacted.

Frankliniella intonsa (Thysanoptera) may be used as prey. The following Hymenoptera are known to occur as parasitoids in this species: Neorhacodes enslini (Rusch.) (Ichneumonidae), Lonchetron fennicum Grah. (Pteromalidae), Kaleva livida Grah. (Pteromalidae), Eupelmella vesicularis (Retz.) (Eupelmidae) and Leptocryptus geniculatus Thoms. (Cryptinae).

42. SPILOMENA EXSPECTATA Valkeila, 1957
Figs. 174, 184, 192.

Spilomena exspectata Valkeila, 1957: 164.

Female: 2.8-3.0 mm. Head seen from above rather strongly developed posteriorly, above mainly dull owing to the strong microsculpture. Punctation hardly visible. Mandibles and scapus brown, flagellum black. Clypeus in middle without longitudinal furrow, anterior border not, or only very weakly, emarginate. Transverse carina of pronotum not interrupted in middle. Humeral tubercle black. Scutum and scutellum with very uniform and rather strong microsculpture and with fine, but distinct punctation. Anterior transverse furrow of scutellum smooth at bottom. Mesopleuron with distinct, very slightly undulating transverse striation, as the microsculpture is partly coalesced. Propodeum dorsally shining, smooth due to the almost vestigial microsculpture. Costae well developed, also posteriorly. Costae on the lateral areas of propodeum, however, somewhat shortened. Tergum 6 without projecting keels or carinae, evenly rounded with a short and very dense pubescence apically. Femora dark brown, tibia 1 red-brown, tibia 2 and tibia 3 brown with lighter apex.

Male: 2.5-2.8 mm. Microsculpture of head very distinct. Clypeus, mandibles, scapus ventrally and a large spot along inner orbits light yellow (Fig. 174). Flagellum brown, ventrally lighter. Segments 6-11 very slightly dilated. Scutum and scutellum dull with distinct microsculpture. Costae dorsally on propodeum sharp, on almost shining ground.

Only known from Fennoscandia and Denmark. - Denmark: a single female from EJ, Molslaboratoriet. - Sweden: widely distributed, but not common, northerly to Gstr. - Not recorded from Norway. - Finland: Ab, Masku (type locality), St and Ta.

The nests are constructed in hollow or soft pith-filled plant stems, e.g. Sambucus or Rubus. They consist of a combination of linear and branched types, the first constructed cells lying in a row, while those built later are placed next to the main tunnel at the end of a short side tunnel. Provision consists of Thysanoptera nymphs. The cocoon is thin-walled and not lined with bore-dust or the like, as is the case in vagans and differens.

Note. S. exspectata can be separated from S. beata Blüthgen from Central and South Europe (2 ♀♀, Finland, Sa, Anttola, Valkeila in litt.) by the following characters (Valkeila, 1961).

Head more cubic. Face, and especially clypeus, distinctly convex. Propodeum with comparatively weaker and denser sculpture ..... beata Blüthgen

Head less cubic. Face and clypeus more even. Propodeum stronger and more sparsely sculptured ..... exspectata Valkeila

43. SPILOMENA TROGLODYTES (van der Linden, 1829)

Figs. 187, 188.

Stigmus troglodytes van der Linden, 1829:74.

2.7 - 3.0 mm. Very close to vagans, from which in most cases it can be distinguished by the characters mentioned in the key. Colour of legs very variable as in vagans, but no specimens with red-yellow femora are known. The carina surrounding area cordiformis often much reduced, as are also the longitudinal and transverse carinae. Propodeum laterally and posteriorly very finely, often somewhat irregularly striate. Pterostigma usually often paler than in vagans, habitus somewhat more slender, and microsculpture of head somewhat weaker. Flagellar segments of males only slightly dilated.

Denmark: three females are known from NEZ, Hellerup. - Sweden: Sk., Nrk., Sdm., Upl. and Gstr. - Not found in Norway. - Finland: only recorded from Tb. - The species is widespread in Europe and seems to have a slightly more southern distribution than vagans.

The species breeds in available cavities in old timber. Deserted burrows of Anobium spp. are preferred. Nests in thatched roofs are also recorded. The selected Anobium tunnels are cleaned, loose bore-dust being removed,

and provisioning started. Prey consists of Thysanoptera nymphs, which are carried to the nest in the mandibles. It is noteworthy that when returning with the prey, the females run about for a rather long time, before they find the entrance to the nest (this seems to be a usual feature within the species of Spilomena). The nest is of the linear type. Each cell contains 50-60 thrips. The egg is comparatively large, 1.25 mm long, weakly curved and sausage-shaped. When the whole tunnel system is fully provisioned, the entrance is closed with a plug of bore-dust, firmly compacted with the abdomen. The outermost part of the plug consists of a mixture of saliva and fine dust, which hardens into a slightly shining disc.

The males are found swarming round bushes and trees, often resting or sucking honey dew on the leaves. Neorhacodes inslini Rusch (Hym., Ichneumonidae) is known as parasitoid.

44. SPILOMENA VAGANS Blüthgen, 1953
Figs. 170, 175, 185, 186, 191.
Spilomena vagans Blüthgen, 1953:272.

Female: 2.5 - 2.9 mm. Head seen from above as Fig. 185, in front view rather shining, slightly wider than high. Clypeus anteriorly with weakly arcuately or angularly emargination, without longitudinal furrow. Mandibles and scapus usually pale red-yellow, but individuals with brown scapus occasionally occur. Flagellum lighter or darker brown, usually with light spots ventrally, especially proximally. Humeral tubercle posteriorly with a light brown or yellow spot. Transverse furrow of scutellum smooth at bottom, without transverse carinae. Propodeum dorsally (area cordiformis) usually surrounded by U-shaped, slightly elevated carina, which may be reduced. The two parallel longitudinal carinae posteriorly reaching this, are connected with each other by distinct, but often irregular, transverse ribs. From the longitudinal carinae issue, in addition, oblique rugae. Lateral and posterior faces of propodeum with distinct, regular striation. Tergum 6 posteriorly with two very closely-placed, weak, longitudinal carinae, partly concealed by a dense, short pubescence. Forelegs usually completely uniform red-yellow or light brown-yellow. Tibia 2 and tibia 3 of same colour, femora darker. Colour pattern very variable. Specimens from Finland often have almost uniformly clear red-yellow legs, mandibles and scapus. Danish and Swedish specimens usually have femora considerably darker than tibiae, and often dark mandibles and scapus.

Male: 2.3 - 2.7 mm. Sculptured as female, but more weakly. Whole clypeus yellow or white-yellow. Spots on lower parts of face of varying size, but always comprising the whole area round mandibular articulations. Mandibles and scapus yellow. Median flagellar segments distinctly thickened

(Fig. 191). Legs and scapus often uniform light red-yellow. Specimens with considerably darker flagellum, femur 2 and femur 3 are known from Denmark and southern Sweden. Sculpture on propodeal dorsum distinct. Larva described by Valkeila, 1957.

The species is found in all Nordic countries. - Denmark: not common, EJ, LFM, NEZ. - Sweden: distributed from Sk. to Dlr. and Hls. in the north. - Norway: a very limited material from AAy, Aurdal. - Finland: often found in great numbers on log-houses. Common in the southern districts, northernmost localities in Kb. - Not common in Europe.

No doubt this species is the most commonly occurring Spilomena in Fennoscandia and Denmark. The females are often met with on sheds and walls or other old timber exposed to the sun, in which abandoned tunnels of e. g. Anobium, Anthraxia or Callidium are plentiful. The males are found swarming round sunlit bushes or resting on leaves. The cells are constructed in the dust at the end of short side tunnels. The cocoon is covered with wood débris.

TRIBE PSENINI

The Psenini comprises the following Nordic genera: Mimesa, Psen, Mimumesa and Psenulus. Inner orbits parallel or diverging ventrally. Frons usually with a longitudinal carina that sometimes joins a transverse carina below the antennal sockets. Antennae more or less clavate, inserted relatively high up on frons. Epicnemial furrow and/or carina present, epicnemium present. Abdomen petiolate, the petiolus formed by sternum 1 alone. Females often with a pygidial area (indistinct in Psenulus). Tarsal pecten usually distinct in females. Forewings with three cubital and two discoidal cells.

Larvae. Parietal bands weak or absent. Antennal papillae present. Mandibles elongate or, in Psenulus, short and heavy, apex with three or four teeth. Galea considerably smaller than the maxillary palpus, vestigial in several species. The spinneret larger than the labial palpus, acute or truncate apically, the openings completely separate.

The tribe comprises 28 genera of which 10 occur in Europe. Most species are arboreal, but terrestrial nesting habits are found in Mimesa and Psen. Homoptera is the main source of prey.

Genus *Mimesa* Shuckard

Mimesa Shuckard, 1837:228.
Type-species: Trypoxylon equestre Fabricius, 1804.

The Danish and Fennoscandian species (Fig. 193) are easily distinguishable by the red colour pattern proximally on the abdomen. On the anterior side of the head the carina, issuing in front of the median ocellus, is very short and may be missing. Between the antennal sockets there is a round swelling, and the transverse carina is absent. Just behind the anterior border of clypeus there is a transverse raised area, which may be divided into two parts, or it may be very weakly developed in the males. Secondary sexual characters are often found on the underside of the antennae, especially as longitudinal pads (tyloidea) ind the males. In the forewings first and second discoidal transverse veins join the second cubital cell. Mesopleuron microsculptured, dull, distinctly punctate. The acetabular suture is missing. Petiolus often sharp-edged. As in Mimumesa a longitudinal swelling may occur dorsally on the petiolus, but this is rarely distinctly marked. Laterally on petiolus is a row of projecting white hairs. Females with pygidial area.

Distributed in the Nearctic as well as in the Palaearctic regions, where about 40 species occur. In Europe there are about 10 species. The species construct their nests mainly in sandy soils. The larvae are provisioned with Psyllidae and small cicadas.

Key to species of Mimesa.

Females

1 Petiolus flattened or concave dorsally, ventrally sharp-edged to base, breadth seen from above considerably larger posteriorly than anteriorly (Figs. 194, 197). Tergum 3 completely black 2

\- Petiolus convex dorsally or with longitudinal pad. Anterior half of ventral side rounded. Tergum 3 more or less red 3

2(1) Petiolus long, longer than tergum 1 (Fig. 197). The latter with a large black spot. Metatarsus 1 light brown-yellow. Length of tarsal spines 3/4 of the breadth of metatarsus 1 ..... 47. bruxellensis Bondroit

\- Petiolus as long as tergum 1, the latter completely red (Fig. 195). Metatarsus 1 brown, tarsal spines shorter than half breadth of metatarsus 1. 46. lutaria (Fabricius)

3(1) Petiolus seen from above as long as, or slightly longer than tergum 1, distinctly increasing in breadth posteriorly (Fig. 194). Tergum 1

usually without black spot. Mesopleuron densely, but finely and distinctly punctate ..... 48. rufa (Panzer)

- Petiolus seen from above distinctly longer than tergum 1, usually with parallel sides (Fig. 196). Tergum 1 usually with a large black or brown-black anterior spot. Mesopleuron with extremely fine and sparse punctation ..... 45. equestris (Fabricius)

Males

1 Antennal segments 4-7 ventrally with a distinct smooth longitudinal pad or only with hairless convexities (Fig. 199) 2

- Antennal segments with quite even and dense pubescence, without swellings of any kind (Fig. 200) 3

2(1) Petiolus dorsally plane or weakly convex, considerably increasing in breadth posteriorly (Fig. 195). Terminal antennal segments distinctly longer than broad ..... 46. lutaria (Fabricius)

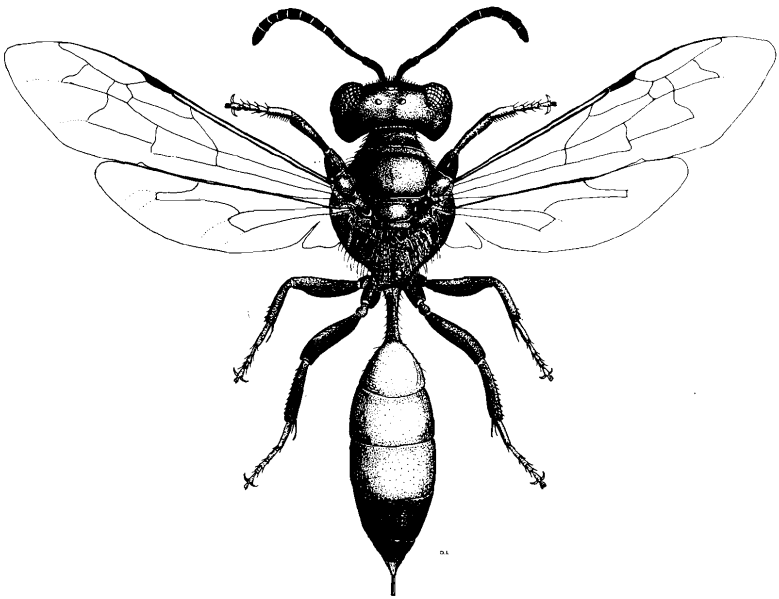


Fig. 193. Female of Mimesa rufa (Panz.). Length: 6-10 mm.

- Petiolus convex dorsally, its sides almost parallel (Fig. 196). Terminal antennal segments as long as broad or even broader than long ..... 45. equestris (Fabricius)

3(1) Mesopleuron rugoso-punctate, with very distinct microsculpture. Antennal segments 11 and 12 broader than long ..... 48. rufa (Panzer)

- Mesopleuron evenly punctate (as in lutaria). Punctures never coalescing or forming rugae, except in area immediately below base of forewings. Antennae long and slender, all segments longer than broad (Fig. 200) ... 47. bruxellensis Bondroit

45. MIMESA EQUESTRIS (Fabricius, 1804)
Fig. 196.
Trypoxylon equestre Fabricius, 1804:182.
Psen (Mimesa) bicolor auctt.

Female: 6-9 mm. Clypeus with silvery or weakly gold-shining pubescence, its transverse raised area strong. Scutum very evenly and regularly punctate with distinct microsculpture. Mesopleuron very finely and very sparsely punctate. Area below base of forewings often striate. Rugae of propodeum as in rufa. Petiolus long, convex dorsally. Tergum 1 usually with a large brown-black spot (Fig. 196). Anterior half of tergum 3 reddish coloured. Tarsus 1 of same colour as tibia 1.

Male: 5-8 mm. Pubescence of clypeus as in female. Scutum finely and sparsely punctate with or without very fine microsculpture. Mesopleuron with extremely fine and sparse punctation, with or without very fine microsculpture. Area just below base of forewings strongly striate. Tergum 1 with a large, brown-black spot, tergum 2 mainly red, tergum 3 completely black. Tibia 1 brown-yellow, femur 1 black-brown. Central antennal segments with round tyloidea.

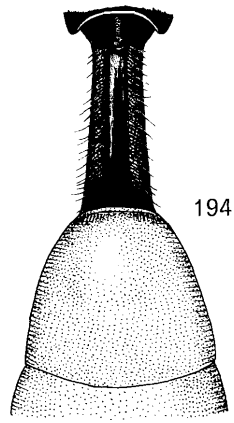
Rather common in Fennoscandia and Denmark. Northernmost records in Sweden: Nb. and Ly. Lpm., Norway: MRy, and in Finland: ObS and Ks. - Widely distributed in the Palaearctic region except North Africa.

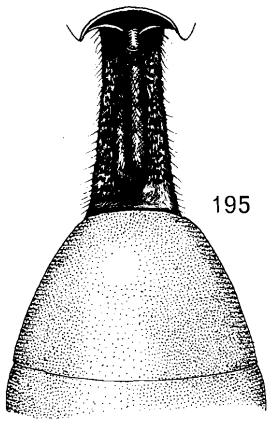
Common in sandy localities. Main tunnel of nest often extending very deep (40-50 cm) vertically down into the ground. From the lower part issue branches, each ending in a nesting chamber. Small cicadas are used as food for the larvae. The species is often gregarious. The larva was described by Janvier (1955).

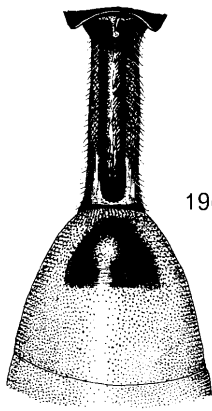
46. MIMESA LUTARIA (Fabricius, 1787)
Figs. 195, 199.

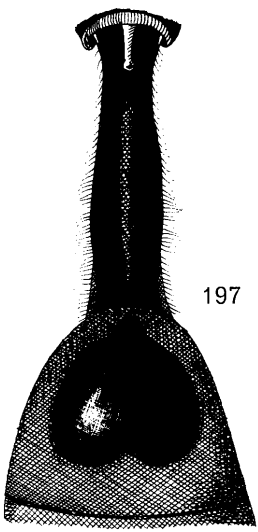
Sphex lutaria Fabricius, 1787:273.
Mimesa shuckardi Wesmael, 1852:278.
Aporia dispar Gussakovski, 1937:668.

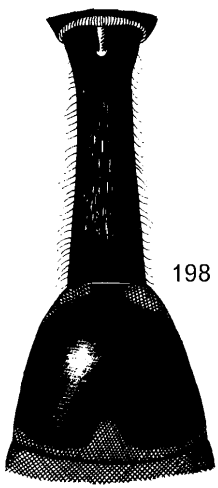
Female: 7-9 mm. Clypeus with strongly shining pubescence, anteriorly with a fairly strong, transverse elevation. Anterior border with slight emargination. Frons in front of median ocellus densely and rather strongly punctate.











Figs. 194-198. Bases of abdomen in dorsal view of Mimesa. - 194: rufa (Panz.), ♀; 195: lutaria (Fabr.), ♀; 196: equestris (Fabr.), ♀; 197: bruxellensis Bondroit, ♀; 198: same, ♂.

Genae finely striate ventrally. Scutum with distinct microsculpture, with sparse punctation. Lateral areas of mesopleuron distinctly but finely and sparsely punctate, with microsculpture. Propodeum dorsally reticulate-rugose. Petiolus dorsally often with irregular, slightly undulating sculpture (Fig. 195), in cross section almost quadrate. Pygidial area broadly rounded at apex. Two first abdominal segments pure red coloured. Small specimens, especially from Norway, often have a brown spot on tergum 1. Tibia 1 brown, same colour as femur 1. Tarsus slightly paler.

Male: 7-9 mm. Pubescence of clypeus silvery. Frons in front of ocellus very densely rugoso-punctate. Microsculpture of scutum weak, hardly visible. Punctation rather sparse, somewhat irregularly distributed. Punctures on lateral parts of mesopleuron finer than those on scutum, but equally dense, with distinct microsculpture. Upper part immediately below base of forewings irregularly rugose. Propodeum coarsely reticulate-rugose. Tergum 1 red with a large brown-black spot. Two-thirds of tergum 2 red, remaining terga black. Individuals exist, in which the red colour on abdomen has almost completely disappeared. Antennae with distinct tyloidea (Fig. 199).

Rather common in Denmark, found in most districts. Widely distibuted in Fennoscandia. Sweden: northern distribution limit in Nb. - Norway: to the north to Nnø. - Finland: northern records from Om and ObS. - Soviet Karelia: Ib and Kr. - Widespread throughout Europe. Also occurring in Japan. Will possibly be found in southern Siberia.

To be found in warm sandy places. Biology as in rufa. Omalus constrictus Forst. (Chrysididae) is recorded as predator.

47. MIMESA BRUXELLENSIS Bondroit, 1934
Figs. 197, 198, 200.
Mimesa bruxellensis Bondroit, 1934:61.
Aporia rossicus Gussakovski, 1937:669.

Very closely related to lutaria, but comparatively easily recognizable by its larger size.

Female: 9-10 mm. Transverse elevation on clypeus less conspicuous than in lutaria. Mesopleuron rather shining, weakly microsculptured. Punctation considerably more sparse and somewhat weaker than in lutaria. Petiolus longer than tergum 1 (Fig. 197), the latter with a brown-black spot. Tergum 2 posteriorly partly black. Tarsus 1 pale, of same colour as ventral face of antennae.

Male: 7-9 mm. Antennae very elongate, ventrally without tyloidea (Fig. 200). Petiolus much longer than tergum 1 (Fig. 198). Tibia 1 and tarsus 1 white.

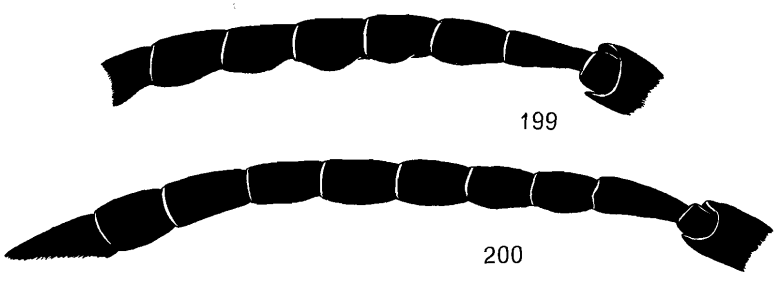
A few records from Sweden: Sm., Södra Vi; Ög., Borensberg.- Finland: N, Hyvinkää (coll. Valkeila). - Soviet Karelia: Ib.

48. MIMESA RUFA (Panzer, 1805)
Figs. 193, 194.
Psen rufa Panzer, 1805: H.96, T.17.
Psen bicolor Jurine, 1807:137.
Mimesa equestris auctt.

Female: 6-10 mm. Pubescence of clypeus silvery or gold-shining. Transverse convexity behind its anterior margin weakly developed, anterior border hardly emarginate. Genae irregularly rugose, not actually striate. Punctation of head and scutum as in lutaria. Mesopleuron densely punctate, laterally with weak transverse rugae. Rugae of propodeum finer and more irregular than in lutaria. Punctures of pygidial area of irregular size. Petiolus dorsally weakly convex (Fig. 194). The two first segments and 2/3 of the third abdominal segment red. Tibia 1 bi-coloured, brown with light tip and base. Tarsus 1 as pale as ventral side of flagellum.

Male: 6-9 mm. Pubescence of clypeus silvery or weakly gold-shining. Frons in front of median ocellus finely rugoso-punctate. Punctation of scutum dense and rather strong, with distinct microsculpture. Mesopleuron very densely and strongly rugoso-punctate. The area just below base of forewings not differing in sculpture from remaining part of mesopleuron. Interspaces between the punctures and rugae distinctly microsculptured. Tergum 1 with a large brown-black spot, tergum 2 completely red. Tibia 1 brown-yellow, femur 1 black or black-brown.

A predominantly southern species in the North. - Denmark: probably occurring in all districts. - Sweden: rather common in the southern parts,



Figs.199-200. Antennae of male Mimesa. - 199: lutaria (Fabr.); 200: bruxellensis Bondroit.

Sk., Sm., Öl. and Gtl. - Finland: very few records from Sa and Ks. - Soviet Karelia: Ib and Kr. - Rather common and widely distributed throughout Europe and Central Asia.

Found in sandy localities. The nests are constructed along paths and slopes, preferably below overhanging vegetation. They consist of a single unbranched tunnel, which most often extends 3-8 cm vertically down into the loose soil. The diet of the larva consists of Psylla (Psyllidae) and small cicadas. The species is gregarious, 20 specimens or more being often found together. Omalus constrictus Forst. (Chrysididae) is known as predator.

Genus *Psen* Latreille

Psen Latreille, 1796:122.
Type-species: Sphex atra Fabricius, 1794 (= Crabro ater Olivier, 1792).

Rather large, generally uniformly black sphecids (Fig. 201). Head short. Lower part of face with well-developed, silvery shining pubescence. The narrow carina from the anterior ocellus ends in a spiny projection between the antennal sockets. The transverse carina anterior to the antennal sockets is weak. Anterior border of clypeus weakly bilobed without transverse elevation behind anterior margin. Antennae thickened distally, deeply excavate ventrally in males. Mandibles bidentate. First transverse discoidal vein joins second cubital cell, second the third. Petiolus considerably longer than tergum 1, slightly angular, cylindrical, dorsally without longitudinal convexity. Females with well developed pygidial area.

Cosmopolitan distribution. Total number of species about 40. Two species in Europe, only one in Fennoscandia.

The species nest in the ground. Larval diet consists of larger cicadas, e.g. Fulgoroidea.

49. PSEN ATER (Olivier, 1792)
Figs. 201 - 203.
Crabro ater Olivier, 1792:517.
Sphex atra Fabricius, 1794:457.

Female: 10-13 mm. Large, robust species. Head broad with very dense, silvery pubescence on lower face. Anterior border of clypeus sometimes light brown and translucent, weakly bilobed. A small, sharp spine between

antennal sockets. Scapus short and thick, distinctly curved. Mandibles red-brown with black base. Scutum sparsely but rather strongly punctate, without microsculpture. Mesopleuron smooth with only a very fine, sparse punctation. Propodeum posteriorly with coarse, irregular reticulation, on the sides smooth with superficial punctation and few, very short, transverse carinae. Petiolus much longer than tergum 1, smooth and without sharp edges, dorsally slightly convex, without sculpture, shining. Pygidial area broad with strong microsculpture and regular, coarse punctation.

Male: 9-12 mm. Pubescence of face and clypeus very dense, strongly silvery or weakly golden, shining. Frons between antennal sockets with a very small spine. Mandibles yellow with red tips. Antennae (Fig. 202) very characteristically formed: scapus strongly thickened, ampulla-shaped; flagellar segments strongly flattened and excavated ventrally; apical segments asymmetrical, dilated on inner side. Sculpture on thorax and propodeum as in female. Petiolus long, considerably longer than tergum 1. Tarsus 2 asymmetrically dilated (Fig. 203). Legs more or less yellow-brown.

Denmark: the record published by Nielsen (1907) can not be verified. - Sweden: a single female specimen from Upl., Vassunda. The record from southern Sweden by Aurivillius (1904) is doubtful. - Not recorded from Nor-

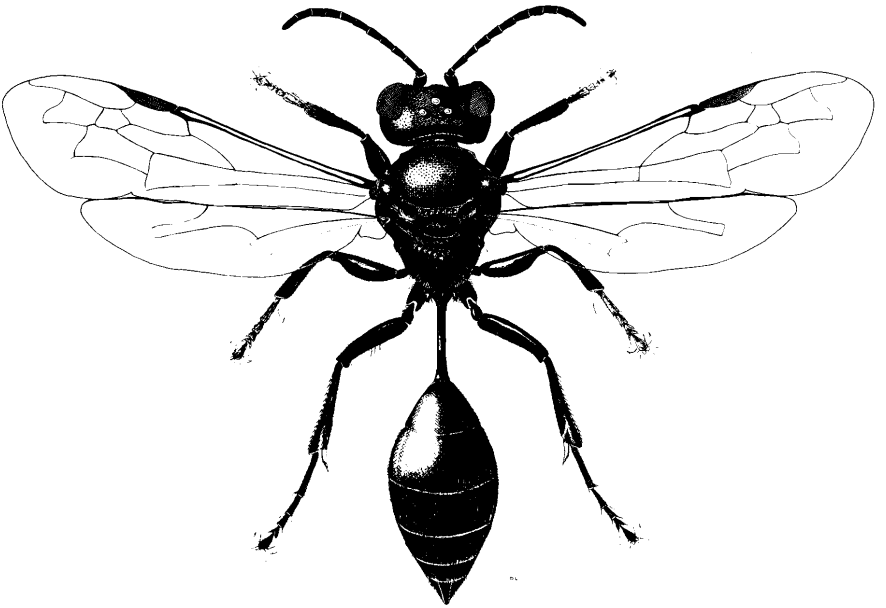
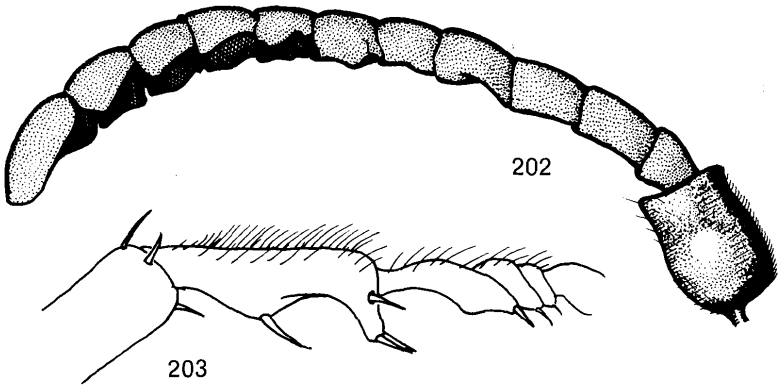


Fig. 201. Female of Psen ater (Oliv.). Length: 10-13 mm.

way or Finland.- The species is widely distributed in the Palaearctic region, eastwards to Japan.

Nests are found in sandy localities, often excavated in steep, sandy banks. From the main burrow - which may be up to 50 cm long - six to twelve short horizontal tunnels, each ending in a single cell, may be found. The prey consists of cicadas of the group Fulgoroidea, e.g. Issus coleoptratus Geoffr., Jassus lanio L. (Issidae) and Thamnotettix confinis (Euscelidae), of which 10 - 20 specimens are placed in each cell. The adult larva spins a cocoon, which is suspended almost in the middle of the cell. The larva was described by Janvier, 1955.



Figs. 202, 203. Psen ater (Oliv.). - 202: male antenna; 203: midtarsus of male.

Genus *Mimumesa* Malloch

Mimumesa Malloch, 1933:16.
Type-species: Psen niger Packard, 1867.

Black, slender species (Fig. 204), which in habitus are very similar to Psen and Psenulus. Frons without spine between the antennal sockets. The longitudinal and transversal carinae on anterior surface of head weak. Anterior margin of clypeus weakly bilobed, no transverse convexity behind anterior margin. Anterior femora rounded. First and second discoidal transverse veins both run into second cubital cell. Mesopleuron smooth, shining. The ventral part of the epicnemial carina continues into the acetabular suture. Petiolus strongly angulate, dorsally with a strongly projecting longitudinal

pad, along which is placed a row of prominent, white hairs. Females with well developed pygidial area.

Distributed in the Holarctic and Indo-Australian regions with about 30 species. About ten species are found in Europe.

The species construct their nests in wood. The diet of the larvae consists of small cicadas.

Key to species of Mimumesa

Females

1 Pygidial area narrow, its surface smooth with a row of large punctures along the margin (Figs. 217, 218). 2

\- Pygidial area broad, dull, evenly punctate over the entire surface (Fig. 216) 3

2(1) Epicnemium anteriorly delimited by a sharp carina, which forms an acute angle with the epicnemial carina close to the midline of mesopleuron (Fig. 214).

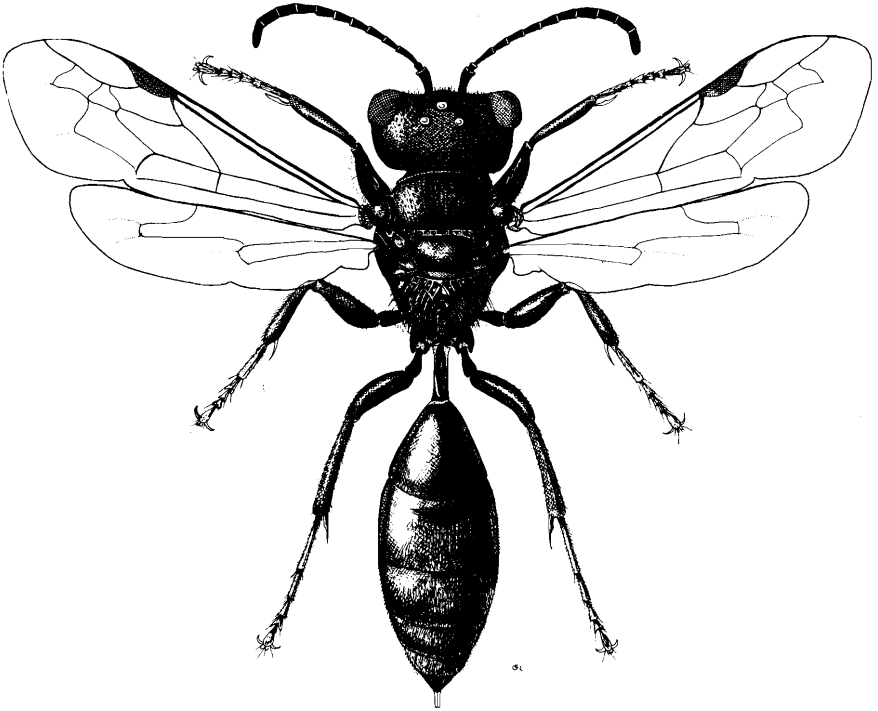


Fig. 204. Female of Mimumesa dahlbomi (Wesmael). Length: 7-9 mm.

Centre of clypeus strongly convex, longitudinally as well as transversely; silvery pubescence very sparse 54. dahlbomi (Wesmael)

- Epicnemium anteriorly without delimiting carina (cf. Fig. 213). Clypeus weakly convex, silvery pubescence very dense ..... 55. beaumonti (v. Lith)

3(1) Epicnemium anteriorly delimited by a sharp carina which forms an acute angle with the epicnemial carina close to the ventral midline of mesopleuron (cf. Fig. 214). Petiolus in lateral view considerably longer than tergum 1 (Fig. 209) .....52. atratina (F. Morawitz)

- Epicnemium anteriorly without delimiting carina. Petiolus in lateral view as long as or slightly longer than tergum 1 4

4(3) Central part of epicnemium forming a deep cup-shaped cavity, whose sides form an obtuse angle with the rest of the area (Fig. 215). The epicnemial carina strongly projecting. Punctation on genae very fine, hardly visible at 50 x magnification. Silvery pubescence of clypeus sparse... 53. spooneri (Richards)

- Epicnemium almost plane without central cavity (Fig. 213). Epicnemial carina normally projecting. Punctation on genae distinct, often coalesced into weak rugae. Silvery pubescence of clypeus thick 5

5(4) Petiolus as long as tergum 1 (Fig. 205). Pygidial area plane throughout. Frons anterior to the ocelli very densely punctate, punctures often coalescing, forming an irregular striation ..... 50. unicolor (v.d. Linden)

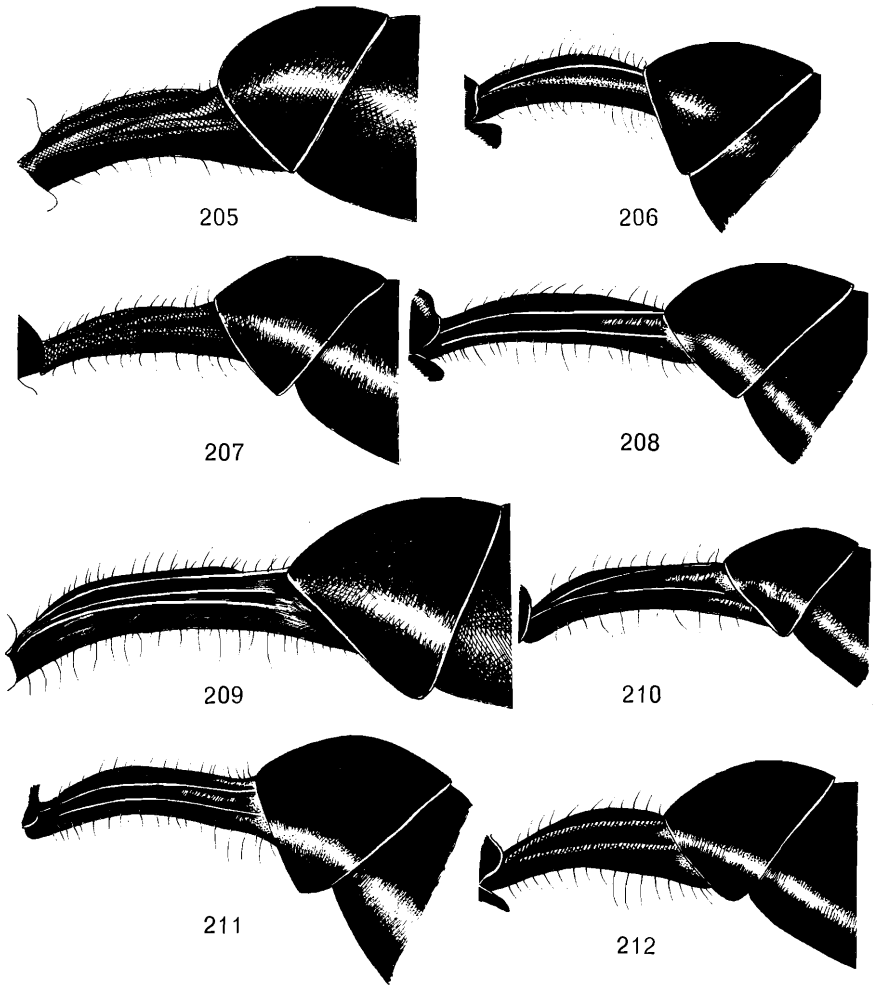
- Petiolus slightly longer than tergum 1 (Fig. 207). Pygidial area posteriorly distinctly convex. Punctation of forehead fine and rather sparse, with smooth interstices ..... 51. littoralis (Bondroit)

Males.

1 Epicnemium anteriorly delimited by a sharp carina, which forms an acute angle with the epicnemial carina near the ventral midline of mesopleuron (Fig. 214) . 2

- Epicnemium anteriorly without delimiting carina (Fig. 213) 3

2(1) Petiolus very long, longer than tergum 1 (Fig. 210) and than tibia 3. Tyloidea as in Fig. 221 ..... 52. atratina (F. Morawitz)



Figs. 205-212. Bases of abdomen in lateral view of Mimumesa. - 205: unicolor (v.d.Lind.), ♀; 206: same, ♂; 207: littoralis (Bondroit), ♀; 208: same, ♂; 209: atratina (F.Mor.), ♀; 210: same, ♂; 211: beaumonti (van Lith), ♂; 212: dahlbomi (Wesmael), ♂.

- Petiolus only slightly longer than tergum 1 and as long as tibia 3 (Fig. 212). Tyloidea as in Fig. 223..... 54. dahlbomi (Wesmael)

3(1) The central part of the epicnemium forms a deep concavity, whose sides form an acute angle with the surrounding area (Fig. 215). The distance from the eyes to the lateral ocelli almost as long as distance between ocelli ..... 53. spooneri (Richards)

- Epicnemium plane without concavity (in beaumonti, however, a very small central shallow excavation). Distance from eyes to lateral ocelli considerably longer than distance between ocelli 4

4(3) Antennal segments 11 and 12 1.5 times as long as broad (1:1.45). Epicnemium with a small central excavation. Petiolus considerably longer than tergum 1 (Fig. 211). Antennal segments 8-11 with two sets of tyloidea on the underside (Fig. 224) ... 55. beaumonti (v. Lith)

- Antennal segments 11 and 12 only slightly longer than broad (1:1.22). Epicnemium completely plane. Petiolus different. Tyloidea single. 5

5(4) Petiolus as in Fig. 206, as long as tergum 1. Punctation dorsally on frons very dense, anteriorly almost coalescing. Antennae with tyloidea on segments 3-12 (Fig. 219) ..... 50. unicolor (v. d. Linden)

- Petiolus distinctly longer than tergum 1 (Fig. 208). Punctation dorsally on frons comparatively sparse, interstices smooth and shining. Antennal segments with tyloidea only distinct on segments 3-9 (Fig. 220) ..... 51. littoralis (Bondroit)

50. MIMUMESA UNICOLOR (van der Linden, 1829)

Figs. 205, 206, 213, 216, 219.

Psen unicolor van der Linden, 1829:105.
Mimesa borealis Dahlbom, 1842:8.

Female: 7-9 mm. Frons very densely and rather deeply punctate. Especially in front of ocelli the punctures have a tendency to coalesce longitudinally. Behind the ocelli the sculpture forms a very distinct transverse striation,

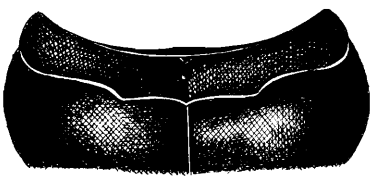
which gradually disappears towards the underside of the head. The lower part of the face including the clypeus is covered by a dense, silvery pubescence. Scutum shining, strongly and rather densely punctate. Mesopleuron laterally distinctly, although rather superficially, punctate. Large specimens have a weak striation here. Petiolus short, not longer than tergum 1 (Fig. 205). Pygidial area broad, with strong microsculpture and evenly punctate over the entire surface (Fig. 216), apically with dense, slightly golden pubescence.

Male: 6-8 mm. Sculpture as in female. Flagellum long and slender, with narrow linear tyloidea on segments 3-12 (Fig. 219).

Rather sporadic and rare in Denmark: LFM, SZ, NWZ, NEZ. - Sweden: few records from Sk., Sm., Öl., Gtl. - Finland: northern distribution limit in Ks. - Soviet Karelia: Ib. - The species is widely distributed in Europe, Asia Minor, and southern Siberia.

The species seems to be associated with sandy localities, but more detailed information about its breeding biology is not available.

51. MIMUMESA LITTORALIS (Bondroit, 1934)
Figs. 207, 208, 220.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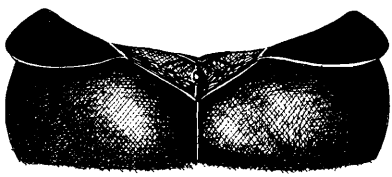
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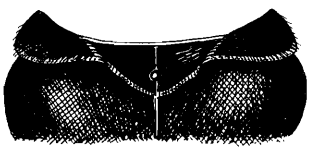
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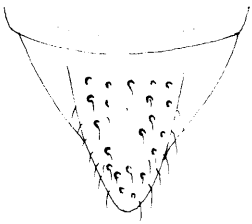
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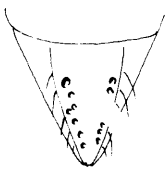
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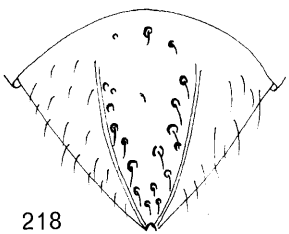
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Figs. 213-215. Mesopleuron in ventral view of Mimumesa. - 213: unicolor (v.d.Lind.); 214: dahlbomi (Wesmael); 215: spooneri (Richards).
Figs. 216-218. Pygidial areas of female Mimumesa. - 216: unicolor (v.d.Lind.); 217: dahlbomi (Wesmael); 218: beaumonti (van Lith).

Mimesa littoralis Bondroit, 1934:64.
Psen celtica Spooner, 1948:164.

Female: 6-8 mm. Very closely related to unicolor, from which it can only be separated by the characters mentioned in the key. Pygidial area relatively broader than in unicolor.

Male: 6-7 mm. Distinguishable from unicolor by the characters mentioned in the key. Tarsi pale. Antennae very slender, tyloidea as in Fig. 220.

Denmark: very rare. NEJ, the Skaw, one male (Schiødte leg). The species seems to maintain a stable population on the west coast of the peninsula Skallingen (WJ) (Lomholdt, 1973). - Sweden: Öl.; the records from Sk. proved to be unicolor (van Lith, 1949). - Finland: sporadic in N, Ka, St, Sa, Om, and ObS. - Soviet Karelia: Ib. - The species is widely distributed in the Palaearctic region. From England recorded from the southern coast. Probably a white dune,or at least a littoral species in western Europe. Also recorded from the Netherlands and Germany. In Asia the species is distributed in Mongolia, Manchuria, and Japan.

Spooner (1948) states that the species breeds in sandy localities near the coast, in localities similar to those where Pompilus plumbeus Fabr. (Pompilidae) is found, i.e. in the white dunes. It is probable that the nests are constructed in decayed, hollow, partly exposed stems of marram-grass (Ammophila arenaria).

52. MIMUMESA ATRATINA (F. Morawitz, 1891)
Figs. 209, 210, 221.

Mimesa atratina F. Morawitz, 1891:206.
Mimesa belgicus Bondroit, 1933:34.

Female: 8-11 mm. Largest species of the genus. Punctation of frons fairly dense, posteriorly forming weak transverse striation. Antennae long and slender, segment 3 more than three times as long as broad at distal end. Clypeus with dense silvery pubescence, anterior border not reflexed. Epicnemium anteriorly delimited by a strongly projecting carina (as in dahlbomi). Petiolus longer than tergum 1 (Fig. 209). Pygidial area broad, with regular punctation and distinct microsculpture.

Male: 7-9 mm. As female, but of more slender build. Antennae with distinct tyloidea on segments 7-11 only. These are oval and rather shiny on segments 9-11, but narrow, almost linear on segments 7 and 8 (Fig. 221). Petiolus very long (Fig. 210), dorsally with a sharp longitunal keel.

A rather local species in Sweden: Sk., Sm., Boh., Gtl., Og., Sdm., and

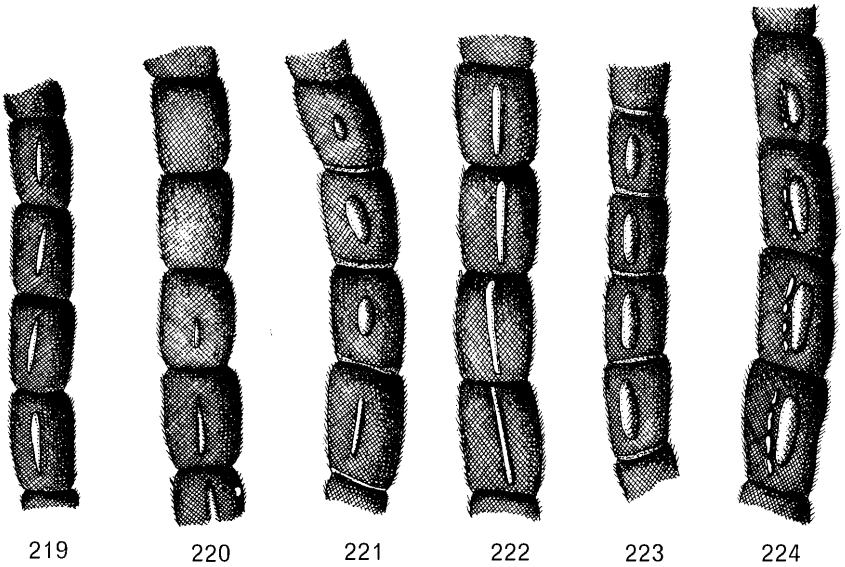
Gstr., and in Finland: Al (common); northernmost records from Om, Sb, and Kb. - Soviet Karelia: Ib. - The species is rather common in Central and South Europe. It also occurs in Japan. It may be found in southern Siberia.

Nests in sandy or clayey banks. The diet of the larvae consists of small cicadas.

53. MIMUMESA SPOONERI (Richards, 1948)
Figs. 215, 222.

Mimesa spooneri Richards, 1948:871.

Female: 7-9 mm. Closely related to unicolor, from which the species is, however, easily distinguishable by the deep cavity in the middle of the epicnemium (Fig. 215). The punctation of frons is sparser, the interstices shining. The punctation behind the ocelli finer and considerably sparser, never forming transverse striation. The silvery pubescence on lower part of frons so sparse that the underlying punctation is distinctly seen. The radial carinae dorsally on propodeum strong, interstices smooth as a mirror (as in dahlbomi). Petiolus in lateral view slightly longer than tergum 1. Pygidial



Figs. 219-224. Antennal segments 8-11 in ventral view of male Mimumesa. - 219: unicolor (v. d. Lind.); 220: littoralis (Bondroit); 221: atratina (F. Morawitz); 222: spooneri (Richards); 223: dahlbomi (Wesmael); 224: beaumonti (van Lith).

area broad, evenly and rather densely punctate, with strong microsculpture.

Male: 6-8 mm. As female, but punctation of head and the silvery pubescence denser. Flagellar segments with strongly projecting, almost linear, tyloidea, which on segments 3-10 are as long as the segments, but on 11th and 12th are gradually reduced (Fig. 222). The distance between the lateral ocelli almost as great as the distance from one of these to the eyes. All tarsi dark.

Very rare in Denmark and Fennoscandia. Denmark: F, Enebærodde, 1 ♂ (Lomholdt, 1973). - Finland: a few records from N, Kb, and Om. - Sporadic occurrence in Central Europe, but relatively widespread in England.

The species breeds in sandy localities.

54. MIMUMESA DAHLBOMI (Wesmael, 1852)
Figs. 204, 212, 214, 217, 223.

Mimesa dahlbomi Wesmael, 1852:271.

Female: 7-9 mm. Head very broad. The area below the transverse carina in front of the antennal sockets shining, weakly punctate like clypeus. Silvery pubescence very sparse. Clypeus strongly convex, anterior border weakly reflexed, with an obtuse central emargination. Frons in front of ocelli with very dense, irregular punctation, whereby the area gets a rugoso-striate appearance. Vertex with fine transverse lines. Scutum evenly and strongly punctate, with very weak microsculpture. Mesopleuron shining, punctation laterally very fine, but somewhat irregular. Epicnemium as in Fig. 214. Pygidial area narrow, shining, with a row of coarse punctures along the lateral edges (Fig. 217).

Male: 6-8 mm. Sculpture as described in female. Silvery pubescence on lower part of face rather dense, although it does not cover the punctation beneath. The emargination in the anterior border of clypeus considerably shallower than in female. Antennae long and slender. Tyloidea single, broad and distinct in antennal segments 6-11 (Fig. 223).

This species seems to be the most common and widespread species of Mimumesa in Denmark and Fennoscandia. The northern boundary for its distribution apparently goes through HOi in Norway, Jmt. in Sweden and ObN and Ks in Finland. - From Soviet Karelia the species is known from Ib and Ks. - Common in most parts of Europe.

The nests are constructed in decayed wood, e. g. tree stumps, dead branches, fencing posts and the like, perhaps associated with abandoned burrow systems of other insects. As prey are used small cicadas, e. g. Delphacodes fairemarei

Perr., Deltocephalus flori Fieb., and D. abdominalis Fabr. (Delphacidae), of which up to 38 specimens are the diet of the larvae.

55. MIMUMESA BEAUMONTI (van Lith, 1949)
Figs. 211, 218, 224.

Psen beaumonti van Lith, 1949:140.

Closely related to dahlbomi, but the epicnemium lacks the delimiting carina anteriorly.

Female: 7-9 mm. Silvery pubescence on lower part of face very dense, almost covering the underlying sculpture. Clypeus less strongly convex, anterior border not reflexed. Punctation in pygidial area somewhat irregular, covering entire surface of apical half (Fig. 218).

Male: 6-8 mm. Silvery pubescence in lower part of face slightly denser than in female. Tyloidea double, one broad and flattened as in dahlbomi, the other narrow, often interrupted in several places, considerably weaker (Fig. 224). Antennae distinctly longer than in dahlbomi, middle segments almost twice as long as broad distally. Petiolus considerably longer than tergum 1 (Fig. 211).

Denmark: NEZ, Strandmøllen, 2 ♂. - In Sweden recorded from Ög., Sdm. and Gstr., and in Finland from Ab, N, Ta, and Kb. - Very local occurrence in Europe.

Genus *Psenulus* Kohl

Psenulus Kohl, 1896:254.

Type-species: Psen fuscipennis Dahlbom, 1843.

Medium-sized black, robust species (Fig. 225), which in habitus may somewhat resemble Mimumesa. Antennae short and strong, inserted high up on frons on either side of a strongly elevated, more or less rhomboid area (Figs. 226-228). Anterior to this runs a sharp transverse keel. Head in anterior view only slightly wider than high. Clypeus weakly convex, its anterior margin with two small teeth. Lower part of face with silvery pubescence. Thorax short, very much broader than head. Pronotum dorsally with a sharp transverse carina. Scutellum with a strongly pitted transverse furrow anteriorly. Propodeum coarsely sculptured without distinctly delimited area cordiformis. Petiolus short. Abdomen short and broad, shining, smooth with sparse, fine punctation. Legs short and strong. Tarsus 1 without spines. Tibia 2 with a single apical spur. Radial cell of forewings large,

triangular. Three cubital cells. First and second discoidal transverse vein join second and third cubital cells respectively. Female with rather indistinctly delimited pygidial area. Antennae of males (Figs. 233, 234) long, slightly moniliform.

A cosmopolitan genus comprising about 100 species, of which 7 occur in Europe.

The nests are constructed in old timber and similar places. The prey consists of Homoptera Sternorrhyncha.

Key to species of Psenulus

Females

1 Occipital carina behind ocelli double-arcuate (Fig. 229). Posterior part of scutum with strong, posteriorly converging, longitudinal rugae. Posterior area of propodeum coarsely and irregularly reticulate-rugose. Frons with strong longitudinal rugae ..... 57. fuscipennis (Dahlbom)

\- Occipital carina not double-arcuate. Posterior part of scutum with at most weak longitudinal rugae. Propodeum, at least above, with regular striation. Frons with at most indicated rugae 2

2(1) Sterna 4 and 5 along posterior margin with a fringe of long, stiff, whitish or yellow-brown bristles. Sternum 2 basally with parabola-shaped, weakly elevated convexity, inside which the sternum is weakly depressed. Anterior border of clypeus with strong U-shaped emargination (Fig. 227) ..... 58. pallipes (Panzer)

\- Sterna 4 and 5 without hair fringe. Sternum 2 at most with a quite weakly indicated raised convexity. Anterior border of clypeus weakly emarginate 3

3(2) Clypeus shining smooth, only posteriorly with distinct punctation; silvery pubescence absent. Flagellar segment 2 almost twice as long as third. Each of the lateral margins in the strongly raised area between base of antennae continuing into a transverse-running carina (Fig. 226). Punctation of head very fine and sparse 56. concolor (Dahlbom)

\- Clypeus dull, evenly and densely punctate with thick silvery pubescence. Flagellar segment 2 slightly lon-

ger than third. Lateral margins of the strongly raised area between base of antennae anteriorly fused into a single carina (Fig. 228). Head rather strongly punctate ..... 59. schencki (Tournier)

Males

1 Frons completely even, without rugae. Punctation very fine and sparse. The part of the radial vein situated between the second and third cubital transverse veins much longer than second cubital transverse vein (Fig. 231). Tyloidea oval ..... 56. concolor (Dahlbom)

\- Frons, especially above, rugoso-punctate, sometimes coalescing into striae. The part of the radial vein situated between second and third cubital transverse veins equal to or shorter than second cubital transverse vein (Fig. 232). Tyloidea linear or absent 2

2(1) Tyloidea very sharply delimited, the proximal ones more than half the length of the segments (Fig. 234). Flagellum ventrally only slightly paler than dorsally. Mesopleuron above strongly punctate, interspersed with rugae ..... 57. fuscipennis (Dahlbom)

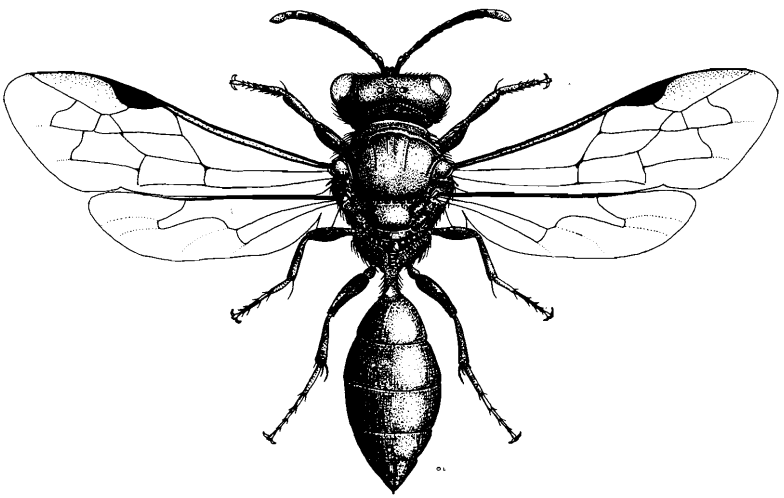


Fig. 225. Female of Psenulus concolor (Dahlbom). Length: 6-8 mm.

- Tyloidea vestigial or absent. Flagellum ventrally light brown or yellow-brown. Mesopleuron smooth and shining, only very rarely with indications of rugae, with sparse and rather fine sculpture 3

3(2) Sternum 2 with a, sometimes weak, parabola-shaped elevated convexity. Anterior border of clypeus with a deep semi-circular emargination. Flagellum without tyloidea ..... 58. pallipes (Panzer)

- Sternum 2 quite smooth, without pad. Anterior border of clypeus with a shallow, arcuate emargination. Flagellar segments 4-11 with quite narrow tyloidea (Fig. 233) ..... 59. schencki (Tournier)

56. PSENULUS CONCOLOR (Dahlbom, 1843)

Figs. 225, 226, 231.

Psen concolor Dahlbom, 1843:429.

Female: 6-8 mm. Head smooth, shining, very finely and sparsely punctate, in anterior view as Fig. 226. Anterior part of scutum with four deep longitudinal furrows, finely punctate. Posterior part weakly longitudinally striate. Propodeum dorsally surrounded by a broad, strongly pitted furrow, otherwise finely, irregularly striate. Mesopleuron shining, finely punctate, with indications of rugae. Pygidial area indistinct. Sternum 2 without parabola-shaped raised area. Sterna 4 and 5 without bristle-fringe.

Male: 6-7 mm. Punctation on head and thorax as in female. Propodeum very strongly, irregularly reticulate-rugose. Trochanter 1 long and narrow. Tibiae and tarsus 1 yellow-brown. Antennae long, not thickened apically. Flagellar segments ventrally yellow-brown with short and broad tyloidea.

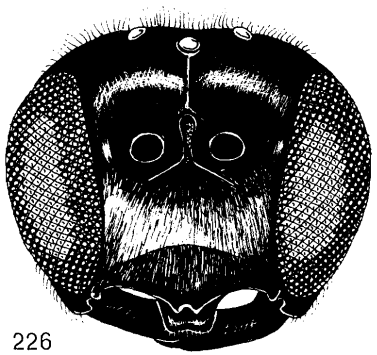
Not common i Denmark and Fennoscandia, but sometimes occurring locally in large numbers. Denmark: SJ, EJ and NEZ. - Sweden: sparse in the southern parts, the most northern records from Upl. and Gstr. - Norway: a single specimen from AK, Tøien. - Finland: rather common on Al, several localities; a single specimen from N, Helsingfors. The species is not found in Soviet Karelia. - Widespread through North and Central Europe, southern Siberia to Japan.

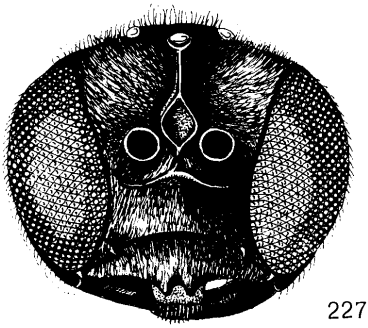
Hollow or pith-filled plant stems are extensively used for nesting, e.g. Phragmites, Sambucus and Rubus. Also a few records from galls of Lipara lucens (Dipt., Chloropidae). In addition, found nesting in eaves of thatched roofs and in old building timber. The number of cells varies considerably,

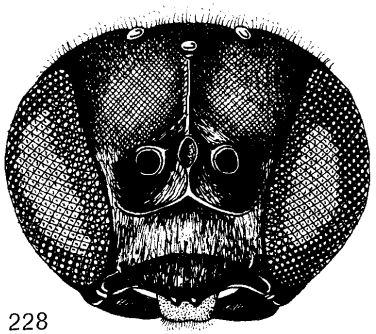
but normally about five are made in each stem. The length of the cell varies from 7 to 11 mm, while the inside diameter is given as 2.5 - 4.2 mm. The cell partitions are made of fine plant material, mixed with saliva. Prey consists of nymphs of Psyllidae, which in a number varying from 14 to 24 constitute the provision of the larva. The egg is attached to one of the midmost psyllids. As hymenopterous parasitoids are stated Perithous mediator Grav. (Pimplinae), Cratocryptus anatorius Grav. (Cryptinae) and Eurytoma nodularis Boh. (Chalcidoidea).

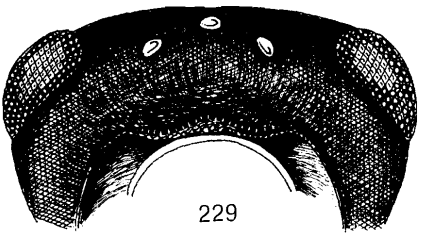
57. PSENULUS FUSCIPENNIS (Dahlbom, 1843)
Figs. 229, 230, 234.

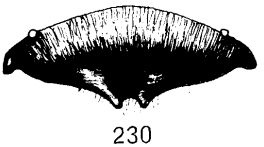
Psen fuscipennis Dahlbom, 1843:5.











Figs. 226-228. Heads in frontal view of female Psenulus. - 226: concolor (Dahlbom); 227: pallipes (Panzer); 228: schencki (Tournier).
Fig. 229. Head in posterior view of Psenulus fuscipennis (Dahlbom).
Fig. 230. Clypeus of female Psenulus fuscipennis (Dahlbom).

Female: 8-10 mm. Head with exception of clypeus and lower part of face with strong striae, interspersed with extremely fine punctures. Clypeus anteriorly shining with two obtuse teeth (Fig. 230). Face, especially the lower part, with dense silvery pubescence. The elevated area between the antennal sockets well-developed. Antennae black with a weak brownish tinge ventrally at the tip. Occipital carina slightly depressed on each side (Fig. 229), hereby forming the typical double-arcuate course. Scutum with fairly dense and strong punctures, which coalesce laterally into very weak grooves, posteriorly with strong longitudinal striae. Mesopleuron, especially laterally, rugose, with distinct microsculpture. Propodeum laterally somewhat irregularly striate. Posterior face coarsely reticulate-rugose.

Male: 7-9 mm. Clypeus evenly and uniformly punctate. Head othervise and thorax sculptured as in female. Lateral faces of propodeum coarsely and irregularly striate, posterior face very coarsely and deeply rugose. Tyloidea well-developed (Fig. 234).

A typical continental species. In Fennoscandia rather common in the central parts of Sweden and Finland, towards the north to Gstr. and Kb. - Norway: a single specimen from HEs, Hoff. - The species is absent from Denmark. - The distribution area covers large parts of Central Europe and extends eastwards to the Pacific Ocean. A subspecies in Japan.

The species is stated to nest partly in dry stems of Phragmites, partly in abandoned insect tunnels in decaying wood. Each nest may contain up to 20 cells. Each cell is about 20 mm long and is provisioned with from 16 to 47 Cinara sp. (Aphididae). The larva was described by Grandi, 1934 and Iida, 1969. - As hymenopterous parasitoids are given Perithous septemcinctorus Thunb. (Ichneumonidae) and Melittobia acasta Walt. (Eulophidae).

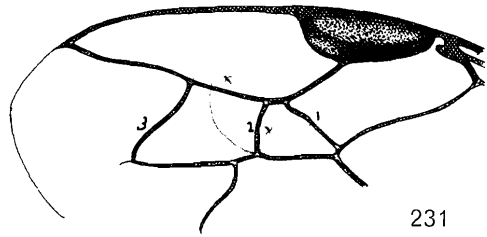
58. PSENULUS PALLIPES (Panzer, 1798)
Figs. 227, 232.

Sphex pallipes Panzer, 1798: H. 52, T. 22.
Trypoxylon atratum Fabricius, 1804:182.
Psen haemorrhoidalis A. Costa, 1871:102.
Psen chevrieri Tournier, 1889:126.
Psenulus rubicola Harttig, 1931:210.
Psenulus puncticeps Gussakovski, 1933:6.
Psenulus lubricus Gussakovski, 1934:80.
Psenulus brevitarsis Merisuo, 1937:84.

Female: 6-8 mm, male: 5-7 mm. Punctation of head very variable. In large,

robust specimens the punctation often coalesces into rugae, notably behind the ocelli. In smaller specimens the punctation of the head is often considerably finer and sparser. The raised area between the antennal sockets varies from being approximately diamond-shaped (Fig. 227) to more or less elongate rhomboid, almost as in concolor. The lateral borders are, however, always fused anteriorly into a single carina. Clypeus densely and evenly punctate, with uniform, silvery pubescence. Anterior border with a strong U-shaped emargination, on each side delimited by a truncate tooth (Fig. 227). This character is most distinct in the females. Antennae short, strong in females, elongate, weakly moniliform and occasionally with vestigial tyloidea in the males. Sternum 1 with distinct parabola-shaped, raised area. Sterna 4 and 5 in females with a strong fringe of bristles. Pygidial area flat, broadly triangular, weakly excavated apically. Last tergum in males often with extensive red-brown colour pattern basally (haemorrhoidalis A. Costa).

The species is widely distributed in Fennoscandia and Denmark. - Sweden: northern distribution limit runs through Vrm., Dlr. and Gstr. - Not recorded from Norway. - Finland: northernmost findings from Kb. - Holarctic species, with a subspecies in North America. Distributed through



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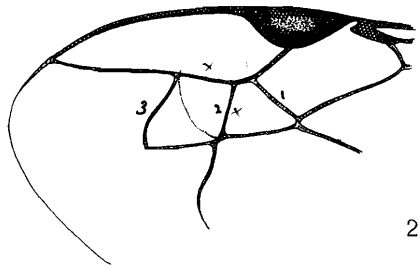

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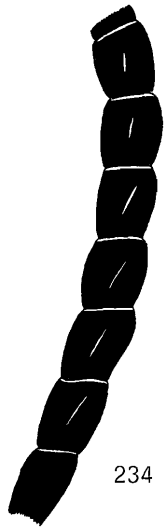

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Figs. 231-232. Distal part of forewings of male Psenulus. - 231: concolor (Dahlbom); 232: pallipes (Panzer).
Figs. 233-234. Antennae in ventral view of male Psenulus. - 233: schencki (Tournier); 234: fuscipennis (Dahlbom).

the more temperate areas of the Palaearctic region, eastwards to China, Japan and Korea.

As nesting place, hollow plant stalks are preferred, e.g. Phragmites, Ribes, Rubus and Rosa, or abandoned insect tunnels with suitable diameter in old timber. The species may be found nesting in great numbers in eaves of thatched roofs. The cell partitions consist of available material, e.g. fine sawdust, which is glued together with a sticky secretion from the salivary glands. The prey is aphids of the genera Macrosiphum, Amphorophora Chromaphis, Myzodes, Doralis and Aphis (Aphididae), of which about 30 specimens represent the provision for each larva. The finished nest may contain 6-8 cells. As hymenopterous parasitoids can be mentioned Omalus auratus L., O. bidens Forst. (Chrysididae) and Perithous mediator Fabr., and P. divinator Rossi (Ichneumonidae).

Note. The great morphological variation in this species has given rise to a considerable number of synonyms (see de Beaumont, 1937). The taxonomical status of some of these does, however, need careful examination, and especially Tsuneki (1959) and Merisuo (1937a, 1937b, 1938, 1967) express a different point of view. For discussion of nomenclature and systematics, see also van Lith, 1972.

59. PSENULUS SCHENCKI (Tournier, 1889)
Figs. 228, 233.

Psen schencki Tournier, 1889:109.

Female: 7-8 mm. Frons quite even, shining, punctation sparse, slightly stronger than on scutum. Antennae short and strong, pale ventrally. Clypeus anteriorly with a slight emargination between the two small teeth (Fig. 228). Silvery pubescence dense anteriorly on head. Punctation on scutum somewhat irregularly distributed, densest round the rather weak longitudinal furrows on anterior half. Propodeum dorsally weakly and indistinctly striate, lateral faces with indications of rugae. Mesopleuron shining, with only very fine, sparse punctures. Pygidial area narrow, posteriorly with sharp lateral margins. Only trochanter 1 plane ventrally. Tibia 2 on the outer side with a very weak longitudinal furrow. Legs black with pale tarsi. Tibia 1 pale on the inner side.

Male: 6-7 mm. Frons anteriorly striate with interstitial rows of punctures. Clypeus with shallow emargination between the two small teeth. Antennae long, moniliform. Tyloidea short, on terminal segments visible only as very small elevations (Fig. 233). Thorax as in female. Propodeum with very coarse, strongly projecting rugae. Sternum 2 without raised convexity.

In Fennoscandia this species has a very restricted distribution in central Sweden including Öl. - Norway: a single male from AK, Bygdeø. - The species might be found in SW Finland, especially Åland. - Distributed in Europe and North Africa.

The nests are constructed in decayed wood, fencing posts and the like, usually in abandoned insect burrows. Each nest contains 4-6 larval chambers; nests with up to 18 cells may however occur. The prey consists of leafhoppers (Psyllidae). As hymenopterous parasitoids are known Diomorus kollari Först. (Torymidae) and Chaenocryptus macilentus Grav. (Ichneumonidae).

SUBFAMILY PHILANTHINAE

A well-defined subfamily comprising brightly-coloured, rather large species. It includes 6 tribes of which only Cercerini and Philanthini are represented in Europe. Inner orbits parallel or diverging ventrally, emarginate in Philanthus. Mandibles without ventral emargination, simply attenuate, inner margin often dentate. Maxillary palpus six-segmented, labial palpus with four segments. Shape of clypeus highly variable in females of Cerceris, only weakly three-lobed in Philanthus. Anterior margin of clypeus in males with a stiff fringe of dense bristles. Antennae filiform in Cercerini, often clavate in Philanthini, inserted well above epistomal suture. Pronotum without transverse carina in European species, slightly depressed below scutum. Mesopleuron without epicnemium, epicnemial suture weakly pitted or vestigial. Propodeum rounded, dorsally with a more or less distinct, triangular area with different sculpture. Abdominal segment 1 often nodiform, constricted posteriorly. European species with pygidial area in both sexes. Females with well-developed tarsal pecten. Tibia 2 with a single spur. First and second discoidal transverse veins join second and third cubital cells, respectively. Second cubital cell petiolate in most Cercerini.

The larvae are easily distinguished by several characters. Anal segment conically protuberant, either the supra-anal or the sub-anal lobe projecting, or the two lobes together forming a tubular projection. Body almost everywhere covered by small spinules. Opening between atrium and subatrium simple, unarmed. Head higher than wide, parietal bands absent. Antennal papillae present. Mandibles long and slender, more than twice as long as maximum width. Galea much smaller than maxillary palpus, sometimes vestigial. Spinneret paired.

The subfamily comprises 11 genera that are mainly represented in the tropics. Only two genera in Europe. Nests in the soil.

Genus *Cerceris* Latreille

Cerceris Latreille, 1802:367.
Type-species: Philanthus ornatus Fabricius, 1790. (=Sphex rybyensis Linné, 1771).

Head large, in front view circular or wider than high. Inner orbits parallel or diverging downwards. Mandibles robust, simply attenuate, but often with one or two triangular teeth on the inside. Antennae filiform, inserted high up on frons, well above epistomal suture. Between these a strong, sharp, longitudinal keel. Clypeus in females usually with very characteristic specific structure, as the central area may be strongly elevated and projecting, sometimes with a deep emargination apically. Males often with a strongly developed fringe of stiff bristles on either side along anterior border of clypeus. Face with yellow pattern, most strongly developed in male. Humeral tubercle broad and flat, distance to tegulae very short. Mesopleuron without epicnemium or epicnemial carina. Thorax with coarse sculpture, consisting of deep, often coalescing pit-like punctures. Propodeum with dorsal, triangular, often strongly striate area. Abdomen very characteristically shaped, with strong constrictions between segments. First segment usually comparatively small, distinctly delimited from the rest, but not forming a proper petiolus in European species. Abdomen and thorax with yellow pattern of very variable extent; can only be used with considerable caution as diagnostic character. Last tergum in both sexes with well developed pygidial area. Foretarsus with pecten, which however is much more strongly developed in females. Tibia 2 with only a single apical spur. Femur 3 very characteristically shaped, especially in females, since apically they carry a plane, dull area, which is partly formed by the posterior area of a broad, downward directed, spiny prolongation, partly by the truncate apex of femur. Forewings with three cubital cells, of which the second is petiolate. First and second discoidal transverse veins join second and third cubital cells, respectively. Apex of radial cell rounded. Stigma narrow.

The genus comprises more than 500 species and has a cosmopolitan distribution, but most species are found in arid tropical and subtropical areas. From Europe about 40 species are known.

The species may be found nesting in dry, usually sandy ground. Prey consists of Apidae (Hymenoptera), Curculionidae, Chrysomelidae or Buprestidae (Coleoptera).

Key to species of Cerceris

Females

1 Clypeus, except narrow strip along anterior border, yellow, anterior part concave, without raised area. Third antennal segment only slightly longer than fourth. Sternum 2 basally with distinctly-margined elevated area; tergum 4 without yellow pattern 60. rybyensis (Linné)

- Clypeus with large black spots, central area strongly projecting. Third antennal segment much longer than fourth. Sternum 2 without elevated area, tergum 4 with yellow pattern 2

2(1) Clypeus with thin, black, shelf-like elevation. Head in front view very broad, inner orbits strongly diverging ventrally (Fig. 236) ..... 61. arenaria (Linné)

- Central part of clypeus very strongly elevated, convex,

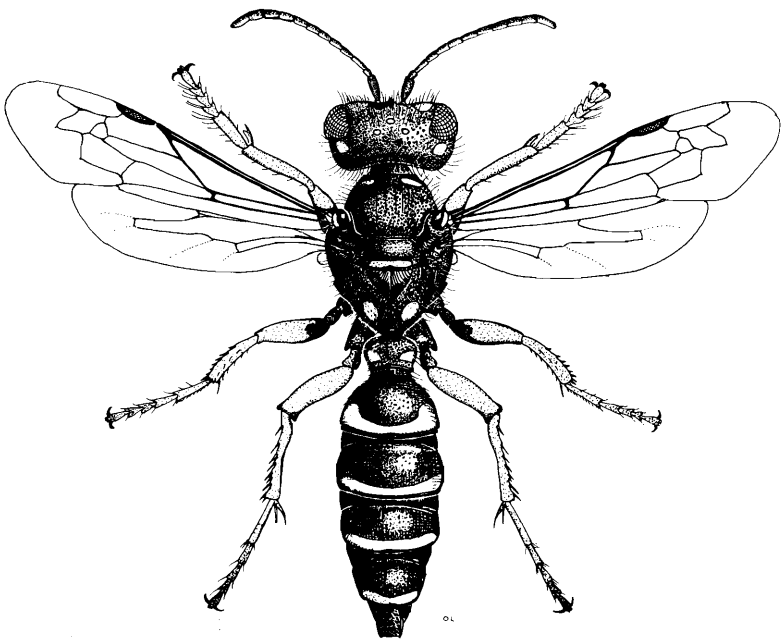


Fig. 235. Female of Cerceris arenaria (L.). Length: 10-16 mm.

anteriorly more or less emarginate. Inner orbits parallel or weakly diverging 3

3(2) Clypeus very characteristically shaped, central part very large, projecting almost like a nose (Fig. 239). Tergum 1 with large, yellow lateral spots.. 64. ruficornis (Fabricius)

- Clypeus different. Tergum 1 without yellow spots 4

4(3) Whole anterior border of elevated area on clypeus deeply semi-circularly emarginate or with an obtuse-angled incision (Fig. 238). Interstices between punctures of scutum shiny. Abdomen rather coarsely punctate. Triangular area dorsally on propodeum usually strongly striate with shiny interstices. Femora 2 and 3 red-yellow. Metanotum usually with yellow pattern ..... 63. quinquefasciata (Rossi)

- If anterior border of the raised part of clypeus is emarginate, this forms either a very shallow arch or a small U-shaped figure, whose maximum width does not exceed half the breadth of the entire anterior margin (Fig. 237). Interstices between punctures of scutum with distinct, reticulate microsculpture, dull. Abdomen rather finely punctate. Triangular area dorsally on propodeum with irregular striation; dull interstices. All femora dark. Metanotum black ..... 63. quadrifasciata (Panzer)

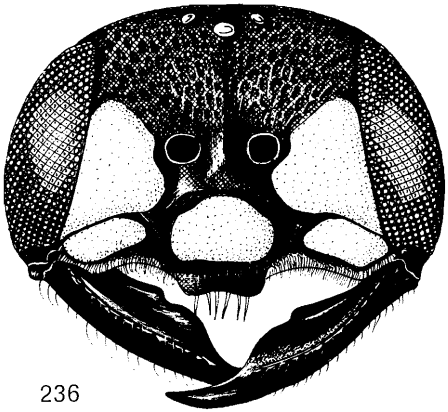
Males

1 Sternum 2 basally with a distinctly margined, elevated area. Terga 4 and 5 without yellow transverse band, at most with lateral spots. Whole body very coarsely and densely punctate. Interstices smaller than diameter of punctures ..... 60. rybyensis (Linné)

- Sternum 2 without elevated area. Terga 4 and 5 with yellow transverse bands 2

2(1) Pubescence on posterior border of sternum 6 forming a distinct bunch of hairs adpressed to sternum 7 on either side. Fringe of hairs along anterior border of clypeus strongly developed, so dense that the anterior border proper is not visible from above 3

- Pubescence on sternum 6 without bunch of hairs. Fringe of bristles along anterior border of clypeus transparent 4



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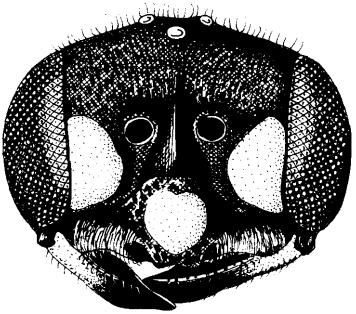

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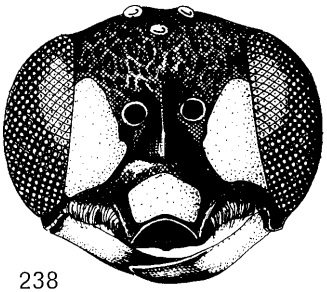

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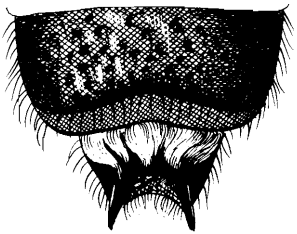

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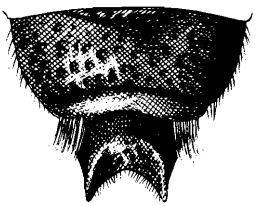

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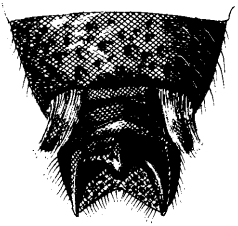

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Figs. 236-238. Heads in frontal view of female Cerceris. - 236: arenaria (L.); 237: quadrifasciata (Panzer); 238: quinquefasciata (Rossi).
Fig. 239. Head of female Cerceris ruficornis (Fabr.) in antero-lateral view.
Figs. 240-242. Apex of abdomen in ventral view of male Cerceris. - 240: arenaria (L.); 241: quinquefasciata (Rossi); 242: ruficornis (Fabr.).

3(2) Punctation on tergum 2 irregular but dense. Size of punctures very varied, from very fine to rather coarse. Brushes of hairs on tergum 6 directed obliquely outward, very dense (Fig. 242) ..... 64. ruficornis (Fabricius)

\- Punctation on tergum 2 regular, consisting only of uniform-sized punctures. Brush of hairs on tergum 6 directed straight back (Fig. 241)..... 63. quinquefasciata (Rossi)

4(2) Punctation on terga 3 and 4 very coarse, interstices smaller than diameter of punctures ..... 61. arenaria (Linné)

\- Punctation on terga 3 and 4 finer, interstices larger than or equal to diameter of punctures ... 62. quadrifasciata (Panzer)

60. CERCERIS RYBYENSES (Linné, 1771)

Sphex rybyensis Linné, 1771:8.

Female: 8-14 mm. Lower part of face and clypeus, except anterior border proper, yellow. Anterior part of clypeus slightly concave, anterior border weakly arcuately emarginate. Frons in front of ocelli longitudinally coarsely rugoso-punctate. Interstices with fine striation. Mandibles yellow with black apex, ventrally with conspicuously projecting, arcuate lamella. Pubescence on clypeus sparse, adpressed and silvery; on frons long and erect, yellow-white. Flagellum black, ventrally brown-yellow. Pronotum with larger or smaller yellow lateral spots (usually absent in Fennoscandian specimens). Scutum very densely and coarsely punctate. Interstices smaller than diameter of punctures. Triangular area on propodeum usually shiny and smooth in the middle, laterally with short, strong striae. Tergum 1 usually, tergum 4 always, without yellow pattern in specimens from Denmark and Fennoscandia. Tergum 3 almost entirely yellow, anteriorly with triangular black spot. Individuals from Fennoscandia often lack yellow pattern on terga 3 and 5. In these specimens the yellow marking on tergum 3 may be divided into two lateral spots. Specimens from Central and South Europe often have very extensive yellow markings on terga 4 and 5 and sternum 3. Tibiae yellow or red-yellow. Femora 1 and 2 black with yellow apex, femur 3 mainly dark in Fennoscandian specimens, red-yellow with dark base in many Danish specimens. The yellow and red-yellow pattern on legs considerably more extensive in specimens from Central and South Europe.

Male: 7-10 mm. Front of head with widely distributed white-yellow or slightly greenish yellow pattern. Hair fringe, covering base of mandibles, light brown and transparent. Mandibles black, sometimes with faint yellow

basal spot, with a weak arcuate lamella ventrally. Antennae black, proximal flagellar segments yellow-brown ventrally. Thorax without yellow pattern. In Danish, Central and South European specimens metanotum may carry a faint yellow transverse spot. Abdomen very coarsely and densely punctate. Tergum 3 always with very extensive yellow pattern. Often a triangular black area anteriorly. In addition, often yellow transverse bands on terga 2 and 6. Very seldom small lateral spots on terga 4 and 5. Variation in extent of yellow pattern appears to be mainly geographically (climatically) conditioned, since specimens from Fennoscandia, on average, are considerably darker than specimens from Denmark and the rest of Europe.

Common and widely distributed in Fennoscandia and Denmark. - Denmark: not found in western and northern Jutland. - Sweden: found in most districts up to Dlr. and Gstr. - Norway: distributed in the south-eastern districts, towards the north to On. Valdres. - Finland: occurring in most of the southern districts. - Soviet Karelia: Ib and Kr. - The species is distributed all over the western Palaearctic region, eastwards to Kazakhstan. In Japan there is a separate sub-species, C. rybyensis japonica Ashmead, (Tsuneki, 1961).

A common species which, like e.g. C. arenaria and C. quadrifasciata, may often be found nesting in large aggregations. Prey usually consists of smaller species of Halictus and Andrena, but species of Halictoides and Panurgus (Hymenoptera, Apidae) are also used. These species often nest in the same type of locality as species of Cerceris. Rybyensis only hunts bees returning to their nest with pollen (Hamm & Richards, 1930). After having paralyzed the prey by a few stings between head and thorax or between pro- and mesothorax the neck region is squeezed vigorously with the mandibles (malaxation). Thereupon the prey is unable to coordinate movements of legs and wings, and it will die within about two days. It is probable that Cerceris, like Philanthus, licks nectar or possibly hemolymph during malaxation.

The main entrance is 10-15 cm long, first descending, later running horizontally. It terminates with a cell, but issuing from the horizontal tunnel up to seven additional cells are constructed. The number of prey in each cell varies from 5-8, dependent on size. Usually only a single species is deposited in each nest. Orientation flight of rybyensis is very similar to that described for Philanthus.

As parasitoids are mainly found Hedychrum nobile Scop. and H. gerstaeckeri Chev. (Hymenoptera, Chrysididae), of which especially the former may occur in great numbers. Species of Metopia and Pterella (Diptera, Sarcophagidae) are known as cleptoparasites.

Note. Specimens from Gotland deviate from the remaining Fennoscandian populations by the following characters: colour pattern on head and abdomen ivory-white or creamy, never yellowish. Female: Tegulae seldom with yellow spot. Only terga 2 and 3 with pattern, spots on tergum 2 very small or absent, on tergum 3 usually separated. Tibia 3 brown. Male: Area round anterior tentorial pit black. Spots on tergum 2 very small, sometimes absent.

61. CERCERIS ARENARIA (Linné, 1758)
Figs. 235, 236, 240.

Sphex arenaria Linné, 1758:571.

Female: 10-16 mm. Head (Fig. 236) very broad ventrally, in front view approximately trapezoid. Inner orbits distinctly diverging ventrally. Clypeus with a thin, shelf-like, slightly reflexed projection. Face ventrally with two yellow triangular spots. Clypeus usually with three yellow spots, one usually covering the central area, but may be very reduced, and two lateral ones. Mandibles often with a basal yellow spot. Just behind the eyes there are generally two yellow spots of variable size. Yellow pattern on head varies considerably. Specimens from South Europe may have the entire clypeus yellow except for a small triangular black spot round anterior tentorial pits. These specimens, in addition, often have small yellow spots just behind and in front of the keel between the antennal sockets, as well as between the ocelli and the very large yellow spots behind the eyes. In specimens from Fennoscandia the yellow markings on clypeus are often absent, and the triangular spots along inner orbits and the spots behind the eyes may be very reduced. Frons in front of ocelli coarsely rugoso-punctate, rugae with weak microsculpture. Pronotum with two larger or smaller yellow lateral spots, only seldom absent in Fennoscandian specimens, but may coalesce to form a transverse band in specimens from South Europe. Scutum dull with coarse, rather sparse punctation. Metanotum with yellow transverse spot, which is only seldom dissolved into two lateral spots. Triangular area on propodeum dull due to the strong microsculpture, with strong longitudinal carinae. Remaining part of propodeum very coarsely and densely pitted, usually with two large yellow lateral spots, although these are frequently absent in specimens from Fennoscandia. Terga 1 - 5 with yellow transverse bands along posterior border, although often intersected in middle on tergum 1. Sterna often with yellow markings. Legs red-yellow, femora proximally black in specimens from Denmark and South Scandinavia. Material from more northern localities usually with completely black femora and partly dark coloured tibiae.

Male: 9-15 mm. Face with very extensive yellow pattern, extending up along inner orbits beyond antennal sockets. Vertex usually with small yellow dot behind eyes in Danish specimens. Mandibles with more or less extensive yellow markings in middle, ventrally near apex with obtuse-angled projecting lamella. Anterior border of clypeus black, with three truncate teeth. Antennae black, scapus yellow ventrally, near apex with obtuse-angled dilation, four proximal segments of flagellum and the most distal one brown-yellow ventrally. Pronotum in specimens from southern Scandinavia and Denmark may have two small yellow lateral spots. Metanotum with yellow transverse spot, which is, however, usually absent in individuals from Fennoscandia. There may be two yellow spots on propodeum, especially in robust specimens from Denmark, Central and South Europe. Abdomen very densely and coarsely punctate, almost pitted, with narrow yellow transverse bands on terga 2-6. Some very few Danish specimens have two yellow lateral spots on tergum 1. Sterna 2-4 generally with yellow marking. Sternum 6 with strong fringe of bristles along posterior border (Fig. 240). Coxa 3 usually yellow centrally. Front and midlegs yellow with base of femora black. Femur 3 yellow with brown-yellow to black apex.

The colour pattern shows, especially in the female, a very conspicuous variation, but also in small populations the extent of the yellow colour varies considerably. Small specimens are more extensively black than larger ones.

C. arenaria is the most common species of the genus occuring in Denmark and Fennoscandia. The northern distribution limit in Sweden runs through Dlr. and Med. - Norway: northern occurrence in SFi and HEs. - Finland: distributed towards the north to Om, Sb and Kb. - Soviet Karelia: Ib and Kr. - The species is very widely distributed in the Palaearctic region. from the Atlantic and the North Sea in the west, to the Sahara in the south and the Pacific in the east.

This species may be very abundant locally, several hundred individuals may nest in a very restricted area. The nest is constructed as in rybyensis, but contains several cells on average. Prey consists of larger Curculionidae (Coleoptera) of the genera Brachyderes, Otiorrhynchus, Strophosomus, Tanymecus, Sitona, Hylobius, Pissodes and Curculio. Exceptionally other Coleoptera are used, e.g. Bromius obscurus L.(Chrysomelidae). In Russia the species has proved to be useful in the biological control of noxious Curculionidae in coniferous forests (Blagoveshchenskaia, 1970). It seems to be usual for each nest to contain only one species of prey. Dependent on size,, each cell is provisioned with 5-12 specimens, usually 8. - Parasitoids are mainly Hedychrum nobile Scop. and H. aureicolle niemeläi Lins. (Hym.,

Chrysididae). Species of Metopia, Pterella, Miltogramma and Leucophora (Diptera) are recorded as cleptoparasites. Larva described by Iida, 1969.

Note. The authors Schletterer (1889), Shestakov (1922), Beaumont (1951), Tsuneki (1961) and Eck (1973) have divided the species into eight subspecies, of which four are stated to occur in North Europe (Eck, op. cit.) The geopgraphical distribution of these, according to Eck, is as follows:
C.a. arenaria L. Sweden: Vrm., Dlr., Upl., Sdm., Vg., Ög., Sm. (Kalmar) and Öl.
C.a. gotlandica Eck. Sweden: Gotland, Fårön.
C.a. erlandssoni Eck. Denmark; Sweden: Sk., Bl., Hall.
C.a. incognita Eck. Central Europe between the North Sea and Baltic coasts and the German "Mittelgebirge", Poland.

The definition of these taxa is, however, not very exact, being exclusively based on colour characters. As indicated above, the colour variation in this species is considerable, but continuous, so that we can speak about a pronounced cline in the distribution range. The population on Gotland is, however, comparatively well delimited and characterized by the sparse yellowish white pattern (see also C. rybyensis (L.)).

The Danish collection of C.a. erlandssoni contains a representation (16 females, 14 males) of the well-delimited population on SW Funen, Svanninge Bakker. These specimens do not agree very well with the remaining Danish material of erlandssoni, and in many features are similar to gotlandica.

In her paper Eck did not refer to subspecies the collection studied by her from Finland (18 females, 15 males). She only stated that "die finnischen Tiere längst nicht so scharf von C.a. arenaria abgrenzbar (sind) wie C.a. erlandssoni von der mitteleuropäischen Form".

62. CERCERIS QUADRIFASCIATA (Panzer, 1789)
Fig. 237.

Philanthus quadrifasciata Panzer, 1789: H. 64, T. 14.

Female: 9-12 mm. Head in front view as Fig. 237, inner orbits only slightly diverging ventrally. Raised part of clypeus with either arcuate or more or less strongly U-shaped emarginate anterior border. Emargination always narrower than half breadth of anterior border. Pattern on head yellow, delimited to central spot on clypeus and large spots along inner orbits. In Denmark specimens occur with larger or smaller lateral spots on clypeus. Only rarely do specimens occur in Denmark with yellow spots behind the eyes. Mandibles dark with a larger or smaller yellow proximal spot. Thorax and

propodeum normally entirely black, but specimens occur with two weak yellow lateral spots on pronotum. Punctation on terga 3 and 4 rather weak. Interstices between punctures considerably greater than their diameter. Tergum 1 always without yellow pattern, terga 2-4 and often also 5 with narrow yellow transverse bands along posterior border. Femora mainly black with brownish apex. A faint yellowish streak may sometimes occur on femur 3. Tibia 1 and 2 mainly yellow, tibia 3 with a large brown spot on the outer side.

Male: 8-11 mm. Very similar to arenaria, from which it can be distinguished by the following characters. Head and thorax with very long pubescence. Anterior border of clypeus with three very weak, rounded teeth. Hair-fringe along anterior border very weak. Spots along inner orbits usually not fused with the triangular spot behind the epistomal suture. Thorax with at most two weak yellowish spots on pronotum. Terga 3 and 4 with distinctly finer and sparser punctation. Hair-fringe on sternum 6 very weak and thin. Femora 1 and 2 black, femur 3 proximally yellow like its trochanter. Tibia 1 and 2 and tarsi yellow, tibia 3 with large brown spot on the outer side.

The species is widely distributed in Fennoscandia and Denmark, but does not seem to be as common as the preceding species. Its northern distribution limit in Sweden passes through Vb. and Nb. - Norway: occurs mainly in the southern coastal districts. - In Finland the species occurs towards the north in ObN. - Soviet Karelia: Ib and Kr. - Distributed all over Europe, through southern Siberia, Manchuria to the Pacific Ocean.

Like arenaria the species may be very abundant locally. Thus Abrahamsen (in litt.) counted 5 - 600 specimens in a single colony. The locality was a fire break in Denmark: WJ, Klosterhede Plantage. Each nest contains about 4 cells and is provisioned with about 10 individuals of weevils of genera like Phyllobius, Polydrosus, Anthonomus or Otiorrhynchus (Coleoptera, Curculionidae). Where quadrifasciata is abundant, it may be useful in decimating the populations of noxious weevils.
Hedychrum nobile Scop. and H. aureicolle niemeläi Lins. (Hym., Chrysididae) are known as parasitoids.

63. CERCERIS QUINQUEFASCIATA (Rossi, 1792)
Figs. 238, 241.

Crabro quinquefasciata Rossi, 1792:139.

Female: 7-11 mm. Head in front view as Fig. 238. Anterior border of raised part of clypeus deeply, semi-circularly emarginate throughout whole

width. A central spot on clypeus, and two large spots along inner orbits white-yellow. In addition, white-yellow markings proximally on mandibles, and a small dot behind the eyes. Lateral spots on clypeus rarely occur in Danish specimens, but are well-developed in specimens from Central and South Europe. Antennae black, red-yellow ventrally. On thorax, white-yellow are: two lateral spots on pronotum, a transverse band on metanotum and spots on tegulae. Thorax shining, smooth dorsally, without microsculpture. Triangular area on propodeum shiny, strongly and regularly striate. Abdomen with white-yellow lateral spots on terga 2 - 5, which may fuse into a narrow transverse band on terga 3-5. On first tergum there may be small lateral spots. Femora in the Fennoscandian and Danish material mainly black, femora 1 and 2 with yellow pattern distally, femur 3 red-yellow distally. Specimens with uniform red-yellow femur 3 may occur, especially in Denmark. Tibiae and tarsi darker or lighter red-yellow.

Male: 6-10 mm. Face with very extensive yellow markings. Large spots along inner orbits coalesced with the triangular spot above the epistomal suture. Anterior border of clypeus with either rounded lateral corners or with a very weak central tooth. Mandibles with very large yellow mark ventrally, and with black, projecting lamella near apex. Antennae ventrally brown-yellow. Danish specimens often have a very small yellow dot behind the eyes. Metanotum always with yellow transverse spot. Triangular area on pronotum shiny, with more or less distinct longitudinal rugae. Abdomen with white-yellow triangular spots on terga 2 - 5. These may be narrowly connected. Danish specimens may have small lateral spots on tergum 1, and tergum 6 may be marked with yellow. Sternum 6 with thin tuft of hairs on either side (Fig. 241). Femora 1 and 2 with large distal yellow mark, femur 3 usually tri-coloured: the proximal part yellow, followed by a larger or smaller black area, while the apex is red-brown or yellow-brown. Specimens with completely black femur 3 may occur. Coxa 3, trochanter 3 and trochanter 2 usually with yellow spots. Tibiae 1 and 2 with a lighter or darker brown streak on the outer side.

A southern species in Fennoscandia and Denmark. - Denmark: sparsely distributed in EJ, NEJ and NEZ. - Sweden: a few records from Sk., Sm. and Öl. - Not found either in Norway or in Finland. - Soviet Karelia: Ib. - Widely distributed throughout the Palaearctic region. From Europe and North Africa to the Pacific Ocean.

The nest may contain up to 10 cells (Grandi, 1961), which are provisioned with smaller Curculionidae, e. g. of the genera Apion, Sitona, Micrelus (Ceuthorryhynchus p. p.), Tychius or Strophosomus, of which each cell may

contain up to 82 specimens. Usually there are about 50 prey specimens in each cell. Hamm and Richards (1930:113) mention that the species should also be able to use Meligethes (Coleoptera, Nitidulidae). In the fact that a single nest often contains several species (see also Adlerz, 1903 and Grandi, 1961), quinquefasciata deviates from the majority of Cerceris species. It is often gregarious. Larva described by Grandi, 1961.

64. CERCERIS RUFICORNIS (Fabricius, 1793)
Figs. 239, 242.

Philanthus ruficornis Fabricius, 1793:292.
Crabro cunicularia Schrank, 1802:234.
Philanthus trifidus Fabricius, 1804:305.
Cerceris labiata auctt.

Female: 10-13 mm. Central part of clypeus quadrate or trapezoid, very strongly elevated, convex, forming angle of about 60° with remaining part of clypeus, with large white-yellow spot. Anterior border of elevated area evenly emarginate or double arcuate-emarginate, with rounded tooth in middle (Fig. 239). Head with additional white-yellow or faintly green-yellow pattern in the shape of two large spots along inner orbits and usually a pair of spots behind eyes. Sometimes two lateral spots on clypeus; these spots mainly found in specimens from Central and South Europe, but may also occur in occasional specimens from Denmark (SJ). Basal half of mandibles with extensive yellow mark. Pronotum with yellow lateral spots, tegulae and metanotum also with yellow markings. Triangular area on propodeum shiny, strongly longitudinally striate. Tiny yellow lateral spots on propodeum may occur in individuals from Central and South Europe. Abdomen with yellow spots on terga 1-5, which are narrowly fused on the two or three last terga. Legs yellow and/or red-yellow, femora 1 and 2 with black base.

Male: 8-11 mm. Very similar to quinquefasciata. Central part of clypeus almost plane, very sparsely and shallowly punctate; anterior border usually with three small rounded teeth. Antennae long, median segments considerably longer than broad. Pattern almost as in quinquefasciata, yellow colour, however, somewhat more extensive, especially on abdomen, where terga 1 and 6 more frequently bear spots. In occasional specimens the legs may be almost uniform yellow and/or red-yellow. Striation in triangular area on propodeum very strong, regular. Pygidial area with margins not parallel, broader posteriorly. Sternum 6 on either side with strong bunch of golden hairs, directed obliquely outward and visible from above (Fig. 242).

Denmark: not common; mainly in the southern and south-eastern districts. - Sweden: sparsely distributed in southern and south-eastern districts, northernmost occurrence in Med. - Norway: a few records from AK, Tøien and SFi, Flesje. - Finland: south-eastern distribution, northwards to Kb. - Soviet Karelia: Ib and Kr. - Not common in Europe. Additional material from Kazakhstan and China.

Only very fragmentary information of the biology of the species exists. Nielsen (1900) states that imagines in Denmark are active later in the summer (August) than remaining species of Cerceris. This should, however, be modified, as specimens exist taken on July 4th and 11th.

The prey mainly consists of species of Curculionidae, e.g. species of the genera Otiorrhynchus, Strophosomus, Sitona and Apion, but species of Chrysomelidae (Longitarsus and Bromius) are also used. Bischoff (1927:358) states that nymphs of Hemiptera might constitute part of the provision. If this is the case, ruficornis shows a greater adaptability in its diet than e.g. quinquefasciata.

Genus *Philanthus* Fabricius

Philanthus Fabricius, 1790:224.
Type-species: Philanthus coronatus Fabricius, 1790.

Head very strongly developed, in front view considerably wider than high. Inner orbits strongly diverging ventrally, with V-shaped emargination. Median ocellus larger than lateral ones. Antennae short and thick, inserted almost in middle on front. Clypeus large, its anterior border usually with characteristic teeth and excavations. Male with a thick fringe of stiff bristles along anterior border of clypeus, almost as in Cerceris. Mandibles simply attenuate, without teeth on the inner side, ventral margin with a very weak excavation. Face with extensive whitish pattern, covering entire clypeus and spreading up along inner orbits as two large, triangular spots. In addition a large two- or three-branched spot above antennal sockets. Since humeral tubercle reaches back to tegulae, scutum is compressed laterally into a small, spinelike prolongation. Scutum rather strongly convex, with strong, almost pitted sculpture. Scutellum strongly convex, anteriorly with a deep transverse furrow. Mesopleuron simply built, epicnemium only indicated, delimited by a transversely carinate furrow. Propodeum short, dorsally with indicated area condiformis. Abdomen sessile, flattened, usually with extensive yellow markings. Females with large, slightly differentiated pygidial area.

Tarsus 1 of females with strong pecten, in males comparatively weak. Tibia 2 with a single spur. Forewings with three cubital cells, of which second and third receive first and second discoidal transverse veins, respectively.

The genus is cosmopolitan and comprises a large number of species. Six occur in Europe, of which only one is represented in the Danish and Fenno-scandian faunas.

The species nest in sandy localities, using Apidae (Hymenoptera) as provision.

65. PHILANTHUS TRIANGULUM (Fabricius, 1775)
Figs. 243 - 245.

Vespa triangulum Fabricius, 1775:373.

Female: 12-17 mm. Head in front view as Fig. 244. Frons in front of ocelli very densely punctate, with sparse, long grey-yellow pubescence. Whole lower part of face with ivory pattern. Above antennal sockets a large, V-shaped spot. Occasionally, an elongate spot above this. Clypeus with two strong median teeth and two considerably weaker lateral ones. Mandibles red yellow with black apex. Posterior part of head with extensive red-brown pattern. Pronotum dorsally, humeral tubercle distally, tegulae and metanotum with

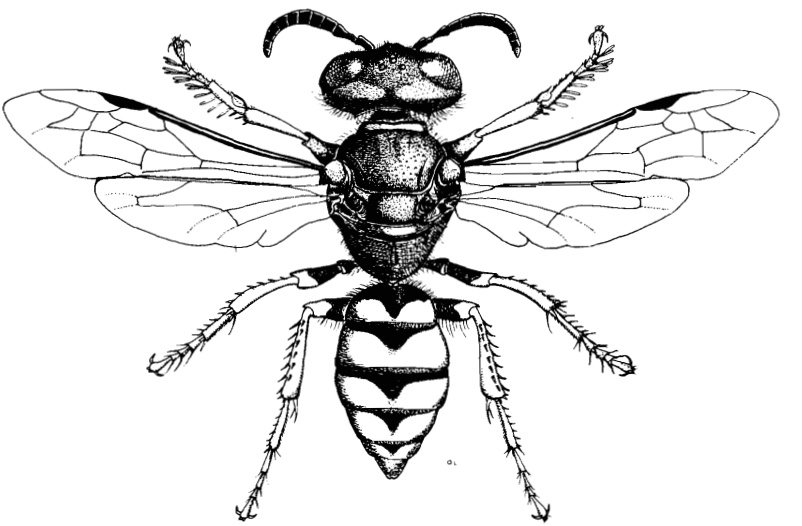


Fig. 243. Female of Philanthus triangulus (Fabr.). Length: 12-17 mm.

white-yellow markings. Punctation on scutum dense and strong, scutellum shining, with very sparse punctation. Mesopleuron very strongly and densely punctate. Propodeum dorsally with dense and very regular punctation, laterally the punctation becomes stronger, forming longitudinal rugulae. Thorax and propodeum with thin, grey-yellow pubescence all over. Abdomen with very extensive, but very variable, yellow pattern. Usually with black triangular areas on terga 1-4. Ventrally usually uniform yellow, but black spots may occur. Pygidial area broad and flat, apically with small U-shaped emargination. Legs yellow, basal part of femora black. Tibiae 2 and 3 and tarsi with strong, dark spines.

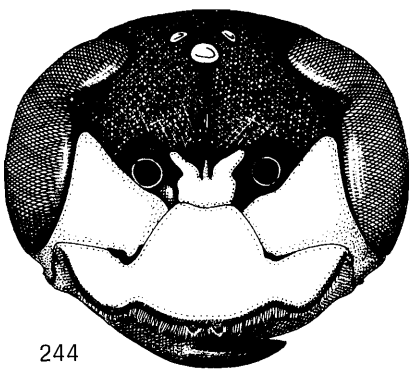
Male: 8-15 mm. Similar to female. Ivory pattern on face even more extensive than in female. Spot between antennal sockets three-pointed (Fig. 245). Fringe of bristles along anterior border of clypeus very well-developed. Colour pattern of mandibles much varying. Usually a basal spot and median area yellow. Behind eyes a large, oblique, yellow spot, surrounded by a red-brown ring. Pronotum, humeral tubercle, tegulae, scutellum and metanotum with yellow markings. Spot on scutellum may be absent. Punctation on thorax and propodeum considerably stronger than in female. Abdomen with large, black triangular spots on both terga and sterna. Legs yellow, base of femora black.

Changes in climate have shown to affect the distribution of the species (Bræstrup & Nielsen, 1941). While all imagines emerge almost simultaneously all over the distribution-range of the species, the period of activity naturally becomes gradually shorter northwards, and late in the 1930's the species actually expanded its range, probably caused by unusually favourable weather conditions in July and August. The species has been recorded from several localities in the North (Erlandsson, 1962), but seems only to maintain very few stable populations. - Denmark: at least earlier common on the island of Bornholm. Nowadays common in several localities in North Zealand and on the island of Anholt (EJ). - Sweden: especially common on the islands of Öland and Gotland and along the sandy south coasts of Sk. Northwards to Vrm. and Upl. - Not recorded from Norway. - Finland: a few records from the southern districts. - Soviet Karelia: Ib. - It is one of the most widely distributed Sphecids, primarily occurring in the Mediterranean area in the Palaearctic region, and is found all over Africa and in Madagascar.

In its breeding biology, P. triangulum is one of the best known Sphecidae (see van Beusekom (1946), Olberg (1953), Simon & Simon (1972), Tinbergen (1932), Vergne (1935), and Rathmayer (1962)). The nests are made in sandy areas fully exposed to the sun, often in large aggregations, similar to Bembix

and Cerceris. Distance between entrances rarely less than about 10 cm, due to agression. The nest proper, which is excavated in about three days, consists of a long main tunnel up to about one metre (!), whose first stretch declines about 30°. Thereupon it continues fairly horizontally. On the latter stretch the cells (3-34) are constructed at the end of short side tunnels, running at right angles to the main tunnel. During excavation the strong forelegs are mainly used, but small pebbles are removed with the mandibles.

Before the prey is caught, an orientation flight above the entrance to the nest is performed. The flight goes in increasing 8-shaped figures, where the intersecting lines in the figure lie just above the entrance. Prey consists of honey bees, Apis mellifera L., of which three to four specimens may be collected per day. Each cell contains three to six specimens. The bees are mainly attacked in flowers, but may also be taken in flight. The prey is paralyzed by being stung through the articular membranes, immediately behind the front legs (Rathmayer, 1962). It has often been observed that Philanthus licks the drops of nectar pressed out of the proventriculus of the bee by strong repeated squeezing of thorax with the mandibles (malaxation). The diet of imago consists of a considerable number of honey bees, which may be found lying on the ground, badly injured, round the breeding site of Philanthus. The victims are easily recognizable by the strongly compressed and shortened abdomen, as Philanthus has emptied the bee both of nectar and partly also of hemolymph. For provision of the nest a single female used up to 108 bees in its life-time, which hardly exceeds six weeks. Where P. triangulum breeds in dense populations this may cause decimation of the stock of honey bees (Johnsen, 1955). The egg hatches after 2-3 days, and in the course of about



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Figs. 244-245. Heads in frontal view of Philanthus triangulum (Fabr.). - 244: ♀; 245: ♂.

14 days the prey is completely eaten and the larva fully grown. It spins a very characteristic bottle-shaped cocoon, whose posterior end is attached to the back wall of the cell. The cocoon is suspended in the middle of the cell by means of fine threads. Larva and cocoon described by Grandi (1961). P. triangulum occurs in a single generation in Denmark and Fennoscandia. From Central Europe specimens of a second generation are known.

As parasitoids are found Hedrychum intermedium Dahlbom (see Simon & Simon, 1972) and H. gerstaeckeri Chevr. (Hym., Chrysididae). Species of Metopia, Sphecapata and Conops (Dipt., Sarcophagidae and Conopidae) are known as cleptoparasites.

SUBFAMILY NYSSONINAE

A rather heterogenous assembly of genera that probably constitutes a monophyletic unity, but this question is still open for discussion. Based on larval morphology Evans & Lin (1959) concluded that the larvae of the Nyssoninae form a clearly defined and closely knit group.

Most species rather large to medium-sized, with rich yellow and/or red pattern. Head wider than high. Eyes strongly convex, inner orbits parallel or converging ventrally. Clypeus large, anterior margin without projecting teeth or emarginations. Mandibles without ventral emargination. Antennae filiform in European species, inserted well above epistomal suture, in males often with conspicuous secondary sexual characters. Pronotum without transverse carina. Scutum antero-laterally with mesonotal laminae, i. e. a sharply delimited, lamellar dilation covering the base of the forewings. Epicnemium and epicnemial carina usually well-developed, but completely absent in Bembix. Propodeum usually with well-delimited dorsal area with strong sculpture. Abdomen sessile in European species. Last tergum in females with triangular pygidial area. Tibia 1 with two apical spurs, in Alysson with only one spur. Forewings with three cubital cells of which the second is petiolate in the Nyssonini. Both discoidal transverse veins usually join second cubital cell.

The following combination of characters separates the larvae from other Sphecidae: integument smooth; parietal bands absent or very short; antennal papillae present, of varying length; labrum retractable below clypeus, its anterior margin with at least some barrel-shaped sensillae; mandibles acumiate, about twice as long as maximum width; apex acute, the inner margin with from one to three teeth; maxillary palpus larger or only slightly shorter

than galea; spinneret paired, each opening at the end of a process of about the length of a labial palpus.

The subfamily comprises five tribes, all represented in Europe. The taxonomical status of the Heliocausini is doubtful, and Mellinus is here treated as constituting a separate subfamily. Cosmopolitan distribution. About 100 species in Europe. Terrestrial species.

Genus *Argogorytes* Ashmead

Argogorytes Ashmead, 1899:324.
Gorytes Latreille, 1804:308.
Type-species: Gorytes carbonarius Smith, 1856.

Rather large species (Fig. 246) with yellow pattern, in habitus very similar to Gorytes. Head in front view comparatively long, median part of clypeus being somewhat protruded. Eyes slightly convex, inner orbits very weakly converging ventrally, dorsally with shallow emargination (Fig. 247). Antennae rather thick, entirely black in both sexes, those of males very long (Fig. 248). Scutum laterally above tegulae with narrow lamellae. Mesopleuron with well-

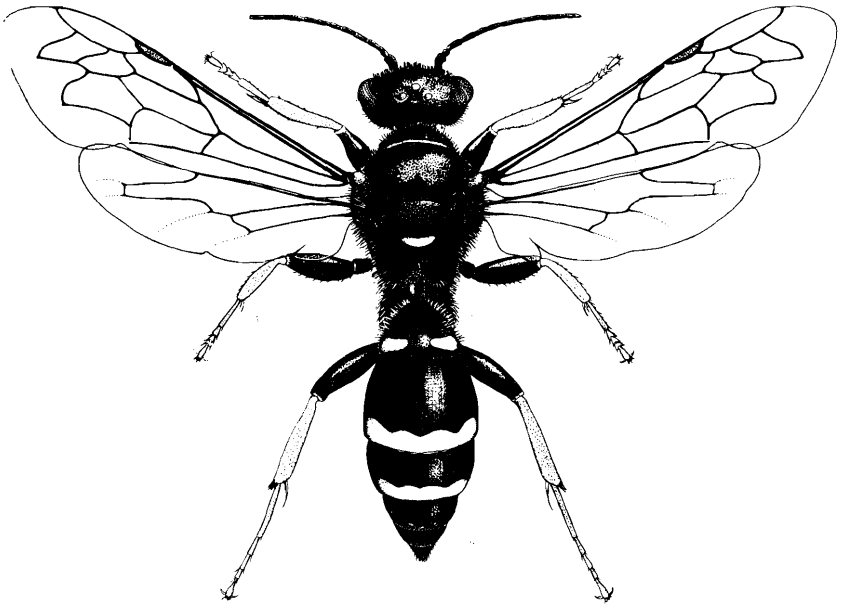


Fig. 246. Female of Argogorytes mystaceus (Linné). Length: 10-13 mm.

developed epicnemium, since the epicnemial carina joins the ventral midline. A very strong, transversely carinate, obliquely-running furrow originates dorso-laterally. Scutellum of females with a kidney-shaped, strongly depressed pit, with hairs at bottom. Thorax with rather dense and strong punctation. Propodeum very short, dorsally without well defined area cordiformis. Sternum 2 in profile with strong swelling, the furrow between sterna 1 and 2 being very deep (Fig. 81). Sternum 6 in females of North-European species with plane, broad, stout pygidial area with dense pubescence. Abdomen with yellow pattern on terga 1-3 or 1-4. All tarsi slender in both sexes. Foretarsi in female without pecten, their claws with a strong proximal spine. Pulvilli very small. Media of hind wings originates distal to apex of anal cell.

Argogorytes is distributed in the Palaearctis, with three species in Europe. In Nearctis another species occurs, which, however, belongs to a separate subgenus.

The species may be found nesting in dry and sunny, not necessarily sandy, localities, often on edge of woods, slopes, glades and the like. The nest is of a simple construction with a main tunnel, distally extended into a cell, or it may be branched and contain several cells. The prey consists of Homoptera, usually Jassidae.

Both mystaceus and fargei, and in some degree also Gorytes quinquecinctus, are important for pollination of the fly orchid, Ophrys insectifera (Orchidaceae). The males seek the flowers mainly by their olfactory sense, being attracted by a scent which is closely related to the pheromone emitted by the females in the mating season. The human olfactory sense cannot distinguish between the two scents. The vision of the wasps also plays an important rôle in locating the flowers. A long series of experiments made by Bertil Kullenberg (1961) clearly shows a greater affinity of the males to the fly orchid than to their natural partners. This is due to a combination of the strong scent of the flower, their morphology and colour, which especially are concentrated on the two big fused petals, the labellum.

During the visit of the male to the fly orchid a "pseudocopulation" is released, whose progress is only slightly similar to a true copulation, carried through in a calmer tempo, without orientating movements and without vibrating wings. During the attempt to copulate with the flower the male receives one or both pollinia, which after a resting period is transferred to the stigma of another flower. For details, see Kullenberg, 1961.

Key to species of Argogorytes

1 Anterior part of sternum 2 with very strong, deep pitlike punctures. Abdomen with well-developed yellow bands on terga 2 and 3. Tergum 4 without or with very weak yellow pattern. Female: femora mainly black with only a small distal red-yellow spot. Male: yellow and brown markings on tibia of equal extent. Antennae ventrally with undulating tyloidea ..... 66. mystaceus (Linné)

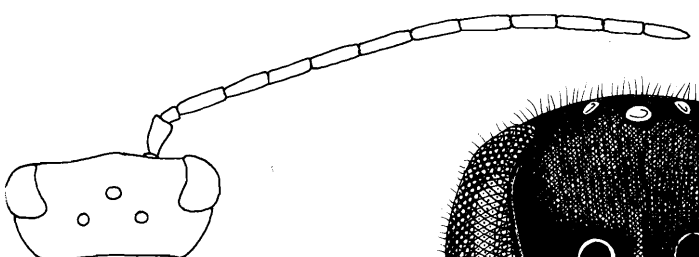
- Anterior part of sternum 2 with very superficial and indistinct punctures. Abdomen with well developed white-yellow bands on terga 2-4.

  Female: femora mainly red-yellow, but anterior ones with extensive black or brown-black marks. Male: tibiae mainly yellow, with only weak brownish streak on the inner side. Antennae ventrally with liniar tyloidea ..... 67. fargei (Shuckard)

66. ARGOGORYTES MYSTACEUS (Linné, 1761)
Figs. 246-248.

Sphex mystaceus Linné, 1761:412.

Female: 10-13 mm. Head densely punctate, with rather long, erect, grey-



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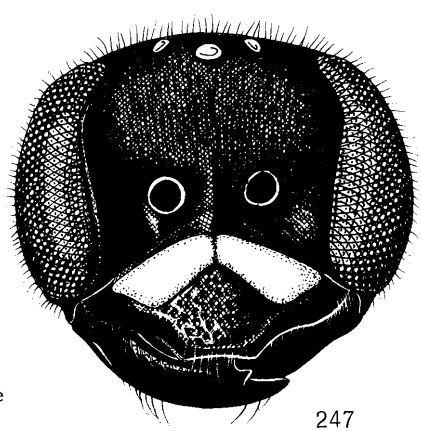

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Fig. 247. Head in frontal view of female of Argogorytes mystaceus (L.).
Fig. 248. Head and right antenna of male Argogorytes mystaceus (L.).

yellow pubescence. Clypeus large, weakly convex, along posterior border with two, sometimes coalescing yellow spots. These may be vestigial or absent in specimens from Fennoscandia. Clypeus anteriorly slightly concave; with sparse, coarse, partly coalescing punctures. The anterior border itself evenly arcuately emarginate. Pronotum with yellow transverse line. Scutum large, with dense and rather coarse punctures and rather sparse pubescence. Metanotum with yellow transverse spot, which may be absent from specimens from Sweden and Finland. Mesopleuron superficially punctate, with a coarsely pitted furrow, extending from the epicnemium to base of forewings. Danish specimens may sometimes have a small yellow spot on mesopleuron below base of forewings. Humeral tubercle yellow. Area on dorsal face of propodeum densely and somewhat irregularly longitudinally rugose, with a deep median furrow. Posterior face of propodeum very coarsely and irregularly, longitudinally rugose. First tergum rather densely punctate, with erect pubescence and two yellow lateral spots. Terga 2 and 3 posteriorly with yellow bands, with extremely short and thin pubescence. Tergum 4, especially in Danish specimens, may have a weak yellow transverse mark. Sternum 2, especially anteriorly, with very large, pit-like punctures. Legs red-yellow or brown-yellow, femora black.

Male: 10-13 mm. Yellow spots on clypeus usually coalescing dorsally, but never throughout their whole height. In Swedish and Finnish specimens the spots may be absent. Antennae very long, flagellar segments more than twice as long as broad (Fig. 248). Segments 3-7 ventrally with rather indistinct, undulating tyloidea. Colour pattern otherwise as in female, yellow spot on metanotum is, however, absent. Sculpture stronger than in female. Femora black. Tibiae yellow on the outer side, brown on the inner. Finnish specimens may lack yellow pattern on tibia 3.

Common and widely distributed throughout the Nordic countries. The northern distribution limit runs through Jmt. and Hls. in Sweden, NSy in Norway and Ob and Ks in Finland. The species avoids the mountain range in Central Scandinavia. - Soviet Karelia: Ib and Kr. - Common throughout much of the Palaearctic region, eastwards to the Pacific Ocean.

Main tunnel of nest usually reaches a length of about 10 cm vertically into the ground, than continuing in a more or less horizontal plane. On this stretch there are generally several larval cells, which are provisioned with nymphs of Cicadas, usually Philaenus spumarius L. Nysson spinosus Forst. (No. 75) may occasionally be found as cleptoparasite on this species.

67. ARGOGORYTES FARGEI (Shuckard, 1837)

Gorytes fargei Shuckard, 1837:214.
Gorytes campestris auctt.

Female: 10-12 mm. Very similar to the preceding species. The yellow spots on clypeus always coalesced, but sometimes very reduced in size in small individuals. Upper part of frons, scutum, scutellum and dorsal area of abdomen shining smooth, which is due to the finer and sparser punctation. Markings on pronotum, metanotum and abdomen very pale, almost white-yellow. Abdomen with bands on terga 2-4. Sterna 2 and 3 often have small lateral spots. Middle and hind legs often uniform red-yellow except base of femora. Tibia 1 and tarsus 1 red-yellow, femora black with red-yellow apex.

Male: 10-12 mm. Whole dorsal part of clypeus yellow. Antennae shorter than in preceding species. Segments 4-7 ventrally with sharply delimited tyloidea. Colour pattern as in female, except for the yellow transverse spot that is often lacking from metanotum. Tibiae yellow, at most with faint brownish spot on the inner side. Femora black with light apex.

Widespread, but not quite as common as the preceding species. - Denmark: not common, mainly occurring in the southern and south-eastern districts. - Sweden: rather common, especially in the central districts in Svealand, towards the north to Nb and Ly. Lpm. - Norway: a rather limited distribution in the southern districts. - Finland: apparently missing on Al., but otherwise found from Ab and N to ObN and Ok. - Soviet Karelia: Ib and Kr. - Apparently not found outside Europe.

The nest is often found in the same localities as Hoplomerus spinipes Linné or H. reniformis Gmelin (Hymenoptera, Eumenidae). From the about 10 cm long vertical main tunnel 6-9 cells are constructed. The number of prey varies considerably, but usually 18-25 nymphs of Philaenus spumarius L. are deposited in each. Nysson spinosus Forst. (No. 75) is recorded as cleptoparasite.

Genus *Gorytes* Latreille

Gorytes Latreille, 1804:180.
Type-species: Mellinus quinquecinctus Fabricius, 1793.

Medium-sized species (Fig. 249), usually with strong yellow pattern. Head in front view very broad. Eyes large and strongly convex, especially in males, the inner orbits converging ventrally. Clypeus large, its anterior border not projecting, without distinct emarginations, teeth or the like. Antennae long

and slender, often yellow or brown-yellow ventrally. Mandibles short and strong, tridentate in females, bidentate in males. Scutum above tegulae with sharply delimited, posteriorly gradually broader, lamella (mesonotal laminae). Posteriorly the lamella has a short oblique carina. Mesopleuron with an incompletely delimited epicnemium, since the epicnemial carina does not reach the ventral midline. Instead it extends backwards into the pleural suture, continuing in front of coxa 2 and joins the suture between meso- and metanotum. Dorsally on mesopleuron a broad furrow extends backwards from the epicnemium. Thorax very finely and superficially punctate. Propodeum with rather distinctly delimited area condiformis with very coarse sculpture, consisting of more or less regular ribs and carinae. Abdomen with yellow transverse bands on terga 1-4. Females with a broad, usually coarsely punctate, hairless pygidial area. Legs strong, pretarsi and pulvilli very well-developed, especially in females. Tarsus 1 in females with very strongly developed pecten. Tibia 2 with two spurs. Forewings with three cubital cells. Both discoidal transverse veins join second cubital cell. Often a dark shadow covers radial cell and a larger or smaller area below this. Media of posterior wing originates from anal cell (Fig. 57).

The genus is represented by several species throughout much of Holarctis, and also occurs in the tropics. In Fennoscandia and Denmark four species occur, of which one, neglectus, seems to be endemic to Lapland and East Karelia.

The nests are constructed in the ground, and usually consist of a branched tunnel system. The prey consists of Homoptera, usually Philaenus spumarius (L.) (Cercopidae).

Key to species of Gorytes

Females

1 Pygidial area very densely longitudinally striate. Legs often uniform red-yellow ..... 68. quinquecinctus (Fabricius)

\- Pygidial area shiny, punctate, without striation. Femur 3 mainly black 2

2(1) Ribs in area cordiformis very irregular, forming a reticulate-rugose sculpture. Longitudinal carinae often fusing, transverse carinae of almost equal strength. Yellow mark along innner orbit large and triangular, joining epistomal suture (Fig. 252). Yellow band on tergum 2 distinctly broader than those on remaining ones ..... 69. laticinctus (Panzer)

- Ribs in area cordiformis approximately parallel, transverse ribs very weak or absent. Yellow mark along inner orbit narrow, linear, not reaching epistomal suture (Fig. 251a). All transverse bands of abdomen of fairly equal breadth 3

3(2) Clypeus with broad black anterior and posterior borders. Intermediate pattern often of the shape of a buffalo horn (Fig. 251a). Yellow colour often very reduced. Tibia and tarsi mainly red-yellow .. 70. quadrifasciatus (Fabricius)

- Clypeus, except narrow black anterior border, completely yellow. Tibiae mainly black ... 71. neglectus Handlirsch

Males

1 Tyloidea in at least the proximal flagellar segments broad and light brown. Humeral tubercle usually with yellow spot ..... 68. quinquecinctus (Fabricius)

- Tyloidea black 2

2(1) Tyloidea on antennal segments 4-8 broad, oval, weakly concave in the middle and of slightly paler

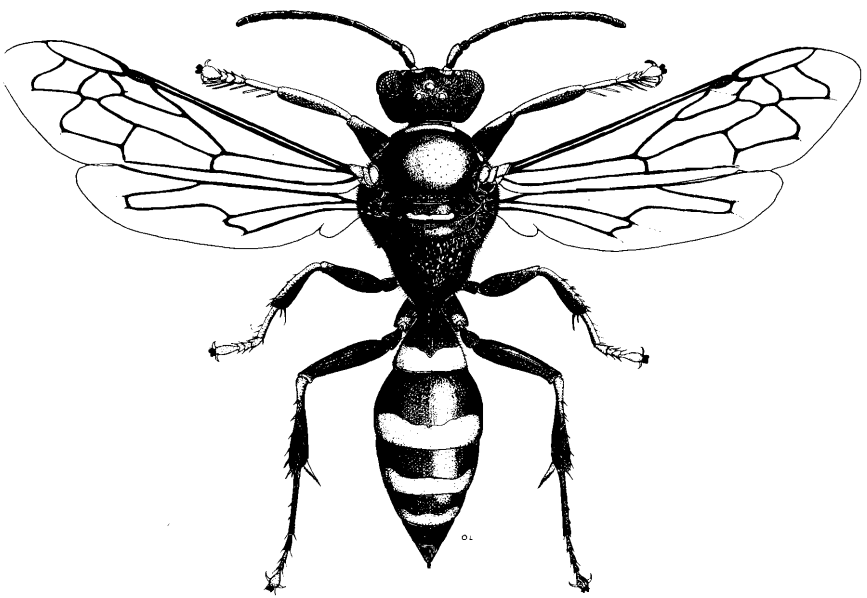


Fig. 249. Female of Gorytes quadrifasciatus (Fabr.). Length: 9-11 mm.

colour. Area cordiformis with regular, parallel, longitudinal ribs, without transverse striation. 71. neglectus Handlirsch

- Tyloidea narrow, sharply delimited, almost linear. Ribs in area cordiformis very irregular 3

3(2) Distance from lower border of yellow mark along inner orbit to epistomal suture usually greater than greatest width of the mark. (Isolated specimens without yellow pattern on face). Yellow band on tergum 2 usually of same width as remaining ones ..... 70. quadrifasciatus (Fabricius)

- Distance from lower border of yellow mark along inner orbit to epistomal suture less than greatest width of mark. Area just in front of antennal sockets usually with small yellow spot. Yellow band on tergum 2 broader than remaining ones ..... 69. laticinctus (Panzer)

68. GORYTES QUINQUECINCTUS (Fabricius, 1793)
Fig. 250.

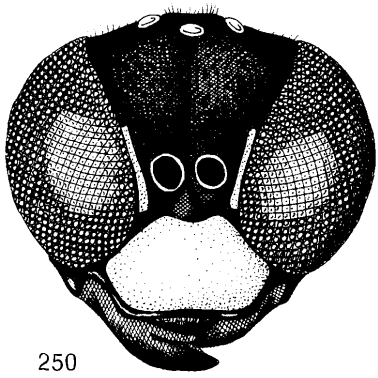
Mellinus quinquecinctus Fabricius, 1793:287.
Hoplisus sinuatus Costa, 1869:81.

Female: 9-13 mm. Head in front view as Fig. 250. Eyes very large, strongly convex, inner orbits strongly converging towards the epistomal suture. Frons in front of ocelli partly with coarse but sparse punctures, partly with fine and dense intermediate punctation. The following parts are yellow: clypeus except anterior border itself; two narrow stripes along inner orbits; antennae ventrally; usually a small proximal spot on mandibles; a transverse stripe on pronotum; a spot on the humeral tubercles, a spot just behind these on mesopleuron; a spot on tegulae and a transverse mark on scutellum. Specimens from South Europe often have also two large spots on propodeum (G. quinquecinctus sinuatus Costa). Legs extensively yellow, tibia 3 usually uniform yellow, tibiae 1 and 2 with more or less extensive black marks. Specimens from Finland usually have mainly black femur 3 and tibia 3, only extreme proximal and distal tips yellow. Abdomen with 5 complete yellow transverse bands. Pygidial area dull, finely longitudinally striate, with sparse punctation.

Male: 8-12 mm. Head in front view almost as in female. Antennae black, with broad, light brown tyloidea on segments 4-8. Specimens from Fennoscandia have only segments 5-7 provided with light brown tyloidea. Scapus

often yellow. Yellow pattern on face may be very reduced or absent, as may also spot on humeral tubercle. Yellow pattern on thorax may be reduced to quite narrow transverse bands on pronotum and scutellum, as the spot on mesopleuron may be absent. Abdomen always with yellow transverse bands on terga 1-6. Femora mainly black with a small yellow distal spot. Femur 3 with proximal spot. Tibia 1 and tarsus 1 mainly yellow, tibia 3 and tarsus 3 occasionally brown-black with only indicated yellow pattern.

The species occurs very locally in southern Fennoscandia. Sweden: rather large and stable populations on Öland. It has not been possible to verify the records published by Aurivillius (1904). - Finland: rather limited records from Ab, N, Ta and Sa. - Soviet Karelia: Kr. - The species seems to have a southern and eastern occurrence in Europe. The records from North Africa might refer to another species (Beaumont, 1953). Also recorded from Kazakhstan.



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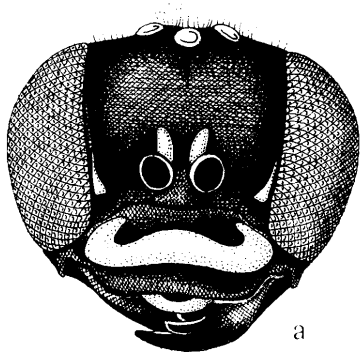

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b

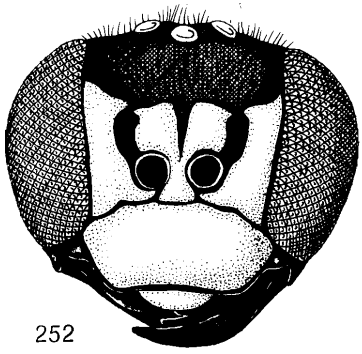

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Fig. 250-252. Heads in frontal view of female Gorytes. - 250: quinquecinctus (Fabr.); 251a: quadrifasciatus (Fabr.); 251b: same, clypeus with reduced yellow markings; 252: laticinctus (Lep.).

It is interesting that males of also this species have been observed as pollinator of the fly orchid, Ophrys insectifera (Orchidaceae). Observations are, however, few, and compared with the species of Argogorytes, the species plays a considerably minor rôle in this connection (Kullenberg, 1961). - Nysson interruptus (Fabr.) (no. 76) is found as cleptoparasite.

69. GORYTES LATICINCTUS (Lepeletier, 1832)
Fig. 252.

Euspongus laticinctus Lepeletier, 1832:66.

Female: 10-13 mm. Head in front view as Fig. 252. Frons with pronounced double punctation, the large punctures, however, not nearly so strong as in quinquecinctus. Face with very extensive yellow pattern. The large triangular spots along inner orbits often coalescing with the more or less smaller Y-shaped spot between antennae in specimens from southern Denmark. Mandibles usually black, but may carry one or two yellow spots. Labrum yellow, clypeus with narrow black anterior border. Antennae ventrally yellow, distally gradually darker yellow-brown. Pronotum usually with well-developed yellow transverse band. Humeral tubercle always black. Mesopleuron with large yellow spot right behind this, rarely with a small additional spot dorsal to this (isolated specimens from Denmark, SJ). A single Danish specimen, Funen (Æbelø) also has a yellow spot ventrally to the large spot. Tegula usually with yellow spot, and scutellum has a yellow transverse band. Terga 1-4 with yellow transverse bands. Sometimes in addition very weak yellow markings on tergum 5. Band on tergum 2 considerably broader than the remaining ones. Sterna 2-4 often with yellow transverse bands along posterior borders, which, however, may be absent from Fennoscandian specimens. Pygidial area shiny, with sparse punctation. Legs, especially the foremost pair, with very extensive yellow markings. Coxae generally with yellow spots.

Male: 9-12 mm. Eyes distinctly more strongly convex than in female, inner orbits strongly converging ventrally, Yellow pattern on face as in female, but distinctly reduced, as especially the spot between base of antennae is often absent. Occasionally the extent of the yellow colour on clypeus is reduced. Scutellum always lacks yellow markings in specimens from Fennoscandia and Denmark, and the transverse mark on pronotum may be very reduced in size. Spot on mesopleuron just behind humeral tubercle often absent from Danish specimens, more frequently from Scandinavian specimens. Abdomen with well-developed, yellow transverse bands along posterior border of first, third, sometimes also on fourth tergum. Band on tergum 2 always much broader than the remaining ones.

The species is common in Denmark and is recorded from most districts. - Sweden: rather common in the southern districts, distributed northwards to Vrm., Nrk. and Upl. - Norway: a few specimens from AK, SFi and HOi. - Finland: not common, occurs in the southern and south-eastern districts up to Kb. - Soviet Karelia: Ib and Kr. - Widely distributed in the western Palaearctic region, eastwards to the Kirgizian steppes, southwards to Africa.

The species nest on slopes exposed to the sun, with comparatively loose soil, often partly covered with vegetation. The nests may also be constructed in horizontal ground. The main tunnel extends about 10 cm down into the soil, whereupon it may continue a small distance upwards. At the end of short side tunnels, issuing from the rising stretch, there are usually 3-4 cells, which are provisioned with Cicadas, notably Philaenus spumarius L.

Nysson trimaculatus (Rossi) (no. 77), N. niger Chev. (no. 78), N. spinosus (Forst.) (no. 75) and Metopia campestris Fall. (Diptera, Sarcophagidae) are recorded as cleptoparasites.

70. GORYTES QUADRIFASCIATUS (Fabricius, 1804)
Figs. 249, 251.

Mellinus quadrifasciatus Fabricius, 1804:298.
Euspongus vicinus Lepeletier, 1832:68.
Hoplisus montivagus Mocsary, 1878:250.

Female: 9-11 mm. Head in front view as Fig. 251. Clypeus usually with yellow pattern similar to a buffalo horn. This may, however, be very reduced and consist of an oblong median spot and two small lateral ones (Fig. 251b). Yellow pattern on labrum may be divided into two lateral spots. A pair of spots on lower part of face, slightly above epistomal suture, and a pair, just behind antennal sockets, yellow. Scapus yellow ventrally. Flagellum black, basal segments light brown-yellow ventrally. Rugae in area cordiformis usually almost linear, very strong. Remaining part of propodeum somewhat more weakly and irregularly rugose. Abdomen shiny, with yellow bands on terga 1-4. Pygidial area shiny with sparse, rather coarse punctures. Femur 1 black, more or less yellow ventrally. Femora 2 and 3 black with light apex. Tibiae and tarsi red-yellow. Yellow pattern on femora usually reduced in specimens from Finland, as tibiae in this material may also be mainly black.

Male: 9-11 mm. Antennae black, rather long and slender, with sharply delimited, black tyloidea. Scapus always yellow spotted ventrally. Dorsal three-fourths of clypeus usually yellow. Pattern may, however, be reduced to two lateral spots. Spots along inner orbits of eyes narrow, parallel, never

reaching epistomal suture. Spots behind antennal sockets missing. Pronotum always with yellow transverse spot in Danish specimens, often missing this in Finnish material. Sculpture of propodeum much varying, rugae of area cordiformis always mainly longitudinally orientated. Abdomen with yellow bands on terga 1-4 and on sterna 2-3. Femora black with light apex. Tibiae brown with larger or smaller yellow spot on the inner side.

Denmark: widely distributed, but rare outside the eastern districts. - Sweden: common, distributed from Sk. to Nb. The northern distribution limit in Sweden continues into Finland and runs through ObN. - Norway: rather common in the south, northernmost occurrence in On, Fron. - Soviet Karelia: Ib and Kr.- The species is recorded from most European countries, but seems to become more rare southwards.

Nests in similar localities as laticinctus, but also in very clayey soil. Prey consists likewise of Philaenus spumarius (L.) (Hom., Cercopidae).

Several species of Nysson are stated as cleptoparasites. Imagines are often observed licking nectar in flowers of e.g. Hieracium and Angelica.

71. GORYTES NEGLECTUS Handlirsch, 1895

Gorytes neglectus Handlirsch, 1895:916.

Female: 9-11 mm. Clypeus mainly yellow, with only comparatively narrow black stripe along anterior border. Spots along inner orbits long, parallel. Head, except labrum, otherwise without yellow pattern. Punctation of frons very fine and dense, almost as in quadrifasciatus. Antennae black, brown-yellow ventrally. Thorax usually wholly without yellow pattern, although specimens with two small yellow spots on pronotum may occur. Notum dull due to microsculpture, on the whole with more distinct punctation than in the remaining species. Dorsal striation on propodeum denser and more regular than in quadrifasciatus; the only transverse striae in area cordiformis are found in the bottom of the middle furrow. Abdomen with rather narrow yellow bands on terga 1-4. Completely black ventrally. Pygidial area as in laticinctus and quadrifasciatus, only somewhat more sparsely punctate, anteriorly with distinct microsculpture. Femora black except a quite small distal brownish spot. Tibia 1 and four first tarsal segments with yellow front side. Tibia 2 black with yellow spot distally and proximally. These may be connected with each other. Tarsi mainly yellow. Tibia 3 black, except a faintly brownish spot distally, and posterior tarsi brown dorsally and ventrally.

Male: 9-11 mm. Antennae somewhat shorter and thicker than in laticinctus and quadrifasciatus, segments 4-8 ventrally with broad, oval tyloidea,

whose slightly concave middle is a little lighter than remainder of segment. Clypeus yellow, except for a narrow black stripe along anterior border. A long stripe parallel to inner orbits and a small triangular spot anteriorly between antennal sockets also yellow. Pronotum with yellow transverse line interrupted in the middle. Thorax otherwise black, densely and uniformly punctate and dull due to the fine microsculpture. Ribs in area cordiformis strong, regular, parallel, almost as in female of quadrifasciatus. All femora, tibia 3 and tarsi black. Tibiae 1 and 2 with yellow pattern on the inner side, tarsi yellow.

A very rare, high-boreal species. In Fennoscandia only recorded from Finnish Lapland, predominantly north of the Polar Circle. - Soviet Karelia: a few specimens from Kr and Lr. - Dalla Torre (1897) mentions the species from Caucasus (?) and Siberia (?).

Note. Recorded as Gorytes fallax Handlirsch by Grönblom (1918), Pulkkinen (1931) and Hellén (1954), corrected to G. neglectus by Hellén (1955). G. fallax is a Central and East European species.

Genus *Dienoplus* Fox

Dienoplus Fox, 1893:548.
Harpactes auctt.
Gorytes Latreille, p. p.
Type-species: Dienoplus pictifrons Fox, 1893.

Comparatively small species (Fig. 253), which in habitus are very similar to Gorytes, but from which the genus is distinguishable by the following characters. Inner orbits parallel. Mandibles bidentate in both sexes. Terminal antennal segments in males without tyloidea, but with more or less distinct excavations ventrally. Scutum above tegulae with vestigial furrow. Oblique carina near posterior corners of scutum missing. Epicnemium indistinct, the faint epicnemial carina continues into the pleural suture as in Gorytes. Propodeum dorsally with a triangular area, delimited by distinct carinae. The area itself with weak sculpture. Abdomen with white-yellow pattern on terga 2-5. Media of hindwings originates distal to anal cell.

The species nest in sand. The prey consists of Cicadas (Homoptera). The genus comprises less than ten species, all distributed in Holarctis.

Key to species of Dienoplus

1 Two first abdominal segments red except two small whitish spots on tergum 2 ..... 72. tumidus (Panzer)

\- Whole abdomen except spots on terga 2 and 5 black ..... 73. lunatus (Dahlbom)

72. DIENOPLUS TUMIDUS (Panzer, 1801)
Fig. 253.

Pompilus tumidus Panzer, 1801:H. 81, T. 15.

7-8 mm. Head black, shiny, partly with sparse punctures, partly with extremely fine and dense punctation. Lower part of inner orbits with large white-yellow triangular spot, joining lateral spots on clypeus; these spots greatly varying in extent. Clypeus, especially in males, covered with a dense, silvery pubescence. Behind the eyes a red-brown streak. Mandibles red-yellow to rusty with darker apex. Antennae of female black, scapus yellow ventrally. Distal segments of flagellum light ventrally. Antennae of male longer and more slender, scapus and last seven to eight segments yellow ventrally. Antennal segments 10-11 weakly excavate ventrally. Thorax shiny with sparse punctation, rather dense greyish pubescence. Scutellum with yellow transverse spot. Triangular area on dorsal face of propodeum anteriorly with short longitudinal ribs, shiny. Remaining part of propodeum with very indistinct sculpture, at most with indication of rugae laterally, here with thin silvery pubescence. First two segments of abdomen red, tergum 2 with white-yellow lateral spots, tergum 5 with white-yellow median spot. Legs mainly red.

Rather limited material from Denmark, where the species seems to have a southern and south-eastern distribution. - Sweden: widely distributed, but not common, from Sk. to Hls. in the north. - A few specimens from southern Norway: AK, VAy. - Finland: not uncommon, especially in the south-eastern districts; towards the north to Ok and Om. - Soviet Karelia: Ib and Kr. - The species is widely distributed in North and Central Europe, Southern Siberia (Kazakhstan) and Japan (a distinct subspecies).

The nests are constructed in sandy soil. Each nest probably contains several cells, which are excavated at the end of a vertical tunnel, about 7 cm long. The prey consists of imagines or nymphs of e.g. species of Acrocephalus or Philaenus spumarius L. (Acrocephalidae and Cercopidae), of which 5-6 are deposited in each cell.

As parasites are known several Nysson and Hedychridium roseum Rossi (Hym., Sphecidae and Chrysididae).

73. DIENOPLUS LUNATUS (Dahlbom, 1832)

Larra lunatus Dahlbom, 1832:52.

6-7 mm. Very similar in habitus to tumidus, but easily distinguishable from this by the black base of abdomen and the completely black scutellum. Moreover, the spots on tergum 2 are often fused into a transverse band. Clypeus of males usually uniform yellow.

The species is often found in the same localities as the preceding one, but it seems to occur a little further north in Fennoscandia. Main distribution in Central and North Europe.

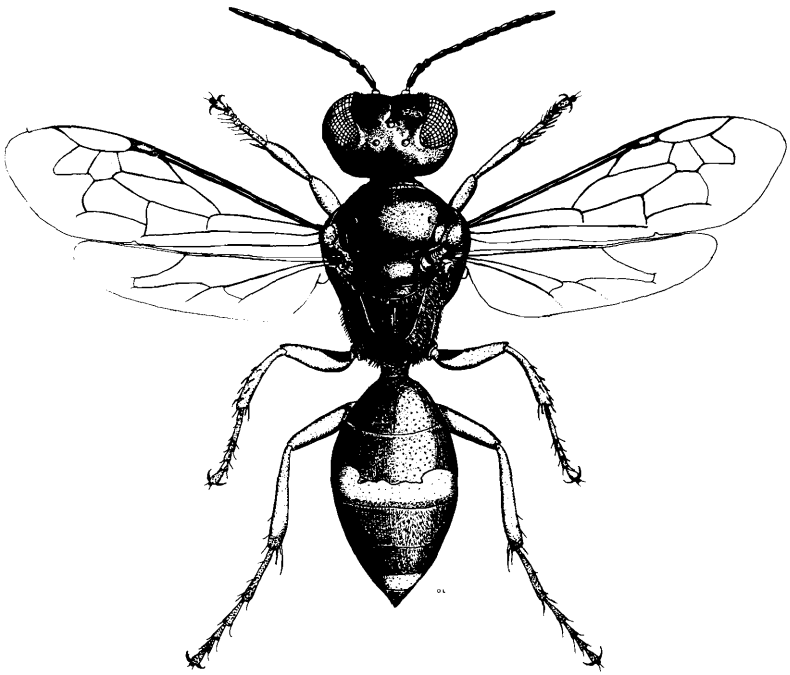


Fig. 253. Female of Dienoplus tumidus (Panzer). Length: 7-8 mm.

Genus *Bembix* Fabricius

Bembix Fabricius, 1775:361.

Type-species: Apis rostrata Linné, 1758.

Genus very easily recognizable, partly by its considerable size, partly by its habitus (Fig. 254), its pattern and the very prolonged labrum. Labrum may be deflected backward thereby covering the labio-maxillary complex. In this position it is held by the mandibles. These are short, almost straight, with a very weak tooth on the inside. Eyes very large and strongly convex. Ocelli, on the other hand, rather weakly developed, elongate and very slightly convex. Lateral ocelli only indistinctly seen through the long strong pubescence. Antennae long and strong, in male dilated and flattened distally. Thorax robust, dorsally slightly convex, finely and densely, somewhat superficially punctate and with rather short, dense pubescence. Abdomen broad, cone-shaped, with yellow transverse bands. Legs powerful, with black and yellow pattern. Male as well as female with pecten on tarsus 1. Both discoidal transverse veins join second cubital cell. Anterior edge of hindwing with about 40 very closely placed frenal hooks.

The genus is cosmopolitan and comprises more than 100 species. Fifteen occur in Europe, of which only one is in the North. The nests are constructed in the soil, on dry, sandy ground. The prey consists of Diptera Brachycera.

74. BEMBIX ROSTRATA (Linné, 1758)
Fig. 254.

Apis rostrata Linné, 1758:577.

Female: 13-25 mm. Head in front view considerably wider than high. Inner orbits very slightly diverging ventrally. Clypeus strongly convex, yellow. Frons excavated in a furrow between the swollen area carrying the ocelli and the inner orbits. Area between antennal sockets with short longitudinal keel. A ring round the eyes, labrum, clypeus and frontal face of scapus yellow. Pilosity long, white. Thorax with uniform, fine punctation. A large transverse spot on pronotum, posterior part of humeral tubercle, tegulae and lateral parts of propodeum yellow. Abdomen with greenish-yellow undulating bands, which may be interrupted on first and usually also on second tergum. Legs mainly yellow, only femora with a proximal black spot. Spines of tarsus 1 extremely strong, broadest in anterior part. Tibiae 2-3 with 2-3 rows of strong spines.

Male: 13-23 mm. Yellow pattern distributed as in female. Scapus distally rather strongly dilated, ventrally with transparent, semi-circular area. Three last segments of flagellum flattened and dilated, ventrally excavate. Antennal segments 9-10 ventrally with a small truncate tooth. Posterior border of femur 2 with a row of sharp, irregular teeth. Sterna 2 and 6 with backwardly directed, curved, broad-based spine.

In Denmark the species maintained rather stable populations in North Zealand and on Bornholm until about 1964. - Sweden: there is a rather large material from Sk., Bl., Öl. and Gtl. Further records from Sdm. and Upl. - The species is not known from Norway.- Finland: a single specimen was observed near Joensuu (Kb) early in August 1974 by O. Martin (pers. comm.).- Also recorded from Ib in Soviet Karelia. - A few records from Northern Germany (Schleswig-Holstein) (Erlandsson, 1965). - Common and widely distributed in Central and South Europe, and in North Africa. The distribution area extends eastward through Central Asia to Mongolia.

The species nests on plane, preferably sandy areas, completely exposed to the sun, with sparse vegetation, i.e. in a similar type of locality to Philanthus, Cerceris and Tachysphex. Large aggregations of nests are often

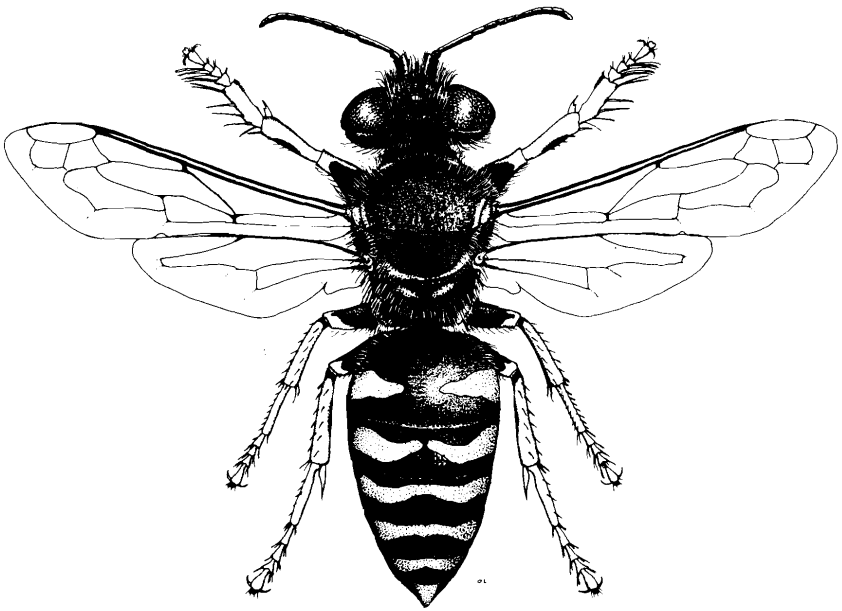


Fig. 254. Female of Bembix rostrata (L.). Length: 13-25 mm.

found, generally constructed in localities previously used by the species. Excavation of nest normally takes about 12 hours, weather permitting. The finished nest consists of a short, declining (c. 40°) tunnel, 10-15 cm long, distally extended into a single celle. The last part of the tunnel runs practically horizontally. The sequence of construction was excellently described by E. Tetens Nielsen, 1945. The prey consists of a large variety of species of Diptera Brachycera. The first prey caught is a comparatively small fly, e.g. of the families Tachinidae or Muscidae, to which the egg is attached. Then the nest is sealed, and while the egg is hatching, and the young larva devouring the fly, the mother wasp excavates another nest. The next prey consists of a larger fly, e.g. Syrphidae or Therevidae, and finally flies are caught and brought home which are of almost equal size to the wasp itself, e.g. Tabanidae, Asilidae og Bombyliidae. Such progressive provisioning is only known from other closely related genera. The egg hatches in the course of a few days, and in about a week the larva has devoured the prey. After a resting period formation of the large firm cocoon takes place, and metamorphosis occurs inside this. As cleptoparasites and parasitoids are stated species of Conopidae and Sarcophagidae (Diptera) and Parnopes grandior Pallas (Hymenoptera, Chrysididae).

Genus *Nysson* Latreille

Nysson Latreille, 1802:340.
Type-species: Crabro spinosus Fabricius, 1775 (= Sphex spinosus Forster, 1771 .

Medium-sized to rather small species (Fig. 255) with yellow and sometimes also red pattern, especially on abdomen. Head in front view very broad, approximately cordiform. Eyes very strongly convex. Inner orbits strongly converging ventrally, whereby distance across mandibular articulations becomes shorter than uppermost frontal distance between eyes (Fig. 256). Mandibles short, strongly curved, ending in a single tooth. Antennae short and thick, in males thickened distally, usually with excavations usable as key characters. Antennae inserted very close together below a slightly elevated area. Head with dense and coarse sculpture. Clypeus large; especially in males with dense, silvery pubescence which extends some distance along inner orbits. Thorax short and broad with strong, dense sculpture except on epicnemium. Propodeum coarsely striate or rugose, laterally with two stout, backwardly directed, teeth or spines. Thorax usually with dense, adpressed,

silvery pubescence ventrally. Abdomen sessile, in females with distinctly delimited pygidial area. Tergum 7 of male flat, laterally prolonged as two attenuate spines. Legs stout, but tarsi long and slender, considerably longer than tibiae. Foretarsus of female without pecten. Tibia 2 with two apical spurs. Forewing with three cubital cells, of which the second is petiolate and joined by both discoidal transverse veins.

The species live as cleptoparasites on species of Gorytes, Dienoplus and Argogorytes. For details: see no. 79. The genus is represented by a large number of species in Holarctis.

Key to species of Nysson

Females

1 First abdominal segment red. Sternum 2 seen in profile weakly swollen (Fig. 258) 2

\- First abdominal segment black. Sternum 2, except

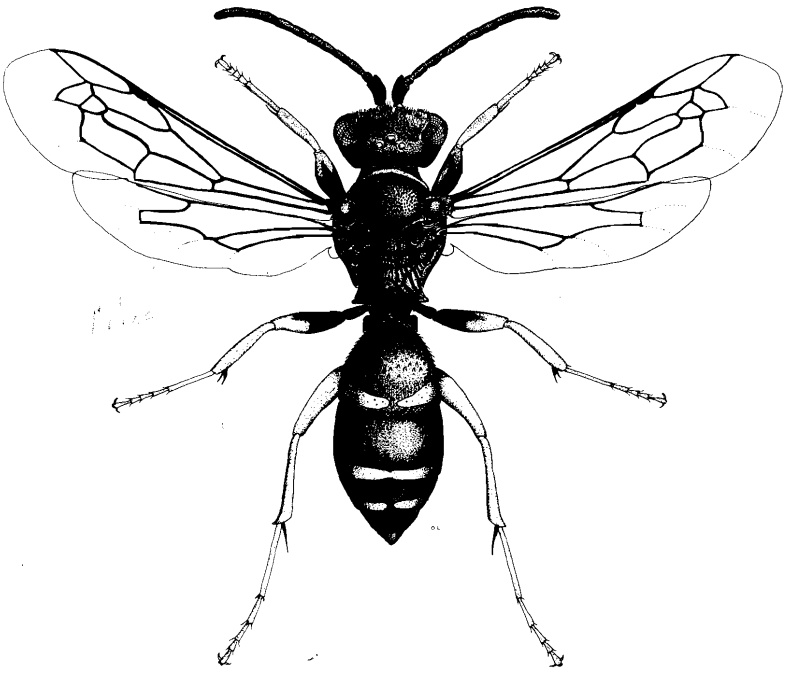


Fig. 255. Female of Nysson spinosus (Forster). Length: 10-12 mm.

in niger, seen in profile strongly humped or angularly protruding (Fig. 257) 5

2(1) Pronotum, and usually also scutellum, with white-yellow transverse spot. Femur 3 uniformly red-yellow ..... 79. maculosus (Gmelin)

- Pronotum and scutellum always without yellow pattern. Femur 3 more or less darkened 3

3(2) Occipital carina stout and strongly projecting, joining the hypostomal carina (Fig. 259). Last sternum with a shiny, impunctate, longitudinal keel. Punctation on remaining part of the sternum rather coarse, drawn out into a rugose sculpture. Propodeum on either side of articulation of abdomen without tooth ..... 80. tridens Gerstäcker

- Lower part of occipital carina absent. Instead an area with weak longitudinal rugae is found near the hypostomal carina. Last sternum finely punctate, without longitudinal keel. Propodeum on either side of articulation of abdomen with small tooth 4

4(3) Scutum with uniform and evenly distributed, rather strong punctation. Interstices between the stout ribs on dorsal face of propodeum with weak irregular sculpture at the bottom, whereby the lustre of the shiny surface is dimmed. Abdomen with yellow lateral spots on terga 1 and 2 or only 2 ..... 81. dimidiatus Jurine

- Scutum with marked double sculpture, which partly consists of a dense punctation (as in dimidiatus), partly of large, rather shallow pits. These may sometimes be difficult to distinguish. Interstices between the very stout ribs on dorsal face of propodeum without sculpture, shining. Abdomen usually with yellow lateral spots on terga 1-3. 82. mimulus Valkeila

5(1) Media of hindwing originates distally to apex of anal cell (Fig. 255). Anterior border of clypeus arcuately emarginate centrally, with two small, longitudinal keels (Fig. 256) 6

- Media of hindwing originates from apex of anal cell (Fig. 260). Anterior border of clypeus without such emargination 7

6(5) Tooth on metanotum immediately above articulation of coxa 3 with rather dense and strong pubescence. Yellow bands on terga 2 and 3 not or only very

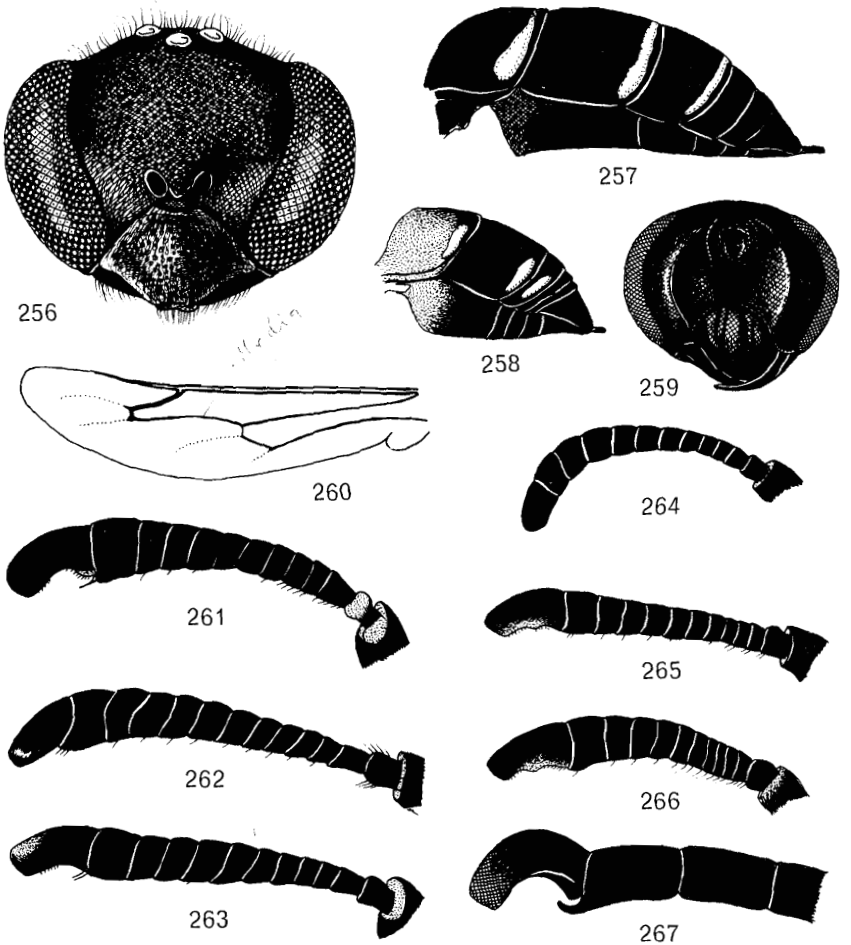


Fig. 256. Head in frontal view of female Nysson spinosus (Forster).
Figs. 257-258. Abdomen in lateral view of female Nysson. - 257: spinosus (Forster); 258: maculosus (Gmelin).
Fig. 259. Head in posterior view of female Nysson tridens Gerstäcker.
Fig. 260. Hindwing of Nysson trimaculatus (Rossi).
Fig. 261-266. Antennae of male Nysson. - 261: maculosus (Gmelin); 262: trimaculatus (Rossi); 263: niger Chevrier; 264: tridens Gerstäcker; 265: dimidiatus Jurine; 266: mimulus Valkeila.
Fig. 267. Distal part of antenna of male Didineis lunicornis (Fabr.).

narrowly interrupted in the middle. Humeral tubercle black. Pattern of abdomen bright yellow. 75. spinosus (Forster)

- Tooth on metanotum with short and very thin pubescence. Yellow bands on terga 2 and 3 usually broadly interrupted in the middle. Humeral tubercle generally yellow. Pattern of abdomen white-yellow ..... 76. interruptus (Fabricius)

7(5) Scutellum dorsally with yellow transverse spot. Femur 3 and tibiae black ..... 77. trimaculatus (Rossi)

- Scutellum without yellow spot. Femur 3 and tibia 3 red-yellow. Tergum 2 in profile slightly swollen ..... 78. niger Chevrier

Males

1 First abdominal segment red 2

First abdominal segment without red pattern 4

2(1) Last antennal segment much shorter than combined length of segments 11 and 12, only very slightly excavate ventrally (Fig. 264). Antennal segment 12 seen from above longer than broad. Anterior part of clypeus very coarsely and densely punctate. 80. tridens Gerstäcker

- Last antennal segment as long as or longer than combined length of segments 11 and 12, ventrally with deep, double emargination (Figs. 265, 266). Antennal segment 12 seen from above broader than long. Anterior part of clypeus finely punctate, admixed with coarser punctures 3

3(2) Humeral tubercle yellow spotted. Metatarsus 1 and 2 distally on the inner side with 4-5 dark, short strong spines. Antennae as in Fig. 265. Abdomen with yellow lateral spots on terga 1 and 2, and sometimes also on tergum 3. Spots on tergum 1 often missing ..... 81. dimidiatus Jurine

- Humeral tubercle without yellow spot. Spines on apex of tibiae 1 and 2 weak and pale. Antennae as in Fig. 266. Terga 1-3, and occasionally also tergum 4, with yellow lateral spots ..... 82. mimulus Valkeila

4(1) Anterior border of clypeus in middle with arcuate

emargination, on either side delimited by a small longitudinal keel (Fig. 256). Sternum 2 seen in profile strongly convex (Fig. 257) 5

- Anterior border of clypeus without such emargination and without longitudinal keels. Sternum 2, expect in trimaculatus, evenly rounded (Fig. 258) .. 6

5(4) Femora and tibiae mainly black. Humeral tubercle black. Sterna 2 and 3 usually with complete transverse, bright yellow bands ..... 75. spinosus (Forster)

- All tibiae and tarsi red-yellow. Femora 1 and 2 mainly black, femur 3 red-yellow. Humeral tubercle usually yellow. Terga 2 and 3 with white-yellow lateral spots ..... 76. interruptus (Fabricius)

6(4) Last antennal segment long, ventrally with a strong excavation, in which is found a row of short, ventrally directed hairs 7

- Last antennal segment short, slightly excavate, without hair fringe ventrally. Pronotum usually black, but may have a single, or very rarely 3, small yellow spots. Sternum 2 seen in profile strongly convex ..... 77. trimaculatus (Rossi)

7(6) Scutellum always black. Emargination of last antennal segment weak (Fig. 263) ..... 78. niger Chevrier

- Scutellum with yellow transverse spot. This may sometimes be very reduced or absent. Emargination of last antennal segment deep (Fig. 261). 79. maculosus (Gmelin)

75. NYSSÒN SPINOSUS (Forster, 1771)

Figs. 255-257.

Sphex spinosus Forster, 1771:87.

Female: 10-12 mm. Pronotum and first three terga with bright yellow transverse bands. Humeral tubercle black. Frons in front of ocelli rather coarsely, longitudinally rugoso-punctate. Clypeus shining, with rather coarse and sparse punctures and also fine, dense punctation, missing in an area along anterior border. Anterior border with U-shaped central emargination, on either side delimited by a short longitudinal keel (Fig. 256). The very dense, pitted sculpture on scutum somewhat irregular, since the pits

are of very unequal size. Interstices, especially in anterior fourth, densely set with fine punctures. Pubescence of head and scutum grey-yellow. Mesopleuron coarsely and densely reticulo-punctate, partly with thin, sateen-like, shining pubescence, partly with sparse erect hairs. Scutellum irregularly, longitudinally rugose. Propodeum dorsally in front of lateral spine with long and sparse pubescence, otherwise with very strong ribs. First tergum closely and rather deeply pitted on anterior part. Legs red-yellow with darker femoral bases.

Male: 9-11 mm. Head in front view very broad above the strongly convex eyes. Frons slightly excavate with densely pitted sculpture, which only in front of the median ocellus shows an indication of longitudinal striation. Inner orbits weakly emarginate. Anterior border of clypeus with small arcuate emargination, delimited by two short longitudinal keels. Lower part of face, inner orbits and clypeus with dense silvery pubescence. Last antennal segment without excavations ventrally. Frons with long and erect grey-yellow pubescence. Yellow transverse spot on pronotum usually present. Sometimes it is reduced to two smaller ones. Scutum with irregular rugose sculpture, often with a tendency to form longitudinal striation as on scutellum. Venter with dense, adpressed, silvery pubescence. Legs black with red-yellow knees and tarsi.

The species seems to have a south-eastern distribution pattern in Denmark. - Rather common in Sweden up to Dlr. and Hls. - Norway: not uncommon in the southern and south-eastern districts. - Finland: rather common, especially in the southern and south-eastern districts, northwards to Ok and Ks. - Soviet Karelia: Ib and Kr. - Known from all European countries and also recorded from the Ussuri region in eastern Siberia; and Japan (a subspecies). Distribution in southern Siberia not known.

The most common species of Nysson in Europe. Stated to live as a cleptoparasite in nests of Gorytes laticinctus (Lep.), G. quadrifasciatus (Fabr.), Argogorytes mystaceus (L) and A. fargei (Shuck.). Often seen licking nectar in flowers, e.g. of Knautia, Succisa, Jasione and several Umbelliferae.

76. NYSSON INTERRUPTUS (Fabricius, 1798)

Mellinus interruptus Fabricius, 1798:266.

Female: 7-9 mm. Pronotum, humeral tubercles and the first three terga with white-yellow pattern. Spots on abdomen seldom coalescing. Frons very densely and coarsely punctate, sculpture very irregular, however, not coalescing longitudinally. Anterior border of clypeus with distinct emargination, on

either side delimited by distinct, almost teeth-like projections. Scutum coarsely, densely and regularly pitted, with fine dense punctation between the large punctures in anterior third. Sculpture of scutellum consisting of oblong punctures, indicating longitudinal striation. Mesopleuron densely and coarsely reticulate-rugose, partly with thin and short silvery pubescence, partly with scattered long hairs. Tergum 1 coarsely punctate, the anterior part with distinct striation. Legs red-yellow, femur 1, however, often partly back.

Male: 7-9 mm. Yellow transverse band of pronotum always complete. Humeral tubercle with yellow mark which, however, may be missing in specimens from Sweden and Finland. The animal covered all over with silvery pubescence, especially pronounced on clypeus and ventrally on thorax. Last segment of antennae without emargination, ventrally with fine, longitudinal carina. Sculpture as in female, but somewhat stronger. Legs red-yellow. Femora 1 and 2 often with black markings.

The species has a rather local occurrence in Fennoscandia and Denmark, and does not seem to be as frequent as the preceding species. The distribution is slightly more southern in this area. Northernmost records in Sweden: Gstr. - Not known from Norway. - Finland: to Om and Kb in the north. - Soviet Karelia: Ib and Kr. - Known from all European countries and Asia Minor.

The species occurs in comparatively dry regions, where males as well as females may be met with on sunny leaves and on flowers, e.g. Knautia and Succisa. It is cleptoparasitic on Gorytes quinquecinctus (Fabr.) and G. quadrifasciatus (Fabr.).

77. NYSSON TRIMACULATUS (Rossi, 1790)
Figs. 260, 262.

Crabro trimaculatus Rossi, 1790:95.

Female: 6-8 mm. Pronotum with yellow transverse stripe, humeral tubercle, a transverse spot behind anterior border of scutellum and the spots along posterior border of the first three terga also yellow. Sculpture of head and scutum consists partly of coarse pits, partly of a fine, dense punctation. Interstices considerably smaller than diameter of the pits. Head with sparse, short, whitish pubescence. Anterior border of clypeus with small truncate tooth in middle. Sculpture on distal third of clypeus consists only of rather coarse sparse punctures, the proximal two-thirds are additionally provided with also a very dense and fine punctation. Mesopleuron very densely and coarsely reticulate; with sparse, greyish pubescence. Dorsal face of propo-

deum anteriorly with short, strong, longitudinal ribs, which are connected posteriorly by an often zig-zag transverse rib. Area in front of the lateral spine with dense, whitish pubescence. Sternum 2 seen in profile strongly convex. Tergum 1 coarsely and rather densely punctate, basally with longitudinal striation. Terga 1-3 with yellow lateral spots which may be fused into a transverse band on tergum 1. Legs black.

Male: 6-8 mm. Pronotum and scutellum usually without yellow pattern. Occasional individuals may, however, have faint yellow spots dorsally on pronotum and its humeral tubercles. Antennae distally strongly thickened. Proximal flagellar segments ventrally with a row of thin, ventrally directed, pale hairs. Last antennal segment short, penultimate segment as long as broad, less than twice as long as the one before it (Fig. 262). Sculpture as in female, only a little stronger. Clypeus with dense, silvery pubescence.

Denmark: very limited material from NEZ. - Sweden: rare, but rather widely distributed from Sk. to Vrm. and Gstr. - Norway: a few specimens from AK, VE and AAy. - Not known from Finland and Soviet Karelia, where niger is a common species. The distribution of trimaculatus and niger in Fennoscandia is interesting, since they seem to be allopatric. In other parts of Europe, however, the two species occur sympatrically. In contrast to niger, trimaculatus occurs in North-West Germany, just south of the Danish border, and therefore might have invaded Denmark from the south. The populations in Sweden might derive from specimens coming either from Denmark (Zealand) or via Bornholm. - The species is rare, but widely distributed, in Europe and Japan.

The species lives af cleptoparasite on Gorytes laticinctus (Lep.) and G. quadrifasciatas (Fabr.).

78. NYSSON NIGER Chevrier, 1868
Fig. 263.

Nysson niger Chevrier, 1868:383.
Nysson erytropoda Yasumatsu, 1942:111.

Female: 5.5 - 7.5 mm. Clypeus with straight or slightly arcuately emarginate anterior border; its punctation considerably finer than in trimaculatus. Area in front of ocelli with comparatively superficial and fine punctation, only slightly mixed with larger and deeper punctures. The double sculpture on scutum is dominated by the finer punctures, since the distance between the large and rather shallow pits is greater than the diameter of these. Sculpture on thorax on the whole distinctly finer than in trimaculatus. Abdomen with

yellow lateral spots on terga 1-3. All tibiae red-yellow, femora 1 and 2 mainly black, femur 3 red-yellow. Sternum 1 in profile weakly swollen (Fig. 258).

Male: 5-7 mm. Pronotum usually with a dorsal yellow transverse spot and yellow humeral tubercles. Scutellum always entirely black in European specimens. Clypeus very slightly convex, its protruding anterior border in the middle very slightly arcuately emarginate (considerably less than in maculosus). Antennae as Fig. 263. Otherwise very similar to maculosus.

In Fennoscandia this species only occurs in southern Finland, towards the north to Om and Kb, and on Gotland in Sweden. The very closely related trimaculatus occurs on the neighbouring island of Öland, and in South Sweden. Niger might therefore have invaded Finland from the east. - Widely distributed, but fairly rare in Central and East Europe, eastwards to Kazakhstan, Mongolia and China.

The species is probably cleptoparasitic on Gorytes laticinctus (Lep.) (Lefeber, 1967).

79. NYSSON MACULOSUS (Gmelin, 1790)
Figs. 258, 261.

Sphex maculosus Gmelin, 1790:2731.
Nysson maculatus auctt.

Female: 7-9 mm. Head in front view very broad. Frons densely and strongly punctate, ventrally mixed with coarser punctures. Protruding median part of clypeus weakly bilobed. Anterior part naked, shiny with scattered, rather coarse punctation; posterior part with sparse, silvery pubescence and double punctation. Antennae rather short and strong. Pronotum with white-yellow transverse spot. Humeral tubercle also with white-yellow pattern. Scutum partly with scattered coarse pits, partly with dense, rather fine punctation. Scutellum usually with white-yellow transverse spot along anterior border. Mesopleuron somewhat superficially and irregularly sculptured, laterally with sharp, vertical carina. Area below base of hindwings with short, stout transverse costae. Area just in front of lateral spine of propodeum with white, felty pubescence. Tergum 1 of abdomen red, posteriorly with two small white-yellow spots. Posterior border in middle with a triangular black spot. Terga 2 and 3 with long, narrow, white-yellow lateral spots. Legs red-yellow, femora 1 and 2, however, mainly black.

Male: 6-8 mm. Pronotum, humeral tubercle, scutellum and three first terga with white-yellow pattern. Spots on abdomen never coalescing. Tergum

1 without red pattern. The strongly silvery pubescence on lower part of face and on clypeus consists of strongly depressed hairs. Antennae much thickened apically. Last antennal segment a little more than twice as long as broad, ventrally with strong, slightly obliquely placed excavation, at the bottom of which a slightly S-shaped carina is found. Antennal segments 4-12 considerably broader than long. Segments 3-5 ventrally with a few, long, ventrally directed hairs (Fig. 261). Sculpture as in female. Legs yellow or red-yellow with black femora.

The species is found in most districts of Denmark, locally in rather large numbers, also where neither Dienoplus tumidus nor lunatus have been found. In Sweden the species is distributed from Sk. in the south to Gstr. in the north. It is rather common on Öland and Gotland, where tumidus is also frequent. - Not known from Norway. - Finland: very limited distribution in the south-eastern districts (Sa). - Soviet Karelia: Ib and Kr (several localities). - Large distribution in Europe, Kazakhstan, China and Korea.

Common, mainly in dry, sandy localities, where the females are seen swarming low above the ground, searching for nests of Dienoplus tumidus (Panz.) (no. 72). Having found such nests, the female will remove the loose sand plug which seals the entrance, and enter. The very small egg is deposited under the wing of one of the paralyzed Cicadas. Then the nest is left and sealed again. The maculosus egg hatches very soon, and the young larva at once seeks the still unhatched egg of the "host" in order to devour it. Later on it feeds on the provision.

80. NYSSON TRIDENS Gerstäcker, 1867
Figs. 259, 264.

Nysson tridens Gerstäcker, 1867:106.

Female: 5-6 mm. Pronotum and scutellum without yellow pattern. Humeral tubercle yellow. Frons convex, evenly and densely punctate. Silvery pubescence on clypeus sparse. Anterior border almost straight. Occipital carina very distinct, especially near anterior part of head. Pronotum and scutum with golden-brown, densely adpressed pubescence. First, and partly second, tergum red. White-yellow spots always present on tergum 2; but may be absent from terga 1 and 3. Legs red-yellow to rusty with brown femora.

Male: 4-6 mm. Antennae only very slightly thickened apically, last segment simple, without excavation, only slightly longer than the penultimate segment (Fig. 264). Posterior face of head with distinct occipital carina.

Only tergum 1 red (may, however, be almost entirely black in very small individuals). Lateral spots usually missing on tergum 3.

A typical southern element in the Danish and Swedish faunas (SJ, EJ, LFM, NEZ and Sk., Arild). - Not known from Norway and Finland. - Widely distributed, but sporadic in Europe. Also recorded from Kazakhstan and Mongolia. - Cleptoparasite on Dienoplus tumidus (Panz.) and lunatus (Dahlb.).

Note. Specimens with completely or partly black tergum 1 were described by Müller, 1918 under the name N. tridens var. melas, but this cannot be regarded as a subspecies, since it occurs sympatrically with the nominate form in several places in the distribution area. The problem needs, however, further investigation.

81. NYSSON DIMIDIATUS Jurine, 1807
Fig. 265.

Nysson dimidiatus Jurine, 1807:191.
Nysson wesmaeli Lepeletier, 1845:50.

Female/male: 4-6 mm. Very closely related to the preceding species, but can be distinguished by the following characters. Lover part of occipital carina missing. Head ventrally finely, but slightly irregularly striate. Anterior border of clypeus weakly arcuately dilated. In addition, the last antennal segment of the male is very large, more than twice as long as broad, ventrally with double emargination (Fig. 265).

Known from most districts in Denmark. In Sweden, Norway and Finland the northern distribution limit is similar to that of its host. In some districts in Norway (On) and Finland (ObN) dimidiatus apparently occurs north of the distribution area of tumidus, but still within the limits of that of lunatus. The species is distributed throughout most of Europe, and it also occurs in Kazakhstan. - Cleptoparasitic on Dienoplus tumidus (Panz.).

82. NYSSON MIMULUS Valkeila, 1964
Fig. 266.

Nysson mimulus Valkeila, 1964:197.
Nysson friesei f. handlirschi Westerlund sensu Hellén, 1954:125.

4-6 mm. Closely related to dimidiatus. Scutum with double sculpture. Interstices smaller than the diameter of the large punctures. Occasional females have a yellow-brown mark instead of a yellow one on the humeral

tubercles. Ribs on pronotum very strong. Abdomen with yellow lateral spots on terga 1-3 and sometimes also on tergum 4 (males). Last antennal segment of males as Fig. 266.

The species is rather common in Finland: Åland, where dimidiatus has not been found. Dienoplus tumidus (Panz.) may thus play the rôle of 'host', especially on Åland, where D. lunatus (Dahlb.) apparently does not occur. Mimulus is fairly rare in Finland, but distributed over large areas, especially in the south-eastern districts, northwards to Kb and Sb. - In Sweden the species is recorded from Gstr. and Med. - The distribution in Central Europe and Fennoscandia suggests a boreo-alpine pattern.

Genus *Didineis* Wesmael

Didineis Wesmael, 1852:109.
Type-species: Pompilus lunicornis Fabricius, 1798.

Closely related to Alysson but distinguishable by the following characters: Inner orbits distinctly converging ventrally, more strongly in males than females. Distance between antennal sockets in both sexes less than greatest breadth of scapus. Scapus in males about twice as long as broad. Last antennal segment in males (Fig. 267) strongly curved in a C-shape, penultimate segment spinose ventrally. Yellow or yellow-brown pattern on face limited to anterior border of clypeus and only present in females. Propodeum evenly rounded posteriorly without transverse carina, but with two posteriorly directed spines. Tergum 2 without yellow pattern. Forewing nervulus is strongly postfurcal (Fig. 268). Tibia 2 with two spurs. Tibia 3 of female with a proximal row of very short spines.

The genus has a Holarctic distribution, but comprises only a few species. Nests are constructed in the ground. Six species in Europe, only a single in the North. The prey consist of Homoptera Sternorrhyncha.

83. DIDINEIS LUNICORNIS (Fabricius, 1798)
Figs. 267, 268.

Pompilus lunicornis Fabricius, 1798:249.

Female: 7-8 mm. Frons in front of ocelli densely and finely punctate, the punctures often having a tendency to coalesce longitudinally. Clypeus short, posteriorly strongly punctate. Anterior half yellow or brown-yellow, anterior border with three teeth, of which the central is considerably stronger than

the lateral ones. Mandibles yellow with red-brown apex. Pronotum long and narrow, laterally with a weakly striate or transversely rugose sculpture, dorsally finely and densely punctate like scutum. Humeral tubercle posteriorly slightly brownish, without yellow mark. Scutellum black. Mesopleuron finely rugoso-punctate, often with indication of striae. Propodeum dorsally with apically attenuate area, with irregular, usually longitudinal sculpture, which consists of undulating carinae. Oblique, regular carinae run back from the delimiting carinae of the area. Two first segment of abdomen red without yellow pattern. The ventrally directed spinose dilation on apex of femur 3 considerably weaker than in Alysson.

Male: 5.5 - 7 mm. Much more slender than female. Frons in front of ocelli evenly and finely punctate, with shining interstices. Punctures without

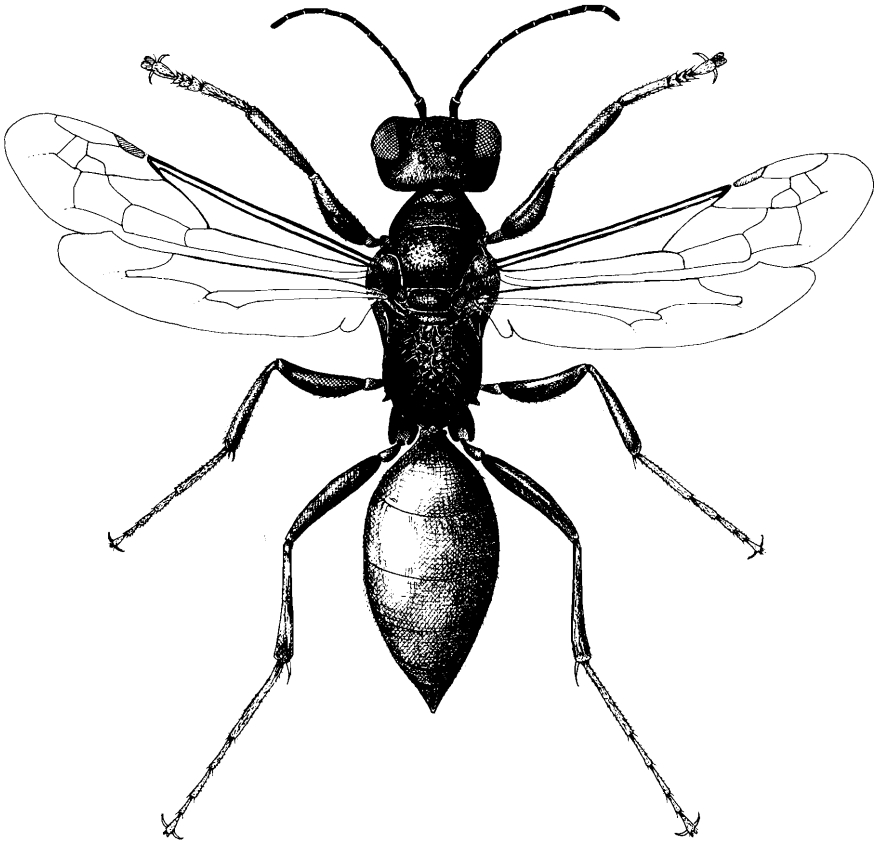


Fig. 268. Female of Didineis lunicornis (Fabr.). Length: 7-8 mm.

tendency to coalesce longitudinally. Clypeus uniform black, its anterior border slightly undulating, without teeth. Mandibles red-yellow with rusty apex. Antennae very long and slender, last segment strongly curved in a C-shape, penultimate segment distally on ventral face with forwardly directed spine (Fig. 267). Thorax and propodeum sculptured as in female. Abdomen with long and sparse pubescence, its base red. Posterior border of tergum 2 more or less dark. Tarsi long and slender.

Rather little, old material (last capture:1913) exists from Danish localities, predominantly from the southern districts (SJ, EJ and SZ). - The species is not recorded from Fennoscandia, but is known both from Great Britain and North Germany. This species is not common, but widespread in Europe and the Mediterranean area. Also occurring in Mongolia.

Nests in small banks and in horizontally placed localities with sparse vegetation. The nest consists of a rather long tunnel, terminating in a single cell. This cell is provisioned with Heteroptera, Homoptera, usually of the family Cicadellidae.

Genus *Alysson* Panzer

Alysson Panzer, 1806:169.
Type-species: Pompilus spinosus Panz., 1801.

Small, rather rare species (Fig. 269). Head fairly small, about as broad as thorax. Inner orbits almost parallel in females, distinctly converging ventrally in males. Distance between antennal sockets greater than width of scapus in female, but considerably smaller in males. This is partly due to the very short, thick scapus in the males. Clypeus short and broad, in females with three distinct teeth on anterior border. Mandibles weakly bidentate. Antennae long and slender, in males the last segment is slightly excavate ventrally. Inner orbits, clypeus, mandibles and scapus with more or less extensive yellow marking. Pronotum elongate, almost neck-like. Thorax otherwise rather narrow, shining, weakly punctate dorsally. Mesopleuron without well-defined epicnemium. Propodeum very long, with strong carinae and ribs, dorsally forming a triangular area. On the junction between posterior and lateral faces of propodeum there are indistinct tubercules. Abdomen sessile, with a pair of round yellow or whitish spots on tergum 2. Tergum 6 in female with distinct pygidial areal. Tergum 7 of male flat, tergum 9 with a pair of sting-like prolongations. Forewings with three cubital cells, of which the second is petiolate. Stigma large. Nervulus inter-

stitial or slightly antefurcal. Legs long and slender. Anterior metatarsi in female with or without very weak pecten, pretarsus and pulvilli very well developed. Tibia 2 with a single, weakly developed spur. Femur 3 distally on the outer side with a well developed, ventrally directed, spinose dilation (Fig. 272). Tibia 3 of females with a double row of long, pale spines.

The genus is distributed in Holarctis, with about 12 species. The species nest in the soil. The main tunnel either terminates in a single cell (Nordic species), or leads to a system of short side tunnels, each terminating in a cell (Japanese species). Prey consists of Homoptera Sternorhyncha. The egg is laid on the last deposited prey.

Key to species of Alysson

1 Area on dorsal surface of propodeum rounded posteriorly or indistinctly delimited, with irregular, partly reticulate coalescing rugae (Fig. 270). Female: base of abdomen red; scutellum usually with a white-yellow spot. Male: flagellum uniform black ..... 84. spinosus (Panzer)

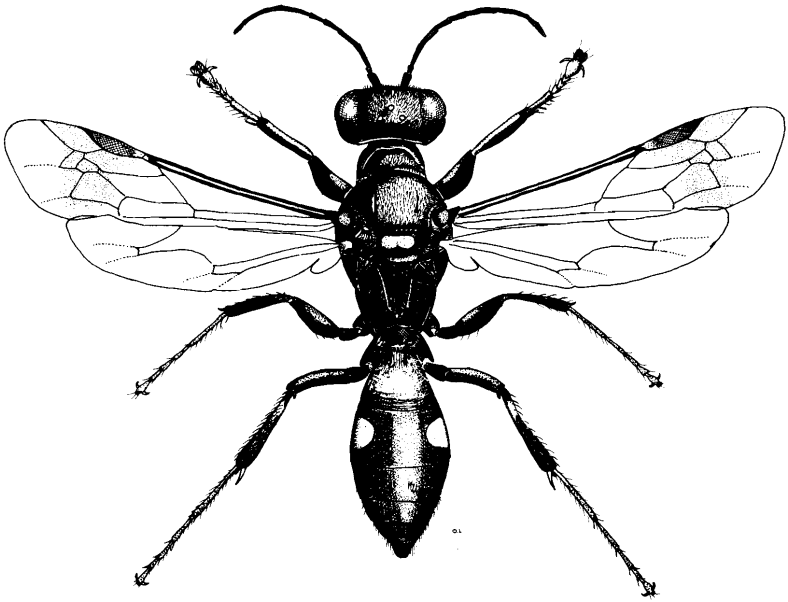


Fig. 269. Female of Alysson spinosus (Panz.). Length: 7-8 mm.

- Area on dorsal surface of propodeum concave, posteriorly attenuate; with strong, regular longitudinal carinae (Fig. 271).
  Female: abdomen without red pattern; scutellum black.
  Male: flagellum ventrally brown-yellow.... 85. ratzeburgi Dahlbom

84. ALYSSON SPINOSUS (Panzer, 1801)
Figs. 269, 270, 272.

Sphex bimaculatus Panzer, 1798: H. 51, T. 4 (preocc.).
Pompilus spinosus Panzer, 1801: H. 80, T. 17.

Female: 6.5 - 8 mm. Inner orbits almost parallel. Frons in front of ocelli densely and strongly punctate. Area between antennal sockets broad, slightly swollen. Lower part of face with silvery pubescence. As a rule with extensive yellow pattern along inner orbits, laterally on clypeus, on anterior part of scapus and on mandibles. This colour pattern is most extensive in specimens from Central and South Europe. In Danish specimens it is very limited and often absent from large parts of clypeus. Anterior border of clypeus with three distinct teeth, of which the median is somewhat more strongly developed than the lateral. Third antennal segment distinctly longer than fourth. Pronotum dorsally very finely punctate, laterally striate. Along posterior border a rather deep furrow, whose bottom is partitioned by weak transverse carinae. Scutellum usually with a double yellow spot. Mesopleuron shining, almost impunctate. Dorsal area on propodeum rather narrow, centrally with two more or less distinct longitudinal ribs. From these, branched, oblique rugae often originate (Fig. 270). The area posteriorly rounded or truncate. Propodeum laterally with very small tubercles. Posterior face not distinctly delimited from remaining part of the sclerite. Tergum 1 red, 2 black with two large, white-yellow spots. Femora black. Tibia 1 with yellow longitudinal stripe along anterior border, tibia 3 with yellow proximal ring. Pretarsus and pulvillus very well-developed. Apical tooth on femur 3 as Fig. 272.

Male: 4.5 - 6,5 mm. Somewhat more slender than female. Head in front view broader than long. Clypeus without teeth on anterior border. Pattern on face as in female, light yellow, but the expansion of the colour more limited on clypeus. Scapus thick and short. Antennae comparatively short, ventrally brown-black, last segment truncate, ventrally with a very weak excavation. Humeral tubercle usually with yellow spot, extending a short distance along posterior border of pronotum. Scutellum usually black, but may bear two indistinct yellow spots. Sculpture on propodeum relatively somewhat stron-

ger than in female. Tergum 1 black, 2 with two yellow spots. Coxa 1 and trochanter 1, coxa 2, tibia 1 on the outer side and tibia 2 proximally with yellow pattern. Last abdominal segment red-yellow.

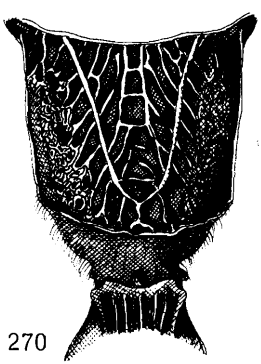
In the North only recorded from Denmark: F, several localities. - Known from Central and southern Europe. Rare.

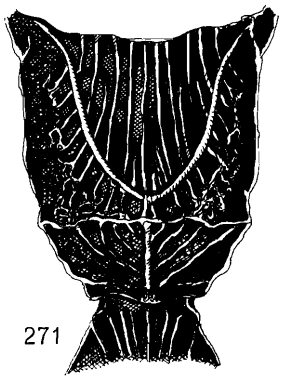
The nests are constructed at the base of slopes exposed to the sun; where the soil consists of sand or gravel. The tunnel at first runs horizontally for some distance, then it turns, running almost vertically down. The number of cells probably varies, but according to previous authors the species constructs only a single cell per entrance. The paralyzed prey (usually Cicadellidae, e.g. Philaenus spumarius L) are flown almost the whole way to the nests, being held exclusively with the mandibles. The last part of the journey to the entrance is made on foot.

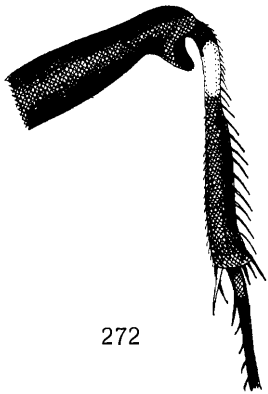
85. ALYSSON RATZEBURGI Dahlbom, 1843
Fig. 271.

Alysson ratzeburgi Dahlbom, 1843:145.

Female: 7-8 mm. Inner orbits distinctly converging ventrally. Frons in front of ocelli finely and rather sparsely punctate, with shiny appearance, distance between punctures being as great as or greater than the diameter of the punctures. Area between antennal sockets slightly swollen, often with a yellow spot. Silvery pubescence on face very sparse, limited to a small







Figs. 270-271. Propodeum in dorsal view of female Alysson. - 270: spinosus (Panzer); 271: ratzeburgi Dahlbom.
Fig. 272. Hindleg of female Alysson spinosus (Panzer).

spot between lower part of eyes and antennal sockets. Yellow pattern of face considerably less extensive than in spinosus, there being usually a narrow yellow or yellow-brown band along the inner orbits. Mandibles brown-yellow with red-brown apex. Yellow spot on anterior side of scapus may be absent. Clypeus without yellow pattern, the shiny impunctate anterior area separated from the posterior, rather densely punctate half by a row of large, deep, bristle-bearing punctures. Anterior border with a broad, rounded, median tooth, lateral teeth very small. Antennal segments 3 and 4 almost equally long. Furrow along posterior border of pronotum very weakly developed, without transverse carinae in the bottom. Scutellum without yellow marking. Propodeum distinctly concave dorsally. Triangular area broad (Fig. 271) with comparatively regular longitudinal carinae. Posterior face of propodeum delimited from the lateral and dorsal faces by well-developed carinae, forming a small tubercular thickening where the three areas meet. Abdomen without red, spots on tergum 2 yellow. Mid- and hindlegs mainly red-yellow. Forelegs red-yellow with black femora. Coxa 1 with yellow or red-yellow distal spot.

Male: 6-7 mm. Clypeus, two large, triangular spots along inner orbits and a spot extending from posterior border of clypeus up between antennal sockets, bright lemon-coloured. Mandibles, palps and scapus also with extensive yellow markings. Antennae ventrally brown-yellow, distally gradually darker. Last antennal segment somewhat more excavated than in spinosus. Posterior border of humeral tubercle yellowish. Often two yellow spots are present on pronotum. Scutellum with or without yellow pattern. Sculpture on propodeum stronger than in female, triangular area more concave. Tergum 2 with lemon-coloured lateral spots. Last abdominal segment red-brown. Coxa 1 distally with a small spine-like prolongation. Forelegs ventrally, including coxae and trochanters, with very extensive yellow markings. Foretarsi black-brown. Fore- and midlegs with more or less extensive yellow and yellow-brown pattern, tibia 3 uniform yellow-brown.

A northern species which is rather common in Central and North Sweden up to Vb. and Ly. Lpm. Not recorded from the southern districts. - Norway: a few specimens from AK. - Finland: widespread but rare from Al in the south to Ks, Li and ObN in the north. - Soviet Karelia: Ib, Kr and Lr. - Recorded from Central and East Europe. Additional records from Japan and Korea. Distribution through southern Siberia unknown.

Biology as in preceding species.

SUBFAMILY MELLININAE

The taxonomical status not fixed. The group was treated as a tribe within the Nyssoninae by Bohart and Menke (1975), Beaumont (1954) and several others, whereas Evans (1959) gave it subfamily rank, concluding from larval morphology that the group is apparently not closely related to the Nyssoninae. As concerns subfamily characters of imagines, see generic description of Mellinus. In addition, it should be noticed that the epicnemium is not differentiated, since the epicnemial carina is absent and the transverse discoidal veins join first and third cubital cells, respectively. The latter character is only found in Ampulex (Ampulicinae) and some Pison (Larrinae, Trypoxylonini), suggesting it to be rather primitive. The only specialized character of imagines might be the petiolate abdomen.

As regards larval morphology the following description it based only on the single species being described. Body with pleural lobes and a series of dorso-lateral prominences conically produced, dark-tipped, and armed with numerous short, stout spinules (Figs. 37, 38). Integument otherwise smooth. Parietal bands only indicated. Antennal papillae absent. Apical margin of labrum bristly, with a strong V-shaped emargination. Mandibles bidentate, strongly excavate proximally. Maxillary palpus slightly longer than galea. Maxillae directed medially. Spinneret paired, the salivary openings at the tip of slender prolongations, proximally connected by a membrane.

The subfamily only comprises a single genus. Probably all species display terrestrial nesting habits.

Genus *Mellinus* Fabricius

Mellinus Fabricius, 1790:226.
Type-species: Vespa arvensis Linné, 1758.

Rather large, easily recognizable species (Fig. 273) with extensive and very variable yellow pattern. Head large, in front view broader than long. In females the lower two-thirds of inner orbits of eyes are parallel, whereas they are distinctly converging downwards in the males. Antennae long, filiform, inserted far from each other. Clypeus with three rounded teeth on anterior border, its yellow or white-yellow pattern most strongly developed in the males. Mandibles stout, in females tridentate, in males bidentate. Thorax with yellow pattern on pronotum, scutellum, and mesopleuron. Propodeum elongate, slightly convex, dorsally with distinctly delimited area

cordiformis, in which is found a drop-shaped, strongly sculptured depression. Lateral faces of propodeum delimited from posterior face by sharply protruding carinae. Tergum 1 long and narrow, posteriorly swollen, only very seldom with yellow pattern. Terga 2, 3 and 5 in female with yellow or white-yellow transverse bands or lateral spots. In males there are yellow patterns on second and third, and usually also on fourth and sixth terga. Females with well developed pygidial area. Legs with more or less extensive yellow or red-brown pattern. Pretarsi very large. Tibia 2 with two apical spurs. Metatarsus 1 in female with 4 to 5 very weak spines. Forewings with three cubital cells. First discoidal transverse vein joins first, the second the third cubital cell.

The genus has a Holarctic distribution and comprises about 10 species.

The nests are excavated in the soil. The prey consists of Diptera Brachycera and Cyclorrhapha.

Key to species of Mellinus

1 Female: abdomen with bright yellow transverse bands, at least complete on tergum 2. The remaining bands may be interrupted in the middle. The distal flagellar segments black or brown-black dorsally. Tibiae yellow or red-brown.
Male: distal antennal segments black dorsally. Propodeum rather strongly sculptured, laterally distinctly, but finely rugoso-punctate ..... 86. arvensis (Linné)

\- Female: abdomen with white-yellow lateral spots that very rarely fuse to form bands. The distal antennal segments uniform red-yellow, of the same shade as the tibiae.
Male: distal antennal segments darker dorsally. Propodeum relatively weakly sculptured, with only indications of rugae, punctate ..... 87. crabronea (Thunberg)

86. MELLINUS ARVENSIS (Linné, 1758)
Fig. 273.

Vespa arvensis Linné, 1758:573.
Mellinus alpinus Handlirsch, 1887:283.

Female: 11-16 mm. Face dull, very densely punctate, dull. Clypeus very slightly convex, anterior half finely pustulate, posterior half punctate- reti-

culate. The surface itself with long, scattered brownish bristles. Head with very short pubescence, which along inner orbits and on lower part of face has a felt-like appearance. Antennae long and slender, black dorsally and brown-yellow ventrally. Pronotum pad-like raised, with a transverse yellow spot, often interrupted in the middle. Scutum dull, very densely punctate. Mesopleuron with very strong episternal and epimeral sutures. Dorsal face of propodeum with a shiny area, in whose middle is a drop-shaped depression, rugose at the bottom. Abdomen shiny with bright yellow transverse bands on terga 2, 3 and 5, and larger or smaller lateral spots on terga 1 and 4. Pygidial area with very dense and fine longitudinal rugae, basally mixed with a rather coarse punctation. Tibiae usually yellow with a dark spot on the inner side.

Yellow pattern varying greatly. Specimens from Denmark and southern Sweden very often carry a larger or smaller basal, and occasionally also a more effaced yellow spot near the middle on mandibles. These spots may coalesce. In this case there is usually a yellow transverse band on clypeus. In addition, the yellow lines along inner orbits are strongly developed, reaching to epistomal suture. A well developed pattern on the head is often

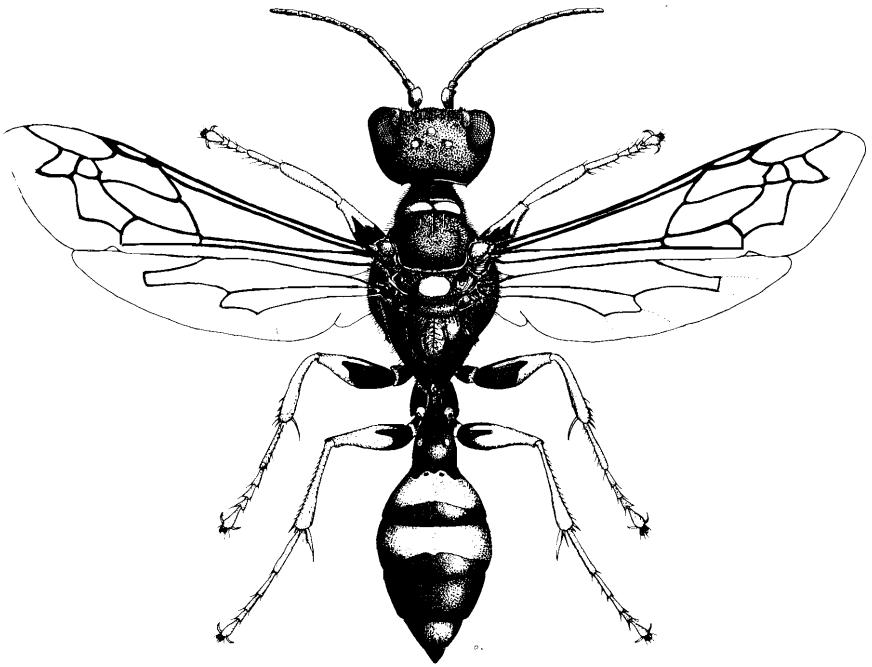


Fig. 273. Female of Mellinus arvensis (L.). Length: 11-16 mm.

correlated with yellow spots on coxae. A few specimens from southern Denmark, besides the large yellow spot on mesopleuron may have one or two additional ones just behind the humeral tubercle ventro-laterally on mesopleuron. In most specimens tergum 1 is entirely black, but small yellow spots occur, especially in individuals from SJ in Denmark and in specimens from Central and South Europe. Terga 2, 3 and 5 with broad transverse bands, which especially in specimens from the northernmost areas of the species' range, are interrupted in the middle. This also applies to specimens from the Alps (see note). Tergum 4 and sternum 3 may carry yellow spots, especially in material from Denmark, South Sweden and Åland. The main rule is that the extent of the yellow colour decreases gradually towards the north. Specimens from Finland nearly always have entirely black femora, mandibles and clypeus, and the yellow markings are absent from coxae and usually from tergum 4.

Male: 8-13 mm. More slender than female. Yellow pattern on head considerably more extensive. Clypeus often all yellow. Mandibles with a large, triangular yellow spot at the base, sometimes extending across the greater part of the anterior face of the mandible. Antennae black, brown-yellow ventrally. Segments 8-12 ventrally with small oval excavations. Head behind ocelli with very weak microsculpture. Propodeum behind shiny raised area dorsally with irregular rugae, which are partly coalescing. True punctation often missing. In addition to the yellow pattern described in the female yellow spots are occasionally found on the humeral tubercle. Abdomen with bright yellow lateral spots on terga 2, 3 and 6. Yellow pattern of legs varying greatly, but coxae usually black with apical spot and a larger or smaller yellow spot ventrally. Small specimens, and particularly individuals from the northernmost regions of the distribution range, may lack yellow pattern on tergum 2 as well as on femora. Tibiae yellow, tibiae 1-2 with dark streak on the inner side.

One of the most common species in Fennoscandia and Denmark. - Denmark: records from all districts except SZ. - Sweden: known from all districts up to Dlr., Hls. and Med. - Norway: northern distribution limit runs through NRy, On, and HEs. - In Finland this species seems to have a southern and southeastern distribution pattern, not being recorded from Oa and Om. - Soviet Karelia: Ib, Kr. - Although it is a very common species, its distribution area seems to include only the European countries, except the close Mediterranean areas.

Frequently met with in sandy localities, but relatively seldom on coastal biotopes. The nests are constructed, often in aggregations, in places with-

out vegetation, in horizontal areas as well as on slopes. Females hunting prey and constructing nests are seen from late June to late September or even October. Males often seen swarming in small aggregations round detached sun-baked trees and bushes, especially of Quercus and Myrica, on whose leaves they often are seen resting and licking honey dew.

The main tunnel of the nest often goes 30-40 cm almost vertically down into the soil, to a single cell; or several cells are constructed at the end of rather short, horizontal side tunnels. These are provisioned with flies of the families Tabanidae, Syrphidae, Muscidae, Calliphoridae and Tachinidae. Many arvensis females seek their prey on fresh cow droppings, where it is attacked with a sudden jump, and held fast with mandibles and forelegs. Then the wasp bends its abdomen forwards to paralyze the fly with one or two stings. After very few seconds, the movements of the fly cease, and it is flown back to the nest. Each cell is provisioned with 4-13 flies. The egg is usually laid on the first-paralyzed fly (Huber, 1961). When fully grown, the larva spins a pale, parchment-like cocoon, covered on the outside with sand grains and food remains. The larva was described by Evans (1959) and Maneval (1939). Known dipterous parasites are Macronychia griseola Fall. and Sphecapata conica Fall. (Sarcophagidae).

Note. Specimens from the Alps were traditionally recorded under the name M. alpinus Handlirsch, and recently Romanova (1969) recorded the species from Northern Caucasus as alpinus. European material has been compared with alpinus, and I must conclude, in agreement with Bohart & Menke (1975), that alpinus is simply to be regarded a junior synonym of arvensis. Material from the Alps is very similar to Finnish specimens, but might be distinguished by the slightly darker yellow colour. It seems probable that the variation in colour-intensity and -distribution is geographically/climatically conditioned.

87. MELLINUS CRABRONEUS (Thunberg, 1791)

Sphex crabronea Thunberg, 1791:126.
Mellinus sabulosus auctt.

Female: 10-12 mm. Head and scapus golden-yellow or light brown-yellow, very different from the white-yellow colour on thorax and abdomen. Mandibles lighter or darker brown, never completely black, only seldom with a yellow basal spot. Clypeus slightly more convex than in arvensis, anterior part finely pustulate, posterior part punctate-reticulate. Yellow patterns may be absent, but often forms an almost complete transverse band. Bristles pale. Antennae brown-yellow or red-yellow, proximal part black

dorsally. The posterior face of propodeum with distinct punctation, sometimes also with weak rugae. Abdomen with white-yellow spots on terga 2, 3 and 5. These are never fused into transverse bands. Legs red-yellow, femora, however, with dark base.

Male: 7-11 mm. Pattern of face of same shade as that of abdomen. Mandibles black with larger or smaller spot at base. Antennae red-yellow, only proximal segments black dorsally. Antennal segment 8-12 with very small excavation ventrally. Frons behind ocelli shiny, with microsculpture sometimes vestigial. Thorax with same yellow pattern as in female. Propodeum considerably more weakly sculptured than in arvensis, posterior face punctate with weak rugae, just above articulation of abdomen. Abdomen with yellow lateral spots on terga 2, 3 and 6. Legs red-yellow with black femora, these often with white-yellow spot near apex.

Not common, but sometimes occurs in large numbers locally. A southern species in Fennoscandia and Denmark. - Sweden: northern distribution limit in southern Vrm., Nrk. and Ög. - Norway: a very small material from AK and VE. - Finland: some rather old specimens from N. - Soviet Karelia: Ib, Kr. - The distribution area covers Europe, extending eastwards through the steppe areas in southern Siberia to Mongolia, Manchuria and Korea.

The nests are often constructed in dry, often coastal localities, usually in aggregations. From a main tunnel, 5-30 cm long, 3-6 short side tunnels issue, each terminating in a cell. Round the entrance the characteristic superstructure of excavated material is found, as in arvensis. The cells are provisioned with flies of the families Syrphidae, Muscidae and Anthomyiidae.

SUBFAMILY ASTATINAE

A small, probably monophyletic subfamily closely related to the Larrinae. It comprises the two tribes Astatini and Dinetini. Size of species about 10 mm. Head large, almost as wide as thorax. Inner orbits strongly diverging ventrally, especially in holoptic Astata-males. Ommatids very small in ventral fourth of the eye. Ocelli circular, the anterior the largest. Mandibles bidentate, the ventral margin in Astata (and Diploplectron) very slightly emarginate, suggesting a strong reduction of both the proximal tooth and the deep emargination found in Dinetus and Larrinae. Antennae filiform, in males with pronounced secondary sexual characters. Prothorax very short, humeral tubercles almost reaching tegulae. Mesopleuron with epicnemial furrow,

epicnemium absent. Propodeum large. Abdomen sessile, depressed and triangular in outline in Astata. Pygidial area of females plane, bordered by dark bristles. Tarsus 1 of females with strong tarsal pecten (also present in Dinetus-males). Tibia 2 with two apical spurs (absent in Dinetus-males). Radial cell truncate, appendiculate. Three or two cubital cells and two discoidal cells. The first cubital cell divided by a very indistinct vein. Hindwings in Astata with a very large jugal lobe.

Larval head much wider than high. Parietal bands strong. Antennal papillae present. Mandibles with a hyaline, strongly setose area laterally near the base, the apex with from two to four strong teeth. Galea slightly shorter and much more slender than the maxillary palpus. Spinneret paired. Maxillae directed medially, closely associated with the labium. Fourth abdominal segment humped dorsally.

The subfamily only comprises four genera of which two are represented in the European fauna. All species nest in the soil, using Heteroptera as prey.

Genus *Astata* Latreille

Astata Latreille, 1796:114.
Type-species: Tiphia abdominalis Panzer, 1798 (=Sphex boops Schrank, 1781).

Medium to small species. Head short, in front view almost circular. Inner orbits of eyes strongly diverging ventrally. Ocelli placed far in front of posterior border of eyes, anterior one much larger than posterior. Antennal segments inserted very low on face, immediately above epistomal suture. Scapus short and thick. Anterior border of clypeus slightly reflexed. Pronotum short, cone-shaped. Thorax weakly convex dorsally, broad and flat. Abdomen short, triangular, base red in Danish and Fennoscandian species. Last tergum in females with pygidial area. Metatarsus 1 with stout pecten in females. Tibia 3 very spiny. Males holoptic (Figs. 278, 279). Upper and forwardly directed ommatids considerably larger than those situated above mandibular articulations. In the subgenus Dryudella males have a large white double spot on anterior frons. Forewing with three cubital cells, of which the first is divided by a pale transverse vein. The second is joined by both discoidal transverse veins (Fig. 274). Hindwing, especially in males, with very large vannus.

The geographically conditioned intraspecific variation, both as regards morphology and colour, is rather little, and also the interspecific variation within the two subgenera is surprisingly slight. The genus has a cosmopolitan distribution, but is unknown in the Australian region.

The species are associated with dry, sandy biotopes, where the nests are constructed in the ground. Prey consists of nymphs or imagines of Heteroptera: Geocorisae.

Note. Dryudella Spinola is here considered a subgenus of Astata, although Parker (1962, 1969) argues that it should have full generic status.

Key to species of Astata
(Sub-genera in brackets)

1 Propodeum dorsally with strong, obliquely, outwardly directed, longitudinal carinae, connected with weaker transverse rugae, in this way giving the sculpture a reticulate appearance. Interspaces shiny, without microsculpture. Males: frons completely black (Astata) 2

\- Propodeum dorsally very strongly microsculptured, of dull appearance, without protruding ribs. Males: frons with white double spot in front of anterior ocellus (Dryudella) 3

2(1) Female: metatarsus 1 ventrally with 16-18 short, stout spines (Fig. 280). Third flagellar segment in dorsal view at least three times longer than broad. Male: third antennal segment 3 - 3.5 times longer than broad, tyloidea as Fig. 282 ..... 88. boops (Schrank)

\- Female: metatarsus 1 ventrally with only 7 - 9 spines (Fig. 281). Third flagellar segment seen from above about twice as long as broad. Male: third antennal segment at most 2.5 times longer than broad, tyloidea as Fig. 283 ..... 89. minor Kohl

3(1) Female: anterior border of clypeus with evenly convex mid-part and two small lateral teeth (Fig. 277). Male: spots on frons above delimited by a strongly arcuate line (Fig. 278). Tyloidea distinct on segments 6 - 8, almost linear ..... 90. stigma (Panzer)

\- Female: anterior border of median lobe of clypeus with two emarginations, whereby three small rounded teeth appear (Fig. 276).

Male: spots on frons above delimited by an almost straight line (Fig. 279). Tyloidea very indistinct, forming oblique, weak convexities on segments 6 - 8 ..... 91. pinguis (Dahlbom)

88. ASTATA (ASTATA) BOOPS (Schrank, 1781)
Figs. 275, 280, 282.

Sphex boops Schrank, 1781:384.
Astata picea Costa, 1867:90.
Astata sicula Kohl, 1884:436.
Astata carbonaria Kohl, 1884:437.
Astata agilis Smith, 1875:39.

Female: 10-13 mm. Frons in front of ocelli shiny and densely punctate. Genae laterally, and area behind ocelli, with only very scattered punctation. Occiput with superficial, but rather dense punctation and long, silvery pilosity. Dorsally on head a weak microsculpture may sometimes be recognizable. Lower part of face with dense, silvery pubescence. Central part of clypeus strongly produced, its anterior border with two very weak

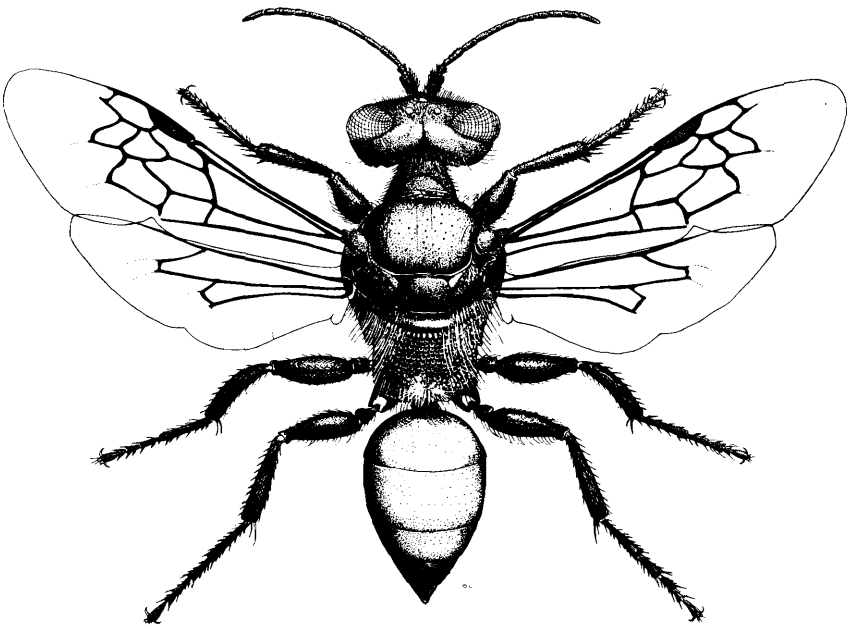


Fig. 274. Female of Astata pinguis (Dahlbom). Length: 6-8 mm.

rounded lobes (Fig. 275). Pubescence here brown. Ocelli forming an obtuse angle. Mandibles stout, slightly reddish with black apex. Antennae long and slender, segment 3 at least three times as long as broad, as long as scapus. Remaining segments more than twice as long as broad. Second segment of labial palpi strongly asymmetrically dilated, triangular. Pronotum dorsally with fine transverse rugae or striae. Scutum shining, smooth, anteriorly very densely, but irregularly and superficially punctate. Posteriorly, punctation becomes very sparse. Scutellum also shiny, with only few scattered punctures. Metanotum appears as a shiny, impunctate transverse pad. Mesopleuron with rather coarse rugoso-punctate sculpture, becoming gradually finer and more superficial ventrally. Pubescence whitish. Lateral faces of propodeum coarsely sculptured, posteriorly usually with very irregular striation. Dorsal face with coarse and rather regular, reticulate sculpture on shiny background. Posterior face with weak and very irregular sculpture and long, whitish pubescence. Abdomen depressed, first three segments red. Pygidial area triangular, broad and plane, with very distinct microsculpture, bordered by dense black or brown bristles. Metatarsus 1 ventrally with 16-18 short spines (Fig. 280). Legs uniform black or slightly red-brown. Radial cell of forewings twice as long as broad. Distal half of forewings distinctly darkened.

Male: 9-11 mm. Frons without white spot, with well developed and rather dense, white pilosity. Anterior ocellus much larger than posterior ones. Frons densely and rather strongly punctate, without microsculpture. Clypeus with only slightly protruding mid-part, which has obtuse-angled corners and very slightly emarginate anterior border. Breadth of mid-part only slightly greater than distance between antennal sockets. Flagellum long and slender, its second segment seen from above at least three times longer than broad distally. Segments 3-9 ventrally with light brown, broadly interrupted tyloidea (Fig. 282). Middle flagellar segments more than twice as long as broad. Punctation on scutum except in middle dense and uniform. Scutellum centrally and anteriorly shiny, almost impunctate, posteriorly with dense punctation. Metanotum very weakly and irregularly rugose. Mesopleuron laterally coarsely but rather superficially rugoso-punctate. Lateral faces of propodeum with finely undulating striation. Sculpture dorsally on propodeum dominated by the regularly running longitudinal carinae. Pilosity whitish, long and slightly curly. First, second and basal part of third abdominal segments red-yellow. First and second sterna usually with large black or brown central spot in Nordic specimens. Sterna 4-6 with long, downwardly directed, yellowish pubescence, Metatarsus 1 long and slender, at least six times longer than broad, ventrally with 8-10 spines.

The species is rare in most parts of Fennoscandia, but occasionally occurs in rather large "colonies" on the Swedish islands of Öland and Gotland. - Denmark: a single male, without locality (coll. Schiødte?) - Sweden: widespread in the southern parts, northern distribution limit in Vrm., Dlr. and Gstr. - Norway: a few specimens from AK and TEy. - Finland: found from Al, Ab and N in the south to Om, Sb and Kb in the north. - Soviet Karelia: Ib. - Widely distributed in the Palaearctic Region, eastwards to northern India, northern China and Korea.

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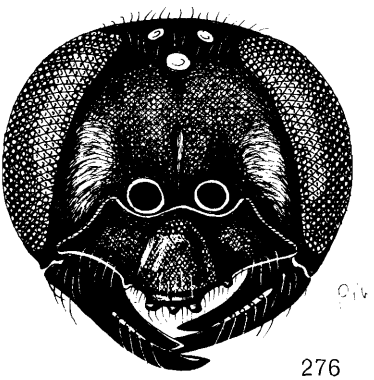

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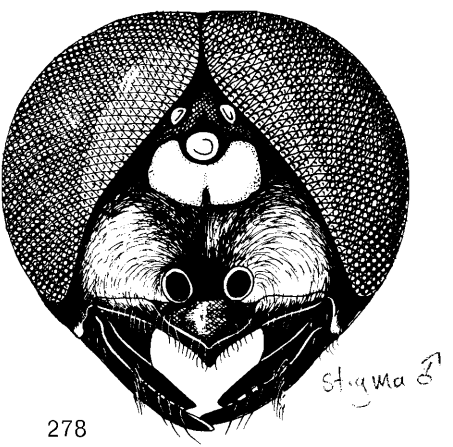
277 stigma ♀



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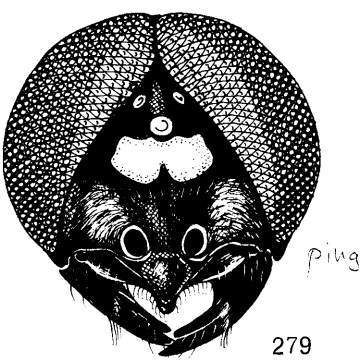

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Figs. 275-276. Heads in frontal view of female Astata. - 275: boops (Schrank); 276: pinguis (Dahlbom).
Fig. 277. Anterior margin of clypeus of female Astata stigma (Panzer).
Figs. 278-279. Heads in frontal view of male Astata. - 278: stigma (Panzer); 279: pinguis (Dahlbom).

The nest (Tsuneki, 1969) consists of a short tunnel, about 10 cm long, ending in from one to three cells. These are placed, one after the other, as simple dilations of the tunnel. Partitions between the cells consist of loosely packed sand or earth. Side branches often occur in the nest system so that a single nest may contain 12 larval chambers. As breeding habitat are usually chosen dry, sandy paths and the like exposed to the sun. Prey mainly comprises immature bugs, but a few imagines may be taken. It is stated that the species in Sweden uses bugs of the family Pentatomidae, e. g. Picromerus bidens, Dolychoris baccarum, Eurydema sp., Aelia acuminata and Pitedia junipera. The prey is flown to the nest, where it is temporarily placed in immediate vicinity of the sealed entrance, while this is cleaned and re-opened. Thereupon it is pulled down, usually by the antennae. Sometimes a number of paralyzed nymphs are found temporarily deposited in one of the tunnels (a phenomenon which can also be observed in Cerceris and Philanthus). None of these nymphs, however, bear either eggs or larvae of Astata. Not until a sufficient number has been collected are they carried to the cells. In this way several cells are finally provisioned simultaneously. Each larval chamber contains two to fifteen nymphs. The egg is placed on the first-deposited prey. Development of the larva (in Korea!) takes three days. After a short resting period the larva spins a cocoon, which consists of a silky lining on the walls of the cell. In this it remains as prepupa for 4-5 days. The pupal stage lasts 11-12 days. It is doubtful whether the Nordic populations succeed in getting more than one generation on the wing per year. Here the species presumably hibernates as a pupa. Hedychridium roseum Rossi (Chrysididae) is known as a parasite.

89. ASTATA (ASTATA) MINOR Kohl, 1885
Figs. 281, 283.

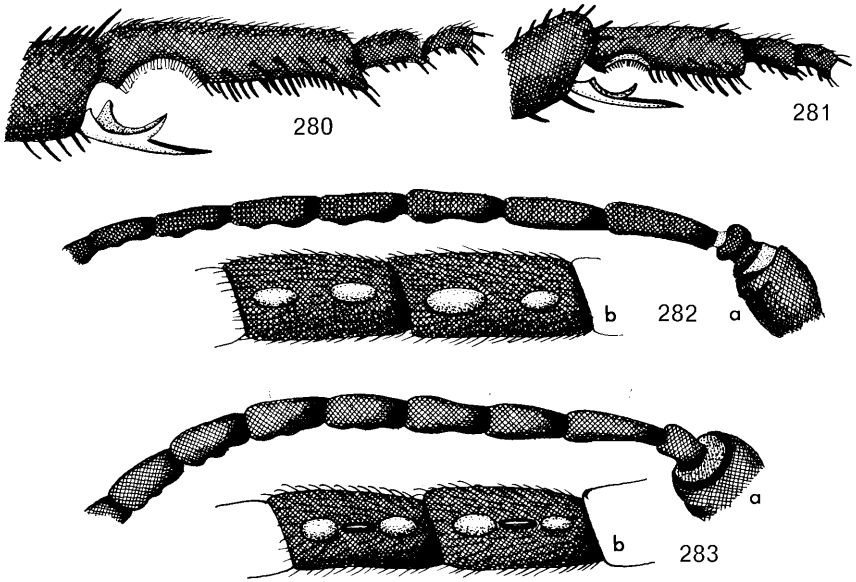
Astata minor Kohl, 1885:434.

Closely related to boops. Distinguished from this, besides being on average slightly smaller, by the morphology of the antennae and the relatively shorter tarsi. Female: 9-12 mm. Clypeus with protruding, narrow, lamellar median part, whose anterior border is arcuate. Third antennal segment seen from above about twice as long as distally broad. The succeeding segments at most twice as long as broad. Punctation of mesopleuron considerably weaker than in boops, only posteriorly with an indication of rugae. Lateral faces of propodeum in Nordic specimens usually with stronger, regular and dense transverse striation. Pygidial area comparatively large, its sides only slightly concave. The bordering bristles very short. Metatarsus 1 short, along

ventral border with at most 9 short spines (Fig. 281). Femora black, tibiae, especially the anterior ones, on the outer side with extensive yellow or red-brown pattern.

Male: 7-10 mm. Middle of anterior border of clypeus distinctly arcuately incised, distance between rounded corners considerably greater than distance between antennal sockets. Antennae comparatively short, their third segment seen from above at most three times longer than broad. Tyloidea of middle segments consisting of longitudinal pads centrally black or dark brown, distally and proximally weaker, narrower and pale brown (Fig. 283). These segments at most twice as long as broad. Metatarsus 1 at most six times longer than distally broad, ventral border with a row of short and very weak spines. Coxa 3 mesally with a broad, fairly deep excavation.

The species has a very restricted occurrence in Fennoscandia and Denmark. - Denmark: only recorded from Bornholm. - Sweden: stable populations on Öland and Gotland. A single specimen from Sm., Kalmar. - Finland: a southern species, only found in Ab, N, Ka, Ta, and Sa. - Soviet Karelia:



Figs. 280-281. Metatarsus 1 of female Astata. - 280: boops (Schrank); 281: minor Kohl.
Figs. 282-283. Antennae of male Astata. - 282: boops (Schrank), a: lateral view, b: two median segments in ventral view; 283: minor Kohl, a: lateral view, b: two median segments in ventral view.

Ib and Kr. - Widespread in Europe, North Africa and western Asia to Kazakhstan.

The species can be found nesting in sandy or gravelly localities fully exposed to the sun. The prey consists of species of the genera Sehirus, and Aphanus (Heteroptera, Pentatomidae). A known parasite is Hedychridium roseum Rossi (Hymenoptera, Chrysididae). Immature stages described by Grandi (1961).

90. ASTATA (DRYUDELLA) STIGMA (Panzer, 1809)
Figs. 277, 278.

Dimorpha stigma Panzer, 1809:H. 107, T. 13.

Female: 7-11 mm. Front of head dull owing to the well-developed microsculpture. Punctation very weak and sparse. Ocelli placed in very acute triangle. Pilosity of lower part of face whitish, very thin. Clypeus with narrow, protruding, rounded midpart and very small,rounded lateral teeth (Fig. 277), the remainder with strong brown bristles. Mandibles stout, black with red-brown or red-yellow middle. Scapus short and thick, considerably shorter than third antennal segment. Flagellum long and slender, its second segment seen from above four times longer than broad. Remaining segments about three times longer than broad. Second segment of labial palpi not dilated. Pronotum strongly microsculptured like the anterior part of scutum. Otherwise with very scattered, but rather coarse punctation, which - like the microsculpture - gradually disappears posteriorly. Scutellum shiny with scattered punctures. Metanotum weakly rugoso-punctate. Mesopleuron laterally strongly microsculptured ventrally shiny, with coarse sparse punctation. Pilosity on thorax dorsally white, ventrally brownish. Whole propodeum with strong microsculpture, lateral faces posteriorly with indicated striae, dorsal face with very weak rugae. Three first abdominal segments red. Pygidial area narrow, with broadly rounded apex. The area itself shiny, at most with indicated microsculpture, posteriorly with scattered punctation. Bordering bristles few and pale. Tarsal spines on metatarsus 1 much longer than width of segment. Legs black or brown. Tibia 1 with a light streak anteriorly. Radial cell of forewings only very slightly longer than broad.

Male: 6-10 mm. Face dull, but without distinct microsculpture. Area in front of anterior ocellus with large, whitish spot (Fig. 278). Central part of clypeus strongly angularly protruding (Fig. 278). Scapus very short and thick, only little more than half as long as third flagellar segment. The latter seen from above almost five times longer than broad. Segments 6-8 ventrally with a long, narrow, black keel. Scutum anteriorly with very dense,

posteriorly with gradually sparser, superficial punctation. Microsculpture weak. Scutellum shiny, with sparse punctures. Metanotum superficially rugose. Mesopleuron as described in female, ventrally punctation weaker, whereas microsculpture here is distinct. Propodeum very strongly microsculptured, laterally and dorsally with very weak rugae or striae. Legs dark, tibia 1 with yellow streak along anterior border.

The species seems to be restricted to coastal localities in Fennoscandia and Denmark, although it inhabits inland localitites in other parts of its distribution area. - Denmark: NEJ: Skagen, 2 specimens. The specimen mentioned by Klefbeck (1951) cannot be verified, but it is almost certain that the specimen belongs to pinguis. - Sweden: several records from the shores of the Baltic Sea and Bottenviken up to Nb. (Valkeila in litt). A few records from the shores of the larger lakes (Ög., Nrk.). - Norway: a female and a male specimen from VE, Frederiksværn and VAi, Sireosen, respectively. - Finland: most specimens originate from the southern archipelago (Ab, N and Ka). Additional material from the shores of Bottenviken in Om and Ob. Recently it was collected at Ylämylly near Joensuu (Kb), 2 ♂, 7. vii. 1975 (O. Martin). - Soviet Karelia: Ib. - The distribution area covers Central Europe, Siberia, Mongolia and Tibet. Townes (1951) recorded the species from Alaska, but as shown by Parker (1969), the Holarctic Astata species is pinguis.

Biology similar to that of boops, but the prey consists of smaller species (Drymus sylvaticus and Sciocoris cursitans). Hedychridium roseum Rossi (Hymenoptera, Chrysididae) is recorded as parasite.

91. ASTATA (DRYUDELLA) PINGUIS (Dahlbom, 1832)
Figs. 274, 276, 279.

Larra pinguis Dahlbom, 1832:50.

Female: 6-8 mm. Frons with shining smooth surface in spite of the strongly developed microsculpture. Punctation sparse as in stigma, but distinct. Ocelli placed at acute angle. Anterior border of clypeus with three small rounded processes (Fig. 276), its pilosity black. Frons with short and very sparse, brownish pilosity. Antennae comparatively short. Third segment at most three times longer than broad, only slightly longer than scapus. Mandibles with a larger or smaller red-brown spot in middle. Pronotum densely microsculptured, without other form of sculpture. Scutum centrally and posteriorly shiny, almost polished, only anteriorly with weak punctation and microsculpture. Scutellum shining, with extremely weak microsculpture and sparse punctures. Mesopleuron strongly microsculptured all over, ventrally weaker and here mixed with superficial punctation. Pubescence short, brownish.

Propodeum uniform and strongly microsculptured, lateral faces posteriorly with short and rather strong striae. The two first and the basal part of third abdominal segment red. Pygidial area shiny, apex rounded. The surface itself with very weak microsculpture and punctation. Bordering bristles almost absent. Tarsal spines on metatarsus 1 not or only slightly longer than breadth of segment. Legs black, tibia 1 yellowish anteriorly. Radial cell of forewing only slightly longer than broad.

Male: 5-7 mm. Frons with white double spot, above delimited by a straight or almost straight line (Fig. 279). Median protruding part of clypeus anteriorly rounded (Fig. 279). Third antennal segment only slightly longer than the very short, almost globular scapus. In dorsal view the segment is at most 3.5 times longer than broad. Segments 6-8 ventrally with slightly protruding black tyloidea. Scutum dull, very densely microsculptured and without proper punctation. Scutellum anteriorly with shining area, otherwise dull, microsculptured. Mesopleuron with only an area anterior to coxa 2 shining, punctation here rather distinct. Microsculpture as on propodeum. First two or three segments of abdomen red. Legs black, tibiae, especially the foremost, yellowish anteriorly. Tarsi brown, yellow-brown anteriorly.

Pinguis is a rare species, but can occur locally in rather large numbers. Recorded from all Nordic countries. - Denmark: restricted to sandy localities along the coasts; found in most districts. - Sweden: from Sk. in the south to Med. and Nb. in the north. - Norway: a very small material from VAi, Sireosen. - Finland: both inland and in littoral localities. Known from Al, Ab and N in the south to Ok and ObS in the north. - A Holarctic species. Distributed in Northern Europe, through Russia to Alaska and Colorado in North America.

The species has been found breeding in small, sandy brinks and banks fully exposed to the sun. The entrance of the nests consists of a tube about six cm long, slightly declining. This merges into a single, slightly enlarged, larval chamber. Provision consists of third and fourth stage nymphs of Lygaeidae, e.g. Trapezonotus arenarius, Drymus sylvaticus and Rhyparochromus pini, of which at least six are deposited in each nest (author's observations from a nest not yet completely provisioned). The female spends the night in the still unfinished cell.

Genus *Dinetus* Panzer

Dinetus Panzer, 1806:192.

Type-species: Crabro pictus Fabricius, 1793.

Medium-sized species, which in habitus (Fig. 284) are similar both to Astatinae and Larrinae. Head large, in front view considerably broader than long. Inner orbits strongly diverging ventrally. Ocelli circular. Clypeus short, with characteristic emarginations and teeth in the anterior broder. Antennae filiform in females, inserted very low on face, just behind epistomal suture. Pronounced sexual dimorphism in morphology of antennae. Mandibles weakly tridentate, with strong emargination in ventral edge, which is proximally delimited by a strong, rounded projection (almost as in Tachysphex). Thorax dull, densely punctate, with weak, short, silvery pubescence. Pronotum, humeral tubercles, mesopleuron, scutellum and metanotum usually with whitish-yellow markings. Propodeal morphology and sculpture almost as in Tachysphex, dorsally without delimited area cordiformis. Abdomen with red and yellow pattern. Both sexes with pygidial area. Females with psammophore. Foretarsi with well developed pecten, strangely enough most strongly developed in males. Tibia 2 with two long apical spurs in females, lacking in males. Radial cell of forewings very short, truncate, with accessory cell

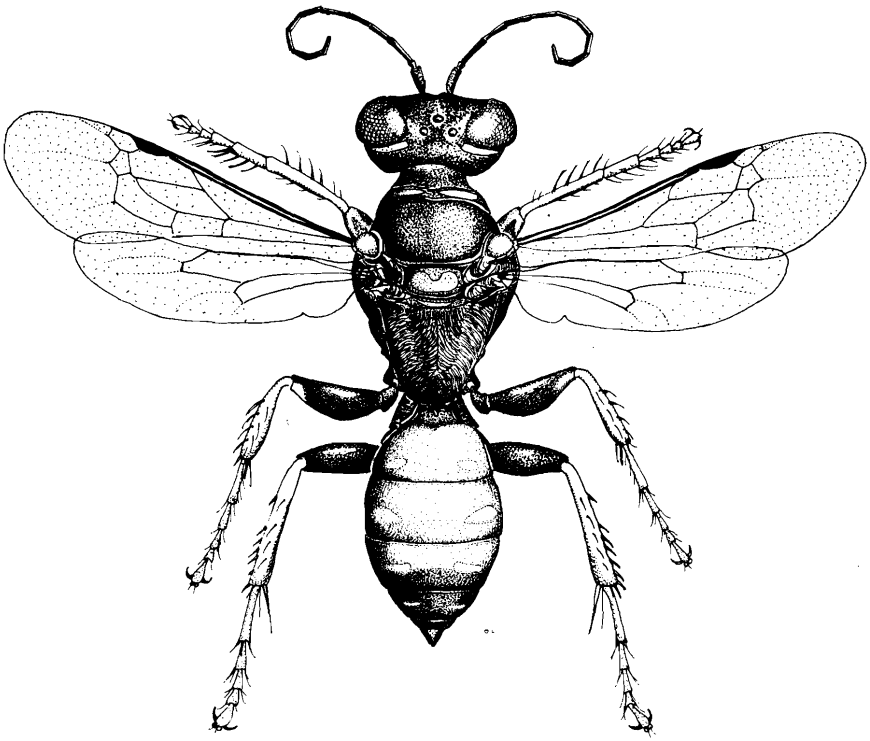


Fig. 284. Female of Dinetus pictus (Fabr.). Length: 6-8 mm.

(Fig. 284). Two cubital cells, of which the second is very small. First and second discoidal transverse veins join first and second cubital cells respectively. In hindwing media issues from anal cell.

The genus is mainly represented in the Mediterranean area, where about seven species occur.

The nest is constructed in the ground, larvae subsisting on Heteroptera, e.g. Nabidae.

92. DINETUS PICTUS (Fabricius, 1793)
Figs. 284-286.

Crabro pictus Fabricius, 1793:299.

Sphex guttata Fabricius, 1793:215.

Female: 6-8 mm. Frons very slightly convex, dorsally very densely punctate except an oblong, shiny area along upper part of inner orbits. Area behind antennal sockets also shiny and impunctate. Lower part of face and lateral faces of clypeus slightly concave, with silvery pubescence. Behind eyes a long yellow or yellow-brown spot. Mandibles yellow with red-brown apex. Antennae long and slender, third antennal segment three times as long as broad. Median area of clypeus shiny, slightly convex. Anterior border with two closely-placed median and two broader lateral teeth (Fig. 285). Pronotum with two white-yellow lateral spots. Scutum black, densely and strongly punctate. Humeral tubercle, and a spot immediately below, white-yellow. Scutellum and metathorax with a white-yellow transverse spot. Mesopleuron dull, very densely punctate, with microsculpture between punctures and with thin silvery pubescence. Propodeum dorsally with dense, obliquely directed striation on minutely reticulate ground, laterally with silvery pubescence. Lateral faces shiny, with stronger striation. First three segments of abdomen red-yellow. Terga 1-4 with small white-yellow lateral spots, tergum 5 with white-yellow transverse band. Pygidial area white-yellow with red-brown apex. Femora black, but femora 1-2 with large, white-yellow apical spot. Tibia white-yellow, black on the inner side. Tibiae 2-3 very spiny.

Male: 5-7 mm. Punctation of head and pubescence as in female, but a considerably more extensive yellow or red-yellow pattern, except for a black area on upper frons, and sometimes two black spots behind antennal sockets. Eyes very large and strongly convex. Flagellum rolled up as a spring (in museum specimens). Scapus very thick and stout, median antennal segments flat and broad, slightly concave ventrally and with distinct silvery pubescence. The last segments very long and thin (Fig. 286). Yellow transverse spot of

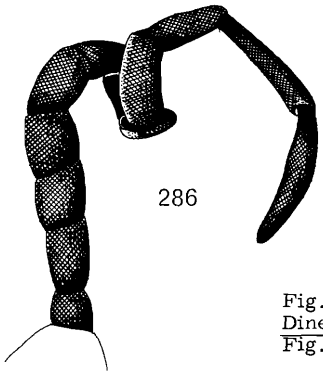
pronotum usually not interrupted in middle. Propleuron, humeral tubercle, a spot behind this, scutellum and metathorax with yellow pattern. Terga 1-3 brown-yellow with yellow transverse bands. Terga 4 and 5 black with yellow lateral spots. Legs yellow, femur 3 and also part of femur 2 black. Metatarsus 1 with very broad and strong spines.

In Fennoscandia only known from Finland: Sa, Taipalsjärvi, and a few localities in Soviet Karelia: Ib, Pyhäjärvi and Muola. A Mediterranean species, widely distributed in southern Europe.

The construction of the nest takes place almost as in Belomicrus, which also has developed a psammophore. By means of the well developed tarsal pecten a small heap of sand is scraped together. This heap is packed together in the psammophore, and by an unbelievably rapid manoeuvre backwards, the excavated material is carried away. It goes so quickly that this procedure cannot be shown sharply on a film, exposed in 1/5000 sec. (Olberg, 1959). The prey consists of nymphs and imagines of Nabis ferus and Aptus myrmecoides (Nabidae). As predator is known Hedychrum szaboi (Hym., Chrysididae).

SUBFAMILY LARRINAE

By far the largest and most diverse group of Sphecidae, probably comprising more than 3000 species. It is highly questionable, however, if the subfamily constitutes a monophyletic unity. Bohart & Menke (1975) consider the crabronine sphecids as making up a subfamily of their own in spite of the consequent injuries to the understanding of phylogeny as elucidated by Evans (1964) on the basis of larval morphology. The Larrinae is the most successful subfamily, having developed a large number of biological adaptations and displaying a



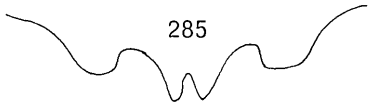


Fig. 285. Anterior margin of clypeus of female Dinetus pictus (Fabr.).
Fig. 286. Antenna of male Dinetus pictus (Fabr.).

rather enormous morphological variation. The subfamily has a cosmopolitan distribution, but most species inhabit tropical and subtropical areas in the Old World, and both terrestrial as well as arboreal nesting habits are displayed. The larvae are more or less cylindrical. Anus directed ventrally, the apical segment forming a rounded, terminal lobe. Pleural lobes prominent, those of thorax most protuberant. Integument often with small spinules on venter. The spiracles with or without a circlet of spines between atrium and subatrium. Head as wide as or wider than high. Parietal bands usually absent. Antennal papillae absent. Labrum broad, bearing sensillae over much of its surfase. Epipharynx spinulose. Mandibles stout, basally with a single, large seta; inner margin with four or five teeth. The lacinial area well developed, usually projecting as a lobe apically. Galea smaller than maxillary palpus, sometimes vestigial. Spinneret paired, much longer than the labial palpus.

The following combination of characters characterises the imagines of the Larrinae: mandibles with a large ventral emargination, proximally delimited by a stout tooth; only a single spur on tibia 2; volsella vestigial.

The Nordic genera are divided into the following tribes: Tachytini, Miscophini, Trypoxylonini, Oxybelini, and Crabronini. Beaumont (1964) included the Dinetini in this subfamily, but I have found it most appropriate to consider it as belonging to the Astatinae.

TRIBE TACHYTINI

Only a single genus in the North. See generic description. Terrestrial species.

Genus *Tachysphex* Kohl

Tachysphex Kohl, 1883:166.

Type-species: Tachysphex filicornis Kohl, 1883.

A genus extremely rich in species, sometimes most difficult to identify, but which in the North comprises only five species. Head short and rather flat, in front view slightly broader than long. Eyes very strongly convex, their inner orbits strongly diverging ventrally. Anterior ocellus circular, posterior ones strongly flattened and elongate. Clypeus behind anterior border usually with an elliptic, shining, smooth area, the remainder with dense silvery or golden pubescence, which also covers the lower part of the face. Antennae long and slender. Mandibles ventrally with strong emargination, basally delimited by a truncate tooth. Thorax stout, at least dorsally with short, dense, slightly silvery pubescence. Sculpture not forming protruding carinae or ribs.

Abdomen usually with more or less distinct silvery transverse bands. Tibia 2 with only one spur. Last tergum in female with pygidial area. Females with long, strongly developed tarsal pecten. Femur 1 of males ventrally with deep emargination. Forewings with three cubital cells, of which the second is joined by both discoidal transverse veins. Apex of radial cell squarely truncate. Stigma very narrow.

The genus is cosmopolitan and comprises more than 300 species, about 30 of which occur in Europe.

The nest is constructed in sandy localities fully exposed to the sun. The prey consists of Orthoptera, Saltatoria and Blattodea.

Key to species of Tachysphex

Females

1	Abdomen uniform black	2
-	First two or three segments of abdomen red	3

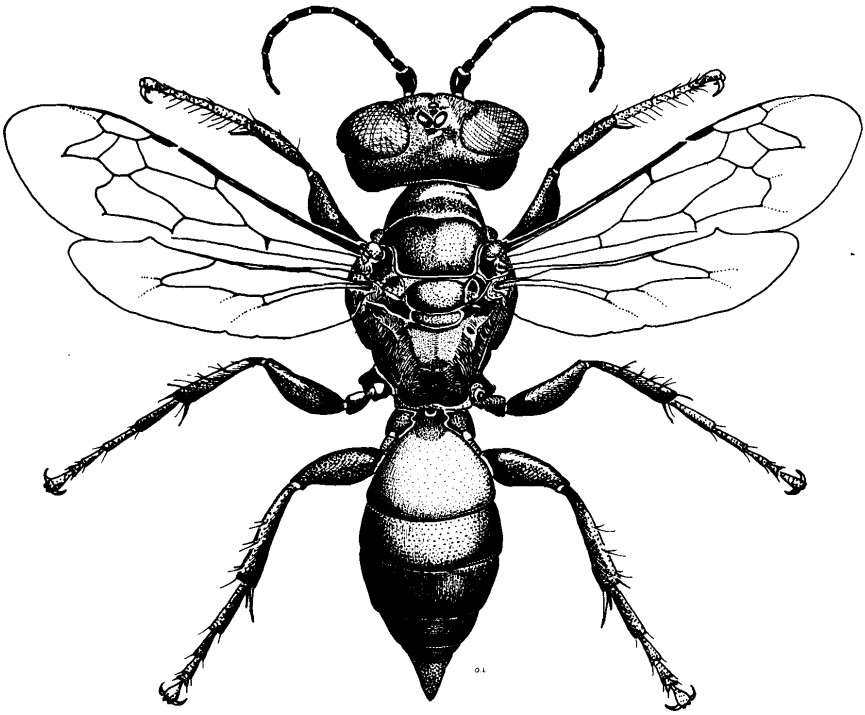


Fig. 287. Female of Tachysphex pompiliformis (Panzer). Length: 7-10 mm.

2(1) Least distance between eyes above on frons at least as great as length of third and fourth antennal segments combined. Clypeus slightly convex, its anterior border as Fig. 296 ..... 97. helveticus Kohl

- Least distance between eyes above on frons distinctly shorter than total length of third and fourth antennal segments. Clypeus strongly convex, anterior border not emarginate (Fig. 293) ..... 96. nitidus (Spinola)

3(2) Head in front view very broad (Fig. 288). Anterior border of clypeus in the middle with small emargination (Fig. 288). Tibia 1 red-yellow on inner side ..... 93. obscuripennis (Schenck)

- Head in front view almost circular (Fig. 289). Anterior border of clypeus without emargination. Tibia 1 completely black 4

4(3) Clypeus shallowly convex, its anterior border in the middle protruding almost angularly (Fig. 291). Pygidial area with very strong microsculpture ..... 95. fulvitarsis (Costa)

- Clypeus strongly convex, anterior border evenly and shallowly concave (Fig. 289). Pygidial area shining, microsculpture weak ..... 94. pompiliformis (Panzer)

Males

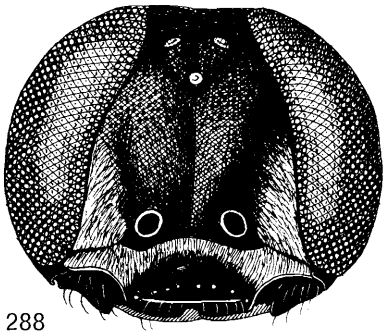
1 Abdomen entirely black 2

- First two or three segments of abdomen red ... 3

2(1) First and second segments of tarsus 1 distally with two strong, flattened spines, which are considerably longer than width of the tarsus (Fig. 299). Third and fourth antennal segments of almost equal length (Fig. 298) ..... 97. helveticus Kohl

- First and second segments of tarsus 1 with only a single short spine, much shorter than width of the tarsus. Third antennal segment much shorter than fourth (Fig. 295) ..... 96. nitidus (Spinola)

3(2) Inner side of tibia 1 red-yellow. Frons usually with strong dark golden pubescence ... 93. obscuripennis (Schenck)



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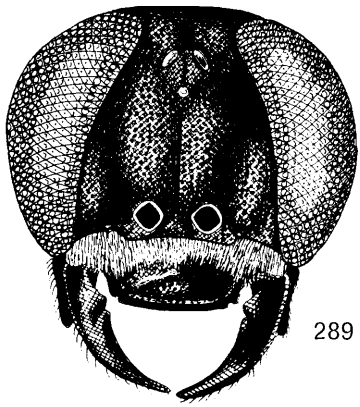

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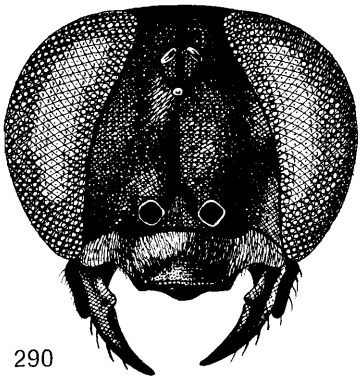

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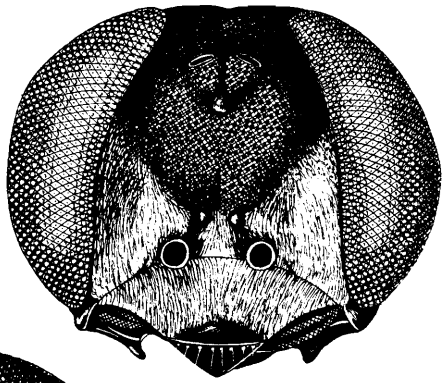

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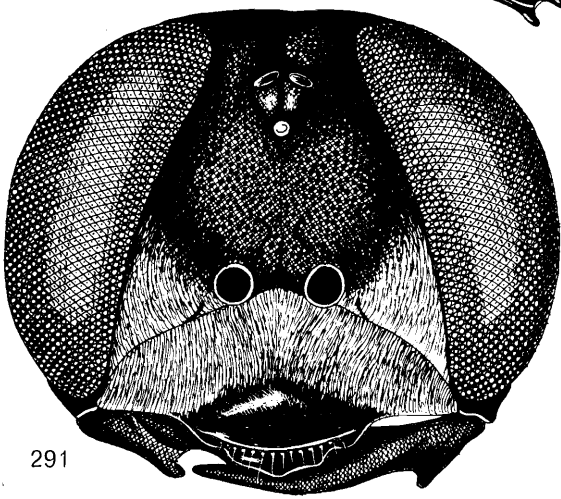

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Figs. 288-292. Heads in frontal view of Tachysphex.
288: obscuripennis (Schenck); ♀;
289: pompiliformis (Panz.), ♀;
290: same, ♂;
291: fulvitarsis (Costa), ♀;
292: same, ♂.

- Tibia 1 completely black. Pubescence of frons silvery 4

4 Mid-part of clypeus strongly protruding (Fig. 292) ..... 95. fulvitarsis (Costa)

- Mid-part of clypeus very slightly protruding, often only evenly convex (Fig. 290) ..... 94. pompiliformis (Panzer)

93. TACHYSPHEX OBSCURIPENNIS (Schenck, 1857)

Fig. 288.

Tachytes obscuripennis Schenck, 1857:194.

Tachysphex lativalvis Thomson, 1870:242.

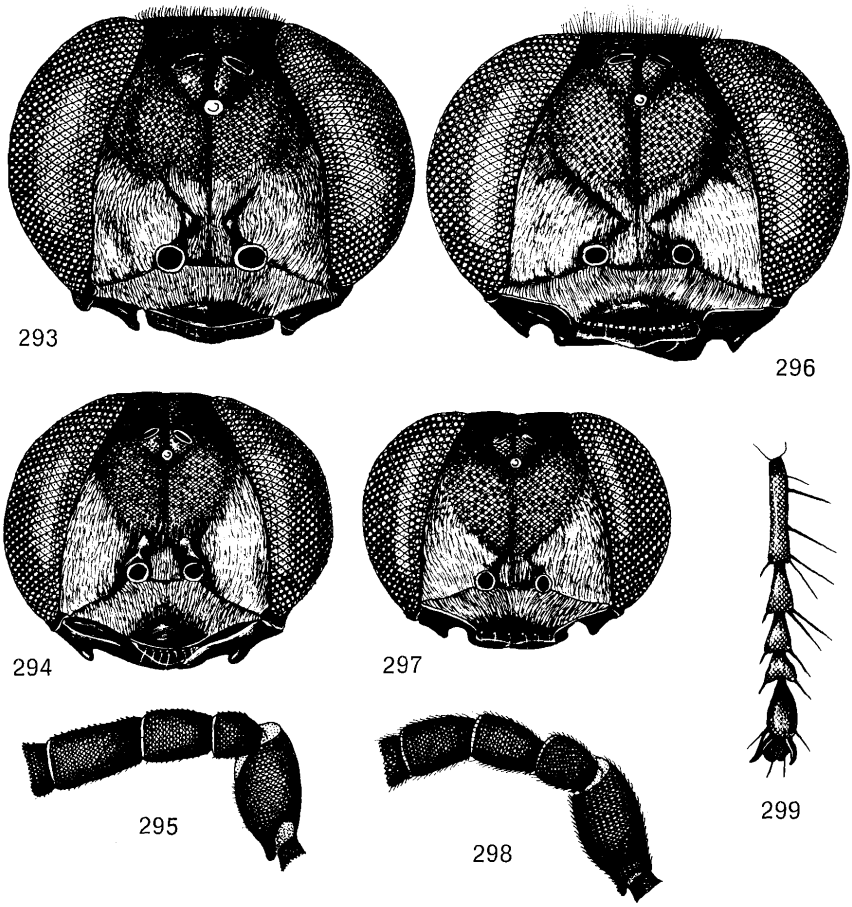
Female: 6-10 mm. Head in front view distinctly broader than long (Fig. 288). Punctation of frons fine and rather sparse, microsculpture well developed in northern material. Silvery pubescence on lower part of face generally less developed than in pompiliformis. Anterior border of clypeus in the middle with a small emargination (Fig. 288). Interstices between punctures on scutum shiny, on average as large as diameter of punctures. Mesopleuron shallowly punctate, with distinct interstitial microsculpture. First two, and often also basal half of third segment of abdomen red. Lateral margins of pygidial area slightly convex, surface itself shiny with scattered punctures and usually without microsculpture. Inner side of tibia 1 yellowish brown. Segment 4 of tarsus 1 and tarsus 2 considerably broader than long. Claws on tarsus 1 and to some extent also on tarsus 2 of unequal size, the mesal the smaller.

Male: 5.5 - 8 mm. Easily distinguishable from pompiliformis by the usually strongly golden, shining pubescence on clypeus and lower part of face. Head much broader than long. Inner orbits throughout their length distinctly diverging ventrally. Whole thorax dull. Pubescence dense, short, usually with a weak golden tinge, at least on scutum. First three segments of abdomen red, silvery transverse bands well developed. Tibia 1 brown-yellow on inner side. Tarsal segment 4 slightly broader than long.

In Fennoscandia this species is rather common in coastal regions in southern Sweden, especially in Sk. and the islands of Öl. and Gtl. Northernmost records in Boh. and Upl. - Finland: a southern and southeastern species, northwards to Sb and Kb. - Soviet Karelia: Ib and Kr. - Not uncommon i NW Africa and Asia Minor, eastwards to Caucasus.

The nest consists of a single cell, situated about 4 cm below the surface of the ground, at the end of a 5-6 cm long tunnel. The entrance is left open during

provisioning. The prey consists of cockroaches, e.g. Ectobius lapponicus or closely allied species, of which 2-3 specimens represent the provision of the larva. The prey is only slightly paralyzed, and before it is dragged into the nest its antennae, legs and palps, wholly or partly, are amputated. A similar behaviour is seen in Dolichurus corniculus. The egg is placed transversely between coxae 1 and 2. The larva was described by Grandi, 1961.



Figs. 293-295. Tachysphex nitidus (Spinola). - 293: female head in frontal view; 294: male head in frontal view; 295: proximal part of male antenna.
Figs. 296-299. Tachysphex helveticus Kohl. - 296: Female head in frontal view; 297: male head in frontal view; 298: proximal part of male antenna; 299: tarsus 1 of male.

94. TACHYSPHEX POMPILIFORMIS (Panzer, 1805)

Figs. 287, 289, 290.

Larra pompiliformis Panzer, 1805:H. 89, T. 13.

Tachytes nigripennis Spinola, 1808:260.

Tachysphex rufo-niger Bingham, 1897:195.

Tachysphex projectus Nurse, 1903:517.

Tachysphex pectinipes auctt.

Female: 7-10 mm. Head in front view almost circular (Fig. 289). Frons in front of ocelli very densely punctate, interstices shining, without microsculpture, much narrower than diameter of punctures. Punctation behind ocelli sparser. Clypeus strongly convex, anterior border evenly convex, only rarely with two weak emarginations (Fig. 289). Pubescence posteriorly on clypeus and on lower part of face strongly silvery. Mandibles black with red central part. Interstices between punctures on scutum shiny, distinctly smaller than diameter of punctures. Mesopleuron dull, with very fine and uniform sculpture. First two or three segments of abdomen red. Pygidial area narrowly triangular, margins straight or very slightly concave. Surface itself slightly convex, with sparse and rather superficial punctation. A fine, reticulate microsculpture is usually present proximally in the area. Legs black, only distal tarsal segments pale. Tarsi 1-2 have segment 4 longer than broad.

Male: 5-7 mm. Head in front view only very slightly wider than high (Fig. 290). Clypeus anteriorly with rounded, obtusely triangular projection. Lateral corners distinct, obtusely protruding (Fig. 290). In small individuals these characters are often very weak so that the anterior margin is almost evenly arcuate. Pubescence on clypeus and lower part of face silvery. Sculpture of head and thorax as described in female, but a little stronger. A weak microsculpture may be present. Pubescence dorsally on thorax sparse, slightly silvery. Three first segments of abdomen normally red, In very small specimens the red colour only covers segments 1 and 2. Legs black, distal tarsal segments, however, gradually paler. Segment 4 of tarsus 1 as long as wide.

A common species in all Nordic countries. Northern records in Sweden: Nb., Norway: On, and Finland: ObN. - The distribution area covers Europe, North Africa, through southern Siberia, Kashmir and Pakistan (?) to Mongolia and Kamchatka.

The nest is constructed in sandy areas, in slopes facing south-west, or in steep, sandy brinks. Entrance short, about 5 cm, larval chamber situated about 3 cm below ground. A female has been seen to have constructed three cells

connected to the same entrance (Adlerz, 1903). During excavation the female frequently undertakes short orientation trips, running on the ground and flying in immediate vicinity of the entrance. The prey consists of nymphs of Acrididae, e.g. Chorthippus and Stenobothrus, flown to the nest, if possible. Here it is deposited, while the female goes into the entrance and turns round. With the mandibles the nymph is pulled down into the cell, where it is placed with the ventral side upward. Each cell is provisioned with 1-10 nymphs, dependent on their size. The egg is laid on the last nymph between coxa 1 and 2. After a few days the young larva hatches, and after a week it is fully grown. Before the cocoon is spun, the inedible remainders are carried outside the cell. The outside of the cocoon is covered with sand grains. The larva was described by Grandi, 1961. The species occurs in Central and South Europe with two generations, and it is probable that similar conditions apply to the populations in the southern part of Denmark and Fennoscandia, since its active period lasts from the beginning of June to the middle of August.

95. TACHYSPHEX FULVITARSIS (Costa, 1867)

Figs. 291, 292.

Tachytes fulvitarsis Costa, 1867:86.

Tachysphex acrobates Kohl, 1878:705.

Female: 10-14 mm. Easily recognizable by its large size. Frons very densely and finely punctate, interstices shining smooth. Pubescence of face silvery. Clypeus posteriorly very finely and densely punctate, mixed with punctures bearing single, stout bristles. Anteriorly shining, smooth, with only large punctures. Anterior border itself almost angularly protruding (Fig. 291). Scutum with dense and uniform punctation. First two or three segments of abdomen red. The silvery transverse bands weakly developed or absent. Pygidial area large, with evenly distributed, strong punctation, which, especially basally, may fuse into a weak, longitudinally rugose punctation. Microsculpture almost missing in Nordic specimens. It is, however, strongly developed in specimens from South Europe. Tarsus 1 with very strongly developed tarsal pecten.

Male: 6-13 mm. Very similar to pompiliformis, but usually easily distinguished by the shape of clypeus (Fig. 292). Mesopleuron dull with very dense and distinct punctation. Interstices between punctures with microsculpture. Propodeum dorsally with irregular rugose sculpture on strongly microsculptured ground. Lateral faces shiny, with strong, dense and regular transverse striation. Tarsus 1 completely devoid of pecten. Femur 1 ventrally only with weak emargination.

A typical Mediterranean species. Only a few records from Sweden: Sk., Löderup, Sandhammaren; Öl., Hornsjön, Algutsrum. Not found in other Nordic countries. - The distribution area covers large parts of Europe, North Africa, Asia Minor, Southern Siberia and Iran.

The nest contains a single cell, which is provisioned with nymphs of Tettigoniidae. The egg is attached to the ventral side of the prey and hatches after about 48 hours.

96. TACHYSPHEX NITIDUS (Spinola, 1805)

Figs. 293-295.

Astata nitida Spinola, 1805:17.

Tachysphex ibericus borealis Pulawski, 1971:148.

Female: 7-10 mm. Completely black. Head in front view only slightly broader than high (Fig. 293). Punctation in front of ocelli dense, interstices on average smaller than diameter of punctures, shiny, usually without microsculpture. Punctation posteriorly between eyes distinctly weaker, interstices broad, shining, smooth. A weak micropunctation may occur. Pubescence on frons very short. Distance between eyes above on frons distinctly less than total length of antennal segments 3 and 4. Mandibles black, often with rust-coloured apex. Clypeus strongly convex in middle, outline of anterior margin somewhat variable, but never with distinct emarginations on either side of midline as in helveticus. Punctation on scutum almost as punctation behind ocelli, interstices shining, smooth, on the disc broader than diameter of punctures. Punctation of scutellum finer. Punctation of mesopleuron almost obsolete, only distinct laterally below base of forewings. Propodeum dorsally with coarse and granular microsculpture, basally with more or less distinct longitudinal rugae. Lateral areas somewhat more shining, with distinct transverse striation. Abdomen with four silvery transverse bands. Pygidial area shiny, proximally with weak microsculpture.

Male: 4-6 mm. Head in front view slightly broader than high (Fig. 294). Clypeus anteriorly with a more or less rounded triangular projection, posteriorly with a slightly golden or rarely silvery pubescence, which also covers lower part of face. Mandibles black with red-yellow middle and red apex. Sculpture of head and thorax as in female. Sculpture of propodeum rather uniform, granular. In large specimens a weak striation may occur laterally and caudally. Pecten on tarsus 1 very weak, its spines seldom longer than width of tarsal segments.

A common species in Fennoscandia and Denmark, especially in coastal localitites and along rivers. Northern distribution limit in Sweden in Nb. - Not recorded from Norway. - Finland: Ks and ObN. - Soviet Karelia: Ib. - The species is widely distributed in western Palaearctic, eastwards to the South-Siberian steppes in Uzbekistan and southwards to North Africa.

Construction of the nest takes place in sandy localities in June and July. The main entrance may reach a length of more than 30 cm. It forms a very acute angle with the surface of the ground, in such way that the single larval chamber is situated at a depth of about 3 cm. The prey consists of nymphs of locusts (Acrididae), which, depending on their size, are flown or dragged to the entrance of the nest. Here it is left for a period, while the female turns in the nest tunnel. Then she pulls the prey down after her. The larval chamber is provisioned with about five nymphs. The elongate, slightly curved egg is laid between first and second pair of legs on the nymph first paralyzed. It is stated (Bonelli, 1969) that a single female may construct several nests simultaneously. Taxigramma sp. (Dipt., Sarcophagidae) is recorded as parasitoid.

97. TACHYSPHEX HELVETICUS Kohl, 1885

Figs. 296-299.

Tachysphex helveticus Kohl, 1885:374.

Female: 7-9 mm. In habitus this species is very similar to nitidus, but the head in front view much broader than high (Fig. 296). Frons anterior to ocelli with moderately strong punctation, interstices with a very distinct and granular microsculpture, whereby the face obtains a dull appearance. Punctation behind ocelli stronger, and interstices more shiny. Pubescence of head longer than in nitidus. Uppermost distance between inner orbits as great as or greater than combined length of third and fourth antennal segments. Mandibles black. Clypeus slightly convex, the shiny area proximal to the weakly double-emarginate frontal margin (Fig. 296) considerably narrower than in nitidus. Scutum shiny. Punctation much denser than on frons behind ocelli. Interstices between punctures smaller than diameter of these. Scutellum likewise very densely punctate. Mesopleuron shiny, punctation a little weaker and sparser than on scutum. Propodeum as in nitidus, but usually with slightly protruding irregular, longitudinal ribs. Legs, except the most distal tarsal segments, black.

Male: 5-7 mm. Head in front view very broad (Fig. 297). Clypeus on either side with a small rounded tubercle or slightly protruding corner. Pubescence silvery. Punctation of head and thorax as in female. Propodeum

dorsally often with distinct longitudinal ribs with shining interstices. Metatarsus 1 with four long, pale spines, tarsal segments 2 and 3 with two and one pale spine, respectively (Fig. 299).

A south-eastern element in the Fennoscandian fauna. Only known from Sweden: Bl., Gtl., Ög., Boh. and Sdm.; and Finland: Al (very common), Ab, N and Ka. - The species is not recorded from England and North Germany. - Distributed in Europe, North Africa, through Jordan to southern Siberia and Mongolia.

The nests are constructed in sand. During excavation the forelegs are used to remove the fine material, whereas the mandibles are employed when removing pebbles and the like. Only one cell is constructed per entrance. The prey consists of nymphs of Acrididae, of which four or five are deposited in each cell. The egg is laid on one of the first deposited nymphs between coxae 1 and 2. The female seals the nest by gradually working her way out through the tunnel, while brushing sand together behind her. The abdomen is used to pack the material together.

TRIBE MISCOPHINI

Inner orbits parallel or diverging ventrally. Ocelli normal. Antennae inserted immediately above epistomal suture, often in large concavities. Mandible with large emargination and tooth in Miscophus and several other genera. In Nitela, the taxonomical status of which is doubtful, the mandible is simple. Tarsus 1 in females with spines in Miscophus; these are absent in Nitela (arboreal). Propodeum large, area cordiformis usually absent. Venation very variable: in Nordic Miscophus the forewings have two cubital cells of which the second is petiolate. In Nitela only a single cubital cell is present. Pygidial area absent in Nordic species. Volsellae vestigial or absent.

According to the concept of Bohart & Menke (1975) the tribe comprises 14 genera, most of which are endemic to southern Africa or Australia. Only three genera in Europe.

Genus *Miscophus* Jurine

Miscophus Jurine, 1807:206.

Type-species: Miscophus bicolor Jurine, 1807.

Small, black, often more or less metallic species (Fig. 300), easily recognizable by petiolate second cubital cell of forewings. Stigma very narrow, some-

times almost vestigial. First and second discoidal transverse veins join first and second cubital cells respectively. Head comparatively large, in front view considerably broader than high. Base of mandibles with strong emargination, proximally delimited by a strong tooth. Propodeum large, dorsal face usually with a distinct longitudinal median carina and more or less distinct oblique rugae. In Nordic species lateral faces with weak, irregular, longitudinal rugulae, which continue on the posterior face. Punctation usually very fine and sparse.

The species, especially the males, may vary considerably, and to make a reliable identification of certain species, it is often necessary to make preparations of the genital organs, which show good specific characters.

As regards the biology, only few fragmentary particulars exist, since the small size of the species and their agility in connection with their rather sporadic occurrence, make investigation difficult. The species occur in sandy areas. Here the nest is constructed in the form of a tube, a few cm long. The prey consists of small spiders. The genus comprises more than 80 species in the Palaearctic region.

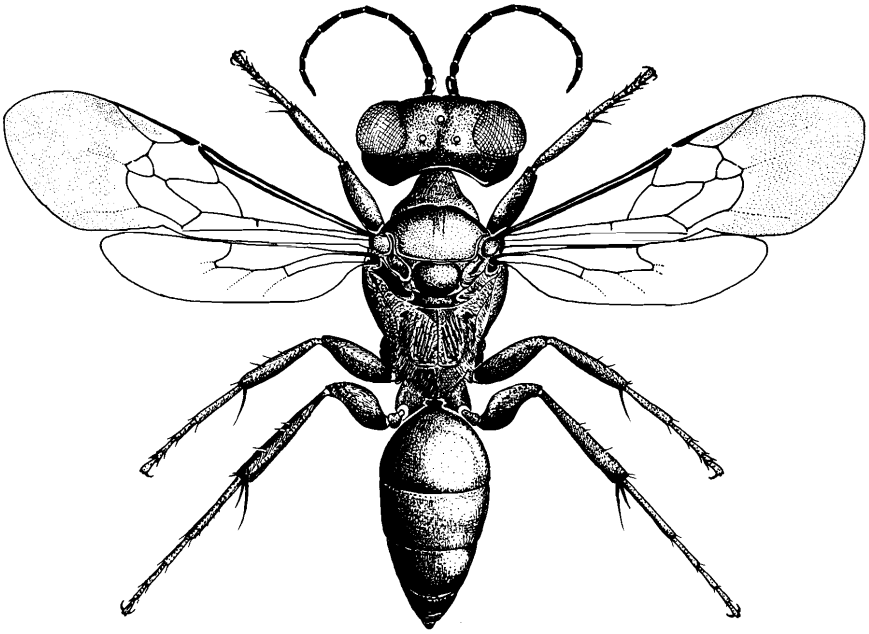


Fig. 300. Female of Miscophus ater Lep. Length: 3.7-5.0 mm.

Key to species of Miscophus

Females

1 First segment of abdomen, and partly also second, red ..... 98. concolor Dahlbom

\- Abdomen completely black 2

2(1) Pubescence on lateral faces of propodeum very fine. Hairs neither depressed nor silvery. The broad and somewhat depressed posterior border of terga 2-4 without pubescence or punctures 99. spurius (Dahlbom)

\- Pubescence on lateral faces of propodeum silvery. Terga 2-4 with very fine punctures on posterior borders, with fine but distinct pubescence 3

3(2) Basal part of mandibles mainly red-brown or red-yellow, never uniformly black. Punctation of scutum weak, punctures anteriorly distinctly delimited, posteriorly merging evenly into the shining interstices. Head, pronotum, scutum, scutellum and metanotum with faint greenish or bronzy tinge ..... 100. ater Lepeletier

\- Basal part of mandibles usually completely black or brown-black, never mixed with red or red-yellow. Scutum with regular, well-defined punctures. Head and thorax black, without metallic lustre ..... 101. niger Dahlbom

Males

1 Pubescence on lateral faces of propodeum very fine. Hairs neither depressed, nor silvery. Mid-rib dorsally on propodeum strong, longitudinal rugae regular, without transverse connections. 99. spurius (Dahlbom)

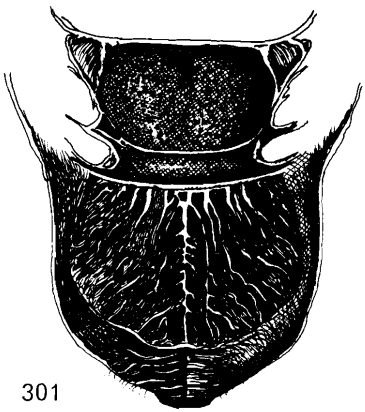
\- Pubescence on lateral faces of propodeum partly consisting of fine, light hairs, partly of depressed silvery hairs 2

2(1) Interstices between punctures of frons shiny, with or without very weak microsculpture. Distance between punctures round ocelli as great as or greater than diameter of punctures 98. concolor Dahlbom

- Interstices between punctures of frons either with strong microsculpture or with fine irregular rugulae, whereby frons has a coriaceous appearance. Distance between punctures round ocelli smaller than diameter of punctures 3

3(2) Basal part of mandibles usually completely black. Sculpture of scutum consisting of regular, well-defined punctures. Genitalia: see Fig. 307 101. niger Dahlbom

- Basal part of mandibles more or less extensively pale. Punctures of scutum weak, posteriorly indistinctly delimited. Genitalia: see Fig. 306 100. ater Lepeletier



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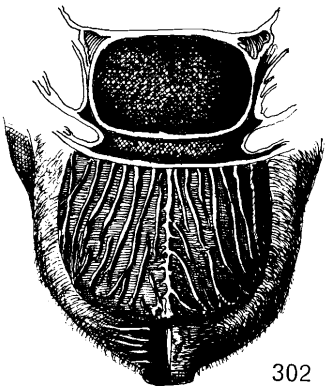

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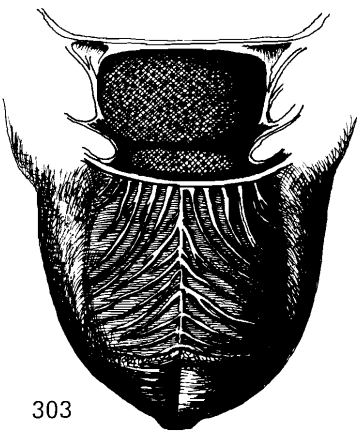


303

Figs. 301-303. Propodeum in dorsal view of female Miscophus. - 301, 302: ater Lep.; 303: spurius (Dahlbom).

98. MISCOPHUS CONCOLOR Dahlbom, 1844

Fig. 304.

Miscophus concolor Dahlbom, 1844:236.

Miscophus bicolor Smith, 1858:91.

Miscophus moravicus Balthasar, 1957:109.

Female: 4-5 mm. Easily distinguished from the remaining Nordic species by red base of abdomen. Head with very dense punctures. Interstices with fairly strong microsculpture, consisting of irregular rugulae. Clypeus strongly convex in middle and rather densely punctate. Silvery pubescence on clypeus and lower part of face very thin, hairs only very slightly depressed. Basal tooth of mandibles very strong, mandible itself yellow-brown centrally, apex red and base brown. Scutum with weak punctures which tend to coalesce transversely. Propodeum dorsally rather strongly excavated. Median carina stout. Pubescence laterally very thin and sparse.

Male: 3,3 - 4,0 mm. As female, abdomen usually completely black. Occasional specimens have sternum 1 slightly reddish laterally. Genitalia as Fig. 304.

Denmark: not uncommon in NEZ. Otherwise scattered throughout the country. - Sweden: rather common along the south coasts of Sk., northernmost localities in Sdm. - Not found in Norway. - Finland: a southern and southeastern species occurring towards the north to Om and Ok. - Soviet Karelia: Ib and Kr. - Scattered in Europe.

Occur in very warm, sandy localities, both near the coast and inland. Hunting takes place in vegetation. The paralyzed spiders are flown to the entrance of the nest. The species may occur, at least locally, in rather large numbers.

99. MISCOPHUS SPURIUS (Dahlbom, 1832)

Figs. 303, 305.

Larra spurius Dahlbom, 1832:56; Dahlbom, 1844:237.

Female: 4.2 - 6.5 mm. Entirely black. Sculpture of frons partly consisting of a rather dense punctation, partly of a strong, granulate microsculpture, whereby the surface obtains a dull appearance. Clypeus laterally densely and finely punctate, centrally shining, with larger and more scattered punctures. The bristle-bearing punctures along the apical margin very large and well developed. Apical margin itself evenly convexly arcuate. Mandibles red-brown with darker

apex and black base. Scutum rather strongly punctate with distinct transverse or reticulate microsculpture. Longitudinal medial carina in area cordiformis well developed. Oblique rugae almost regular (Fig. 303). Pubescence laterally extremely fine and sparse, without any silvery tinge. Mesopleuron anterior to coxa 2 without distinct reticulate microsculpture. Terga shining, smooth; sterna with microsculpture.

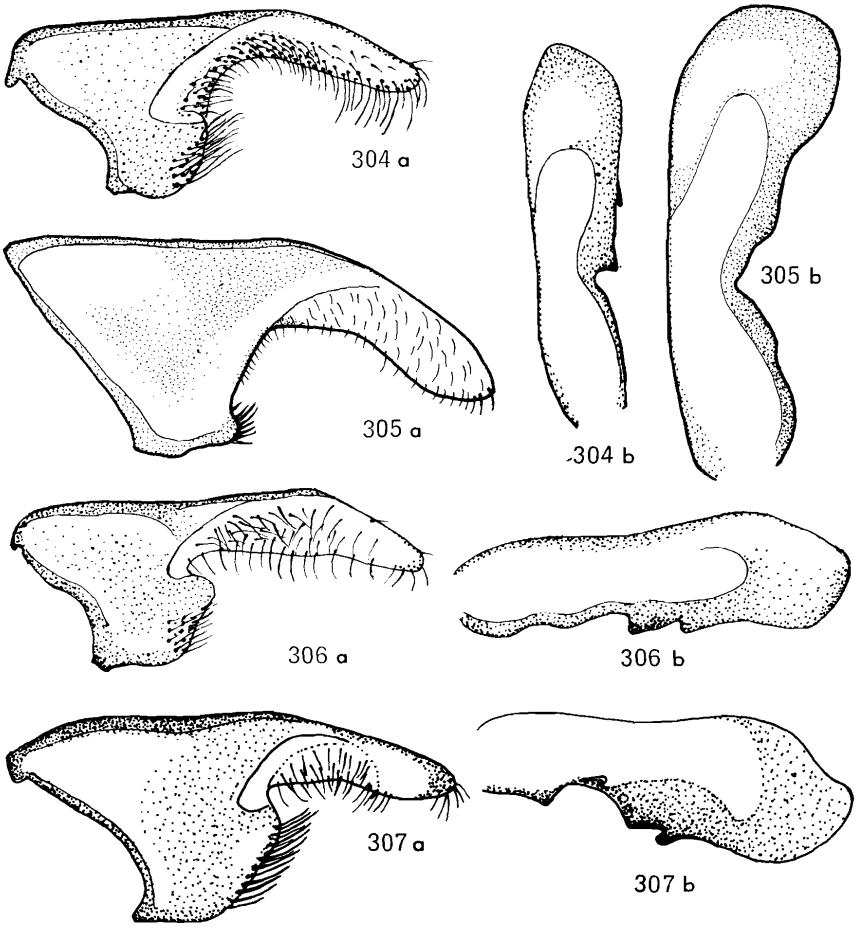


Fig. 304-307. Sclerites of male genitalia of Miscophus. - 304: concolor Dahlbom; 305: spurius (Dahlbom); 306: ater Lep.; 307: niger Dahlbom; a: paramere, b: aedeagus.

Male: 3.5 - 4.5 mm. Like female, but punctation on average weaker and the microsculpture absent except from frons. Mesopleuron shining, smooth, with rather sparse punctation. Genitalia as Fig. 305.

Widespread in Fennoscandia and Denmark, but a rather local species. - Denmark: small material from EJ, NEJ, LFM and NEZ. - Sweden: from Sk., Öl. and Gtl. to Gstr. and Med. - Not recorded from Norway. - Finland: like the preceding species it has a southern and south-eastern distribution. Northernmost records are from ObS. - Soviet Karelia: Ib and Kr. - Scattered occurrence in northern and eastern Europe.

100. MISCOPHUS ATER Lepeletier, 1845

Figs. 300-302, 306.

Miscophus ater Lepeletier, 1845:238.

Miscophus maritimus Smith, 1858:91.

Female: 3.7 - 5.0 mm. Head, pronotum, scutum, scutellum and metanotum often with a faint greenish or bronzy tinge. Mandibles mainly red-yellow or red-brown, only black near articulations. Posterior face of head and genae very indistinctly and superficially punctate. Punctation of pronotum and scutum slightly stronger, but not distinct. Only when scutum is viewed at a slight angle from behind, with the light coming horizontally from in front, are the individual punctures visible. Sculpture of mesopleuron likewise weak and indistinct. Sculpture of the somewhat swollen area just ventral to the base of forewings does not differ distinctly from the punctation of the remaining part of mesopleuron. Lateral faces of propodeum usually with regular, transverse striation. Pubescence, especially posteriorly, distinctly silvery, the hairs slightly depressed. Sculpture on dorsal face of propodeum extremely variable (Figs. 301, 302).

Male: 3.7 - 4.6 mm. Differs from female by the following characters. The weak metallic tinge considerably less pronounced, often completely missing. Anterior face of head distinctly and densely punctate, with only very weak interstitial microsculpture. Punctation on lateral faces of mesopleuron somewhat more regular. The shining swelling below base of forewings with very fine and scattered punctation. Genitalia as Fig. 306.

The species occurs in large numbers in several localities in Denmark, especially along the west coast of Jutland and on the island of Læsø in the Kattegat. - Sweden: common on the southern coasts of Sk. and on northern Öland. - Not recorded from Norway. - Finland: scattered occurrence along the

southern and north-western coasts. - Soviet Karelia: Ib. - The species is recorded from most European countries and seems to occur rather frequently along the southern coasts of England and on the Friesian Islands.

101. MISCOPHUS NIGER Dahlbom, 1844

Fig. 307.

Miscophus niger Dahlbom, 1844:236.

Close to spurius as well as to ater. It is absolutely necessary to have material for comparison during identification.

Female: 3.8 - 5.6 mm. Head and thorax only rarely with weak metallic lustre. Midpart of mandibles red-brown, base up to the tooth ventrally usually completely black. Punctation on scutum as in spurius, consisting of well-defined punctures. Central carina dorsally on propodeum very indistinct or quite missing. Pubescence on lateral faces of propodeum as in ater, depressed and silvery.

Male: 2.8 - 5 mm. Besides the characters mentioned in the key, characterized by the morphology of the genitalia (Fig. 307).

This species seems to have a pronounced eastern occurrence in Fennoscandia and is apparently absent from both Denmark and Norway. - Sweden: Sk., Löderup, Sandhammaren; Gtl.; G.Sand.; Ög. and Sdm. - Finland: widely distributed from Al, Ab, N and Ka in the south to Ok and ObN in the north. - Soviet Karelia: Ib and Kr. - Scattered throughout Europe.

Genus *Nitela* Latreille

Nitela Latreille, 1809:77.

Type-species: Nitela spinolae Latreille, 1809.

Small, black species (Fig. 308). Head in front view slightly broader than high. Inner orbits diverging ventrally. Lower part of face with strong concavity on either side, covered with silvery pubescence. Clypeus narrow, with sharply projecting longitudinal keel. Antennae inserted very low on face. Mandibles bidentate in female, simply pointed in males. Pronotum on either side with a broad, deeply depressed furrow, between which is found an acutely triangular area. Distance between humeral tubercle and tegula very small. Thorax depressed. Scutum with short oblique rugae near posterior border. Propodeum large, with strong, usually reticulate sculpture. Abdomen shining, smooth, last tergum in females without pygidial area. Legs long and slender, without

spines. Tibia 2 with a single apical spur. Forewings slightly fuscous, with only one discoidal and cubital cell. Distal half of anal vein only indicated. In hindwing the veins are strongly reduced, only radius and first anal vein are sclerotized.

The genus is widely distributed and represented in the Holarctic (c. 10 species), Neotropical (c. 2 species), Ethiopian (c. 10 species), Oriental (c. 4 species), and Australian regions (7 species).

The species use hollow plant stems, abandoned larval tunnels of xylophagous insects and the like for constructing the nests. The prey consists of nymphs of Psocidae and Aphididae.

Key to species of Nitela

1 Terga 1 and 2 with extremely weak, sparse punctation. Propodeum with coarse, reticulate sculpture with shiny, very weakly sculptured interstices. Male: anterior border of clypeus as fig. 309 ..... 102. borealis Valkeila

\- Terga 1 and 2 with distinct and rather dense punctation. Propodeum with fine, reticulate sculpture, interstices rather dull, with distinct microsculpture. Male: anterior border of clypeus as fig. 311 ..... 103. spinolae Latreille

102. NITELA BOREALIS Valkeila, 1974

Figs. 308-310.

Nitela borealis Valkeila, 1974:75

Nitela spinolae Dahlbom, 1845, p.p.

Female and male: 3.5 - 4 mm. Frons shining, with fine, dense punctation. Punctures partly coalescing, so that the interstices form weak, longitudinal rugulae. Anterior border of clypeus with three indistinct lobes in female, in male the lobes are considerably more pronounced (Fig. 309). Dorsal to the horizontally running, coarsely pitted furrow the mesopleuron is shining, smooth, with or without very weak reticulate microsculpture. Propodeum, especially in female, coarsely, reticulately sculptured, with smooth interstices. Terga 1 and 2 with extremely weak, sparse punctation. Male genitalia, Fig. 310.

The species is rare, but probably overlooked. In Sweden and Finland it occurs locally in rather large numbers. A few specimens from Denmark: EJ, NEZ. - Norway: AK. - Northern limit in Sweden in Vb. and in Finland in Sb. - Soviet Karelia: Ib and Kr. - Scattered occurrence in Europe.

The species is usually met with on trunks, fencing posts and wooden houses, fully exposed to the sun. The nests are found in abandoned insect tunnels (e.g. Ernobius sp., Coleoptera, Anobiidae). Hollow plant stems (e.g. Rubus idaeus Chamaenerion angustifolium and Urtica dioica) may also be used (Valkeila, 1955). The number of cells is stated to vary from one to five. The partition between the cells is made of fine plant material. The adult larva was described by Valkeila, 1955. The prey consists of nymphs of Psocidae, of which each cell may contain up to 30 specimens. Eurytoma rubicola (Hym., Eurytomidae) has been found as parasite.

103. NITELA SPINOLAE Latreille, 1809

Figs. 311, 312.

Nitela spinolae Latreille, 1809:77.

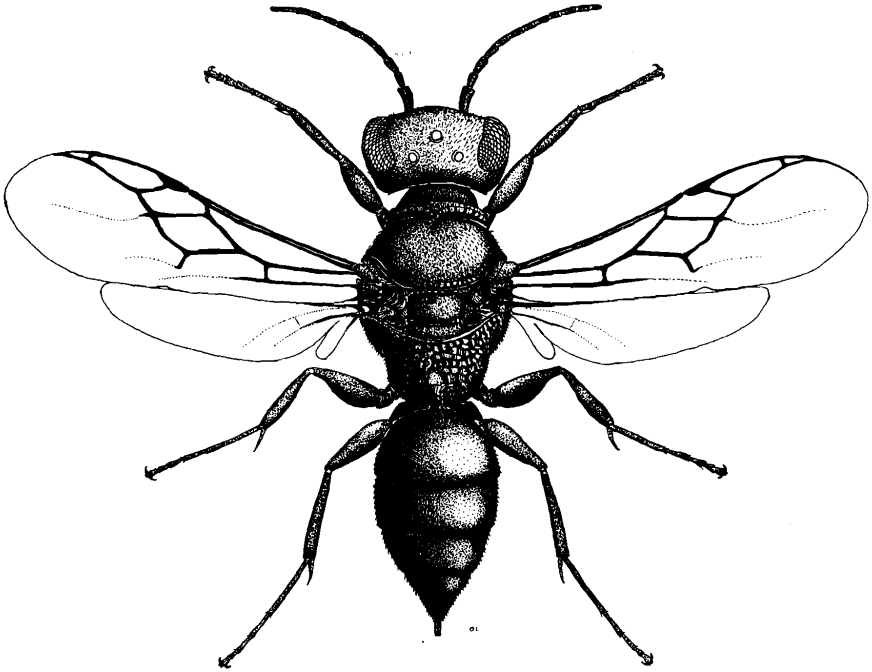
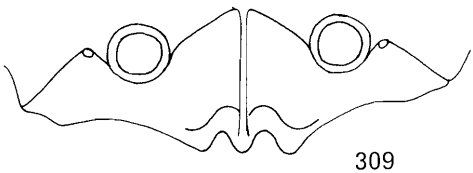


Fig.308. Female of Nitela borealis Valkeila. Length: 3.5-4.0 mm.

Female and male: 3-4 mm. Close to the preceding species, with which it was long confused (Valkeila, 1974). Can be separated by the characters mentioned in the key. Male genitalia, Fig. 312.

Nitela spinolae seems to have a more southern distribution in Europe. In Fennoscandia it has only been found in Sweden: Sk., Bl., Öl., Gtl., Ög., Vg., Nrk., Vstm. and Upl. Northernmost findings in Dlr.

The habits of this species are similar to those of the preceding one, but the prey consists of both Psocidae and Aphididae. The larva was described by Janvier, 1962.



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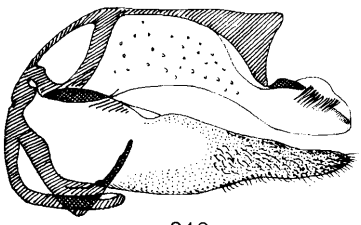

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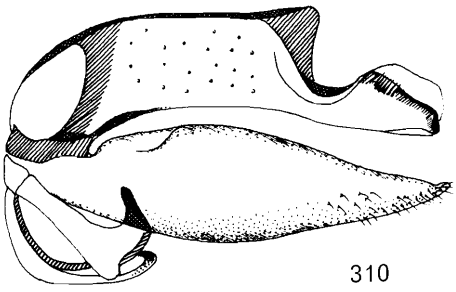

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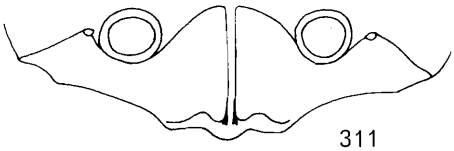

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Figs. 309, 310. Nitela borealis Valkeila. - 309: clypeus of male; 310: male genitalia in lateral view.
Figs. 311, 312. Nitela spinolae Latr. - 311: clypeus of male; 312: male genitalia in lateral view.
309 and 311 redrawn after Valkeila, 1974.

TRIBE TRYPOXYLONINI

Only a single genus in the North. See generic description. Several species use wet clay as building material.

Genus *Trypoxylon* Latreille

Trypoxylon Latreille, 1802:338.

Type-species: Sphex figulus Linné, 1758.

The genus is easily recognizable by the very elongate habitus and deep V-shaped emargination in the inner orbits. Body entirely black in Nordic species. Head in front view considerably narrowing ventrally. Clypeus large, with silvery pubescence. Antennae long, slightly dilated distally in females, considerably in males. Scapus short and thick, only slightly longer than broad. Eyes strongly convex. Ommatids of very varying size, the forwardly directed ones near antennal sockets several times larger than those placed dorsally in the eye. Thorax elongate, usually dull, but without actual sculpture. Propodeum dorsally with indistinctly delimited area cordiformis, whose sculpture is usually radiately striate. Forelegs comparatively short, metatarsus 1 without pecten. Tibia 2 with a single apical spur. Radial cell of forewings very long, almost reaching apex of wings. One cubital and one discoidal cell. Hamuli in two well separated groups. Females without pygidial area. Last antennal segments of males thickened, distal segment slightly hook-shaped apically.

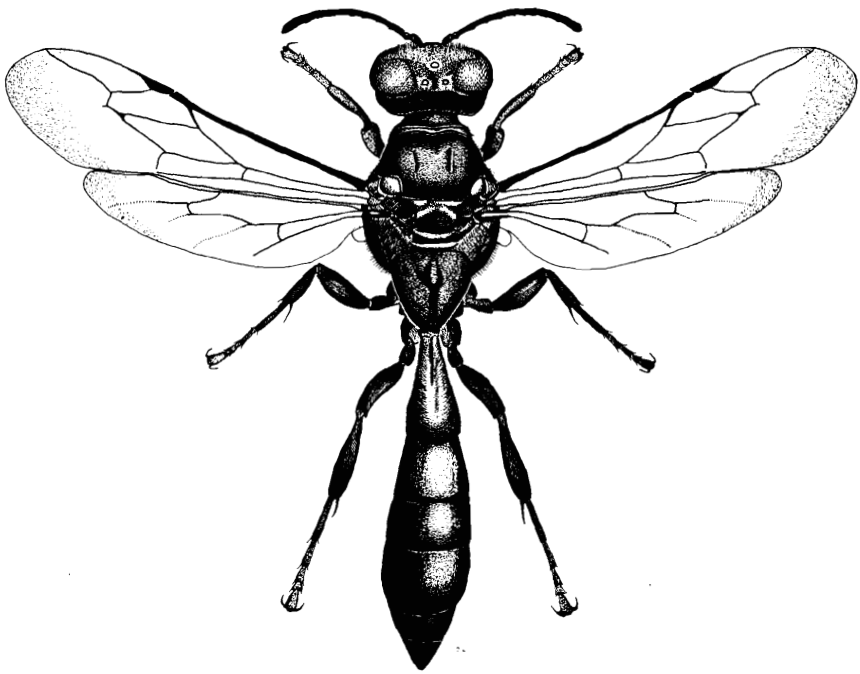


Fig. 313. Female of Trypoxylon figulus (L.). Length: 8-12 mm.

The genus is cosmopolitan, comprising a large number of species, of which many are tropical. Eight species in Europe. The Palaearctic species are found breeding in hollow plant stems, abandoned insect tunnels in dry wood and the like. The prey consists of spiders. The partitions between the cells, and also the final nest closure, are made of clay.

Key to species of Trypoxylon

1 Tibia 1 and tarsus 1 completely or partly brown-yellow. Mandibles mainly brown-yellow or red-yellow.
Female: head in front view, fig. 314.
Male: distal segment of antennae short, at most twice as long as broad. Apex not, or only slightly, directed outward (Fig. 319) ..... 104. clavicerum Lepeletier

\- Foreleg all black. Basal part of mandibles black 2

2(1) Smallest distance between eyes below antennal sockets considerably smaller than distance between eyes just behind ocelli (Fig. 315). First abdominal segment very long (Fig. 317). Anterior border of clypeus with two rounded teeth. Male: last antennal segment very long (Fig. 320) ..... 105. attenuatum Smith

\- Smallest distance between eyes below antennal sockets equal to distance between eyes just behind ocelli (Fig. 316). First abdominal segment at most 2.5 times longer than broad (Fig. 318). Clypeus without teeth, at most with weakly arcuately incised emarginate anterior border. Male: last antennal segment, fig. 321 ..... 106. figulus (Linné)

104. TRYPOXYLON CLAVICERUM Lepeletier, 1825

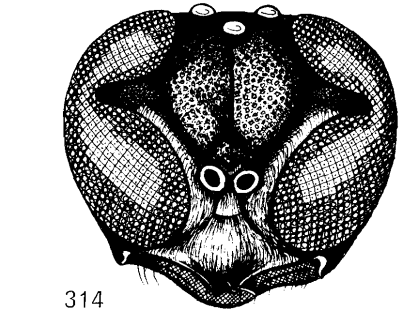
Figs. 314, 319.

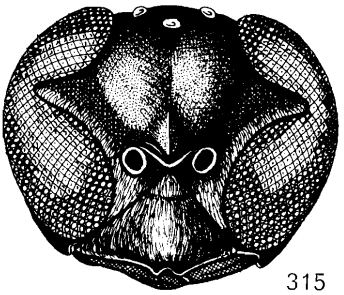
Trypoxylon clavicerum Lepeletier, 1825:750.

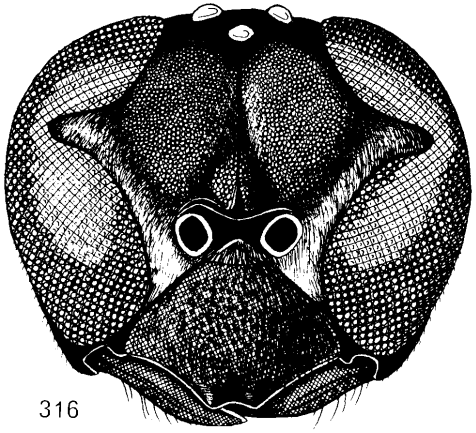
Female: 7-10 mm, male: 6-8 mm. Easily recognizable by the light yellow-brown colour on tibia 1 and tarsus 1. Head ventrally strongly narrowed (Fig. 314). Scutum dull, finely and densely punctate, with distinct microsculpture. Lateral faces of mesopleuron shiny with very fine, sparse punctures; micro-

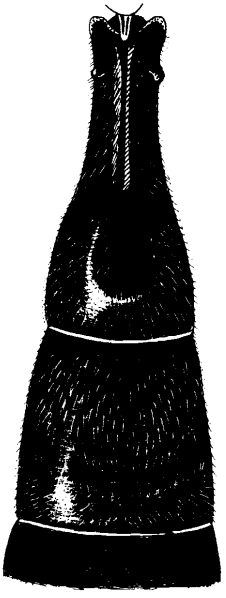
sculpture effaced. Lateral faces of propodeum shiny, impunctate, only upper part finely and densely striate.

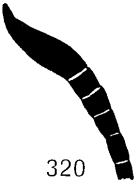
Not quite so common as figulus, but may locally occur in very large num-











Figs. 314-316. Heads in frontal view of female Trypoxylon. - 314: clavicerum Lep.; 315: attenuatum Smith; 316: figulus (L.).
Figs. 317, 318. Base of abdomen of female Trypoxylon. - 317: attenuatum Smith; 318: figulus (L.).
Figs. 319-321. Distal part of antennae of male Trypoxylon. - 319: clavicerum Lep.; 320: attenuatum Smith; 321: figulus (L.).

bers. - Denmark: not found in WJ. - Sweden: distributed northwards to Jmt. - Norway: sporadic, mainly in the southern and south-eastern districts; northernmost records from SFi. - Finland: not common, occurring mainly in the southern districts; northernmost record from Kb. - Widely distributed in Europe and further through Asia to Japan.

The nests are constructed in abandoned insect tunnels in dry wood, hollow plant stems (Phragmites) or stems of Artemisia vulgaris gnawed by the tortricid moth, Epiblema foenella. The cells are provisioned with small spiders, e. g. of the genera Epeira, Linyphia and Tetragnatha. As parasitoids are known Ephialtes manifestator L. (Hym., Ichneumonidae), Omalus pusillus Fabr. (Hym., Chrysididae) and Pachyophthalmus signatus Meig. (Dipt., Sarcophagidae).

105. TRYPOXYLON ATTENUATUM Smith, 1851

Figs. 315, 317, 320.

Trypoxylon attenuatum Smith, 1851:120.

Female: 7-10 mm, male 7-9 mm. Completely black. Mesopleuron dull with distinct microsculpture, punctation very fine and sparse. Lateral faces of propodeum finely and very densely striate throughout. First abdominal segment very long, almost as long as second and third combined (Fig. 317). Last antennal segment of male very long, almost as long as segments 9-12 together (Fig. 320).

Not common, but very widely distributed in Denmark and Fennoscandia. - Denmark: occurs everywhere. - Sweden: distributed in South and Central Sweden, to the north to Gstr. - Norway: a few specimens from AK. - Finland: distributed northwards to a line from Om through Sb to Kb. - In Soviet Karelia from Ib. - The distribution area covers most of Europe, North Africa and great parts of Asia.

The nests are exclusively found in hollow plant stems, usually of Phragmites. The prey consists of e. g. Bolyphaltes and Tetragnatha. As parasitoids are known Chrysis cyanea, Omalus pusillus, O. auratus (Hym., Chrysididae), Eurytoma rubicola Gir. (Hym., Eurytomidae) and Pachyophthalmus signatus Meig. (Dipt., Sarcophagidae).

106. TRYPOXYLON FIGULUS (Linné, 1758)

Figs. 313, 316, 318, 321.

Sphex figulus Linné, 1758:570.

Female: 8-12 mm, male: 6-11 mm. Recognizable by its often considerable size. Microsculpture of head very strong, granular. Whole thorax with somewhat weaker, but still strong microsculpture. Pubescence greyish. Lateral faces of propodeum finely and densely striate. First abdominal segment comparatively short, not reaching farther backwards than apex of femur 3 (Fig. 318). Last antennal segment of males very large, apically somewhat outwardly directed (Fig. 321).

The most common species of Trypoxylon in the north. - Occurring throughout Denmark. - Sweden: known from all districts except T. Lpm., Nb., Ås. Lpm., Ång. and Med., but certainly occurs in the four last-mentioned districts. - Norway: comparatively few records; northernmost occurrence in Fn. - Finland: probably throughout the country. - In Soviet Karelia records from Ib and Kr. - The species has a Holarctic distribution. It is common in temperate and subtropical regions of the Northern Hemisphere and found in the Palaearctic region from the Atlantic in the west to the Pacific in the east.

Often found in very large numbers in thatched roofs. Several other hollow plant stems, abandoned tunnel systems of xylophagous insect larvae and cavities in brickwork are also used for nesting. The prey is mainly species of Epeira, but several other genera are also used, e.g. Tetragnatha, Linyphia and Salticus. Of predators are known a long series of parasitic Hymenoptera within Chrysididae, Ichneumonidae, Chalcidoidea and Evaniidae. Larva described by Soika, 1934.

Note. This species has undergone considerable taxonomical consideration through the time. Beaumont (1945) considered it as comprising three European "forms": T. figulus major Kohl, 1883, T. figulus media Beaumont, 1945, and T. figulus minor Beaumont, 1945. Wolf (1959) argued that these forms should be regarded as subspecies and described a new "variety": figulus minus rubi, which Beaumont (1963) considered a junior synonym for figulus media. Valkeila (1961) reared major and minor from the same nest and correctly concluded that these taxa had no validity. Tsuneki (1956) described two new subspecies: T. figulus koma from Korea and T. figulus yezo from Japan. It seems doubtful whether the Japanese populations are referable to separate subspecies.

TRIBE OXYBELINI

A small tribe with cosmopolitan distribution, only comprising five genera that probably constitute a monophyletic unity. Easily recognizable by the following combination of characters: the single cubital and discoidal cells are fused;

metanotum with lateral dilations, partly translucent; propodeum with a medial carina either strongly raised or developed into a backwardly directed, deeply grooved furrow.

Three genera in Europe. Terrestrial species.

Genus *Belomicrus* A. Costa

Belomicrus A. Costa, 1866:80.

Type-species: Belomicrus italicus A. Costa, 1866.

Small, robust species (Fig. 322), which share several characters with both Oxybelus and several genera within Crabronini, e.g. Encopognathus Kohl (Africa) and Entomognathus Dahlbom. The genus is, however, placed near Oxybelus, primarily because of the venation (Fig. 322). Shape of eyes as in Oxybelus, but species with relatively large eyes occur, in which the inner orbits converge strongly ventrally. In these the forwardly directed ommatids are considerably larger than the others. The ocelli are placed in a very obtuse triangle. Clypeus and the lower part of the face with silvery pubescence. The sexual dimorphism in the anterior margin of the clypeus is considerably less

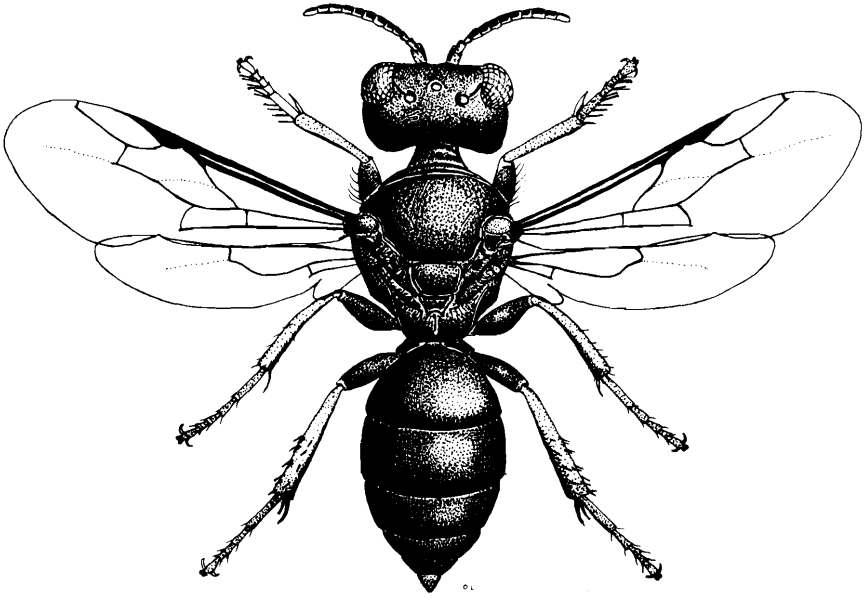


Fig. 322. Female of Belomicrus borealis Forsius. Length: 5 mm.

than in Oxybelus, and the teeth and emarginations are weaker. Antennae short, median segment of flagellum wider than long (Belomicrus s.str.). Mandibles simply attenuate (Belomicrus s.str.), with an obtuse process on the inner side. Pronotum conical, evenly rounded,dorsally without transverse carina. Thorax robust, with fine sculpture. Metanotum with more or less well-developed lateral lamellae which are posteriorly attenuate. Propodeum dorsally with narrow spine or a longitudinal, lamellar, protruding carina (subgenus Oxybeloides). Lateral faces of propodeum delimited from posterior face by a sharp carina. Mesopleuron in the Fennoscandian species without epicnemial carina, evenly rounded in front of coxa 2. Abdomen ovoid. Male as well as female with pygidial area. Female with psammophore, i.e. a row of bristles on external side of femur 1, which together with a corresponding row on ventral face of head form a basket for collecting dug out material. Tibia 2 with a single apical spur. Tibiae 2-3 with strong spines.

The genus comprises about 50 species and is distributed in the Nearctic, Palaearctic and Ethiopian regions. In Palaearctis 26 species occur.

The nest is constructed in warm, dry, sandy ground. The prey consists (exclusively?) of Coleoptera, Dasytidae (Williams, 1936; Valkeila, 1963).

107. BELOMICRUS BOREALIS Forsius, 1923

Fig. 322.

Belomicrus (Oxybeloides) borealis Forsius, 1923:65.

Female: 5 mm. Clypeus strongly convex, anteriorly with three rounded teeth, the foremost part shiny, impunctate. Mandibles black with red-brown middle, without emargination in lower edge. Frons anterior to ocelli shining, very finely and densely punctate, interstices with very fine microsculpture. Behind ocelli, especially laterally, with fine, transversely striate microsculpture. Facial fovea anteriorly delimited by a sharply depressed groove. Antennae brown, flagellum brown-yellow ventrally. Thorax all black. Scutum and scutellum with fine punctation, interstices larger than diameter of the punctures, with extremely weak microsculpture. Metanatum with translucent, posteriorly attenuate, lamellae. Propodeum dorsally with a short longitudinal, infuscate lamella, otherwise with fine reticulate microsculpture and fine, short rugae. Area cordiformis very indistinctly marked. Abdomen dull, with fine microsculpture. Pygidial area apically red-yellow, shining, with rather coarse, sparse punctation. Femur 1 and trochanter 1 flattened ventrally, along outer side with a row of stiff bristles. Tibia 1 yellow with a brown spot on the inner

side. Tarsus 1 brown-yellow, with well developed pecten. Tibiae 2-3 yellow with a brown spot on the inner side.

Male: 5 mm. Head in front view considerably longer than in female. The convex areas behind the eyes more strongly developed, whereby the head acquires a rounded, rectangular outline. Sculpture of head as in female, punctation slightly stronger. Mandibles brown, slightly paler distally. Antennae brown, ventral surface of flagellum and posterior surface of scapus yellow. Sculpture of thorax and abdomen as in female. Pygidial area with almost parallel sides, red-yellow. Femur 1 with a large distal yellow spot, extending especially along ventral margin. Femur 2-3 with a small distal yellow spot. Tibiae 1-2 yellow with a brown spot on the inner side. Tibia 3 with rather extensive black markings.

The species is only recorded from Fennoscandia, but may also occur in western Siberia. - Sweden: a few specimens from Upl., Eckerö; Gstr., Forsby near Hille, and Dlr., Mora. - Finland: Ab, Pernio; Ta, Hattula; Sa. - Soviet Karelia: Ib, Sakkola, holotype.

The species inhabits warm, sandy glades in pine forests. Flying at a height of 2-4 cm the female seeks a suitable nesting site, e.g. where the sandy surface already forms a small pit. The first section of the nest is excavated as follows: the female quickly throws herself on the ground, collects a small amount of sand in the psammophore, and very rapidly flies about 10 cm backwards, when she drops the load. This is repeated several times, all the time at an angle of about 30° with the ground. The last section of the tunnel and the cells, which are situated in the horizontal plane, a few cm below the surface of the ground, are excavated in the normal way. The prey consists of Dasytes niger, of which 4-5 are placed in each cell. Each nest may contain four cells (Valkeila, 1963).

Genus *Oxybelus* Latreille

Oxybelus Latreille, 1796:129.

Type-species: Vespa uniglumis Linné, 1758.

Small to medium-sized species (Fig. 323). Head short, in front view almost circular or distinctly broader than high. In males the head is comparatively higher than in females. Inner orbits slightly diverging ventrally. Antennae inserted just above the epistomal suture, distance between antennal sockets greater than diameter of a socket. Clypeus in males with a very strong median

keel. On either side of this the anterior margin is deeply emarginate, whereby two strong teeth are formed. Anterior margin of clypeus in female of rather simple shape, with two small lateral teeth. Frons and clypeus with silvery pubescence, most strongly developed in the male. Ocelli placed in a very obtuse angle, the lateral often larger than the median. The compound eyes rather small, all ommatids of fairly equal size. Mandibles ending in a single tooth, basally with an obtuse process on the inner side. Head densely punctate. Pronotum very short, with strong transverse carina, often ending in sharp lateral corners. Mesothorax very robust. Mesopleuron usually strongly sculptered, anteriorly with well developed epicnemium; the epicnemial carina continues to the ventral midline. Precoxal carina very well developed. Scutellum with median keel, laterally produced into narrow, lamellar-like, translucent dilations. Metanotum with two backwardly directed, often bidentate, more or less translucent dilations. Propodeum with a strong dorsal spine, or more or less leaf-shaped, grooved process. Lateral areas of propodeum with transverse sculpture, separated from posterior face by a sharply protruding carina. Abdomen broadly triangular, usually with yellow or white-yellow lateral spots. Pygidial area of females broadly triangular, that of the males trapezoid. Legs short and strong, tarsus 1 in females with well developed pecten. Tibia 2 with a single spur. Last tarsal segments strongly thickened, pulvilli large. Dis-

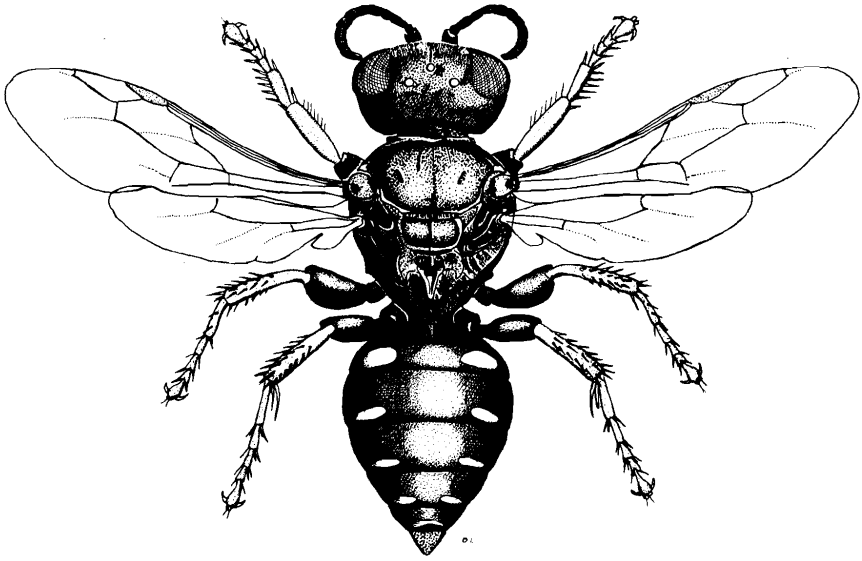


Fig. 323. Female of Oxybelus uniglumis (L.). Length: 5-8 mm.

coidal and cubital cells of forewing fused, only separated by an indistinct vein. Radial cell with a small accessory cell.

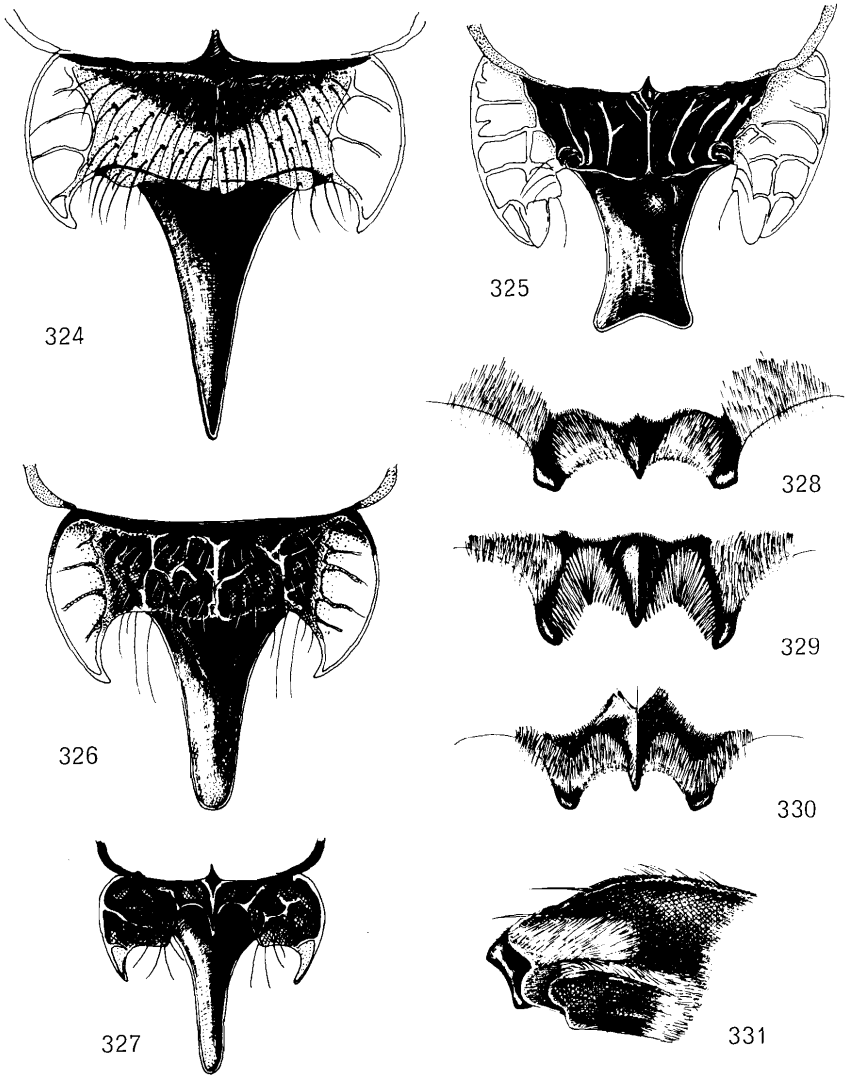
The genus, which has a cosmopolitan distribution, but seems to be absent in the Australian region, comprises about 160 species, of which c. 90 occur in the northern hemisphere. Of these about 20 occur in Europe.

The species nest, especially in sandy, strongly sun-exposed localities, where the nests are excavated in the soil. The prey consists of Diptera.

Key to species of Oxybelus

Females

1	Femora 2-3 red or yellow-brown. Metanotum between lamellae with more or less yellow markings	2
-	All femora black or brown-black, at most with a small, distal, paler spot	3
2(1)	Scutum with yellow longitudinal lines. Remaining part of thorax and abdomen with rich yellow pattern. Mandibles yellow or brown-yellow centrally. Propodeal spine depressed, with parallel sides, and truncate apex	108. lineatus (Fabricius)
-	Scutum without yellow markings. Mandibles light yellow-brown or brown-black. Terga 1-5 with lateral spots, which on the last terga are fused into transverse bands. The whole surface often with densely adpressed silvery pubescence. Propodeal spine attenuate (Fig. 324)	109. argentatus Curtis
3(1)	Propodeal spine broadest subapically, here only slightly narrower than long, apex itself emarginate (Fig. 325)	111. latidens Gerstäcker
-	Spine much longer than broad apically, not emarginate	4
4(3)	Mandibles mainly yellow, red-yellow or yellow-brown, with dark red to black apex. Propodeal spine excavated in a groove, sides almost parallel, apex rounded. Tibiae 2-3 uniform light or dark brown	5
-	Mandibles brown or brown-black	6



Figs. 324-327. Metanotal processes and propodeal spine of female Oxybelus. - 324: argentatus Curtis; 325: latidens Gerstäcker; 326: uniglumis (L.); 327: bipunctatus Olivier.
Figs. 328-330. Anterior part of clypeus of male Oxybelus. - 328: argentatus Curtis; 329: mandibularis Dahlbom; 330: trispinosus (Fabr.).
Fig. 331. Clypeus in antero-lateral view of male Oxybelus latidens Gerstäcker.

5(4) Metanotal lamellae brownish transparent or infuscate. Metanotum black. Tarsal spines on metatarsus 1 2-2.5 times longer than width of the metatarsus. Abdomen shining smooth, very finely punctate. Tergum 1 with almost circular lateral spots ..... 113. bipunctatus Olivier

- Metanotal lamellae mainly yellow, their transparent part colourless. Metanotum between lamellae often yellow. Spines on metatarsus 1 almost as long as width of the metatarsus. Abdomen with scattered punctation. Tibiae light red or yellow-brown. Terga 1-3 with oval lateral spots ..... 110. mandibularis Dahlbom

6(4) The transparent part of the lamellae colourless. Tibiae 2-3 pale brown, proximally with a small, often somewhat effaced whitish spot. Pubescence on lower part of frons closely adpressed, silvery. Spines on metatarsus 1 about 1.5 times longer than width of the metatarsus. Terga 1-4, often also tergum 5, with ivory lateral spots ..... 112. uniglumis (Linné)

- Lamellae brown-black, their transparent part strongly infuscate. Tibiae 2-3 dark-brown, almost as dark as femora. Pubescence on lower part of frons sparse with faint reddish tinge. Spines on metatarsus 1 shorter than width of the metatarsus. Usually only terga 1 and 2 have yellow lateral spots. ..... 114. trispinosus (Fabricius)

Males

1 Sterna 3-6 with strong, very conspicuous white or yellowish hair fringe, whose base is covered by the anterior sternum. The median part of sterna smooth, very sparsely and indistinctly punctate, almost bare. Mandibles with yellow or yellow-brown median area 2

- Sterna 3-6 without distinct hair fringe. Sterna usually distinctly punctate 3

2(1) Large species (8-10 mm). Sutures between scu-

tellum and metanotum and between metanotum and propodeum yellow. Propodeal spine depressed and broad with rounded apex. Metanotum between lamellae yellow. Lamellae with very large medial dilations. Tarsi, tibiae and femora extensively yellow or brown-yellow ..... 108. lineatus (Fabricius)

- Smaller (5-7 mm). Sutures dorso-posteriorly on thorax black. Propodeal spine excavated in a groove. Metanotum between lamellae black. Lamellae without medial dilations, at most slightly thickened. Femora mainly black 110. mandibularis Dahlbom

3(1) Sutures between scutellum and metanotum and between metanotum and propodeum yellow 4

- These sutures black 5

4(3) Anterior margin of clypeus on the steeply declining part below the median keel with a small tubercle, giving the median keel, seen in profile, a bidentate appearance (Fig. 331). Propodeal spine broadest subapically, usually incised apically. Mesopleuron deeply and densely punctate, without true rugae. Tibia 1 usually uniform yellow. Femora 1-2 as a rule each with a small yellow spot ..... 111. latidens Gerstäcker

- Anterior margin of clypeus on the steeply declining part without tooth or tubercle. Median keel strongly compressed. Propodeal spine evenly narrowed with rounded apex. Mesopleuron coarsely, almost reticulately rugose. Tibia 1 with a large brownish spot on the inner side. Femora 1-2 on the outer side each with a large yellow spot, usually reaching farther than to middle of femora ..... 114. trispinosus (Fabricius)

5(3) Mandibles black or brown-black, seldom red-brown, with a rounded, triangular, subapical dilation ventrally. Propodeal spine with rounded apex. Lateral angles of pronotum attenuate in front view. All femora black. Tibiae 1-2 usually brown-yellow, often with a yellow stripe along the front side. Femur 1 sometimes with a yel-

low spot on the inner side near apex ..... 112. uniglumis (Linné)

- Mandibles without triangular dilation ventrally 6

6(5) Mandibles yellow with red apex. Metanotal lamellae with large median dilations (Fig. 327). Propodeal spine rounded apically. Femora black with yellow apex. Tibiae 1-2 yellow with brown or brown-black inner side. Tibia 3 with yellow basal half. Abdomen shining, smooth, with fine, sparse punctation and pubescence ..... 113. bipunctatus Olivier

- Mandibles black or brown-black. Metanotal lamellae without medial dilations. Propodeal spine attenuate. Femora 1-2 extensively yellow. All tibiae yellow with only weakly indicated spot on the inner side. Abdomen rather densely and strongly punctate, often with rather dense silvery pubescence ..... 109. argentatus Curtis

108. OXYBELUS LINEATUS (Fabricius, 1787)

Nomada lineata Fabricius, 1787:306.

Female: 9-11 mm. Head strikingly small. Mandibles yellow with rusty or red-brown apex. Antennae brown, flagellar segments paler proximally. Pronotum with a very large, white-yellow double spot. Humeral tubercle also white-yellow. Scutum with two median, almost complete, white-yellow longitudinal bands and two shorter, lateral ones. Scutellum with two yellow lateral spots. Metanotum between lamellae white-yellow. Sutures between scutellum and metanotum and between metanotum and propodeum whitish. Just in front of coxae 2-3 two pairs, often indistinct, yellow spots. Propleuron may carry an effaced yellow spot. Whole thorax with slightly silvery pubescence. Spine on propodeum broad, sides almost parallel, apex rounded, often with a median yellow spot or uniform yellow. Abdomen with white-yellow transverse bands on first, fourth and fifth terga, second and third with very large lateral spots. Pygidial area red-brown, slightly arcuately emarginate distally. Sterna 2-6 with larger or smaller transverse spots. Legs mainly white-yellow and brown-yellow. Coxa 1 with a large white-yellow spot.

Male: 8-10 mm. The silvery pubescence on the face very well developed. Mandibles yellow, distally red-brown, subapically with a rounded triangular dil-

ation ventrally. Pronotum and humeral tubercles of same colour as in female. Scutum and scutellum usually devoid of yellow markings. Median tooth on lamellae on metanotum may be highly reduced. Thorax without ventral spots. Abdomen without bands, lateral spots on last terga may be missing. Sterna generally without yellow markings, sterna 3-6 with very well developed hair fringes, the central parts of these sterna shiny without punctation. Pygidial area distally light coloured, with a weak, arcuate emargination. Femur 1 brown with a broad yellow stripe along outer side. Femur 2 with a large yellow distal spot, femur 3 brown-yellow distally. Tibiae 1-2 and tarsi 1-2 yellow and brown-yellow, tibia 3 brown with a proximal yellow ring.

A few specimens from Denmark: EJ, Glatved (Abrahamsen). - Not known from Fennoscandia. - A rare Central and South European species. Nearest records in Holland and North Germany.

109. OXYBELUS ARGENTATUS Curtis, 1833

Figs. 324, 328.

Oxybelus argentatus Curtis, 1833:480.

Oxybelus mucronatus auctt., nec Fæster, 1949:17.

Female: 8-10 mm. Habitus relatively elongate. Face with well developed silvery pubescence. Mandibles red-yellow and brown-yellow basally, red-brown distally. Pronotum dorsally at most with indicated lateral spots. Humeral tubercles white-yellow. Scutum very densely and coarsely punctate, interstices considerably smaller than diameter of punctures. Metanotum with a white-yellow double spot, which may be divided. Lamellae transparent, simply attenuate. Spine on propodeum long and slender, attenuate (Fig. 324). Mesopleuron with silvery pubescence, punctate, with shiny interstices. Abdomen with large, often ivory lateral spots on terga 1-3, and terga 4-5 with bands. Pygidial area distally with a slight emargination. Femur 1 black with a larger or smaller yellow or brown-yellow apical spot. Femur 2 mainly brown-yellow, basally darker, often completely black, distally usually with a yellow spot. Femur 3 usually uniform red-yellow. Tibiae and tarsi red-yellow, but tibiae with larger or smaller white-yellow proximal markings.

Male: 5-9 mm. Mandibles mainly black, often with a slightly paler area proximally; some individuals have extensive yellow markings like mandibularis. Lateral teeth on clypeus very strong, truncate, directed almost straight forward (Fig. 328). Pronotum often with small lateral spots. Humeral tubercle always with a yellow spot. Scutum with very dense and rather strong punctation. Metanotum always with a divided double spot, which in small individuals may be

very reduced. Lamellae on metanotum and the spine on propodeum as in female. Abdomen with very dense punctation, terga 1-5 with yellow spots of which the posteriormost may be missing, especially in small specimens. Femora 1-2 basally black, distally, notably on ventral face, with a large yellow spot. Femur 3 may be almost entirely black, but often yellow and brown-yellow markings extend from the apex along the ventral and outer side.

According to Verhoeff (1948), the species is divided into six subspecies, of which four occur in Denmark and Fennoscandia. This division, in certain cases, especially as the males are concerned, may be rather difficult.

Note. O. mucronatus (Fabr.) sensu Balthasar, 1972, should be identified as argentatus Curt., while the Fabrician species was clearly defined by Fæster, 1949, and Oehlke, 1970. The Fabrician type specimen (a male) runs in Balthasar's key to pungax Oliv.

Key to sub-species of Oxybelus argentatus Curt.

1	Female: abdomen and thorax with dense and very well developed silvery pubescence, consisting of strongly depressed bristles, whereby the sculpture, especially on abdomen, may be difficult to discern. Male: thorax and abdomen with distinct, but rather thin silvery pubescence. Pubescence on thorax, and partly on tergum 1 consists of depressed hairs. Admixture of differently coloured bristles does not occur. ..... argentatus argentatus Curtis	
-	Female: pubescence on thorax with at most slight admixture of silvery bristles, otherwise with grey-golden hairs. Silvery pubescence on abdomen very sparse, covering at most the first two terga. Male: hairs dorsally on abdomen not depressed and at most slightly silvery	2
2(1)	Females	3
-	Males	5
3(2)	Thorax and abdomen dorsally interspersed with silver-shining hairs ..... argentatus aculeatus Thomson	
-	Thorax with uniform and well developed grey-golden to dark pubescence of non-depressed hairs	4

4(3) Markings on abdomen white-yellow or ivory
..... argentatus bouwmani Verhoeff

- Markings on abdomen bright yellow
..... argentatus gerstaeckeri Verhoeff

5(2) Markings on abdomen bright yellow, pubescence dorsally on thorax often slightly gold-shining
..... argentatus gerstaeckeri Verhoeff

- Markings on abdomen white-yellow, pubescence dorsally on thorax with strong admixture of slightly silvery hairs 6

6(5) Occurs in southern Denmark and Sweden
..... argentatus aculeatus Thomson

- Occurs in southern Finland ..... argentatus bouwmani Verhoeff

109a. OXYBELUS ARGENTATUS ARGENTATUS Curtis, 1833

Oxybelus argentatus Curtis, 1833:480.

Associated with coastal shifting sand areas in England, France and Holland. Also distributed in Central and East Europe. In Denmark it occurs in the northernmost and easternmost regions. From Sweden recorded from Hall. and Sk.

109b. OXYBELUS ARGENTATUS ACULEATUS Thomson, 1870

Oxybelus aculeatus Thomson, 1870:177.

Only known from Denmark and southern Sweden including Gotland. In Denmark the subspecies has a pronounced southern occurrence.

109c. OXYBELUS ARGENTATUS GERSTAECKERI Verhoeff, 1948

Oxybelus argentatus gerstaeckeri Verhoeff, 1948:179.

Widely, but sporadically distributed in Central and East Europe, and in southern and south-eastern Sweden.

109d. OXYBELUS ARGENTATUS BOUWMANI Verhoeff, 1948

Oxybelus argentatus bouwmani Verhoeff, 1948:175.

Inhabits inland localities in Holland. Additional occurrence in southern Finland.

The two last-mentioned subspecies are difficult to separate on the basis of morphological characters.

The prey consists of species of Therevidae, often Thereva annulata (Fabr.). The larva was described by Grandi, 1961. Smicromyrme rufipes Fabr. (Hym., Mutillidae) and Metopia argyrocephala (Dipt., Sarcophagidae) are known as predators.

110. OXYBELUS MANDIBULARIS Dahlbom, 1845

Fig. 329.

Oxybelus mandibularis Dahlbom, 1845:514.

Oxybelus sericatus Gerstaecker, 1867:89.

Female: 5-7.5 mm. Head behind ocelli swollen. Pubescence on face sparse, only slightly silvery with a faint golden tinge. Mandibles basally pale yellow, distally gradually darker, apex often black. Pronotum with white-yellow lateral spots. Humeral tubercle with white-yellow spot. Punctation on scutum rather strong, interstices as large as or slightly smaller than diameter of punctures. Pubescence on scutum and scutellum sparse, golden-brown. Lamellae on metanotum simply attenuate, their median margins slightly yellowish. Propodeal spine rather broad, apex rounded. Mesopleuron with sparse and rather weak, somewhat irregularly distributed punctation, without rugose sculpture. Abdomen shining, smooth, very slightly hairy, sparsely and rather finely punctate. Tergum 1 with large, white-yellow lateral spots. Spots on terga 2-4 small, sometimes missing on third and fourth. Femora black, femur 1 and sometimes also femur 2 with a distal white-yellow spot. Tibiae and tarsi red-yellow.

Male: 5-7 mm. Lateral teeth on clypeus very well developed, the strong emarginations on either side of the median keel with a very strong fringe of white, depressed bristles (Fig. 329). Mandibles proximally yellow, distally red-brown with a rounded triangular subapical dilation ventrally. Pronotum with white-yellow lateral spots. Humeral tubercle with a yellow spot. Pubescence on scutum varying from grey-golden to silvery. In occasional cases yellow spots occur on scutellum. Pronotum and metanotum each have a complete transverse band. Mesopleuron dorsally punctate with strong admixture of rugose sculpture. Ventro-laterally is a shining area, often with 3-5 strong transverse carinae or ribs. Lamellae on metanotum fairly long, simply attenuate, yellow on the inner side. Spine on propodeum comparatively broad, rounded distally. Abdomen with varying number of white-yellow lateral spots, seldom less than two pairs. Sterna 3-6 with well developed hair-fringe, with a transverse, slightly convex, impunctate area. Femora black, femur 1 and femur 2 with distal white-yellow spot. Tibiae 1-2 yellow anteriorly. Tibia 3 with proximal yellow ring.

This species is rather common locally in Fennoscandia and Denmark. - Denmark: found in most districts, - Sweden: a southern species, but also material from Ång. - Not found in Norway. - Finland: rather extensive distribution, northwards to ObS. - Soviet Karelia: Ib and Kb. - Widespread in Europe, but not common. Also recorded from Kazakhstan (Kazenas, in litt.).

Prefers warm, sandy localities, but not dunes. The provision consists of Diptera of the families Muscidae, Sarcophagidae and Tachinidae. Each cell contains from four to six flies.

111. OXYBELUS LATIDENS Gerstäcker, 1867

Figs. 325, 331.

Oxybelus latidens Gerstäcker, 1867:92.

Female: 5.5-7.5 mm. Head in front view distinctly broader than high. Face with short, dense, almost felty silvery pubescence. Clypeus slightly protruding. Mandibles yellow or red-yellow, distally red-brown or rust-coloured. Pronotum without yellow markings. Humeral tubercle with a white-yellow spot. Scutum very densely punctate, distance between punctures less than their diameter; pubescence sparse, often slightly grey-golden shining. Punctation on mesopleuron denser, but of same strength as on scutum, interstices only seldom forming rugae. Metanotum black, lamellae bidentate (best seen in profile). Propodeal spine short, broadest distally, here distinctly emarginate (Fig. 325). Sutures between scutellum and metanotum and between metanotum and propodeum often slightly yellowish transparent. Abdomen with strong and dense punctation on terga 1 and 2, gradually finer on succeeding terga. White-yellow lateral spots occur on terga 1-4. Femora black. Femur 1 often with a small yellow distal spot. Femur 2 distally red-yellow. Tibiae and tarsi mainly red-yellow, tibiae 1-2 often with a yellow stripe anteriorly. Tibia 3 may have a somewhat darker shade, whereby the slightly yellowish proximal spot becomes more distinct. Wing-nerves proximally, and tegulae light yellow-brown. Tegulae sometimes with a faint yellow spot.

Male: 4-6.5 mm. Median keel on clypeus in profile more or less distinctly S-shaped curved. Anterior margin with a median, small rounded tubercle, whereby the median keel appears bidentate (Fig. 331). Mandibles as in female, mainly golden or red-yellow. Sculpture of thorax as described in female, but punctation on mesopleuron somewhat stronger, whereby indications of a rugose sculpture appear. Propodeal spine strongly varying in shape, in typical specimens emarginate distally, but specimens with a com-

paratively long, narrow spine, rounded apically, occur. Abdomen with narrow, white-yellow lateral spots on terga 1-5. Spots on tergum 5 may form a transverse band. Pattern of legs almost as in female, but tibia 1 almost uniform yellow. Tibia 3, and also part of tibia 2, brown, with a yellow proximal ring. Tarsi red-yellow.

A small material is available from Denmark: EJ, Horsens, Funder, Gødvad, Alstrup; NEZ, Ll. Esbønderup, Tibirke. - Not found in Fennoscandia. The northernmost German records are from Schleswig-Holstein. - The distribution area covers Central and South Europe. Additional material from SE Kazakhstan.

Note: The species can easily be confused with subspinosus Klug, which seems to have a somewhat more southern distribution range (see Balthasar, 1972).

112. OXYBELUS UNIGLUMIS (Linné, 1758)

Figs. 323, 326.

Vespa uniglumis Linné, 1758:573.
Oxybelus quadrinotatus Say, 1824:338.

Female: 5-8 mm. A highly variable species. Frons in front of ocelli densely and rather finely punctate, with fine rugulae between punctures, whereby the area obtains a slightly longitudinally striate surface. Lower part of face with a rather strong, silvery pubescence. Pubescence on upper frons grey-yellow. Lateral teeth on clypeus acute, directed obliquely forwards. Mandibles usually uniform dark brown or completely black, but specimens with red-brown or slightly red-yellow midpart occur. Humeral tubercle often with an ivory spot. Scutum densely punctate, pubescence slightly brown-yellow, shining. Lamellae on metanotum simply attenuate, laterally hyaline, basally slightly infuscate, medially often with a whitish spot. Propodeal spine broad, apex rounded (Fig. 326). Abdomen with ivory lateral spots, which may form transverse bands on tergum 5 and exceptionally also on tergum 4. Occasional specimens with strongly reduced lateral spots occur. Such can always be distinguished from bipunctatus by the distinct punctation on abdomen. Femora black, often with a tiny, pale apical spot. All tibiae and tarsi usually mainly red-yellow, tibiae with a white-yellow proximal spot. The red-yellow colour on tibia 3 and tibia 2 may be completely or partly replaced by a dark brown pattern, but the proximal white-yellow spot is always retained.

Male: 5-7 mm. Median keel on clypeus very strongly protruding, apically rounded. Lateral teeth also very well developed, emargination on either side

with dense, silvery pubescence. Mandibles usually uniformly dark, with rounded, triangular, subapical dilation ventrally. Sculpture of frons as in female, slightly stronger. Humeral tubercle only seldom light coloured, prolonged into a sharp spine. Thorax otherwise without yellow markings. Scutum and scutellum with a thin, slightly golden or silvery pubescence. Spine on propodeum more slender than in female, apically rounded. Abdomen with comparatively dull surface, which is partly due to the thin, greyish pubescence. Ivory lateral spots are usually present on terga 1 and 2. In addition, there may be very faint spots on tergum 3. Pattern on legs strongly varying. Tibiae 1-2 usually red-yellow with a yellow stripe anteriorly. Tibia 3 red-yellow with a larger or smaller dark brown spot, proximally with a yellow spot. Specimens with almost uniformly black tibiae 2-3 occur.

The species is very abundant and widespread through Fennoscandia and Denmark. - Sweden: northern distribution limit runs through Nb. - Norway: northernmost record from On. - Finland: common from Al, Ab, N and Ka in the south to Ks and LkW in the north. - Soviet Karelia: Ib and Kr. - A Holarctic species. Common in Europe, southern Siberia and southern Canada. Recently recorded from Alaska. Throughout the whole U.S.A., southwards to Mexico (recorded as quadrinotatus Say in America before 1958).

The species has an extensive range of biotopes, and may be found nesting in almost any type of soil, even among paving stones, e.g. in farm yards, often occurring in large aggregations. The nest tunnel is 5-8 cm long and contains a single cell, which is situated at the end of a more or less horizontally running part of the tunnel, about 4 cm below the surface. The entrance is sealed while the female is hunting. The prey is hunted stealthily on the ground among grass, leaves, on stumps and the like. It is paralyzed by a sting in the neck region, and brought home pinned on the sting, with its ventral face upwards. Each cell contains from 4 to 12 Diptera, mainly belonging to the families Muscidae and Anthomyiidae. According to Nuorteva (1945) every female wasp apparently specializes on collecting a single or a very few species. The species produces two or perhaps three generations, from the middle of June to the end of August. As predators are recorded Myrmosa melanocephala Fabr. and Smicromyrme rufipes Fabr. (Hym., Myrmosidae and Mutillidae), Macronychia griseola Fall. and M. polydon Meig. (Dipt., Sarcophagidae).

113. OXYBELUS BIPUNCTATUS Olivier, 1811

Fig. 327.

Oxybelus bipunctatus Olivier, 1811:597.

Female: 3.5-5.5 mm. Head in front view very broad. Frons in front of ocelli shiny, with scattered punctation. Silvery pubescence sparse. Lateral teeth on clypeus acute. Mandibles yellow, with black base and red-brown apex. Antennae distally yellow or yellow-brown ventrally. Thorax without yellow markings, but sometimes a faint yellowish spot on humeral tubercle. Sometimes a slight bronzy tinge is found on thorax as well as on abdomen. Distance between punctures on scutum equal to or larger than diameter of punctures. Lamellae on metanotum simply attenuate, infuscate like the transparent part of the spine on propodeum (Fig. 327). Mesopleuron with superficial and rather sparse punctation. Abdomen rather broad, shining, smooth; slightly green-yellow spots on tergum 1. Only seldom spots on tergum 2. Especially in small specimens abdomen may be completely devoid of yellow markings. Colour of pygidial area varying from dark brown to red-yellow. Legs mainly black. Tibia 1 and tibia 2 partly with a yellow stripe anteriorly. Metatarsus 1 with very long spines.

Male: 3-5 mm. Frons in front of ocelli often with weak longitudinal rugosity, punctation as in female. The two emarginations on either side of median keel on clypeus rather weak; silvery pubescence sparse. Median keel in profile slightly bifid. Mandibles simply attenuate, yellow with red-brown or red-yellow apex and dark base. Thorax black, humeral tubercle sometimes with a yellow spot, sculpture stronger and denser than in female. Lamellae on metanotum medially with a large lobelike dilation, which may be yellowish distally. Number of yellow lateral spots on abdomen varying from 2-5. Terga distinctly, but finely punctate. All tibiae with a yellow stripe anteriorly. Spines on metatarsus 1 considerably longer than width of metatarsus.

The species has a southern distribution in Denmark and is only found in SJ, Spandet Egekrat, Stensbæk Plantage, and F, Svanninge Bakker. - It is not known from Sweden and Norway. - Finland: rare, but rather widely distributed in the southern and southwestern districts. Northwards to Kb. - Soviet Karelia: Ib and Kr. - A Holarctic species. In the Palaearctic region it is known from most European countries, North Africa through southern Siberia to Japan. In North America the species is found in north-eastern U.S.A.

The nests are constructed in sandy soil, often in stony areas. The first short section of the nesting tunnel is constructed at right angles to the surface. Then follows a more or less horizontally running section, and then the tunnel continues almost vertically downwards. It ends with a single cell, situated 8-13 cm below the surface. The provisioning of the cell may take more than two days. The prey usually consists of Anthomyiidae, but species of Calliphoridae and Syrphidae may also be used. The prey is brought home pinned on the sting (Tsuneki, 1969; Olberg, 1959). The egg is laid after the last prey

has been deposited in the cell, but is placed on the first caught prey. The egg hatches after 2-3 days, and about 8 days later the larva is fullgrown. The cocoon is externally covered with sand grains. As predators are known Smicromyrme rufipes Fabr. (Hym., Mutillidae) and Taxigramma multipunctatum Rond. (Dipt., Sarcophagidae). The larva was described by Evans, 1957.

114. OXYBELUS TRISPINOSUS (Fabricius, 1787)

Fig. 330.

Apis trispinosa Fabricius, 1787:303.

Oxybelus nigripes Olivier, 1811:596.

Female: 6-8.5 mm. Head densely punctate, distance between punctures smaller than their diameter. Interstices may be rugose. Silvery pubescence on face with a slightly reddish tinge, sparse, at times vestigial. Frons behind ocelli with long, erect, brownish pubescence. Mandibles dark, often with faintly reddish centre. Thorax without yellow markings. Scutum with short, dark pubescence. Mesopleuron coarsely and somewhat irregularly rugoso-punctate. Lamellae on metanotum brown-black, the transparent part infuscate. Medially an obtuse dilation is present so that the lamellae in profile become slightly bifid. Propodeal spine with often almost parallel sides, apex rounded. Abdomen densely and finely punctate, with yellow lateral spots on terga 1-3 and sometimes also on tergum 4. Tibiae 2-3 uniformly dark brown, almost as dark as femora. The spines on the external side of these remarkably short and thick.

Male: 5-7 mm. Medial keel on clypeus strongly compressed, sharp-edged, lateral teeth depressed, distally broadly, obliquely truncate (Fig. 330). Mandibles simply attenuate, dark in specimens from Denmark and Fennoscandia. Pronotum with yellow lateral spots, which may form a transverse band. Humeral tubercles generally with yellow spots. Mesopleuron coarsely rugoso-punctate, ventrally with adpressed silvery pubescence, consisting of depressed hairs. This pubescence covers also part of the ventral faces of coxae 2-3. Scutellum may carry two anterolateral spots. Sutures between scutellum and metanotum and between metanotum and propodeum usually yellow. Metanotum, like the median parts of the lamellae, may be yellow. Abdomen with large, oval or ovoid lateral spots on tergum 1. Spots on second, and occasionally also on third and fourth terga narrow, parallel. Yellow pattern on legs very variable. Femur 1 with a large distal spot on external face. Spot on femur 2 may be missing. Femur 3 often with a distal spot dorsally. Tibiae 1-2 yellow with a larger or smaller, brown,longitudinal stripe on the inner side. Tibia 3 with a broad yellow proximal ring. Tarsi yellow, red-yellow or brown.

A few specimens of this species are known from Denmark: SZ, Sorø, Vordingborg; NWZ, Jyderup. - Sweden: very rare, only known from Sk., Sm., Gtl. and Ög. - Not found in Norway. - Finland: a rare southern and south-eastern species, towards the north occurring in Kb. - Soviet Karelia: Ib and Kr. - Widely distributed, but not abundant, in Central, East and South Europe. Additional material from North Caucasus.

The nesting tunnel is often bifurcate, each branch ending in a single cell. The tunnel system is about 5 cm long. As prey are used Anthomyiidae, Muscidae and Calliphoridae. The species produces two generations, at least in South Europe (Bonelli, 1952, 1968-70).

TRIBE CRABRONINI

Taxonomical status much questioned. Here the views of Evans (1964) are followed. A very homogenous group, closely related to the Oxybelini. Forewings with a single cubital and discoidal cell. Eyes very large, the forwardly directed ommatids several times larger than those situated dorsally. Antennae geniculate. Clypeus with dense covering of strongly golden or silvery shining, adpressed pubescence consisting of depressed hairs; the anterior margin with teeth and/ or emarginations. Mesopleuron usually with a sharply projecting, precoxal carina which is sometimes reduced to a pointed tubercle. Females and occasional males with pygidial area. The males often with several very conspicuous secondary sexual characters in the antennae and the forelegs. Volsella vestigial or absent.

The tribe is cosmopolitan and comprises 39 genera of which nine are represented in Europe. Ectemnius and Crossocerus comprise by far the largest number of species. Both terrestrial and arboreal nesting habits are displayed. Various dipterous families make up the provision, only occasionally other insect orders are used.

Genus *Crabro* Fabricius

Crabro Fabricius, 1775:373.

Thyreopus Lepeletier & Brullé, 1835:751.

Type-species: Vespa cribraria Linné, 1758.

Rather large, strongly built species with yellow pattern, in habitus similar to Ectemnius. Inner orbits strongly converging ventrally, antennae inserted

very close to each other. Clypeus with well developed silvery pubescence, its anterior margin usually evenly rounded, without teeth or emarginations. Ocelli placed in a very obtuse-angled triangle. Pygidial area of females plane, triangular, surrounded by a sharp carina. Abdomen of males very elongate. Antennae of males with 13 segments. Flagellum often dorso-ventrally flattened and broadened,with strong pubescence ventrally. Mandibles bidentate, without tooth on the inner side. Forelegs of males often strongly modified, tibiae with large, shield-like dilations. Sexual dimorphism in many cases considerably more pronounced in Crabro than in Ectemnius. Mesopleuron without spine in front of coxa 2.

The genus is distributed almost exclusively in the Holarctic region with about 80 species. Only six species in Denmark and Fennoscandia.

The species are met with in the height of the summer, often on large flowering Umbelliferae. The nests are constructed in the soil; the prey consists of Diptera.

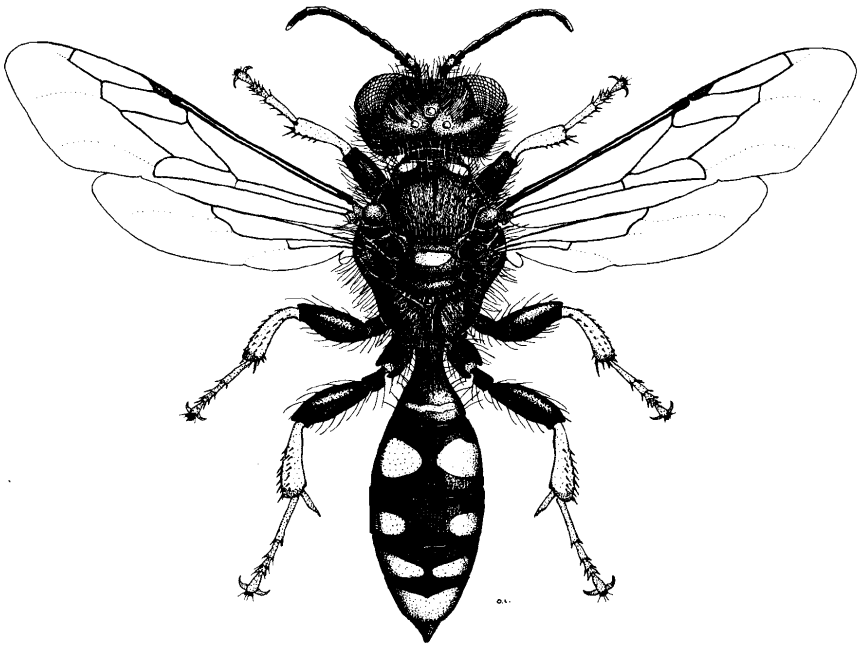


Fig. 332. Female of Crabro cribrarius (L.). Length: 10-16 mm.

Key to species of Crabro

Females

1 Scutum with longitudinal striae. Propodeum evenly rounded, without strong carinae. Vertex depressed like a trough, striate anteriorly. Space between eyes and posterior ocelli twice as large as distance between these ..... 115. cribrarius (Linné)

\- Scutum without striation. Posterior part of propodeum laterally delimited by strong carinae. Frons evenly rounded, vertex without striae. Distance from eyes to lateral ocelli as great as or slightly greater than distance between these 2

2(1) Thorax, especially mesopleuron, dull, with very distinct microsculpture, pubescence long, dark, and erect. Pronotum and humeral tubercle without yellow markings. Sculpture of propodeum weak 3

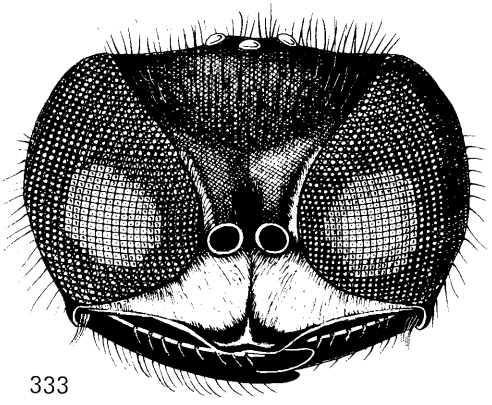
\- Thorax shining, smooth, with or without extremely weak microsculpture; pubescence long and white, or (scutellatus) short and dark. Pronotum often, and humeral tubercle usually, with yellow markings. Propodeum with strongly protruding ribs (except in maeklini) 4

3(2) Scapus all black. Tergum 5 usually with a yellow double spot ..... 119. lapponicus Zetterstedt

\- Scapus with a large yellow spot. Tergum 5 without yellow markings ..... 118. ingricus (F. Morawitz)

4(2) Pronotum with rounded lateral angles, these with a large yellow spot. Propodeum without protruding ribs. Markings of abdomen white-yellow. Tibiae and tarsi red-yellow ..... 120. maeklini A. Morawitz

\- Pronotum with sharp-edged lateral angles. If markings on pronotum are present, they are bright yellow. Propodeum with very strongly protruding carinae, which form a reticulate pattern. Abdomen with bright yellow pattern. Tibiae black and yellow 5



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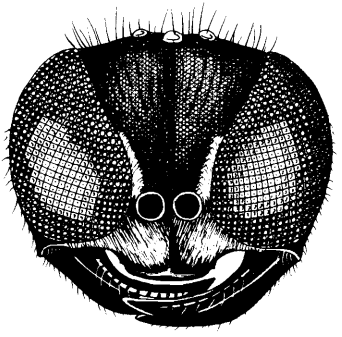

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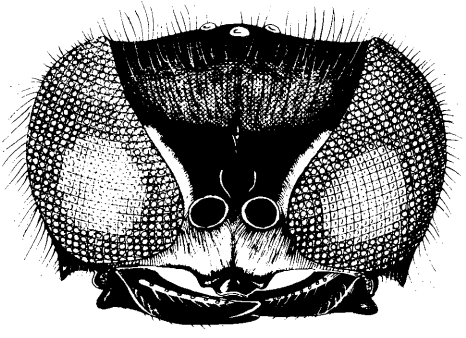

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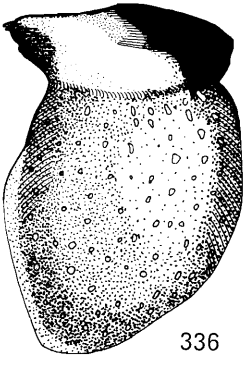

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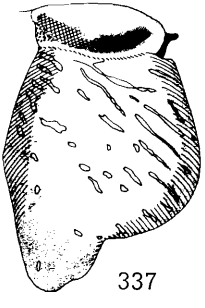

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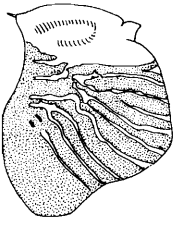

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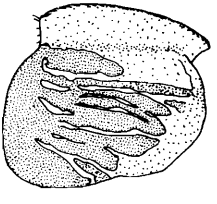

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Figs. 333-335. Heads in frontal view of Crabro. - 333: cribrarius (L.), ♀; 334: same, ♂; 335: lapponicus (Zett.), ♀.
Figs. 336-339. Right femur I in lateral view of male Crabro. - 336: cribrarius (L.); 337: peltarius (Schreber); 338: scutellatus (Scheven); 339: ingricus (F. Morawitz).

5(4) Third antennal segment almost 1.5 times longer than fourth. Tergum 1 usually with large yellow lateral spots. Tibia 1 with a large black spot on the external side. Mandibles black or black-brown ..... 116. peltarius (Schreber)

- Third and fourth antennal segments almost equally long. Tergum 1 without yellow pattern. Tibia 1 with yellow outer side. Mandibles with rust-coloured or red-yellow apex ..... 117. scutellatus (Scheven)

Males

1 Scutum densely and strongly longitudinally striate. Vertex strongly excavate, anteriorly strongly striate. Laterally to the mandibular articulation there is a stout triangular tooth. Femur 1 very short, with a large, irregular process. The shield-shaped dilation with pale dots only (Fig. 336) ..... 115. cribrarius (Linné)

- Scutum punctate. Vertex not excavate, at most with weak rugae (peltarius). No tooth near mandibular articulation. Femur 1 at most with a long, thin process on inner side. If shield-like dilations are present, these, in addition to pale dots, carry pale lines 2

2(1) Forelegs with large shield-shaped dilations. Flagellar segments, except in ingricus, dilated and excavate ventrally 3

- Forelegs and antennae without distinct secondary sexual characters 5

3(2) Last tergum with pygidial area. Head and thorax dull due to strong microsculpture. Antennae not dilated or excavate. Mesopleuron without horizontal, pitted furrow ..... 118. ingricus (F. Morawitz)

- Pygidial area absent. Head and thorax shiny, without microsculpture. Antennae strongly dilated and excavated ventrally. A very coarsely pitted furrow issues from the episternal suture posteriorly towards coxa 2 4

4(3) Flagellar segments ventrally with a fringe of

long, pale hairs. Segments 4-7 twice as broad as long. Trochanter 1 ventrally near apex with a short spine ..... 116. peltarius (Schreber)

- Flagellar segments without hair fringe, with only adpressed short hairs. Segments 4-7 almost as broad as long. Trochanter 1 without spine ..... 117. scutellatus (Scheven)

5(2) Last tergum with pygidial area. Abdomen with white-yellow markings on terga 2-6, often additional small lateral spots on tergum 1. Tibiae rust-coloured with a yellow proximal spot ..... 120. maeklini (A. Morawitz)

- Last tergum without pygidial area. Abdomen with bright yellow markings on terga 2 and 3. Tibiae black with a yellow proximal spot 119. lapponicus Zetterstedt

115. CRABRO (CRABRO) CRIBRARIUS (Linné, 1758)

Figs. 332-334, 336.

Vespa cribraria Linné, 1758:573.

Female: 10-16 mm. Head very broad, in front view as Fig. 333. Vertex in front of ocelli with dense longitudinal striae, usually with dull surface. Punctation fine and sparse. Facial fovea well developed. Ocelli placed in a very obtuse angle, distance from a lateral ocellus to inner orbit about twice as large (1.8 x) as distance between the lateral ocelli. Frons with long, erect, black-brown pubescence. Head ventrally with gradually paler pubescence. Clypeus with triangular, non-pubescent, slightly concave area just behind anterior margin. Mandibles black, sometimes with a faintly red-brown area subapically. Antennae black, but scapus often with a small distal yellow spot on inner side. Pubescence on scapus long, white and erect. Pronotum usually with yellow lateral spots; these never fuse into a transverse band, but may be strongly reduced or missing. Scutum posteriorly with dense longitudinal striae, shiny. Anteriorly with rugoso-punctate sculpture, often with an interstitial, very fine microsculpture. Scutellum shiny, sparsely punctate, with or without yellow median spot. Whole thorax with long pubescence, brownish dorsally, whitish ventrally. Mesopleuron laterally rather shiny, with sparse punctation and very fine reticulate microsculpture. Propodeum with a broad, strongly pitted, median furrow, which together with the anterior, also coarsely pitted transverse furrows, forms a T-shaped area. The remaining part of

propodeum with fine and rather superficial sculpture. Abdomen with yellow transverse bands on terga 1, 4 and 5. In addition, large yellow lateral spots on tergum 2 and a few smaller ones on tergum 3. Femora black. Tibia 1 yellow with a large dark spot on the inner side, distally on the outer side a row of stout spines is found. Metatarsus 1 with 4 stout spines. Tibiae 2-3 and tarsi 2-3 uniform yellow or yellow-brown; tibiae, especially the posterior ones, with very strong spines on outer side.

Male: 9-16 mm. Head in front view as Fig. 334. Striation in front of ocelli stronger and more regular than in female. Anterior margin of clypeus narrowly projecting centrally, lateral teeth distinct. Mandibles near articulations with strong swelling. Just dorsal to this is found a strong tooth. Scapus thickened distally, sometimes with a small yellow spot. Flagellum strongly depressed and dilated, especially the proximal segments with concave ventral face and well developed pubescence. Pronotum with projecting lateral angles; yellow lateral spots are often absent. Scutum with strongly developed longitudinal striation over the entire surface. Spot on scutellum may be missing or be divided into two. Pubescence on head and thorax as described in female. Abdomen with yellow transverse bands on terga 1 and 4-6, and lateral spots on terga 2 and 3. Sternum 7 on either side with compressed rounded tooth. Forelegs very strongly modified. Trochanter depressed ventrally, somewhat dilated and with distal spine. Femora with large, irregular dilation and a smaller, more proximally placed spine. Often a small distal yellow spot is present on front femora. The shield-shaped dilation on tibiae with light, transparent dots (Fig. 336). Tarsi strongly dilated, mesal claw very well developed, the lateral very reduced. Femur 2 strongly dilated, with basal, longitudinal pad. Tibia 2 curved, with a weak, dark-coloured dilation distally on inner side.

The species is common in Fennoscandia and Denmark. Northern distribution limit in Sweden in Jmt. and Ång.; in Norway in MRy and On (a single specimen from TRy); in Finland in Kb and Ok. - Soviet Karelia: Ib and Kr. - The distribution area covers Europe and expands through Asia to Mongolia. The species is also recorded from Korea.

The nest is usually constructed in the soil, in sandy ground exposed to the sun, but the species has also been found nesting in decayed wood (Kohl, 1915). The main tunnel is 15-20 cm long, and ends in a cell. Later two or three cells are constructed at the end of short side branches. The walls of the tunnel system are carefully smoothed. As provision are used medium-sized Diptera of the families Muscidae, Anthomyiidae, Calliphoridae, Therevidae, Tabanidae, and Syrphidae. Each cell contains from 5 to 8 specimens.

Note. Moscar (1901) described C. cribrarius var. inornatus which is distributed in Caucasus, Siberia and northern Mongolia, and Kokujev (1927) published C. cribrarius var. hypotheticus from the region around the Lake Bajcal. Both these forms are melanistic, but all transitions from typical coloured specimens to melanistic forms occur in several European countries. The variation is probably climatically conditioned.

116. CRABRO (CRABRO) PELTARIUS (Schreber, 1784)

Fig. 337.

Sphex peltaria Schreber, 1784:98.

Female: 9-13 mm. Vertex convex, densely punctate, without striation, but with distinct reticulate microsculpture. Distance between lateral ocelli as great as distance to inner orbits. Anterior margin of clypeus very broadly protruding in the middle, evenly rounded. Specimens from Central and South Europe often have two yellow spots on clypeus. Mandibles dark in specimens from Denmark and Fennoscandia, sometimes there is a faint yellowish or red-brown spot along dorsal margin. Scapus with a shorter or longer yellow mark along anterior face. Pubescence on head white. Pronotum with small lateral angles, dorsally without yellow markings in Danish and Fennoscandian specimens. A few specimens from Denmark (SJ) have very small lateral spots. Humeral tubercle, as well as scutellum, often with yellow spots in Danish and South Scandinavian specimens. Scutum shiny, evenly and rather densely punctate. Mesopleuron at most with indicated microsculpture, laterally with very sparse punctation. Pubescence on thorax short. Propodeum dorsally with very coarse, irregular, reticulate sculpture. Abdomen with yellow lateral spots on terga 1-4, tergum 5 with a narrow transverse band. Spots on tergum 4 may coalesce. Spots on tergum 1 only exceptionally missing. Sculpture on pygidial area rather coarse, punctures partly coalescing. Femora usually with yellow or yellow-brown apical spot. Tibia 1 yellow, dark on inner side and with a larger or smaller black spot on outer side. Tibia 2 with a black spot on inner side. Tibia 3 yellow dorsally and yellow-brown ventrally.

Male: 9-12 mm. Vertex in front of ocelli strongly, slightly radially, and somewhat irregularly striate. Pubescence long, white. Genae with very strong concavities. Clypeus with very slightly protruding lateral teeth. Mandibles usually uniformly dark, a light stripe may sometimes be found dorsally. Proximally a triangular concave area. Scapus with yellow frontal face. Proximal segments of flagellum strongly dilated, excavated ventrally. Thorax without yellow markings. Pronotum with distinct lateral angles. Scutum shining, strong-

ly punctate. Mesopleuron ventrally with dense, silvery pubescence, ventro-laterally a horizontally running, strongly pitted furrow. Sculpture dorsally on propodeum strongly outstanding. Abdomen with yellow transverse bands on terga 4 and 5, and yellow lateral spots on terga 1-3. Small yellow spots are also often found on sterna 2 and 3. Sternum 7 distally protruded into two sharp, tooth-shaped processes. Trochanter 1 with short distal spine. Femur 1 with a large, broad dilation and a proximal, slender, strongly curved spine. Dilation of tibia 1 with transparent oblong spots and lines (Fig. 337). Tarsus 1 strongly dilated and depressed, pale, mesal claw very strongly modified, basal lobe transparent, the claw itself drawn out into a long slender spine, the lateral one normally developed. Femur 2 and trochanter 2 yellow ventrally, not dilated, metatarsus 2 very long and slender.

The species is common in Fennoscandia and Denmark. - The northernmost records are in Sweden from Jmt., Ång., Vb.; in Finland from Ok and ObS. - From Norway the species is only known from the southern districts. - Soviet Karelia: Ib and Kr. - Distributed from the Atlantic Ocean and the North Sea in the west to the Pacific Ocean in the east.

The species prefers sloping, sandy localities as nesting places. The main tunnel often has a strongly undulating course descending as far as 28 cm into the soil. The nest contains up to 7 cells. Many families of Diptera serve as prey; e.g. Dolichopodidae, Therevidae, Stratiomyidae, Muscidae, and Calliphoridae. Each cell contains up to 9 specimens, depending on the size of the prey, and sex of the offspring. In rainy weather and during the night, the females remain in the nest, whereas the males seek shelter in cavities in wood. As parasites are known Myrmosa melanocephala Fabr. (Hym., Myrmosidae), Sphecapata conica Fall. and Metopia argyrocephala Meig. (Dipt., Sarcophagidae). For more details, see Simon Thomas & Veenendaal, 1974.

Note. Distribution of the yellow pattern, especially in females, seems to be geographically conditioned, since in specimens from the northernmost parts of the distribution-range, it is considerably reduced. Southwards the extent of the yellow markings gradually increases.

117. CRABRO (CRABRO) SCUTELLATUS (Scheven, 1781)

Fig. 338.

Sphex scutellata Scheven, 1781:82.

Female: 8-11 mm. Vertex evenly and densely punctate, with very fine microsculpture. Facial fovea very indistinct or missing. Anterior margin of clypeus evenly rounded, without any processes, the silvery pubescence very sparse.

Mandibles often with red-yellow or rust-coloured middle. Scapus very rarely with yellow spot. Pubescence of head comparatively short, white. Pronotum with very slight projecting lateral angles, sometimes very faint yellowish lateral spots may occur. Humeral tubercle only seldom with yellow spot. Scutum very densely and rather coarsely punctate. Mesopleuron finely punctate, as a rule with distinct reticulate microsculpture. Occasional specimens have an indistinct tooth in front of coxa 2. Propodeum very coarsely sculptured. Abdomen with white-yellow lateral spots on terga 2-4 and a transverse band on tergum 5. Pygidial area with rather weak longitudinal ribs. Tibiae and tarsi yellow and yellow-brown, tibia 1 with a dark spot ventrally. Metatarsus 1 with 5-6 spines.

Male: 7-11 mm. Vertex in front of ocelli coarsely and densely, but rather superficially punctate. Genae with strong concavities and two large, triangular processes. Clypeus usually black, but may have two yellow spots. Scapus slightly dilated, yellow ventrally, flagellum very slightly dilated, proximal segments without hair fringe. Mandibles with basal tooth-like process. Thorax without yellow markings. Pronotum with well developed lateral angles. Mesopleuron ventrally with silvery pubescence, ventro-laterally with a very coarsely pitted horizontal furrow. Propodeum with strong ribs. Abdomen with yellow markings on terga 2 and 3. In addition, narrow bands may be present on terga 4 and 5. Completely black specimens may occasionally occur. Femur 1 with large, rounded dilation, near the middle with a long slender spine. Dilation on tibiae with long, transparent stripes (Fig. 338). The mesal claw on the pale, strongly flattened tarsus 1 represented by a thin almost membranous lamella. Femur 2 compressed basally, with two broad, yellow, longitudinal bands.

Very few specimens exist from Denmark: EJ, Grejsdalen, Thorsø. - Sweden: rather rare, but locally (Gotland) occurring fairly frequently; northernmost findings in Vrm. and Gstr. - Norway: a few specimens from AK, Lillestrøm, and Bø, Aamot. - Finland: a southern and south-eastern distribution, northwards to Om and Ok. - Soviet Karelia: Ib and Kr. - A fairly rare species. The distribution area covers most of Europe and extends through southern Siberia til Irkutsk.

The species is found nesting in sandy soil, often in aggregations. As prey especially Dolichopodidae are used.

118. CRABRO (CRABRO) INGRICUS (F. Morawitz, 1888)

Fig. 339.

Thyreopus ingricus F. Morawitz, 1888:294.

Female: 9-12 mm. Head dull with fine, granular sculpture, without proper

punctation. Mandibles black with rust-coloured apex. Scapus with a large yellow apical spot, flagellum black. Pronotum black with very slightly projecting lateral angles, but with strong microsculpture - at least anteriorly and laterally - distinct. Scutellum shining, with indistinct microsculpture. Episternal furrow comparatively slightly pitted. Mesopleuron otherwise with weak and sparse punctation, very strongly microsculptured. Propodeum rather shiny, without ribs, dorsally without proper sculpture, with a deep, marginate median furrow. Posterior area of propodeum almost plane, laterally well delimited by sharp carinae. Thorax with long, erect, brownish pubescence. Abdomen with large, yellow, lateral spots on terga 2 and 3. Spots on tergum 4 vestigial or missing. Femora black with a small yellow apical spot. Tibiae yellow with brown apex. Tarsi brown-yellow.

Male: 9-11 mm. Colour pattern and sculpture as in female. Antennae without dilations, excavations or hair-fringe. Last segment slightly curved and depressed. Third antennal segment twice as long as broad. Lateral angles of pronotum rather strongly projecting. Last tergum with distinct pygidial area. Trochanter 1 distally on ventral face rather strongly, triangularly dilated. Femur 1 basally with a long, thin, slightly curved spine. Dilation of tibia 1 with transparent lines (Fig. 339), metatarsus 1 only very slightly dilated and depressed, remaining tarsal segments not depressed or dilated.

The species is recorded from Soviet Karelia from the surroundings of Lake Ladoga and Lake Onega (Ib and Kr.) - Very sporadic occurrence and very rare in Europe: western Russia, Hungary, Roumania and Switzerland.

119. CRABRO (ANOTHYREUS) LAPPONICUS Zetterstedt, 1838

Fig. 335.

Crabro lapponicus Zetterstedt, 1838:433.

Female: 9-11 mm. Head and thorax with strongly developed microsculpture, dull, with long brownish pubescence. Facial fovea and frontal line distinct. Punctation of head indistinct, superficial. Clypeus without teeth or emarginations, anterior margin evenly rounded (Fig. 335), silvery pubescence thin. Mandibles strongly curved, antennae uniformly black. Pronotum with indistinctly indicated lateral angles. Punctation on scutum distinct, but superficial. On scutellum a very effaced yellow transverse spot may be found. Episternal furrow deeply pitted. Dorsally on propodeum a slightly defined area cordiformis with a longitudinal, somewhat irregularly striate sculpture is found. Median furrow deep. The area is surrounded by a weak, semi-circular furrow and carina. Propodeum laterally often with transverse carinae, delimitation of the posterior

area indistinctly marked. Abdomen short and broad, with large yellow lateral spots on terga 2 and 3. Tergum 5 with transverse band, which may be very narrowly interrupted in the middle. Specimens from Central Europe often have yellow lateral spots on terga 1 and 4. Pygidial area with very fine microsculpture, densely punctate. Femora black. Tibia 1 with a broad yellow stripe along anterior face. Tibia 2 with a proximal yellow ring, which may continue in a weak stripe to apex. Basal half of tibia 3 yellow. Wings fuscous.

Male: 9-11 mm. Microsculpture on head and thorax stronger than in female. Antennae uniform black, flagellum filiform, without hair-fringe, with very narrow tyloidea. Pubescence ventrally on thorax white. Sculpture of area cordiformis very irregular, stronger than in female. Abdomen with yellow spots on terga 2 and 3. Sometimes also two small lateral spots are found on tergum 1. Legs without conspicuous secondary sexual characters, coloured as in female.

A rather common species in northern Fennoscandia up to the Barents Sea north of Norway. Southern distribution limit in Sweden in Dlr. and Sdm., in Norway in BØ and TEi. - The species has been found in all Finnish districts except Ka, St, and Oa. - Soviet Karelia: only recorded from Kr. - The species is rare outside Fennoscandia and only recorded from mountainous regions in Germany, Poland and Czechoslovakia.

The nests are often found in aggregations, e.g. on sandy paths. The main tunnel descends about 10 cm into the ground, and thereafter turns almost horizontally. On the latter stretch 2-4 cells are constructed, which are provisioned with e.g. species of Rhagionidae (Diptera).

120. CRABRO (ANOTHYREUS) MAEKLINI A. Morawitz, 1866

Crabro (Anothyreus) maeklini A. Morawitz, 1866:262.

Female: 10-11 mm. Sculpture on head and thorax as in lapponicus, but finer Pubescence long and erect, white or silvery. Pronotum, metanotum and usually also scutellum with white-yellow spots. Abdomen with white-yellow lateral spots on terga 2-4, tergum 5 with transverse band. Femora black, tibiae red-yellow with proximal white-yellow spots.

Male: 9-10 mm. Head in dorsal view only slightly narrowed behind eyes, pubescence whitish. Thorax shining, only on mesopleuron with distinct microsculpture. Scutum with indications of radiate striation. Lateral angles of pronotum white-yellow, protruded in a tooth. Metanotum with yellow double spot. Area cordiformis as in female, with weak longitudinal rugae. Lateral faces of propodeum with irregular striae, with interstitial microsculpture.

Abdomen with white-yellow lateral spots on terga 1-4 and a transverse band on terga 5 and 6. The spots on tergum 1 are often reduced. Tergum 7 with distinct pygidial area. Legs of same colour as in female.

This high-boreal species has a very discontinuous distribution in northern Fennoscandia, eastern Siberia (Okhotsk) and northern Mongolia. In Fennoscandia it is not uncommon, occurring in Sweden in T. Lpm.; in Norway in southern and northern Nordland and in Finmark. - Finland: north of the Arctic Circle in ObN, Lk, Le and Li. - U.S.S.R.: Lr, Petsamo.

The nests are constructed in even slopes with sandy soil (Merisuo, 1932). As distinct from lapponicus, no accumulation of dug out material is found round the entrance. The main tunnel, whose diameter is about 3 mm, descends 10-12 cm into the ground, where it may divide into two short branches, each ending in a cell. The provision consists of flies of the genera Trichopticus, Coenosia and Lophosceles (Dipt., Muscidae).

Genus *Ectemnius* Dahlbom

Crabro (Ectemnius) Dahlbom, 1845:389.

Type-species: Crabro guttatus van der Linden, 1829.

Large to medium-sized, robust species (Fig. 340) with black and yellow pattern. Eyes very large, inner orbits strongly converging ventrally so that the antennae are inserted very close to each other. Ommatids of very diverse sizes. Those directed forwards many times larger than those situated near posterior margin of eye. Clypeus with strong silvery or golden pubescence, its anterior margin with species-specific teeth and emarginations. Scapus usually more than four times longer than broad, its yellow colour more or less extensive. Flagellum black, its second segment always longer than the third. In the male these segments may have excavations ventrally or protruding teeth, which are of great taxonomic value. In front of coxa 2 a sharp arcuate or angular carina is always present on mesopleuron (precoxal carina). Forewings with only one cubital and discoidal cell. Abdomen with yellow lateral spots and/or transverse bands. Pygidial area of female usually excavated in a groove posteriorly, bordered by strong, golden bristles. Males with 12 antennal segments. The yellow pattern is only very seldom completely absent, but usually varies considerably within a species. Its value as a key character is therefore limited. In the description of the species this variation is discussed in broad terms. It is mainly influenced by geographical and climatic factors, and specimens from southern Europe have a considerably more extensive

yellow pattern than specimens from Denmark and Fennoscandia. Even within the border of the last mentioned regions the variation is very conspicuous.

The genus is cosmopolitan, but with most species in the Holarctic region.

The species nest in old timber, where the nests are constructed by means of the very well developed mandibles. Males as well as females are often seen foraging in flowering Umbelliferae. The prey consists of Diptera.

Key to species of Ectemnius

Females

1 Scutum without punctures, finely and regularly striate. Entire anterior part regularly, transversely striate. Remaining part with longitudinal striae 2

\- Scutum different, often with fine rugae between punctures 3

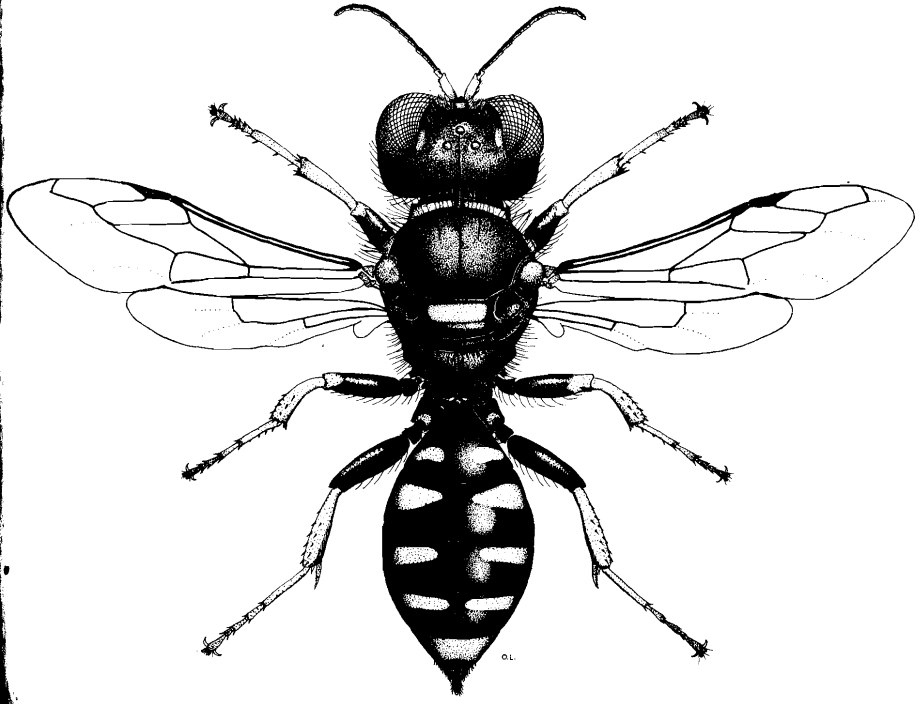


Fig. 340. Female of Ectemnius cavifrons (Thomson). Length: 11-16.5 mm.

2(1) Lateral angles of pronotum strongly projecting as angles or teeth. Lateral faces of propodeum strongly transversely striate. Greatest width of head across mandibular articulations (Fig. 341). ..... 121. fossorius (Linné)

- Lateral angles of pronotum rounded. Lateral faces of propodeum very densely and finely striate. Greatest width of head across middle of eyes (Fig. 342) ..... 122. cephalotes (Olivier)

3(1) Third antennal segment at least 3 times longer than distal width. Pubescence on clypeus golden shining. 4

- Third antennal segment less than 3 times as long as distal width. Pubescence of clypeus silvery or pale golden 7

4(3) Head in front view broad and approximately rectangular in outline (Fig. 344). Median lobe of clypeus arcuately or slightly angularly emarginate. Lateral lobes rounded and plump. Third antennal segment 4 times longer than broad distally. Lateral faces of propodeum coarsely striate. Bands on abdomen usually not interrupted in the middle. Venter with yellow markings .. 124. sexcinctus (Fabricius)

- Head in front view approximately trapezoid. Bands on abdomen interrupted in the middle. Venter black 5

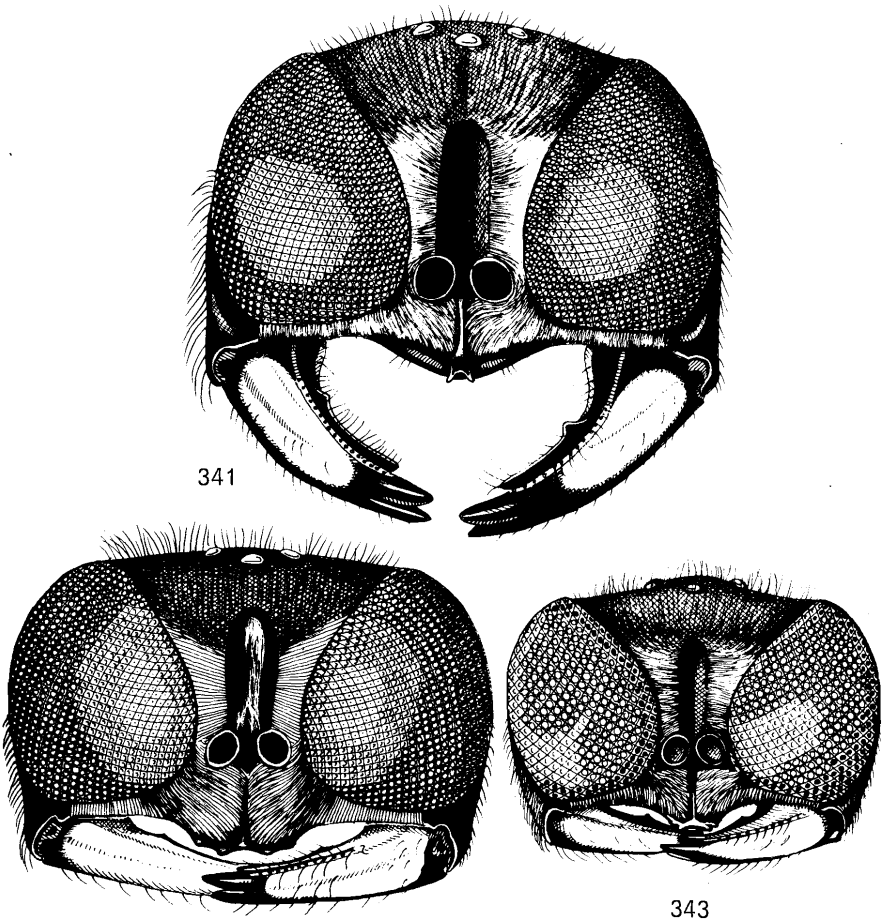
5(4) Ocelli forming an acute angle. Vertex surrounding ocelli depressed like a trough. Lateral lobes of clypeus small (Fig. 345). Lateral faces of propodeum very finely and densely striate, usually with silky lustre. Third antennal segment 4 times longer than broad ..... 125. cavifrons (Thomson)

- Ocelli forming an obtuse angle. Vertex not or slightly depressed. Third antennal segment 3-3.5 times longer than broad 6

6(5) Lateral lobes of clypeus small, obliquely forwardly-directed, separated from median lobe by distinct emargination (Fig. 347). Posterior face of propodeum forming a more or less distinct-

ly delimited triangular area, which is indistinctly and irregularly, transversely, partly reticulately rugose. Interstices between rugae of area cordiformis shiny ..... 127. lapidarius (Panzer)

- Lateral lobes of clypeus very strong, directed laterally (Fig. 346), the median keel distinct, combining with the anterior margin of the median



Figs. 341-343. Heads in frontal view of female Ectemnius. - 341: fossorius (L.); 342: cephalotes (Oliv.); 343: lituratus (Panz.).

lobe to form a shiny T-shape. Posterior face of propodeum very finely punctate with dense, fine striae, continuing laterally. Interstices dull between rugae of area cordiformis ..... 126. ruficornis (Zetterstedt)

7(3) The shiny area above antennal sockets without transverse carina dorsally. Scutum with conspicuous, long, erect pubescence. Posterior face of propodeum not sharply delimited laterally 8

- The shining area above antennal sockets dorsally delimited by a carina. Pubescence on scutum short. Posterior face of propodeum usually laterally delimited by a strong carina, so that a triangular area is formed 11

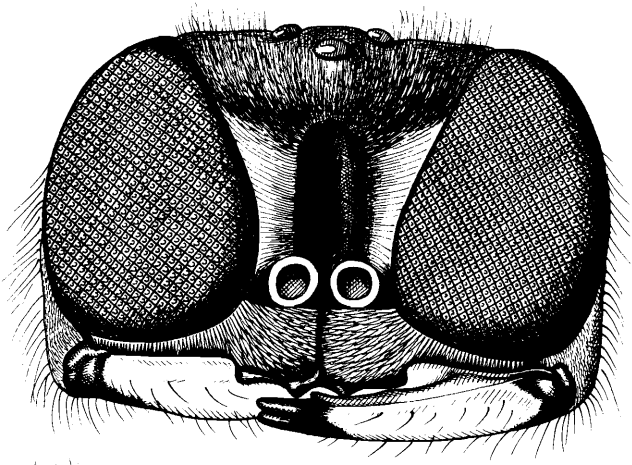
8(7) Thorax without yellow markings. Mesopleuron shiny, without striation ..... nigritarsus (Herrich-Schäffer)

- Pronotum usually with two yellow lateral spots, sometimes almost effaced. Mesopleuron strongly transversely striate 9

9(8) Frons in front of ocelli with shiny interstices between punctures. Distance between the anterior and a lateral ocellus smaller than diameter of ocellus. Pronotum with rounded lateral angles. Terga 1-5 with yellow bands, which may be missing on first and interrupted on third ..... 123. lituratus (Panzer)

- Frons in front of ocelli without shiny areas between punctures. These often form ruga-like rows. Distance between the anterior and a lateral ocellus greater than diameter of an ocellus. Pronotum usually with sharp lateral angles. Terga 1 and 3 usually without yellow markings 10

10(9) Anterior margin of median lobe of clypeus broad, slightly angularly emarginate. Lateral lobes very indistinct (Fig 349). The very regular, fine and dense striation laterally on propodeum continues uninterruptedly on posterior face. Third antennal segment about twice as long as wide ..... 128. continuus (Fabricius)



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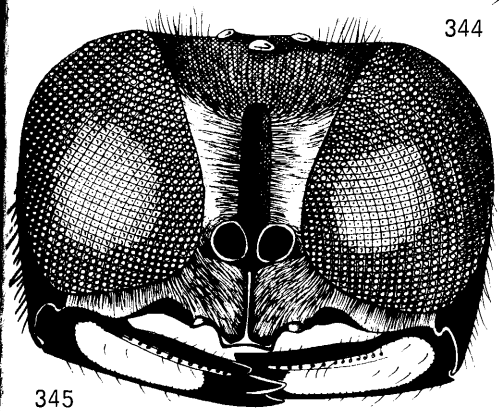

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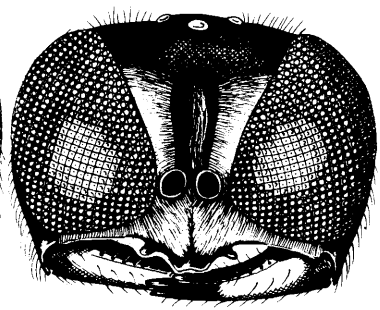

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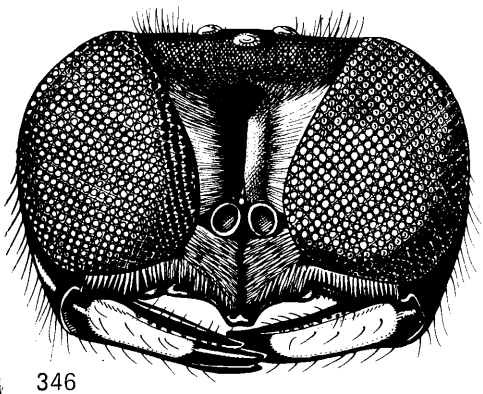

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Figs. 344-347. Heads in frontal view of female Ectemnius.
344: sexcinctus (Fabr.);
345: cavifrons (Thomson);
346: ruficornis (Zett.);
347: lapidarius (Panz.).

- Anterior margin of clypeus with three rounded tubercular processes (Fig. 350). Striae on lateral faces of propodeum not continued on posterior face. Sculpture here consists of very irregular rugae. Third antennal segment not quite 1.5 times longer than broad ..... 129. rubicola (Dufour & Perris)

11(7) Lateral angles of pronotum usually projecting as a strong, forwardly-directed, acute tooth. Third antennal segment distinctly longer than fourth. Pubescence on clypeus faintly golden-shining. Lateral faces of propodeum uniformly, very finely and densely striate ..... 130. dives Lepeletier & Brullé

- Lateral angles of pronotum rounded or with a very small, upwardly directed, obtuse tooth. Clypeus with silvery pubescence. Lateral faces of propodeum interspersed with coarser striae 12

12(11) Carina dorsally delimiting smooth area dorsal to antennal sockets usually angularly bent. Scutellum usually shiny in the middle, without rugae. Tibia 2 brown only on the inner side or entirely brown. Pronotum dorsally usually without yellow pattern. Third antennal segment only slightly longer than fourth ..... 132. borealis (Zetterstedt)

- Carina dorsally delimiting smooth area dorsal to antennal sockets forming an even, shallow arc. Scutellum longitudinally rugose throughout its length. Tibia 2 pure yellow, sometimes with an effaced darker spot on inner side. This spot is larger in Lapland specimens. Pronotum with yellow pattern dorsally ..... 131. guttatus (v.d. Linden)

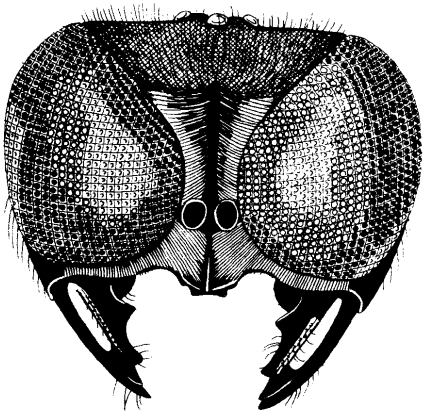
Males

1 Scutum impunctate but very finely and regularly striate. Anterior half of scutum regularly transversely striate. Stripes parallel to posterior margin of pronotum 2

- Scutum punctate with rugose interstices 3

2(1) Third flagellar segment with strong excavation

ventrally, fifth segment also excavate, distally on ventral face produced into a truncate tooth



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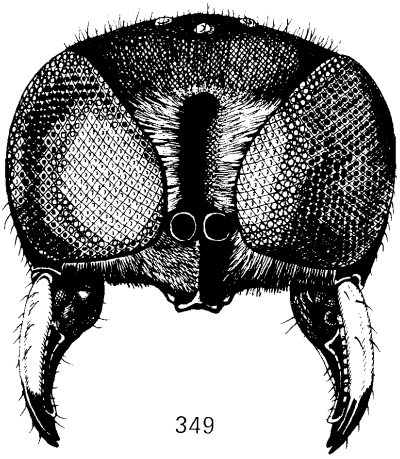

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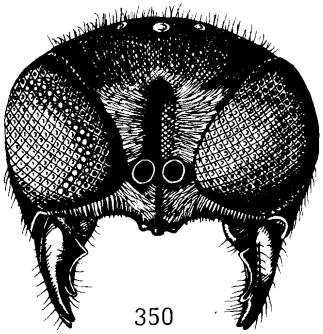

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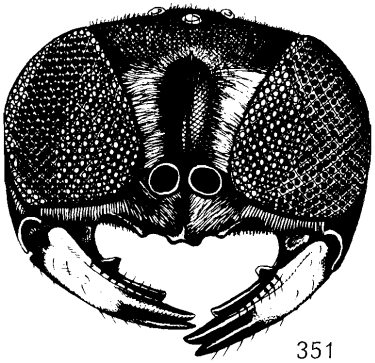

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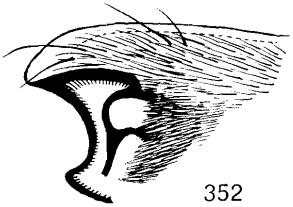

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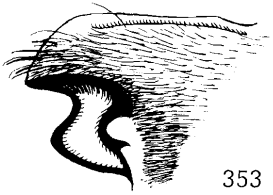

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Figs. 348-351. Heads in frontal view of female Ectemnius. - 348: nigritarsus (Herrich-Schäffer); 349: continuus (Fabr.); 350: rubicola (Duf. & Perris); 351: dives (Lep. & Brullé).
Figs. 352-353. Clypeus in lateral view of female Ectemnius. - 352: dives (Lep. & Brullé); 353: borealis (Zett.).

(Fig. 359). Trochanter 1 with blunt, triangular, ventrally directed dilation ..... 121. fossorius (Linné)

- All flagellar segments normal. Trochanter 1 without dilation ..... 122. cephalotes (Olivier)

3(1) Metatarsus 1 and second tarsal segment broad, colourless and transparent. Second tarsal segment much larger than third, and differing considerably in colour from that and the following. Third antennal segment in dorsal view at most twice as long as wide apically, ventrally usually strongly excavate, fourth and sixth segments slightly excavate 4

- Metatarsus 1 and second tarsal segment of normal shape and colour. Tarsal segments 2-4 gradually decreasing in size 6

4(3) Metatarsus 2 asymmetric, short, laterally dilated (Fig. 375). Metatarsus 1 ventrally with 4 strong, broad, flattened spines (Fig. 372). Lateral angles of pronotum produced into very stout, forwardly directed teeth ..... 130. dives Lepeletier & Brullé

- Metatarsus 2 normal, symmetrical. Metatarsus 1 ventrally with vestigial spines. Lateral angles of pronotum not, or only very slightly produced 5

5(4) Third antennal segment excavate ventrally, distinctly longer than fourth. Lateral angles of pronotum rounded or obtuse ..... 132. borealis (Zetterstedt)

- Third antennal segment not, or slightly excavate ventrally, as long as fourth. Lateral angles of pronotum acute ..... 131. guttatus (v. d. Linden)

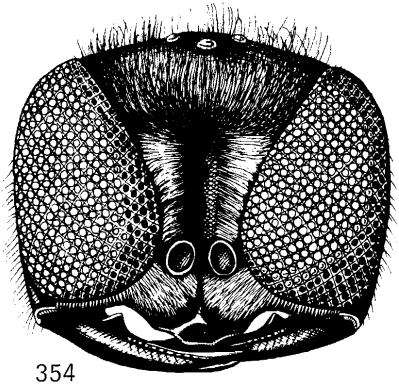
6(3) Third antennal segment in dorsal view at most 3 times longer than thick apically, not excavate ventrally 7

- Third antennal segment 3-4 times longer than thick apically, ventrally with two excavations .. 10

7(6) Mesopleuron smooth, with fine punctation. Legs mainly black. Abdomen without yellow markings

on terga 1 and 4. Head very strongly narrowed ventrally. Tooth on inner side of mandibles very strongly developed (Fig. 357). Last tergum with pygidial area ..... nigritarsus (Herrich-Schäffer)

- Mesopleuron transversely rugose. Legs with



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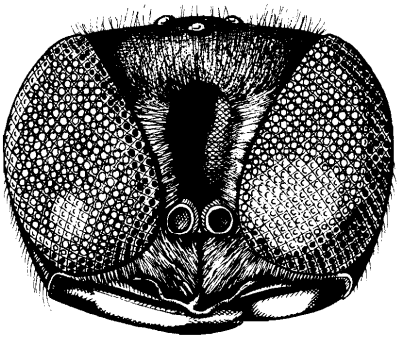

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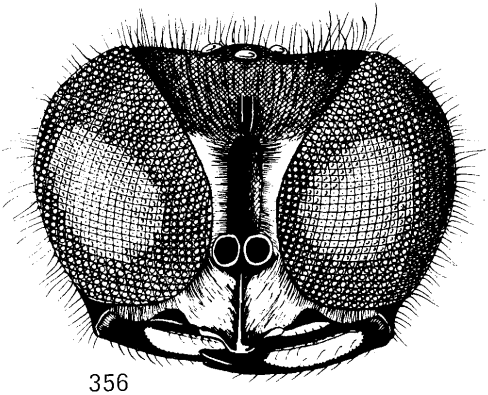

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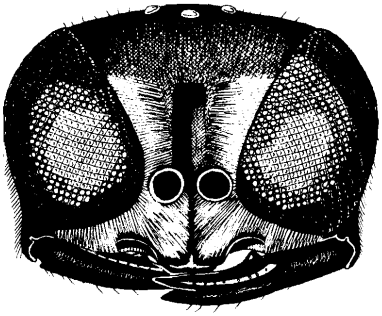

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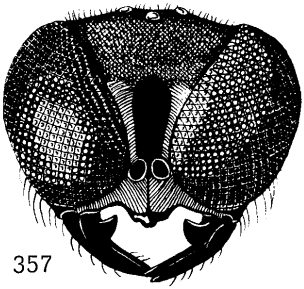

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Figs. 354-358. Heads in frontal view of male Ectemnius. - 354: fossorius (L.); 355: sexcinctus (Fabr.); 356: cavifrons (Thomson); 357: nigritarsus (Herrich-Schäffer); 358: continuus (Fabr.).

extensive yellow markings. Tergum 4 with yellow lateral spots or a transverse band. Tooth on inner side of mandibles much weaker. Last tergum without pygidial area 8

8(7) No antennal segments excavate ventrally, 3rd-11th with a narrow, pale brown longitudinal pad. Abdomen with very extensive yellow pattern ..... 123. lituratus (Panzer)

- Antennal segment 6 more or less distinctly, fifth often slightly, excavate ventrally. Flagellum without longitudinal pads ventrally. Abdomen usually without yellow pattern on terga 1, 3, 6 and 7 9

9(8) Metatarsus 2 and tarsal segment 3 in lateral view each with a strong tooth-like dilation distally on ventral face (Fig 368). Ventral edge of femur 1 in lateral view evenly curved ..... 128. continuus (Fabricius)

- Metatarsus 2 and tarsal segment 2 normal. Femora proximally with sharp-edged dilation (Fig. 371) ..... 129. rubicola (Dufour & Perris)

10(6) Third antennal segment with a dorsal swelling, proximal tooth slender, distal one broad and thick, cone-shaped. Segments 4 and 5 slightly excavate (Fig. 364). Flagellum except pedicellus ventrally black ..... 127. lapidarius (Panzer)

- Third antennal segment not swollen, teeth almost equal, segments 4 and 5 strongly excavate, with large teeth. Ventral face of flagellum except terminal segments more or less pale 11

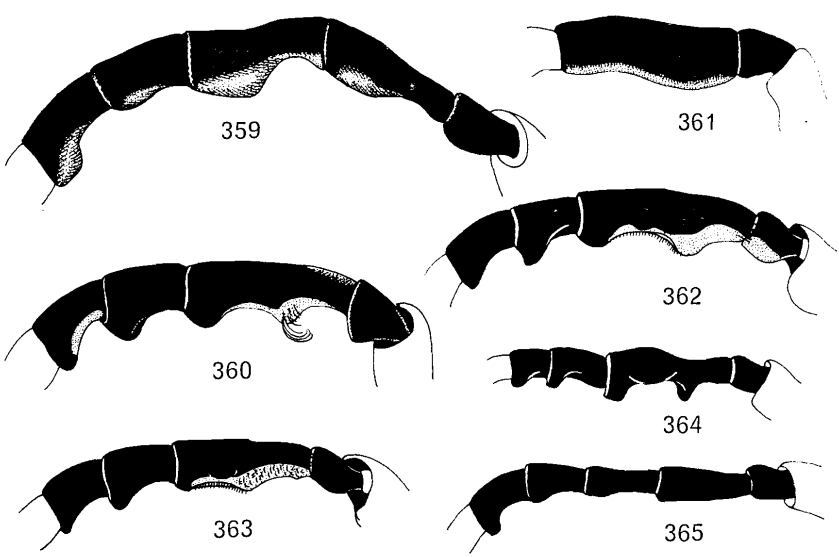
11(10) Proximal tooth on third antennal segment cone-shaped with a small tuft (or a single hair) of light curly hairs apically (Fig. 360). Pubescence of frons brown. Lateral faces of propodeum coarsely striate..... 124. sexcinctus (Fabricius)

- Proximal tooth on third antennal segment without hair tuft. Pubescence of frons black.

Lateral faces of propodeum finely striate 12

12(11) Third antennal segments in dorsal view about four times longer than wide centrally, sides distinctly curved in an S-shape (Fig. 361). Distance between the proximal two teeth ventrally on flagellum greater than distance between 2nd and 3rd (Fig. 362). Vertex distinctly depressed (Fig. 356). Pubescence of clypeus pale golden, seldom silvery ... 125. cavifrons (Thomson)

\- Third antennal segment in dorsal view about three times longer than wide centrally, sides straight, almost parallel. Distance between the proximal two teeth on flagellum almost equal to the distance between the second and the third (Fig. 363) ..... 126. ruficornis (Zetterstedt)



Figs. 359-365. Proximal part of antennae of male Ectemnius. - 359: fossorius (L.); 360: sexcinctus (Fabr.); 361, 362: cavifrons (Thomson); 363: ruficornis (Zett.); 364: lapidarius (Panz.); 365: continuus (Fabr.).

121. ECTEMNIUS (METACRABRO) FOSSORIUS (Linné, 1758)

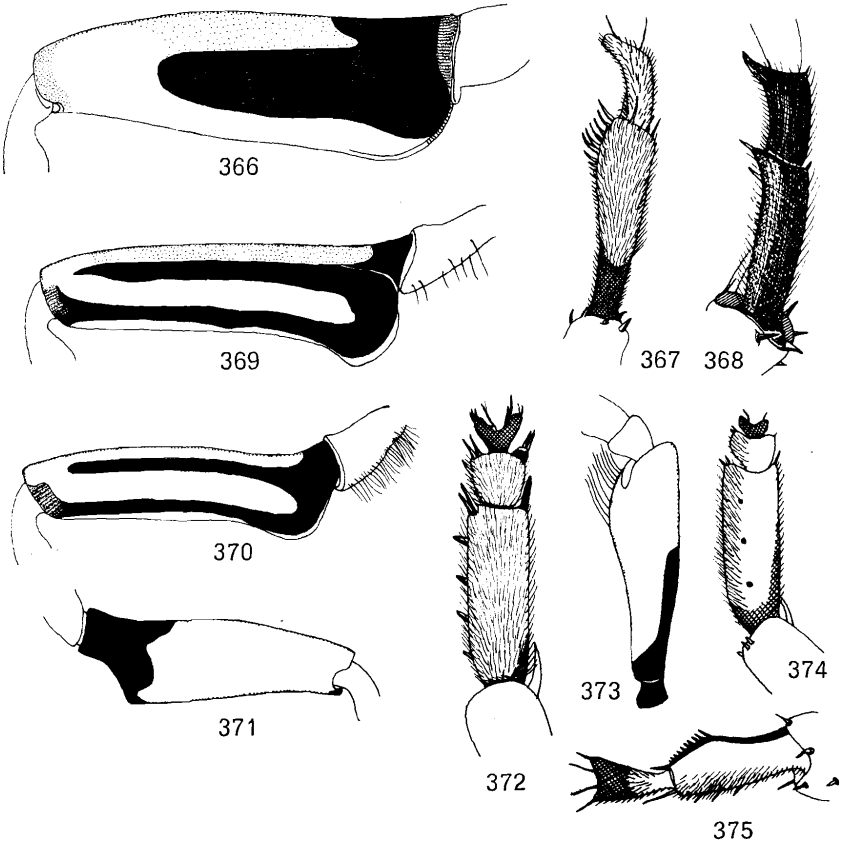
Figs. 341, 354, 359.

Sphex fossorius Linné, 1758:571.

Female: 16-21 mm. Head in front view trapezoid in outline (Fig. 341). Distance across mandibular articulations considerably larger than distance posteriorly across the eyes. Vertex very well developed. Punctation on vertex very fine and dense, ventrally, towards genae, coarser and sparser. Clypeus narrow, the longitudinal median keel especially anteriorly projecting sharply. The thickened anterior margin with two small teeth. Pubescence on clypeus silvery or slightly golden-shining. Mandibles very stout, yellow with black margins, apex and base. Scapus entirely yellow, or proximally with a faint dark spot on posterior face. Pubescence of head dorsally light brown, ventrally white, rather long and erect. Lateral angles of pronotum slightly projecting in an obtuse angle, the surface itself weakly transversely striate. Humeral tubercle black. The two yellow spots uppermost on pronotum very variable in size, usually missing in specimens from the northernmost part of the distribution range. Scutum shiny, its anterior third transversely striate, posterior two-thirds with longitudinal striation. Lateral parts with fingerprint-like sculpture. Scutellum anteriorly shiny and slightly punctate, posteriorly densely striate. Mesopleuron of rather dull appearance, its striation rather strong, ventrally towards the base of midleg gradually changing into an irregularly rugose sculpture. Lateral faces of propodeum also dull with strong, arcuate carinae and ribs. Area cordiformis very indistinctly delimited, its striation weak and irregular. The bottom of the median furrow divided into quadrate pits. A pair of yellow spots ventrally on lateral faces of propodeum are usually found in specimens from Central and South Europe. Pubescence of thorax brownish, white ventrally. Fennoscandian specimens have larger or smaller yellow, triangular, lateral spots on terga 1-4, tergum 5 with transverse band. Central and South European specimens often have complete bands on terga 1-4. Wings darkened, often with a faint violet tinge. Femora black, tibiae usually mainly yellow or brown-yellow. The distal tarsal segments usually brown. Specimens from the central and southern parts of the distribution range have more or less extensive yellow patterns on femora 2-3 and on coxa 3.

Male: 13-16 mm. Head in front view narrowed ventrally, across mandibular articulations distinctly narrower than across eyes (Fig. 354). Head in dorsal view narrowed posteriorly, the sides straight. Frons in front of ocelli very finely, although slightly irregularly, longitudinally striate. Behind ocelli is distinct transverse striation, running parallel to posterior margin of head, disappearing just before the hypostomal carina. Facial fovea distinctly depressed, shiny, with

extremely weak punctation. Median part of clypeus comparatively strongly projecting, anteriorly with a shiny, triangular, hairless area. Median keel weak, shiny. The surface itself with dense, silvery or very faintly golden-shining pubescence. Mandibles black with slightly reddish apex, with a very strong tooth near the base on the internal side. Scapus mainly black, frontal face with a larger or smaller yellow spot. Third flagellar segment basally with a strong excavation with a distal swelling. Fourth and fifth segments with weaker excavation (Fig. 359). Frons, especially in front of ocelli, with long, erect, brownish pubescence.



Figs. 366, 369-371. Femur 1 of male Ectemnius. - 366: lituratus (Panz.); 369: guttatus (v. d. Lind.); 370: borealis (Zett.); 371: rubicola (Duf. & Perris).
Figs. 367, 368, 375. Proximal part of tarsus 2 of male Ectemnius. - 367: lapidarius (Panz.); 368: continuus (Fabr.); 375: dives (Lep. & Brullé).
Figs. 372, 374. Proximal part of tarsus 1 of male Ectemnius. - 372: dives (Lep. & Brullé); 374: borealis (Zett.).
Fig. 373. Scapus of male Ectemnius dives (Lep. & Brullé).

Pronotum black in Nordic specimens. Specimens from Germany and Switzerland with larger or smaller yellow lateral spots. Lateral angles of pronotum almost rectangular. The transverse and longitudinal striation on scutum somewhat stronger, but more irregular (sometimes undulating) than in female. Scutellum and metanotum with irregular, longitudinal rugae. Lateral faces of mesopleuron coarsely striate on almost smooth substrate. Towards the ventral midline of thorax the sculpture becomes very irregular. Lateral and posterior faces of propodeum, as in female, strongly, transversely striate on dull substrate. Dorsally without delimited area cordiformis, irregularly reticulate-rugose, with well delimited median furrow. Whole thorax with erect greyish pubescence. Abdomen with yellow lateral spots on terga 1-4, tergum 5 usually with transverse band. Spots on tergum 1 may be missing. Tergum 7 considerably more strongly punctate than the others, with a broad, smooth, longitudinal furrow. Trochanter 1 distally with a broad, sharp-edged process. Legs mainly black, tibia 1 and tarsi partly yellow-brown. Specimens from Central and South Europe often have five complete yellow transverse bands on abdomen. Band on tergum 3 usually interrupted in the middle.

In Fennoscandia this rather rare species occurs in Central Sweden: Sm. to Jmt. and Ång., south-eastern Norway: AK, and southern and south-eastern Finland, northwards to Ok. - It is unlikely to occur in Denmark. - The distribution pattern in Europe may be boreo-alpine. The species occurs in Central Europe, eastwards to the Urals, Caucasus, Kazakhstan and Uzbekistan in the U.S.S.R. Isolated populations occur in Mongolia and North-East China.

The biology of the species is incompletely known. It is however stated that the nests are constructed in steep, clayey slopes. The prey consists of rather large flies, e.g. Asilidae.

122. ECTEMNIUS (METACRABRO) CEPHALOTES (Olivier, 1792)

Figs. 9, 342.

Crabro cephalotes Olivier, 1792: 513.

Ectemnius quadricinctus auctt.

Female: 12-17 mm. Head in front view almost rectangular in outline, only very slightly narrowing ventrally (Fig. 342). Vertex with very dense punctation, uniformly fine round the ocelli, but anteriorly and posteriorly coarser, with a slight tendency to coalesce into short rugae. Facial fovea large and flattened. Anterior margin of the slightly projecting median lobe of clypeus forms a very obtuse angle. Lateral lobes small and obtuse-angled. Pubescence strongly silvery. Mandibles yellow with black apex, margins and base. Scapus entirely yellow, lateral-

ly with a long, transparent lamella. Pronotum completely devoid of lateral angles, dorsally finely transversely striate. Yellow lateral spots may be absent, and the humeral tubercles in individuals from northernmost localities are without yellow markings. Scutum shiny with distinct transverse striation on anterior third. The posterior two-thirds with longitudinal striae. Scutellum anteriorly with a narrow, shiny punctate area, otherwise strongly, longitudinally striate. Mesopleuron rather dull in Danish and Fennoscandian specimens, shining and smooth in Central and South European specimens. The areas below the base of the forewings have rather uniform ribs, gradually developing into a weaker, more irregular rugosity near the ventral midline. Lateral faces of propodeum mainly with a very fine, dense striation. Area cordiformis distinct, shining, with radiating, longitudinal ribs. Median furrow strong. While Nordic specimens often have completely black thorax (except the spots on pronotum), the scutellum, metanotum and a spot behind the humeral tubercle are usually yellow in specimens from the remaining Europe. Pubescence of thorax rather long and erect, white, dorsally sometimes brownish. Terga 2-4 usually with yellow lateral spots, tergum 5 with transverse band. Specimens from southern Denmark often have a complete transverse band on tergum 2, and, in rare cases, a yellow pattern on terga 1 and 6. Sterna black, often with paler posterior margins. Femora black, sometimes with small distal yellow spots. Tibiae mainly yellow.

Male: 9-14.5 mm. Head in front view more narrowed ventrally than in female. Vertex rather well developed, posteriorly narrowed, with distinctly convex sides. Punctation round ocelli very dense and rather coarse. Towards posterior margin of head, and forwards towards the steeply declining portion, the punctures become less distinct, shallow, and now and then coalesce. Clypeus with a broadly rounded median part, lateral lobes very indistinct. Pubescence silvery, in Central European specimens often faintly golden-shining. Mandibles ventrally with a stout tooth curving towards the base, black in Nordic specimens. Some Danish specimens, however, have a faintly yellowish streak along the dorsal margin. Scapus with a narrow, longitudinal transparent lamella, mainly yellow, on posterior face with a large black or brownish spot. None of the flagellar segments excavated or dilated. Pronotum sculptured as in female, but the yellow lateral spots are often absent. Humeral tubercle with or without yellow spot. Scutum with somewhat coarser sculpture than in female. Scutellum black. Sculpture of mesopleuron as in female, without yellow pattern. Lateral faces of propodeum rather shiny, above with a fairly strong admixture of short ribs. Posterior face of propodeum with strong transverse ribs. Area cordiformis anteriorly with a row of short, strong longitudinal ribs, otherwise with irregular, radiating rugae. Dorsal face of thorax with brownish, ventral face with white pubescence. Abdomen with yellow lateral spots on terga 2-4, terga 5-7 usually

with complete transverse bands. Tergum 7 with a short and rather strong longitudinal depression. Femur 1 generally with a broad, yellow stripe along ventral margin. Femora 2-3 sometimes with a small yellow apical spot. Tibiae yellow, tibiae 1-2 with more or less extensive black pattern. Metatarsi yellow, metatarsus 2 distinctly asymmetrically dilated on the outer side, sometimes with a strong distal spine. Second tarsal segment very slightly dilated.

This species is rare in Fennoscandia and Denmark. Denmark: a southern distribution, - Sweden: from Sk. to Dlr. and Gstr. - Norway: a small material from AK and Bø. - Finland: a few specimens from Ta and Sa. - Soviet Karelia: Ib. - A Holarctic species. In the Palaearctic region it occurs from England in the west to the Urals and Caucasus in the east. The species may have been introduced in North America, where it occurs in South-East Canada and the North-East U.S.A.

The species often breeds in large aggregations. Occasionally several females have been observed to use same nest entrance (Hamm & Richards, 1926). A number of lateral tunnels issue from the short common entrance, corresponding to the number of inhabitants (Fig 9). The prey mainly consists of Diptera: Syrphidae, Muscidae, Calliphoridae and Tabanidae.

Note: The specimen in coll. Fabricius under the name Crabro quadricinctus Fabr. is a female Crossocerus (Acanthocrabro) vagabundus Panzer, possibly originating from southern Europe.

123. ECTEMNIUS (METACRABRO) LITURATUS (Panzer, 1805)

Figs. 343, 366.

Crabro lituratus Panzer, 1805: H. 90, T.13.

Female: 11-14.5 mm. Head in front view very distinctly narrowed ventrally (Fig. 343). Punctation on frons very regular, dense, punctures not coalescing. Facial fovea distinct, shining and usually impunctate. Median part of clypeus rather narrow, raised like a roof, its interior margin emarginate in an obtuse angle. In front view the anterior margin is strongly thickened. Lateral lobes indistinct, rounded. Pubescence strongly silvery. Mandibles yellow with black apex and base, margins brownish. Scapus without longitudinal dilations, uniform yellow. Pedicellus may be partly yellow in South European specimens. Pronotum with rounded lateral angles, without striation. Humeral tubercle and two large dorso-lateral spots yellow. Scutum anteriorly with two, generally strong, longitudinal carinae, the anterior part with transverse sculpture interspersed with more or less coalescing punctures. Between the carinae scutum is very densely punctate anteriorly, posteriorly the punctures fuse into weak longitudinal

rugae, which continue in the extensive longitudinal rugosity on posterior two-thirds of scutum. Scutellum with irregular longitudinal rugae interspersed with punctures. Mesopleuron shiny, laterally with regular, strong ribs, ventrally with sparse and rather coarse punctation. Lateral faces of propodeum shiny with weak striation. Posterior face with sparse punctation, without striation. Area cordiformis very indistinct, only anteriorly with short, radiating ribs. Yellow pattern on thorax (excluding pronotum), in Danish specimens restricted either to a narrow stripe on metanotum and a double spot on scutellum sometimes vestigial. Central and South European specimens have very extensive yellow markings on these sclerites. In addition lateral faces of propodeum and mesopleuron are often provided with yellow spots. In rare cases two yellow spots are found in area cordiformis. Abdomen in Danish specimens usually with complete transverse bands on terga 2-5. The band on tergum 3 may be narrowly interrupted. Tergum 1 with yellow lateral spots. In material from other parts of Europe these yellow spots are usually fused into a transverse band. Sterna 2 and 3 may be provided with round lateral spots or seldom with transverse bands. Metatarsus 1 on the other side with very few (2-3) pale spines. Femora black with a larger or smaller yellow, apical spot. In more southern European specimens this spot is very large on femora 1-2. Tibiae and tarsi yellow.

Male: 9-12 mm. Head ventrally strongly narrowed. Distance across mandibular articulations equals greatest distance between inner orbits on upper frons. Head posteriorly narrowed, with convex sides. Vertex between ocelli very densely and finely punctate, otherwise with coarser and sparser punctation. Distance between punctures on anterior part of vertex on average slightly smaller, but posteriorly greater than diameter of punctures. Median part of clypeus rather strongly projecting, anterior part rounded, lateral lobes slightly projecting. Median part of mandibles yellow or red-yellow, apex and base black. Tooth on inner side weak. Scapus in Danish specimens mainly black. No flagellar segments excavate or dilated. Pronotum usually with slightly projecting lateral angles, with two yellow lateral spots, which are greatly reduced in Danish specimens. Humeral tubercle yellow. Longitudinal and transverse striation on scutum only indicated. Admixture of rather coarse punctation dominates, especially anteriorly. Right in front of the rather strongly, longitudinally rugose scutellum, striation is however very pronounced. Mesopleuron as described in female, but admixture of punctures laterally more conspicuous. The rather strong striation on lateral faces of propodeum is continued onto posterior face. Area cordiformis with strong and usually longitudinal ribs. In the hitherto known Danish specimens thorax is devoid of yellow markings. Abdomen with complete transverse bands, at least on terga 5 and 6, terga 1 and 7 without yellow pattern in Danish specimens. Terga 2-4 with large lateral spots, which in

material from other parts of Europe form complete transverse bands. Tergum 7 without depression. Femur 1 with proximal sharp-edged dilation (Fig 366). Metatarsus 1 flattened ventrally. Tibia 2 slightly compressed, somewhat curved in an S-shape. Metatarsus 2, second and third tarsal segments distally on the ventral side slightly dilated. Legs mainly yellow, but femur 3 usually all black.

In the North only known from Denmark: F, Frederiksgave, and LFM, Toreby and Roden Skov.-Distributed, but not abundant, in Central and South Europe, and in a large area between the Black and the Caspian Seas.

Nests in wood. Remains of flies on external side of cocoon have been found to belong to Anthomyiidae or Cordyluridae.

Note: The external morphology shows several features which place this species in the sub-genus Clytochrysus. These features are most obvious in the secondary sexual characters.

124. ECTEMNIUS (CLYTOCHRYSUS) SEXCINCTUS (Fabricius, 1775)

Figs. 344, 355, 360.

Crabro sexcinctus Fabricius, 1775:374.

Crabro zonatus Panzer, 1797: T.7.

Female: 11-17 mm. Head in front view almost rectangular, in outline considerably broader than long (Fig 344). Entire frons so densely punctate that interstices are smaller than the diameter of the punctures. Ocelli placed in an acute angle. Facial fovea very indistinct. Clypeus with very characteristic anterior margin (Fig 344), and the lower part of the face, and in a certain degree also genae, has a dense, faintly golden, seldom silvery pubescence. Mandibles long, mainly yellow. Scapus entirely yellow. Flagellum, except ventral face of pedicellus, black. Pronotum with two large yellow spots. Humeral tubercle with a large yellow spot. Scutum anteriorly with two rather strong, shiny, longitudinal carinae; punctation anteriorly very dense and regular, rather fine, posteriorly less distinct, forming short, longitudinal rugae. Scutellum, except anterior part, also longitudinally rugose, interstices punctate. Metanotum often, scutellum more seldom, with yellow pattern. Mesopleuron laterally with only weak transverse striation. Propodeum laterally, however, with very sharp, regular ribs, which continue uninterruptedly onto the posterior face. Area cordiformis shiny, very weakly delimited, with irregular, longitudinal rugosity. Pubescence on thorax long and erect, dorsally pale brown, ventrally white. Usually yellow transverse bands are found on all terga. In addition sterna 2-6 often have ex-

tensive yellow markings as does also the basal half of the pygidial area. Femora black with larger or smaller yellow apical spots. Tibiae and tarsi entirely yellow. Coxa 3 often with a small yellow spot ventrally.

Male: 10-13 mm. Head ventrally narrowed much less than in the other species of the subgenus. Distance across mandibular articulations much larger than the least distance between eyes dorsally on frons. Dorsal part of frons very densely punctate, interstices everywhere smaller than diameter of punctures. Vertex strongly developed. Median part of clypeus normally broad, projecting almost like a nose, not quite as broad as scapus. Anterior margin evenly rounded (Fig 355). Lateral lobes very slightly projecting. Mandibles usually with yellow marks, which are generally missing in small specimens. No tooth at the base. Scapus yellow with a larger or smaller black spot on posterior face. Longitudinal carina along anterior margin very weak. Flagellum brown-yellow ventrally. Third antennal segment ventrally with two, fourth and fifth with a single excavation. The tubercular process between the excavations of third antennal segments bears a small tuft, or seldom only a single hair (Fig. 360). Pubescence of head dorsally light brownish, ventrally whitish. Pronotum shiny, slightly punctate, often with indications of lateral angles. The yellow lateral spots may be missing in small specimens. Humeral tubercle always with a yellow spot. Scutum anteriorly with two, rather strong, longitudinal carinae, the surface itself uniformly, densely and rather strongly punctate, only just in front of scutellum with short rugae. Scutellum very weakly longitudinally rugose, black. Metanotum often has a yellow transverse spot. Lateral faces of mesopleuron and propodeum sculptured as in female. Area cordiformis usually somewhat more coarsely and irregularly sculptured than in female. Pubescence on thorax dorsally light brownish, ventrally white. Abdomen in Danish specimens often with interrupted, transverse bands on terga 1-3. The remainder with complete bands. All abdominal transverse bands usually complete in more southerly specimens. Venter with more or less extensive yellow pattern. Femur 1 with two black, a yellow and a brown-yellow longitudinal stripe. Pretarsi with distinct, dark, longitudinal stripe. Femora 2-3 mainly black. All tibiae and tarsi yellow. Metatarsus 2 distally slightly asymmetrically dilated, second segment also with dilation. Tibia 2 slightly curved in an S-shape, with very short apical spur.

The species has a pronouncedly southern and south-eastern distribution in Denmark. It is a common species in several localities on Funen. - From Fennoscandia it is only known from Sk., several localities, in southern Sweden. - The distribution area covers Central and South Europe and extends through southern Siberia to western China.

The species may be found nesting in old timber exposed to the sun, fencing posts and the like. The prey consists of rather large Syrphidae, e.g. Scaeva pyrastri (L.), Syrphus ribesii (L.) and the like, which are captured on leaves and flowers in the sun. The dermestid beetle Megatoma undata L. has been found in a nest of this species. The larva was described by Maneval, 1937.

125. ECTEMNIUS (CLYTOCHRYSUS) CAVIFRONS (Thomson, 1870)

Figs. 340, 345, 356, 361, 362.

Crabro (Solenius) cavifrons Thomson, 1870: 173.

Female: 11-16,5 mm. Head in front view considerably narrower across mandibular articulations than across eyes (Fig. 345). Vertex round ocelli distinctly depressed. Punctation in front of these dense, interstices on average smaller than diameter of punctures. Facial fovea rather distinct, shiny with sparse punctation. Clypeus with rather strongly projecting median lobe, the anterior margin of which is slightly angularly emarginate. Lateral lobes small, directed obliquely forward (Fig. 345). Pubescence strongly golden. Mandibles yellow with black apex and base. Scapus entirely yellow, flagellum black, first and sometimes also proximal part of second flagellar segment yellow in Danish specimens, terminal segments pale ventrally; third segment almost four times longer than broad distally. Head with long, black pubescence on frons, ventrally with slightly brownish pubescence. Pronotum dorsally without distinct sculpture, with two large, yellow lateral spots. Humeral tubercle usually yellow in Danish and South Swedish specimens. Norwegian, Finnish and Central Swedish specimens lack this yellow pattern. The two longitudinal carinae anteriorly on scutum weak. Anteriorly on scutum the sculpture consists of an obliquely outwardly directed, very fine, dense, rugose punctation. Posteriorly the striation becomes stronger, interstices broader and more shiny. Posterior two thirds of scutellum distinctly striate. A large number of the specimens from Fennoscandia lacks the yellow transverse spot on scutellum, in Danish specimens it is usually present. Mesopleuron densely, more or less regularly, transversely striate, striae often of different strength. Lateral and posterior faces of propodeum very finely and regularly striate, sometimes with sateen-like tinge. Area cordiformis very indistinct with weak, obliquely, outwardly directed rugae or irregular striae. Abdomen with yellow lateral spots, which may form a transverse band on tergum 5. Sternum 6 occasionally with two yellow spots. Pygidial area black, narrow, posteriorly deeply excavate in a groove. Sterna shining black, sometimes with yellow posterior margin. Femora black, usually with a very small yellow apical spot, usually missing in Fenno-

scandian material. Tibiae yellow with larger or smaller black spots apically. Tarsi brown, metatarsi yellow.

Male: 8-12.5 mm. Head in front view only very slightly broader than long. Eyes strongly convex, vertex rather strongly depressed. These features, together with the rather projecting clypeus, give the head an almost cordiform outline (Fig. 356). Vertex anteriorly very densely punctate, behind ocelli, on either side is a shiny, weakly punctate area. Ocelli placed in a distinctly acute angle. Pubescence on frons long and erect, black. Clypeus with silvery pubescence, anterior margin of median lobe evenly rounded, rather broad, lateral lobes distinct, rounded. Yellow spot on mandibles often vestigial, or absent. Scapus yellow with a larger or smaller black spot on posterior face . Frontal face with a narrow, transparent, sharp, longitudinal carina. Flagellum black, brown-yellow ventrally. Third antennal segment in dorsal view with distinctly concave margins (Fig. 361), ventrally with two strong excavations between which there is a large, almost truncate cone-shaped process. Segments 4 and 5 also excavated distally, and with a distinct dilation (Fig. 362). Pronotum with or without yellow lateral spots. These are absent - like the spots on the humeral tubercles - in most Fennoscandian specimens. Carinae on anterior scutum very indistinct, sculpture anteriorly densely rugoso-punctate, laterally with very weak, obliquely, outwardly directed rugae; posteriorly distinctly, but somewhat irregularly longitudinally striate. Scutellum black, with longitudinal striae. Striation of mesopleuron less pronounced than in female. Striation on lateral faces of propodeum considerably stronger in male than in female. On posterior face striation becomes very strong (almost as in sexcinctus). Area cordiformis indistinctly delimited, anteriorly with strong but short, longitudinal ribs, otherwise with irregular and weak sculpture. Thorax dorsally with brown, ventrally with white pubescence. Abdomen with yellow lateral spots on terga 1-4, terga 5 and 6 usually with yellow transverse bands, which may however be interrupted on tergum 5. Tergum 7 with a weak longitudinal depression. Femur 1 brown-yellow with two black and a yellow longitudinal stripe. Tibia 1 with only a black longitudinal stripe, which may be absent in rare cases. Tarsal segments 1-4 pale yellow, pretarsus 1 basally on ventral face usually with a strongly blue-violet shining spot, slightly asymmetrical, with a dark spot on the external face. Femur 2 black with brown-yellow, and usually also a yellow stripe along anterior margin. Apical spot on femur 3 considerably smaller. Tibia 2 curved in an S-shape, with black, yellow and brown-yellow pattern. Spur very short. Metatarsus 2 and next segment weak distally, asymmetrically dilated. Tibia 2 with more extensive yellow and yellow-brown pattern.

Common in Denmark and southern Fennoscandia. Found in all districts in Denmark, except SZ, where it undoubtedly also occurs. - Sweden: northern distribution limit in Vrm. and Gstr. - Norway: only found in the southern and south-eastern districts. - Finland: from Al, Ab, N and Ka in the south to Om and Ok in the north. - Soviet Karelia: Ib and Kr. - Widespread in Europe, eastwards to Lake Baikal in southern Siberia, Sakhalin and Japan.

The nests are constructed in decayed wood, often as an enlargement of the nest system of preceding years. The first few centimetres of the entrance are at right angles to the surface. The system branches in several planes. If two or more females use the same entrance, fights may occasionally occur near the entrance. At the end of each short lateral tunnel, a larval chamber is constructed, and provisioned with rather large Syrphidae, of which 6-12 are placed in each cell. Each nest may contain more than a hundred flies. While the females are placing the prey, depositing eggs, constructing the nest system, or are hunting, it often happens that Pemphredon lugubris Latr. tries to force its way into the nest in order to construct its own nest system. The intruder is, however, rapidly chased away by the "furious-looking" owner, which with wide-open mandibles and a deep buzzing from the vibrating wings pursues Pemphredon to the entrance of the nest. Eustalomyia hilaris Fall. (Diptera, Anthomyiidae) is herewith recorded as cleptoparasite. In warm long summers the species may produce two generations in Denmark. The latter may be met with till late in September. The larva was described by Leclercq, 1954.

126. ECTEMNIUS (CLYTOCHRYSUS) RUFICORNIS (Zetterstedt, 1838)

Figs. 346, 363.

Crabro ruficornis Zetterstedt, 1838:443.
Crabro nigrifrons Cresson, 1865:482.
Crabro septentrionalis Packard, 1866:110.
Crabro planifrons Thomson, 1870:173.
Crabro hector Cameron, 1891:147.
Ectemnius (Clytochrysus) nigrifrons taiwanus Tsuneki, 1968:2.

Closely related to cavifrons, but distinguishable from it by the following characters: Ocelli placed in an obtuse angle; distance between the lateral almost twice as great as the diameter of one of them. Vertex without depression.

Female: 10-15 mm. Median lobe of clypeus strongly projecting, lateral lobes very conspicuous, tooth-like, directed outwards at right angles (Fig. 346). Median keel strongly projecting, together with anterior margin forming a shining T-shaped figure. Third antennal segment in dorsal view as long as or slightly

longer than fourth and fifth together. Humeral tubercle entirely black. Scutum anteriorly with two sharp, shining, longitudinal carinae, which are weaker in small specimens. Sculpture on posterior third of scutum weak in the middle, interstices between punctures and rugae broad and shiny. Spots on abdomen somewhat less extensive than in cavifrons.

Male: 7.5-12 mm. Due to the convex shape of vertex, the outline of the head, in frontal view, does not show the cordiform shape characteristic of cavifrons. The tooth between the two excavations on third antennal segment is small and acute (Fig. 363). Scutum anteriorly with two distinct, longitudinal carinae. The depression on tergum 7 weak or absent. The black colour on legs 2-3 considerably more extensive.

Not common in Denmark, but found in most districts. - A very large distribution in Sweden, northwards to Ly. Lpm., Lu. Lpm. and Nb. - Rather widespread in Norway up to Nordland. - Finland: common, occurring in most districts up to Ks and LkW. - Soviet Karelia: Ib and Kr. - A Holarctic species, which has a very wide distribution in the Palaearctic, Nearctic and Neotropic regions. Apparently, it does not occur in southern Europe. Isolated populations in Mexico (ssp. hector Cameron), in Caucasus, Kazakhstan, Sakhalin, Kamchatka, Formosa, and Japan (ssp. taiwanus Tsuneki).

Biologically, the species closely approaches cavifrons. The nests are constructed similarly in old timber, dead trunks, fencing-posts and the like. The prey consists of larger Syrphidae.

127. ECTEMNIUS (CLYTOCHRYSUS) LAPIDARIUS (Panzer, 1804)

Figs. 347, 364, 367.

Crabro lapidarius Panzer, 1804: H.90, T.12.

Crabro chrysostomus Lepeletier & Brullé, 1834:704.

Female: 9-12 mm. A relatively small, robust species. Head in front view rounded (Fig. 347). Vertex distinctly convex, large, very well developed. Ocelli placed in an obtuse angle, distance between the posterior ocelli twice as large as the diameter of one of them. Punctation anteriorly on vertex dense, interstices smaller than diameter of punctures. Facial fovea weak with sparse punctation. Clypeus with rather strongly projecting, narrow median lobe, its anterior margin slightly angularly or arcuately emarginate. Lateral lobes rather small, tooth-like, directed obliquely forward (Fig. 347). Median keel strongly projecting. Scapus entirely yellow. Flagellum black, third antennal segment almost as long as the succeeding three segments combined. Yellow colour of mandibles considerably less extensive than in the other species of

the subgenus. Pubescence of frons brownish. Pronotum usually with two yellow lateral spots, without pronounced lateral angles. Humeral tubercle nearly always without yellow marks in Fennoscandian specimens. Scutum anteriorly with two weak longitudinal carinae, very densely and uniformly punctate, only laterally and posteriorly with rugosity, which right in front of scutellum forms a well-defined striation. Scutellum usually black, but sometimes with yellow marks in specimens from Central and South Europe. Mesopleuron shiny, striation weak (distinctly weaker than in cavifrons), in front of coxa 2 the sculpture consists partly of a weak, sparse punctation, partly of an indistinct, reticulate microsculpture. Lateral faces of propodeum with dull appearance, striation rather strong, slightly undulating. Posterior face dull, without proper striae, laterally delimited by a strong carina. Sculpture in area cordiformis irregular, only anteriorly well-defined by short longitudinal carinae. Median furrow distinct, anteriorly usually twice as broad as posteriorly. Abdomen with elongate yellow lateral spots on terga 2-4, tergum 5 often with transverse band. Specimens from Denmark and Fennoscandia with yellow spots on tergum 1 are rare. Bristles bordering pygidial area pale yellow. All femora black. Tibiae yellow with a larger or smaller black spot on the inner side. Tarsi light brown-yellow, distal segments brown.

Male: 7-11 mm. Width of head across mandibular articulations only very slightly larger than greatest distance between inner margins of eyes when head is seen in front view. Eyes strongly convex. Head distinctly broader than high. Vertex convex. Ocelli placed in an obtuse angle. Punctation anteriorly on vertex very dense, posteriorly with shining interstices. Clypeus with strongly projecting median lobe, lateral lobes weak; pubescence silvery. Flagellum black, proximal segments brown-yellow ventrally. Third antennal segment in dorsal view with a slight concavity on either side, almost as long as combined length of segments 4-6, seen in profile with two deep emarginations and two teeth; dorsally strongly convex (Fig. 364). Ventral emarginations on projecting lateral angles, dorsally with or without yellow lateral spots. Humeral tubercles usually completely black. Longitudinal carinae anteriorly on scutum weak or absent, the sculpture consists of a very dense uniform punctation, but anterior-laterally with distinct transverse rugosity. Just in front of scutellum striation is strong. Scutum distinctly longitudinally rugose. Thorax dorsally with long, erect, brownish pubescence. Mesopleuron shiny, finely transversely rugose with extremely fine punctation. Propodeum laterally with dense, somewhat undulating striae. Transition between lateral portion and posterior face marked by a carina. The dorsal face of propodeum with very irregular carinae or ribs. Posterior face regularly transversely striate. Abdomen with yellow

lateral spots on terga 2-5, tergum 6 with a transverse band. In Fennoscandia specimens with both yellow spots on first and a complete band of fifth tergum are rare. Sterna black. Femur 1 and tibia 1 with the black, yellow and brown-yellow striping which is characteristic of the subgenus. Pretarsus 1 with a dark longitudinal stripe, ventrally with a slightly asymmetrically placed, dark, sometimes slightly bluish, metallic spot. Femora 2-3 black with a small yellow apical spot. Tibia 2 slightly curved, the black colour predominating. Metatarsus 2 only very slightly dilated distally (Fig. 367). Tibia 3 with a large, yellow, longitudinal spot dorsally.

The species is not common in Denmark, where it seems to have a southern and south-eastern distribution. - Widespread in Sweden, from Sk. in the south to Ång. and Vb. in the north. - Rather common in Norway, northwards to Nordland. - Finland: common and widely distributed, northwards to ObN and Ks. - Soviet Karelia: Ib and Kb. - A Holarctic distribution-pattern. In the Palaearctic region the species occurs in Europe, Caucasus, Kazakhstan, Mongolia, Manchuria and Japan.

The species is usually found nesting in decayed wood, e.g. Populus. The anterior section of the main tunnel is very characteristically enlarged to about twice the diameter of the rest of the tunnel. The remaining part of the nest consists of one or several tunnels, from which the larval chambers are constructed as very short lateral branches. The prey consists of Syrphidae, Therevidae, Muscidae or Calliphoridae. Males as well as females are commonly met with on Angelica flowers.

ECTEMNIUS (CAMERONITUS) NIGRITARSUS (Herrich-Schäffer, 1841)

Figs. 348, 357.

Crabro nigritarsus Herrich-Schäffer, 1841:14.

Female: 10-13 mm. Vertex in front of ocelli very densely punctate, interstices equal to or a little less than diameter of punctures. Ocelli placed in a very obtuse triangle, the distance from a lateral ocellus to the median is smaller than the diameter of an ocellus. Facial fovea missing. The shiny area dorsal to antennal sockets very narrow. Median lobe of clypeus narrow, angularly arcuately emarginate, lateral lobes very small, rounded (Fig. 348). Pubescence on clypeus silvery or pale golden. Pubescence of frons long, black or faintly brownish. Mandibles comparatively short, usually with a white-yellow spot. Scapus yellow, with a very small black spot distally. Thorax without yellow markings. Transverse carina of pronotum not forming lateral angles. Scutum with very fine and dense punctation, antero-laterally with transverse, posteriorly

with longitudinal, fine rugae. Pubescence paler than on head. Mesopleuron shiny and smooth, with very sparse punctation. Area cordiformis broad, fairly distinctly delimited. Anterior delimiting furrow deeply pitted. Area itself shining, with fine and somewhat irregular, slightly radiating striae. Posterior propodeal area laterally delimited by a very indistinct, pitted furrow, sometimes missing. Lateral areas with dense and fine undulating striation, posteriorly interspersed with fine punctation. Abdomen with yellow lateral spots on terga 2-4. Spots on first tergum small or missing, transverse band on tergum 5 vestigial. Lateral margins of pygidial area slightly concave, the area itself with coarse punctation. Femora and tarsi black, in European specimens tibia 1 partly, tibiae 2-3 mainly, yellow. Wings rather strongly infuscate.

Male: 8.5-12 mm. Head strongly narrowed ventrally. Distance across mandibular articulations considerably smaller than greatest distance between inner margins of eyes (Fig. 357). Head strongly narrowed behind eyes. Vertex in front of ocelli shining, with sparse and rather coarse punctation. Clypeus with a narrow, truncate median lobe, lateral lobes rounded. The silvery pubescence rather thin. Mandibles with a very stout tooth on the inner side. Scapus with yellow frontal face. Antennal segments 4 and 5 slightly swollen ventrally, segment 6 very slightly excavate. Thorax without yellow markings. Scutum shiny, punctation considerably coarser and sparser than in female. Punctation on mesopleuron as in female. Area cordiformis with rather strong, radiating striation, dorsal and lateral faces sculptured as in female. Terga 2-4 with yellow lateral spots, terga 5 and 6 with transverse bands. Very small lateral spots may occur on tergum 1 in European specimens. Tergum 7 with pygidial area. Legs without secondary sexual characters. Tibia 1 brown-yellow on inner side. Femur 2 may have a small yellow spot distally. Spines on tibiae 2-3 missing on outer side.

The species is not known from Fennoscandia and Denmark, but might be expected to occur in southern Denmark. - It has a very sporadic distribution and is found mainly in mountainous regions in Central Europe, Turkey and southern Siberia. It is also recorded from north-eastern China, Sakhalin, Japan and southern Vietnam.

The species has been found nesting in decayed wood (Tsuneki, 1960), where earlier constructed nests can be used and added to. The prey consists of Diptera, e.g. Muscidae, Anthomyiidae, Therevidae or Syrphidae.

Note: The species is recorded as belonging to the Swedish fauna since the publication of Kohl's monograph in 1915 (Ög., Lärketorp, 17.7.1835, Dahlbom leg.). In Dahlbom's collection 3 females and 4 males are present under the name rubicola. These are all identical with rubicola (Duf. & Perris), and not

as supposed by Kohl, with nigritarsus (Herr.-Sch.). A female specimen from Ratzeburg in Germany completely lacks the sculpture on mesopleuron, and area cordiformis is almost smooth, punctate. An almost identical female specimen from the same locality is kept at the Zoological Museum of Copenhagen (Coll. Wüstnei). It is probable that Dahlbom used the Ratzeburg specimen when he wrote his differential diagnosis. His diagnosis includes, however, characters associated with the morphology of the head, clypeus, and the colour pattern on the abdomen, which are characteristic of rubicola.

128. ECTEMNIUS (HYPOCRABRO) CONTINUUS (Fabricius, 1804)

Figs. 349, 358, 365, 368.

Crabro continuus Fabricius, 1804:312.

Crabro vagus auctt.

Female: 9.5-14.5 mm. Head in front view considerably broader than high (Fig. 349). In dorsal view almost rectangular, only slightly narrowed posteriorly. Ocelli placed in an obtuse-angled triangle, distance between lateral ocelli more than twice as great as the diameter of an ocellus. Punctation in front of ocelli very dense and fine, forming narrow, longitudinal rugae. On vertex punctation becomes stronger and considerably sparser. A weak transverse rugosity is discernible in a few specimens. Facial fovea plane, shining, smooth, punctation extremely weak. Pubescence of head long and erect, brownish, ventrally lighter. Median part of clypeus slightly angularly convex, with a very obtuse-angled emargination anteriorly; median keel strong. Lateral lobes very small, rounded (Fig. 349); pubescence strongly silvery. Mandibles with a stout tooth on the inner side near the base, black with ivory-yellow spot in the middle near the dorsal margin. This spot is considerably larger in South European specimens. Third antennal segment about twice as long as wide. Pronotum with very weak or no lateral angles, the transverse carina also weak. The yellow spots are most frequently found in specimens from the central and southern part of Fennoscandia, being often reduced or absent in specimens from the northernmost parts of the distribution range. Humeral tubercle usually black in Fennoscandian specimens. Anterior part of scutum dull, very densely and coarsely, but rather superficially sculptured, laterally with slight transverse rugosity, posteriorly with shining, even interstices. Scutellum rather coarsely punctate, with shining, posteriorly ruga-forming interstices. Metanotum dull, with irregular and dense, longitudinal rugosity. Mesopleuron shiny, laterally without proper punctation, usually distinctly and regularly transversely striate. Ventrally the striation gradually becomes weaker; close to ventral midline it is replaced by a fine, sparse punctation. Propodeum laterally with

very dense, fine striation, which continues uninterruptedly on posterior face. Area cordiformis without distinct delimitation, with irregular, slightly radiating striation. Median furrow deep, at bottom with several fine, transverse striae. Whole thorax with a thin, rather long and erect light-brown pubescence, becoming gradually paler ventrally. Tergum 1 basally very densely and finely longitudinally striate, with long erect pubescence. Terga 2, 4 and 5 with yellow lateral spots. A rather indistinct spot may occur on tergum 3. Pygidial area black, posteriorly strongly narrowed, excavated in a groove, surrounded by stout, golden bristles. The surface proper proximally coarsely and densely punctate, distally with a row of shallow punctures along the margin. Femora black. Tibiae 1-2 yellow with a large black spot on the inner side, tibia 3 with only a small black apical spot. Tarsi black or brown, The yellow markings on the legs are considerably more extensive in South European specimens which usually also have broad yellow transverse bands on scutellum, metanotum, and on terga 2, 4 and 5. Wings distinctly darkened.

Male: 8-12 mm. Head across eyes distinctly broader than high (Fig 358). Ventrally distinctly narrowed. Frons in front of ocelli, which form a very obtuse triangle, rather weakly sculptured, with densely placed longitudinal rugae, posteriorly gradually disappearing in oblique rugae between ocelli and eyes. Pubescence of frons somewhat darker than in female. Median part of clypeus strongly projecting, anterior margin almost evenly rounded. Lateral lobes only very weakly developed. Mandibles mainly black, usually with a small yellow spot near the middle. The basal tooth very strong. Scapus yellow with a large black spot on posterior face. This spot usually extends throughout the length of the segment. Flagellum black, its second segment twice as long as broad, segments 4 and 5 ventrally with an excavation, strongest on segment 5 (Fig. 365). Segments 2 and 3 ventrally with a narrow, pale brown, longitudinal pad. Pronotum with a small acute tooth on either side. Transverse carina distinct. Yellow lateral spots usually very reduced or even absent. Humeral tubercle black. Scutum dull, with uniformly dense and rather coarsely pitted sculpture, anteriorly without longitudinal carinae. Very robust specimens often have a weak transverse striation anteriorly, while posteriorly, just in front of scutellum, a weak longitudinally rugose sculpture may be present. Mesopleuron shiny, laterally with irregular, coarse striation or rugosity. Ventrally the sculpture consists of only fine, sparse punctures. A very weak transverse striation may occur in rare cases. Propodeum laterally with a mixture of coarser carinae and very fine, dense striation. The latter may almost disappear. The coarser carinae usually continue uninterruptedly on posterior face. Area cordiformis with a very irregular, slightly irregularly,

longitudinal rugosity, posteriorly often joining a transverse carina, which represents the posterior delimitation of the area. Tergum 1 basally with a dense, fine, longitudinal striping, and tergum 4 normally with yellow lateral spots. Tergum 5 generally with a transverse band, which may be separated into spots. The spots on terga 2 and 4 may exceptionally form transverse bands in Danish and Fennoscandian specimens, and a very small lateral spot may occur on tergum 3. Femora 2-3 black, sometimes with a yellow apical spot. Femur 1 yellow-brown with a black-and-yellow longitudinal stripe. Along the ventral margin runs a sharp carina. Tibia 1 also tri-coloured. Metatarsus 1 pale, slightly transparent. Tibiae 2-3 yellow with more or less extensive black pattern. Metatarsus 2 and next tarsal segment with asymmetrical dilation distally (Fig. 368).

The species is distributed all over Denmark and Fennoscandia and is probably the most common sphecid of all. - The distribution area covers subtropical, temperate and subarctic regions in the northern hemisphere. The southermost records originate from Venezuela, the northernmost from northern Finnmark (about 70°N.).

Nests in old timber, e.g. solitary tree stumps, fallen decayed branches and the like. The tunnel system may be branched and consists of up to 10 cells. The species shows great plasticity in its breeding behaviour. The appearance of the nest depends on the material in which it is constructed. There are several observations of apparently "unusable" prey, e.g. of too small-sized flies being thrown out of the nest after some time, or otherwise carried away from the nest. The prey consists of Diptera, e.g. Muscidae, Calliphoridae, Tabanidae, Therevidae and Syrphidae. Each cell contains from 6 to 8 specimens. When the larva is fullgrown, it collects the remains at the bottom of the cell, and then starts spinning the long pear-shaped cocoon, in which it winters as a pre-pupa. The larva was described by Evans, 1964b.

129. ECTEMNIUS (HYPOCRABRO) RUBICOLA (Dufour & Perris, 1840)

Figs. 350, 371.

Solenius rubicola Dufour & Perris, 1840:25.

Crabro larvatus Wesmael, 1852:614.

Female: 7-9.5 mm. Head in front view very broad (Fig. 350). Distance across mandibular articulations only slightly greater than greatest distance between eyes, when the head is seen in front view. Vertex very well developed. Punctation in front of ocelli coalescing to a dense, longitudinal rugose sculpture. Behind ocelli punctures become stronger, with only a slight tendency

to form transverse rugae. Clypeus anteriorly with three rounded tubercles (Fig. 350), its pubescence silvery. Mandibles short and strong, usually with a yellow median spot. Their three teeth almost equally stout. The tooth on the inner side near the base also strong. Scapus short, yellow with a black spot near the base. Flagellum short, segments 2 and 3 at most 1.5 times longer than broad. Pronotum with a sharp, transverse carina and well developed lateral angles. Lateral spots may be absent in rare cases. Humeral tubercle usually black in Fennoscandian specimens. Scutum coarsely sculptured, densely grooved, anteriorly often transversely rugose or striate. Posteriorly punctation becomes considerably sparser and the interstices smooth and flat. Sculpture of scutellum very weak anteriorly, posteriorly consisting of short, strong transverse rugae. Metanotum is always black in Fennoscandian specimens. Mesopleuron shiny, variation in sculpture very great, but usually laterally consisting of an irregular transverse striation. Specimens without any transverse striation occur. Propodeum laterally very densely and finely striate. On the transition to the posterior face a coarsely pitted or very irregularly sculptured zone is often present. The sculpture on posterior face may be more regular, often consisting of transversely or obliquely running carinae. At any rate, the rather coarse sculpture on posterior face of propodeum is distinctly different from the fine regular lateral striation. Area cordiformis often shiny, very slightly sculptured, with indistinct rugosity or only with weak, sparse punctation. Tergum 1 basally with a considerably coarser and more irregular striation than in continuus. Terga 2 and 4 with yellow lateral spots. Tergum 5 usually with a transverse band. Specimens from Central and South Europe usually have bands both on terga 4 and 5, and tergum 3 has large, yellow lateral spots. Pygidial area triangular, its lateral margins very slightly concave, the surface proper almost plane, very weakly punctate, the bordering bristles weak and pale. Femora black. Tibiae 1-2 yellow, in Fennoscandian specimens with extensive black markings throughout the length of the segment. Tibia 3 with black proximal and distal spots. Tarsi black or brown.

Male: 6-9.5 mm. Head ventrally strongly narrowed. Distance across mandibular articulations as great as the greatest distance between eyes, when the head is seen in front view. Frons in front of ocelli with a rather strongly striate or longitudinally rugose sculpture. Frons behind ocelli densely and rather coarsely punctate, in robust specimens with distinct transverse rugosity. Median part of clypeus narrow, rather strongly projecting; anterior margin with only very weak tubercles. Scapus with yellow frontal side, short and strong, at most 3.5 times longer than broad. Fifth flagellar segment ventrally with distinct excavation. Excavation on fourth very weak. Segments 3, 4 and 6-8

ventrally with broad, flat, usually pale brown longitudinal pads. Transverse carina of pronotum strong, laterally obtuse-angled. The yellow lateral spots may be missing in Fennoscandian specimens. Scutum shining, strongly sculptured, anteriorly with very pronounced, but usually irregular, transverse rugosity. Posteriorly the rugae are distinctly longitudinal. Scutellum coarsely pitted,in Fennoscandian specimens without yellow markings. This also applies to metanotum. Mesopleuron laterally with a usually strong, irregular, transverse striation, which gradually disappears towards the ventral midline. Lateral faces of propodeum with distinctly weaker striation, at the transition to the posterior face changing to a row of very coarse vertical pits. The posterior face proper with coarse, irregular carinae and rugae, and the area dorsally is delimited by a strongly projecting carina. Area cordiformis with coarse sculpture, consisting of pits, the margins of which are sharply raised. Tergum 1 basally with irregular, rather dense and strong striation. Fennoscandian specimens lack the yellow lateral spots on terga 1, 3, 6 and 7. Femur 1 basally on ventral face with a strong, obtuse-angled dilation (Fig. 371), yellow with a large yellow distal spot. Femur 3 completely black. All tibiae with yellow frontal face and black posteriorly. Metatarsus 1 flattened, pale yellow-brown like the remaining part of tarsus. The other tarsi brown.

The species is not found in Denmark, but might be expected to occur there.- Northern distribution limit in Sweden: Gstr. - A few records from southern Norway. - Finland: rather common, from Al, Ab and N to Sb and Kb. - Soviet Karelia: Kr. - Widely distributed in Europe, North Africa, Caucasus, Kasakhstan and in north-eastern China and Japan.

The species is the only one in the genus which nests in plant stems, e.g. Rubus and Phragmites. The cells are placed successively in the single tunnel. This method is commonly used by e.g. Trypoxylon, Passaloecus and Psenulus. Rubicola uses material such as plant dust for making partitions between the cells, of which there may be up to 17 in a single stem. Flies belonging to the families Muscidae, Cyrtidae, Syrphidae, Lauxaniidae, Trypetidae etc. represent the prey. Although the same nest may contain representatives of several fly families, it seems as if the provision of each individual cell comprises only a single or very few species. Each cell contains about 8 flies. It is stated that other Hymenoptera, e.g. Trypoxylon and Anchistrocerus trifasciatus (Müll.) (Eumenidae) might be found nesting in the same plant stems as rubicola.

130. ECTEMNIUS (ECTEMNIUS) DIVES (Lepeletier & Brullé, 1834)

Figs.351, 352, 372, 373, 375.

Solenius dives Lepeletier & Brullé, 1834: 716.

Female: 7-10.5 mm. Head in front view distinctly broader than high (Fig.351). Vertex well developed. Ocelli placed in a very obtuse triangle. Punctation of frons very homogeneous, not forming rugae or striae. In front of ocelli the punctation is rather strong and very dense. The carina which dorsally delimits the shiny area dorsal to the antennal sockets is angularly bent. Clypeus with a very faintly golden or brassy pubescence, its anterior margin with a rather narrow, strongly projecting median part. Lateral lobes rounded, directed obliquely forward, seen in profile as Fig.352. Mandibles yellow with black apex and base. On inner side with a stout tooth. Scapus entirely yellow. Second flagellar segment distinctly longer than third. Pronotum usually with large, yellow lateral spots, and strongly developed, obliquely forwardly directed, attenuate lateral angles; the transverse carina on dorsal face of pronotum is not continued into the spines. Humeral tubercle yellow. Scutum anteriorly with two very strong, shining, longitudinal ribs; its sculpture otherwise consisting of partly fused punctures, which are much stronger than the punctation on frons. Scutellum anteriorly shining with sparse punctation, posteriorly with weak longitudinal striation. Two lateral spots on scutellum and metanotum are usually yellow in specimens from Central Europe. Mesopleuron laterally shining, strongly transversely striate, interspersed with distinct punctures. Near the ventral midline the sculpture consists of only a few rather weak punctures. Lateral areas of propodeum with very uniform, very dense and fine, transverse striation. Posterior area laterally without distinct delimitating carina so that the lateral sculpture continues on posterior face. Striation here, however, considerably stronger. Striae in area cordiformis rather weak, somewhat irregular. Abdomen with yellow lateral spots on terga 2-5. Sometimes spots also occur on tergum 1. The spots on tergum 2, and particularly on tergum 5, may form transverse bands. Pygidial area strongly narrowed posteriorly, only slightly excavate, here with rather strong punctation. Femora black, seldom with a small distal spot. Tibiae 1-2 yellow with a large black spot on inner side. Tibia 3 usually entirely yellow. Tarsi yellow-brown, distal segments darker.

Male: 6.5-8 mm. Head in front view very distinctly broader than long, ventrally only slightly narrowed. Punctation on frons in front of ocellus very dense, interstices much smaller than diameter of punctures. Pubescence on clypeus silvery or very slightly golden shining, anterior margin with broad median lobe,

lateral lobes very small and rounded. Mandibles usually with a large yellow median spot. Scapus yellow with a large black spot on posterior face, distally bearing a row of long, pale hairs (Fig.373). Flagellar segments 2 and 5 ventrally with distinct excavation, second segment in dorsal view distinctly longer than third. The strong, obliquely forwardly directed lateral spines of pronotum without connection with the almost lamella-like projecting transverse carina. The yellow-white lateral spots usually well developed. Humeral tubercle also yellow-white. Scutum anteriorly with two very strong, shining longitudinal carinae, the sclerite proper very coarsely and irregularly rugose or striate. Scutellum anteriorly shining, with sparse punctation, posteriorly irregularly, longitudinal rugose. Metanotum usually with a yellow transverse spot. Mesopleuron laterally with strong transverse striation, without interspersed punctures, but with a thin, short, white or slightly silvery pubescence. Ventrally the striation is replaced by a rather dense but fine punctation. Lateral faces of propodeum with dense, regular striation. Admixture of short, coarser striae often occurs. Transition to posterior face not distinctly marked, since the delimiting carina is often very reduced. Sculpture of posterior face consists of a rather coarse transverse striation. Striae in area cordiformis strong. Abdomen with yellow lateral spots on terga 2-6. Spots on tergum 1 may occur in specimens from Central and South Europe, and the comparatively larger spots on terga 2 and 5 may form transverse bands in these specimens. Femur 1 basally with a very weakly developed sharp-edged swelling. Metatarsus 1 slightly dilated, not broader than apex of tibia. Ventrally the metatarsus carries four strong, brown, depressed spines; next tarsal segment almost quadrate (Fig.372). Metatarsus 2 distinctly, somewhat asymmetrically dilated (Fig.375). Femur 1 ventrally yellow-brown, with two equally broad longitudinal yellow or black stripes. Tibia 1 mainly yellow and brown-yellow, with a black longitudinal spot on outer face.

This species has not yet been found in Denmark, but might be expected to occur there. - Widely distributed in Fennoscandia, but not common. Northernmost localities in Sweden: Dlr. and Gstr. - Only a few specimens from Norway: AK, Tøien.-Finland: southern and south-eastern distribution, northwards to Ok. Soviet Karelia: Ib and Kb. - A Holarctic species. The distribution area covers most of Europe (not found in the Iberian Peninsula), Caucasus, Central Asia, Japan and north-eastern China. Also occurs in temperate North America.

Only a very few biological data exist. It is, however, known that the tunnel systems are gnawed in decayed wood, and that the prey consists of Diptera, e.g. Syrphidae and Tachinidae. Each cell contains from five to eight specimens.

131. ECTEMNIUS (ECTEMNIUS) GUTTATUS (Van der Linden, 1829)

Fig. 369.

Crabro guttatus van der Linden, 1829:51.

Crabro borealis Dahlbom, 1838:81.

Crabro spinicollis Herrich-Schäffer, 1841:14.

Closely related to borealis. In many cases a safe identification is only possible by comparison with abundant material of the species, on the basis of which an idea can be formed of the rather great infra-specific variation.

Female: 7-9 mm. The mandibles have a larger or smaller yellow or yellow-white spot in the middle, which is only seldom missing. The yellow colour of scapus is considerably more extensive than in borealis. The transverse carina, dorsally delimiting the shining area dorsal to antennal sockets, forms an even, shallow arch. The yellow spots on pronotum, like the lateral angles, are well developed. Punctation on scutellum is much obscured by the longitudinal rugosity, which covers all the sclerite. The yellow transverse spot on metanotum only seldom absent. Punctation distinct on lateral faces of mesopleuron. The yellow lateral spots on abdomen are largest on terga 2 and 5, where they form transverse bands in many specimens from Central and South Europe. Small spots on tergum 1 may occur in these specimens. The yellow markings on tibia 2, on average, considerably more extensive than in borealis.

Male: 6-8 mm. Mandibles very often with yellow pattern. The yellow colour on scapus occupies more than half the surface of the segment. Second flagellar segment as long as third. Pronotum often with yellow lateral spots. Scutum with rather coarse, irregularly rugose punctation, carinae anteriorly strongly projecting. Scutellum with irregular sculpture, not forming distinct longitudinal rugosity. The yellow lateral spots on terga 2-6 always present, although the last may be strongly reduced. Femur 1 at the base with a strong, protruding, sharp-edged swelling (Fig. 369). Tibiae 2-3 always yellow on outer face. Metatarsus 2 and next tarsal segment rather long and slender, distally with a weak, ventrally directed dilation.

This species is not found in Denmark, but might be expected, particularly in NEZ. - Sweden: a rather common species, occurring from Sk. to Dlr. and Gstr. - Norway: sparse occurrence, found northwards to Troms. - Finland: common and widely distributed, northwards to Ok and Ob. - Soviet Karelia: Ib and Kr. - Found all over Europe, except the Iberian Peninsula and the Balkans, Eastwards the species reaches the Urals and Caucasus.

The biology of the species is very little known. It is recorded that it nests

in old timber, and that the cells are provisioned with flies of the families Syrphidae and Muscidae. The larva was described by Minkiewicz, 1931.

132. ECTEMNIUS (ECTEMNIUS) BOREALIS (Zetterstedt, 1838)

Figs. 353, 370, 374.

Crabro borealis Zetterstedt, 1838:443.
Crabro nigrinus Herrich-Schäffer, 1841:15.

Female: 7-9 mm. Head in front view only slightly broader than long. Punctation of frons dense and regular, never forming rugae or striae. In front of the ocelli, which are placed in a very obtuse triangle, the interstices between the punctures are shining, equal to or a little narrower than the diameter of the punctures. Further anteriorly the punctation becomes denser. The carina, which delimits the shining area dorsal to the antennal sockets, usually distinctly angularly bent. Pubescence on vertex short, missing posteriorly. Median lobe of clypeus comparatively broad, rather strongly projecting, seen in profile as Fig. 353. Lateral lobes strong, rounded, directed obliquely forward. Pubescence strongly silvery. Mandibles black, strong, with a stout basal tooth. Their middle has a yellow-white spot, which in Lappland specimens is usually reduced in size . Scapus yellow with a larger or smaller black spot on posterior face. Second flagellar segment slightly longer than third. Pronotum black, yellow lateral spots are generally absent in Fennoscandian specimens. Danish specimens often have very small lateral spots. The sharp, transverse carina continues directly into the obtuse lateral angles. Humeral tubercle yellow. Scutum anteriorly with three, rather strongly projecting, longitudinal carinae. The sculpture consists mainly of punctation, only slightly stronger than that on frons in front of the ocelli. Interstices form a distinct striation anteriorly and especially posteriorly. Scutellum shining in the middle, with sparse punctation. Anteriorly and posteriorly punctation is considerably stronger and denser, interstices here forming longitudinal rugae. Metanotum in Danish and South Swedish specimens usually strongly and regularly transversely striate, interspersed with a weak punctation, which ventrally becomes dominant. Lateral faces of propodeum finely and densely striate, interspersed with short ribs. Posterior face both laterally and dorsally delimited by a sharp carina. The surface proper regularly transversely striate. Area cordiformis without distinct delimitation, its sculpture consists of irregular and weak, obliquely outwardly directed striae or rugae. Abdomen with yellow lateral spots on terga 2-5. Specimens from Central and South Europe in addition have yellow spots on tergum 1. Pygidial area strongly narrowed posteriorly, bordered by golden bristles. Femora black, femora 1-2 often with a small yellow spot distally. Tibiae yellow with

black inner face. Tibia 2 may be completely black in specimens from Lappland. Tarsi 2-3 dark-brown, tarsus 1 paler.

Male: 6-8 mm. Head in front view slightly broader than high (73:70). Frons in front of ocelli densely punctate with a very fine intermediate micro-sculpture and rugosity, which is distinctly seen at 100 times magnification. Clypeus with a broad, anteriorly rounded median lobe. Its lateral lobes very small, only distinct if viewed obliquely from below. Mandibles always completely black, at any rate in Danish and Fennoscandian specimens, with a large tooth near the base. The yellow spot on scapus usually very reduced. Segments 2, 4 and 5 ventrally distinctly excavated. Second segment seen from above only slightly longer than third. Pronotum very seldom with yellow lateral spots, its transverse carina continues direct into the obtuse lateral angles. Humeral tubercle yellow. Carinae on anterior part of scutum, compared with the remaining species of the subgenus, slightly developed, which also applies to the remaining sculpture of scutum. Interstices between punctures form fine, regular rugae, especially posteriorly. Scutellum densely, longitudinally rugose, black like metanotum. Lateral faces of mesopleuron with a mixture of coarse and finer carinae, ventrally replaced by a fine and rather dense punctation. Striation on lateral faces of propodeum usually slightly stronger. Area on posterior face surrounded by a carina, strongly transversely striate. Area cordiformis with oblique outwardly directed irregular rugosity or striation. Yellow pattern of abdomen very variable. Lateral spots are usually found on terga 2-6, but these may be missing in small specimens, but only exceptionally are the spots on tergum 2 missing. Femur 1 basally on ventral face with a slightly projecting, sharp-edged dilation (Fig. 370), dorsally mainly yellow-brown, ventrally yellow with two black or slightly brownish longitudinal streaks. Tibia 1 yellow with a broad, black, longitudinal stripe. Metatarsus 1 strongly depressed, broader than apex of tibia, transparent like second tarsal segment (Fig. 374), ventral spines very weak, pale. Femora 2-3 black, often with a distinct yellow streak along dorsal face, joining a larger or smaller distal spot. Yellow colour of tibiae very reduced. Metatarsus 2 not dilated distally.

Sparse occurrence in Denmark. - Sweden: rather common, extensive distribution northwards to T. Lpm. and Nb. - Norway: found in the south-eastern districts, southern and northern Nordland, and in Troms. - Finland: rather common, northwards to Ks. - Soviet Karelia: Ib and Kr. - Distributed in Central and East Europe, western U.S.S.R., around Lake Baikal, north-eastern China, Korea, Kamchatka, Sakhalin and Japan. Possibly occurs in southern Siberia, but is not recorded.

As regards the biology of the species, it is only known that males as well as females have a marked preference for Umbellifers, e.g. Angelica, when foraging. It is, however, supposed that its breeding biology does not differ considerably from that of dives and guttatus.

Genus *Lestica* Billberg

Lestica Billberg, 1820:107

Type-species: Crabro subterraneus Fabricius, 1775.

Medium-sized species with pronounced yellow markings (Fig. 376). Head and thorax with very dense punctation or pitted sculpture. Head large, usually well developed behind the eyes. Ocelli generally forming an obtuse angle. Clypeus and inner orbits with dense, silvery pubescence. Inner orbits strongly converging ventrally, antennae inserted very close to each other. Facial fovea well developed, frontal line absent. Mandibles bidentate (tridentate in female Clypeocrabro), without tooth on inner side. Antennae 12-segmented in both sexes. Pronotum with a sharp transverse carina, laterally usually projected into sharp lateral angles. Mesopleuron with sharply projecting

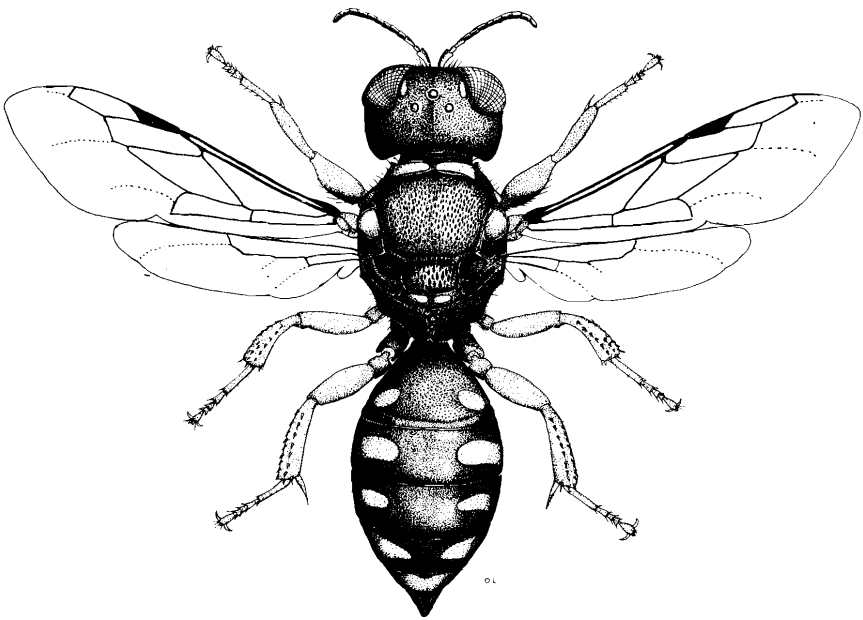


Fig. 376. Female of Lestica subterranea (Fabr.). Length: 9-12 mm.

carina in front of coxa 2. Propodeum without well delimited area cordiformis. Abdomen strongly punctate. Females with pygidial area. Tarsus 1 in males often strongly depressed and dilated. Forewings with a single cubital and discoidal cell.

The genus is distributed in all zoogeographical regions and comprises over 30 species. Most of these occur in the northern hemisphere.

The nest is constructed either in the soil or in wood (Clypeocrabro). The prey consists of adult Lepidoptera, often Crambidae.

Key to species of Lestica

Females

1 Median keel on clypeus broad, strongly projecting, continued into a narrow nose-like median lobe. Lateral lobes also strongly projecting (Fig. 380). Pygidial area apically considerably narrowed ..... 135. clypeata (Schreber)

\- Median lobe of clypeus slightly projecting, abruptly truncate, lateral lobes small. Pygidial area plane, triangular 2

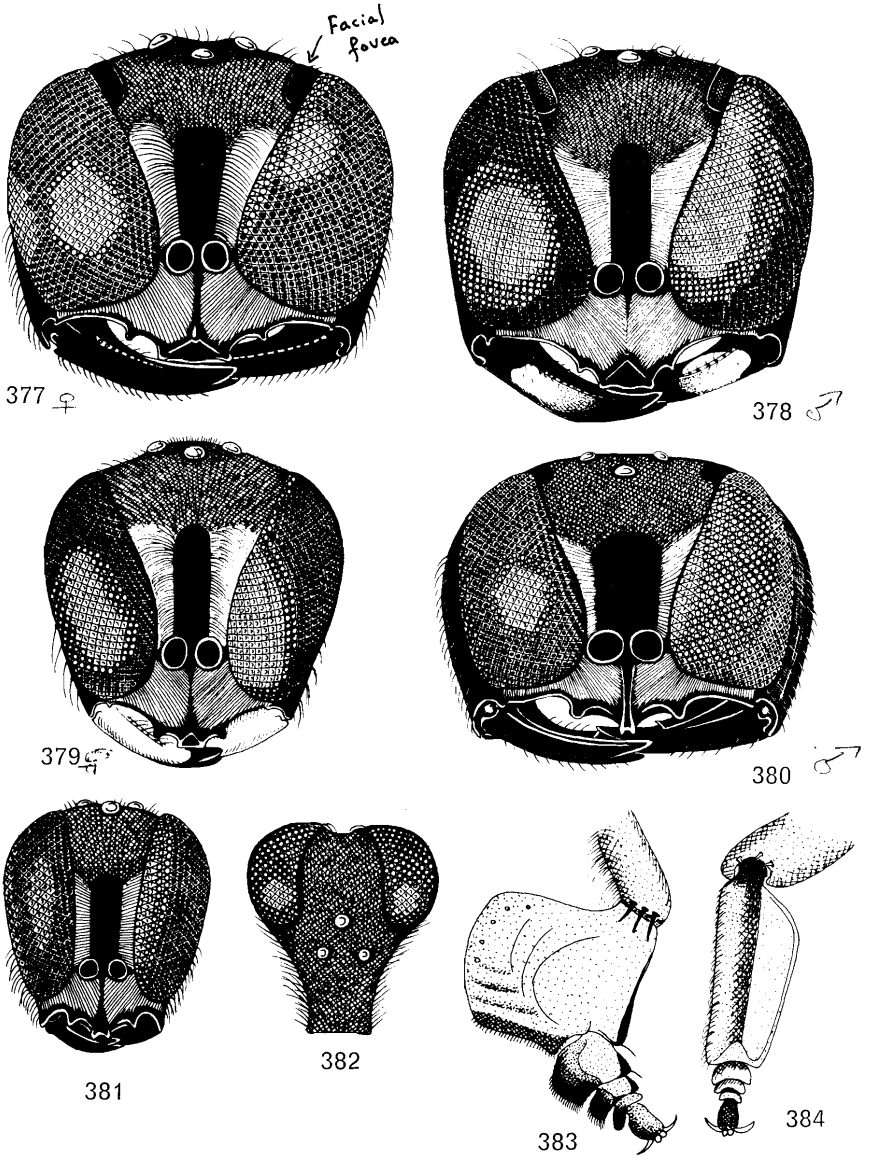
2(1) Mesopleuron very coarsely pitted and rugoso-punctate, dorsally with interrupted, rather strong, transverse ribs. Median furrow in area cordiformis anteriorly at most twice as broad as posteriorly ..... 134. alata (Panzer)

\- Mesopleuron shiny with sparse, coarse punctures, dorsally with only indications of transverse striae. Median furrow in area cordiformis anteriorly more than twice as broad as posteriorly .....133. subterranea (Fabricius)

Males

1 Head behind eyes very strongly constricted like a neck (Fig. 382). Pronotum prolonged in a cone. Metatarsus 1 dilated to an almost quadrate, partly transparent shield (Fig. 383). .....135, clypeata (Schreber)

\- Head and pronotum not strikingly constricted or prolonged. Metatarsus 1 with at most a



Figs. 377-381. Heads in frontal view of Lestica. - 377: subterranea (Fabr.), ♀; 378: same, ♂; 379: alata (Panz.), ♀; 380: same, ♂; 381: same, ♂.
Fig. 382. Head in dorsal view of male Lestica clypeata (Schreber).
Figs. 383, 384. Tarsus 1 of male Lestica. - 383: clypeata (Schreber); 384: alata (Panz.).

rather weak, transparent dilation 2

2(1) Metatarsus 1 dilated on outer side (Fig. 384). Mandibles yellow with red-brown apex. Mesopleuron coarsely and densely rugoso-punctate, with weak transverse striation ..... 134. alata (Panzer)

- Metatarsus 1 completely devoid of dilation. Mandibles uniform black. Mesopleuron shining, with sparse punctures ..... 133. subterranea (Fabricius)

133. LESTICA (LESTICA) SUBTERRANEA (Fabricius, 1775)

Figs. 376, 377.

Crabro subterraneus Fabricius, 1775:374.

Female: 9-12 mm. Head in front view considerably broader than long (Fig. 377). Vertex rather well developed, sides only slightly converging posteriorly. Punctation in front of ocelli rather sparse and irregular, interstices shining. Behind ocelli punctation is considerably denser and more irregular. Frontal fovea almost as broad as scapus with extremely fine punctation. Clypeus anteriorly with three rounded tubercles, between which a shining triangular area is found. Mandibles black, often with a faint reddish portion subapically. Scapus yellow with a large black spot posteriorly. Flagellum black, sometimes weakly yellow proximally, median segments broader than long. Pronotum dorsally with a sharp, transverse carina, laterally projected into small, often acute, lateral angles. Danish specimens usually have white-yellow lateral spots on pronotum; these are usually missing in Fennoscandian material. Humeral tubercle with a large white-yellow spot. Scutum with coarse sculpture. Punctation dense, interstices forming short, longitudinal rugae. Scutellum anteriorly shining, even, posteriorly with sharp longitudinal carinae. Mesopleuron shining, with sparse and rather coarse, slightly irregular punctures, only immediately below the base of forewings with transverse rugosity. Lateral faces of propodeum dull, with dense and rather coarse, irregular striation, continuing uninterruptedly on posterior face. Area cordiformis with slightly radiating striation, median furrow very broad, at the bottom with transverse carinae. Abdomen shining, smooth. Tergum 1 with very dense and rather coarse punctation. Punctures slightly stronger than on vertex. Succeeding terga gradually more weakly punctate. Terga 1-4 with white-yellow lateral spots, tergum 5 usually with a transverse band. Pygidial area black, plane, densely punctate, with rather strongly concave lateral margins, distally with a dense, slightly golden shining pubescen-

ce. Legs red-yellow, femur 1 with a black, basal spot. Tibia 1 often with a yellow stripe along anterior face.

Male: 8.5-11 mm. Head in front view slightly longer than broad. Vertex well developed, slightly narrowed posteriorly. Punctation of frons dense and coarse. Facial fovea narrow, rather deep. Pubescence of frons, especially anteriorly, long, slightly grey-golden. Clypeus with a slight median projection, anterior margin as in female, but the area between the rounded processes somewhat more shining and as a rule slightly smaller. Scapus yellow with a larger or smaller spot posteriorly. Flagellum black, median segments ventrally with yellow-brown swelling. Mandibles chiefly black, but often with paler distal markings. Pronotum usually without yellow lateral spots, lateral angles weak. Humeral tubercle yellow. Scutum very coarsely sculptured, punctures large, partly coalescing longitudinally, interstices forming distinct longitudinal rugae. Scutellum somewhat more weakly sculptured. Metanotum in some Danish and South Swedish specimens with two yellow spots. Lateral parts of mesopleuron shining with sparse but coarse punctation. In front of coxa 2 the punctation becomes very dense, while the size of the punctures decreases slightly. Lateral faces of propodeum shining with regular and rather strong striation. Striation in area cordiformis coarse and very irregular, reticulate. Abdomen shining, punctation, especially on tergum 1, rather coarse, on succeeding terga gradually weaker. Terga 1-3 and 6 with yellow lateral spots, terga 4 and 5 usually with transverse bands. Metatarsus 1 very slightly pigmented, not dilated, slightly depressed. Legs 2-3 with red-yellow femora and more or less uniform coloured tibiae and tarsi.

Widely distributed, but not common in Fennoscandia and Denmark. - Denmark: only recorded from Jutland and North Zealand. - Sweden: found from Sk. in the south to Nb. in the north. - Norway: a few specimens from AAy, Dømmesmoen, and SFi, Skjolden. - Finland: found in all districts except St up to Kb and Sb. - Soviet Karelia: Ib and Kr. - The distribution area covers most of Europe. In the east the species occurs in South-East Kazakhstan.

The nests are usually constructed in sandy, strongly sunexposed localities. The unbranched tunnel, upwards of 20 cm long, descends into the soil. The cells are built at the end of 4-10 cm long lateral tunnels, at right angles to the tunnel. The number of cells varies between 2 and 11. The prey consists of smaller adult Lepidoptera, generally of the families Crambidae, Zygaenidae and Tortricidae. Each cell contains from 8-12 specimens, whose heads always point towards the bottom of the cell. The uppermost cells are provisioned first. The egg hatches in 1-2 days, and after 8-10 days the larva is full-grown. The surface of the cocoon is covered with wings, legs and other food remains.

134. LESTICA (CERATOCULUS) ALATA (Panzer, 1797)

Figs. 378, 379, 384.

Crabro alatus Panzer, 1797: T.6.

Crabro basalis Smith, 1856:415.

Female: 9-12 mm. Head ventrally considerably narrowed (Fig. 378). Punctation in front of ocelli coarse, interstices broad, slightly convex. Behind ocelli punctation becomes considerably finer and denser. Facial fovea strongly impressed, as broad as scapus, extremely finely punctate. Clypeus with distinct, projecting median lobe, anterior margin with a shining triangular area, whose corners consist of three rounded processes, of which the median one is vestigial. Mandibles with a larger or smaller central yellow spot, apex red-brown. Scapus entirely yellow like the first segment on flagellum. Pronotum dorsally with a sharp transverse carina, laterally projecting into acute, almost tooth-like spines. The two white-yellow lateral spots large. Humeral tubercle also white-yellow spotted. Scutum very coarsely rugose, punctation almost pit-like. Scutellum somewhat more weakly punctate. Sutures between scutellum and metanotum and between metanotum and propodeum laterally white-yellow. Mesopleuron coarsely and densely pitted with indications of transverse striation. Lateral faces of propodeum shining, with very regular transverse striation, interstices with very fine granular microsculpture. Posterior face with similar sculpture. Area cordiformis with coarse, irregular, radiate striation, with numerous transverse connections between striae. Median furrow often indistinct, only slightly broader anteriorly. Punctation on abdomen very distinct, especially on tergum 1. Terga 1-4 with yellow lateral spots, tergum 5 with transverse bands. Pygidial area densely punctate, plane, with concave lateral margins and slightly golden shining apical pubescence. Legs red-yellow. Anterior face of tibia 1 yellow.

Male: 8.5-11 mm. Head distinctly longer than broad (Fig. 379). Vertex short, rather strongly narrowed posteriorly. Punctation of frons in front of ocelli rather weak, behind these stronger and denser. Facial fovea narrow, distinctly marked. Where the occipital carina joins the hypostomal carina a rather strong concavity is found. The shining, triangular area anteriorly on clypeus small, indistinct. Right behind the anterior margin a yellow transverse line is often present. Mandibles mainly yellow, apex reddish. Scapus entirely yellow, flagellum proximally yellow, distally gradually darker. Segments longer than broad, ventrally with double, narrow tyloidea. Pronotum densely and strongly punctate, with yellow lateral spots and usually projecting lateral angles. Humeral tubercle yellow. Scutum and scutellum with very coarse pitted-rugose

sculpture. The area just in front of coxa 2 shining, smooth with only very sparse punctation. Lateral faces of propodeum coarsely striate, interstices shining, with microscopically fine sculpture. Posterior face of similar appearance, but with somewhat weaker striation. Area cordiformis coarsely pitted or reticulate-rugose. Punctation on tergum 1 very strong, on succeeding ones gradually weaker. Terga 1-3 with yellow lateral spots, but those on first may be missing. Terga 4-6 with transverse bands, but that on fourth may be interrupted. Metatarsus 1 with a long lamella-like and transparent dilation, the breadth of which hardly exceeds that of the metatarsus. Tarsal segments 2-4 distinctly depressed, slightly dilated (Fig. 384). The whole tarsus very faintly pigmented. Tibiae yellow. Femora yellow with extensive yellow pattern. Femur 1 with fringes and tufts of long, white hairs. Femur 2 basally on ventral face with a small swelling, the metatarsus very slightly asymmetrically dilated. Tibia 2 very slightly curved in an S-shape. Hindlegs without secondary sexual characters.

The species has an eastern occurrence in Fennoscandia; it is found in Sweden: Vg. (Aurivillius), south-eastern Finland: Ka, Sa, and in Soviet Karelia: Ib and Kr. - Widely distributed in Europe, through southern Siberia to Mongolia, and further through China and Japan to the Pacific Ocean.

The nests are constructed in the soil. The tunnel is often long, descending in a spiral (Tsuneki, 1960). Each nest contains up to 7 cells, which are provisioned with adult Lepidoptera, e.g. Crambidae, Tortricidae, Pyralidae and Noctuidae. When the female has located her prey, she stays hovering for a moment, whereafter she approaches it slowly. With a sudden movement she seizes the prey, grasping it with her legs and injects the poison. Number of prey per cell varies from 4 to 9.

Note. Kohl (1915), Pulkkinen (1931), Merisuo (1946), Romanova (1969), Tsukeni (1947, 1971) and Mocsar (1959) mention the "aberration" basalis Smith, 1856, which in Fennoscandia is restricted to south-eastern Finland. The name of this aberration is due to the more or less extensive red colour of first, and partly also of second abdominal segment in female. Specimens of this appearance seem to have a pronounced eastern occurrence, since specimens deriving from Hungary, Asia Minor, Ukraine, Caucasus, North China, Manchuria and Mongolia show this feature. From Japan and Korea the subspecies japonicus Schulz is recorded. The taxonomic status of basalis Smith is open to discussion, but it is not probable that it should be regarded as a subspecies, since apparently it occurs sympatrically with the nominate form both in eastern Finland and in northern Caucasus.

135. LESTICA (CLYPEOCRABRO) CLYPEATA (Schreber, 1759)

Figs. 380-383.

Apis clypeata Schreber, 1759:14.

Female: 9-12 mm. Head in front view broader than long (Fig. 380). Vertex rather well developed, its margins running almost parallel for a comparatively long distance. Punctation behind ocelli strong, irregular, with shining interstices. The area in front of ocelli with densely placed, rather shallow pits. Facial fovea distinct, narrower than scapus. Clypeus with very strongly convex median keel, anteriorly slightly bifid. Lateral lobes well developed, rounded. Mandibles black with slightly reddish apex. Scapus yellow, in Danish and Fennoscandian specimens with a larger or smaller brown spot posteriorly. Along the anterior margin a sharp, lamella-like dilation is found. Flagellum black, the proximal segments often yellowish basally. Pronotum generally completely black, coarsely and densely punctate, with sharp, partly forwardly directed angles. Humeral tubercle with a yellow spot. An almost entirely yellow pronotum may occur in specimens from Central and South Europe. Scutum anteriorly densely and coarsely pitted with weak longitudinal rugosity, posteriorly the sculpture becomes sparser. Mesopleuron laterally dense and coarsely pitted, ventrally near the mid-line and usually also in front of coxa 2 the sculpture and the interstices become wider. Lateral faces of propodeum with dull sateen-like lustre, extremely finely and densely striate. Posterior face with a fine, granular sculpture. Area cordiformis only marked by its more shiny appearance and somewhat coarser and more irregular sculpture. Tergum 1 very densely and coarsely punctate. Interstices in many places smaller than diameter of the punctures. On the succeeding terga punctation becomes gradually weaker. Pygidial area apically strongly narrowed into a smooth, groove-like part. The area is surrounded by stiff golden bristles. All terga with yellow spots, which in Danish and Fennoscandian specimens may form transverse bands on terga 4 and 5. In South European specimens the abdomen may be mainly yellow dorsally, and also the sterna may have yellow markings. Ventral face of femur 1 plane, surrounded by a carina. Femora are mainly black in specimens from Denmark and Fennoscandia, while tibiae, except for a few black spots on tibia 3, are pure yellow. Specimens with entirely yellow legs frequently occur in South Europe.

Male: 8-11 mm. The external morphology is extremely striking. Head in front view very narrow, considerably longer than broad (Fig. 381), seen from above strongly constricted behind the eyes (Fig. 382). Lateral ocelli are placed far behind the compound eyes. Occipital carina projecting like a collar.

Sculpture of frons consists of a coarse and dense punctation, slightly rugose behind the ocelli. Clypeus displays only a slight longitudinal keel, which is characteristic of the female, and the small lateral teeth. Mandibles black with slightly reddish apex. Scapus about twice as long as broad, yellow with a larger or smaller black or brownish spot posteriorly. Flagellum long, ventrally brown-yellow, with double longitudinal tyloidea. Pronotum conical, strongly narrowed anteriorly, without yellow pattern or protruding angles. Humeral tubercles yellow spotted. Scutum strongly pitted, centrally and posteriorly with shining interstices, anteriorly and laterally the interstices are smaller than the diameter of the punctures. Scutellum shining with sparse, rather pronounced pits. Mesopleuron shining, laterally with very coarse, sparse pits, ventrally with a fine, granular sculpture and sparse shallow pits. Pilosity laterally very long, ventrally short, felty, silvery. Lateral faces of propodeum with dense slightly undulating striae. The transition to the posterior face marked by a narrow, coarsely and irregularly pitted region, medially delimited by a more or less distinct undulating carina. Area cordiformis without distinct delimitation, coarsely, reticulately pitted. Tergum 1 with dense, strong punctation, succeeding terga finely and sparsely punctate. Last tergum with a rather sharp, longitudinal impression. All terga with yellow markings, usually forming transverse bands on the last three or four terga. Sterna 2 and 3 usually with a large, yellow, median spot. The legs, especially the forelegs, with several, very conspicuous secondary sexual characters. Trochanter 1 with a sharply projecting, transparent, lamella-like dilation. Femur 1 on the outer face with dense, long, silvery pubescence. Tibiae slightly dilated, metatarsus 1 with a shield-like dilation, the other tarsal segments more weakly dilated (Fig 383). Femur 2 at the base of the ventral face with a strong, triangular, spine-like dilation, which continues into a fine, longitudinal carina on ventral face of femur. The femur with a distinct brown longitudinal band. Tibia 2 smooth, without spines. Metatarsus 2 distally slightly asymmetrically dilated. Trochanter 3 with backwardly directed spine. Femur 3 dark with a broad, yellow, longitudinal stripe.

The species is very rare in Fennoscandia and Denmark. - A single female specimen from Denmark: LFM, Keldskov on Lolland. - Sweden: very sparse occurrence from Sk. to Dlr. and Gstr. in the north. - Norway: no records, and the species is unlikely to maintain populations in the country. - Finland: a rare southern and south-eastern species; northernmost records from Kb and Ok. - Soviet Karelia: Ib and Kr. - The distribution area covers Europe, North Africa, Asia Minor, the near Orient and expands through southern Siberia to Lake Baikal.

In contrast to the two preceding species, clypeata nests in wood. Abandoned tunnel systems of Ectemnius or xylophagous insect larvae are often used. These are however first cleaned. The prey consists of adult Lepidoptera, e.g. Crambidae, Sesiidae and Sterrhidae.

Genus *Entomognathus* Dahlbom

Entomognathus Dahlbom, 1844:295.

Type-species: Crabro brevis van der Linden, 1829.

Small, stout species, in habitus (Fig. 385) similar to Lindenius. Mandibles end in a single tooth, ventral margin with a deep emargination, proximally delimited by a broad tooth, as e.g. Tachysphex (Fig. 388). On the inner side one or two tiny teeth. Clypeus convex, anteriorly with a shining, more or less lens-shaped area; silvery pubescence thin. Eyes hairy. Between posterior border of eyes and the lateral ocelli are distinct frontal markings. Ocelli placed in an obtuse-angled triangle. Thorax short and broad, shining, smooth. Epicnemium and epicnemial carina well developed. Propodeum very short, dorsally with distinct area cordiformis, surrounded by a strongly pitted furrow. Abdomen broad, ovoid. Both sexes with pygidial area. Legs short and stout, females with extremely weak pecten on metatarsus 1. Tibiae 2-3 with short, dark spines on the outer side.

The genus comprises about 30 species, which occur in Holarctis as well as in tropical Africa and South America. In Denmark and Fennoscandia only a single species occurs.

The nest is constructed in the soil, often in slopes. The prey consists of small Chrysomelidae (Coleoptera).

136. ENTOMOGNATHUS BREVIS (Van der Linden, 1829)

Figs. 385-388.

Crabro brevis van der Linden, 1829:72.

Female: 4-6 mm. Head in front view broader than long, with thin, grey-yellow erect pubescence (Fig. 386). Anterior border of clypeus without special emarginations or teeth. Mandibles brown or red-brown, without yellow markings. Antennae black, scapus with either yellow distal and proximal spots or with completely yellow anterior face. Frons shining with rather sparse punctation. Humeral tubercle usually with a yellow spot. Thorax otherwise without yellow pattern, shiny, with very fine scattered punctation. Area cordiformis shining, without

sculpture. Lateral faces of propodeum also smooth, with extremely fine punctation. Pygidial area red-brown or red-yellow, plane, triangular, with dense and rather coarse punctation. Coxa 1 distally with a small downwardly directed spine. Femur 1 triangular in cross section. Tibiae 1-2 yellow, tibia 3 black with yellow proximal ring.

Male: 3-5 mm. Head strongly narrowed ventrally. Clypeus with rather dense silvery pubescence, anterior border with a usually truncate median lobe and two rather strong, lateral teeth (Fig. 387). Eyes densely hairy. Mandibles basally with a larger or smaller yellow area, distally red-yellow or red-brown. Scapus often entirely yellow, flagellum ventrally with yellow spots on distal segments. Thorax and propodeum as in female, but slightly more strongly punctate. Pygidial area with broadly rounded apex, red-yellow. Legs with very extensive yellow markings, but femur 3 completely black. Femur 1 with two narrow, black, longitudinal stripes, femur 2 with basal black spot, extending upwards.

The species is relatively common in Fennoscandia and Denmark. Its northern distribution limit in Sweden runs through Vrm., Nrk. and Upl. - Rather little material is known from Norway: AK, On. - The species seems to have a southeastern distribution pattern in Finland, the most northern records from Kb

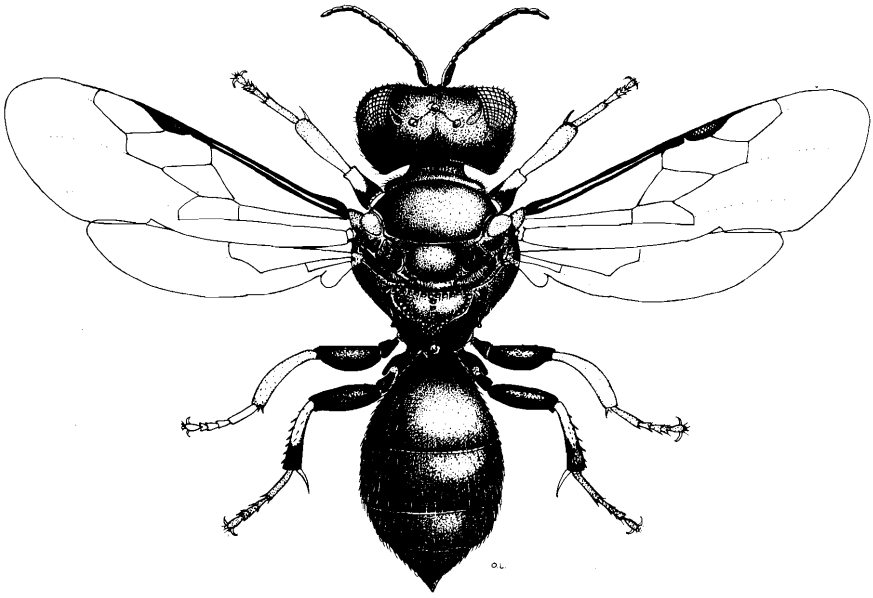
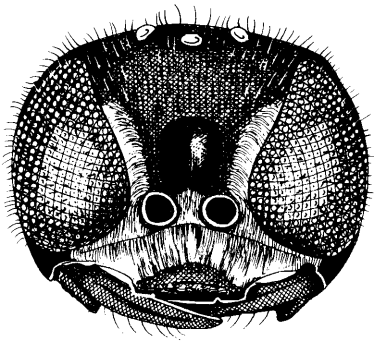


Fig. 385. Female of Entomognathus brevis (v. d. Linden). Length: 4-6 mm.

and Sb. - Soviet Karelia: Ib and Kr. - The distribution area of this species covers large areas of the Palaearctic region. It is recorded from England and Spain in the west, through Central Asia to Northern China and Japan in the east. Towards the south it is recorded from Tunisia and Egypt.

The species often nests gregariously in slopes, where the soil is sandy and gravelly (e.g. gravel pits). As is the case of Lindenius panzeri v.d. Lind. (no. 138) the number of cells in the nest is considerably smaller in Denmark (maximally 3) compared with the conditions in France (maximally about 10) (Abrahamsen, 1951). Branching of the nest is racemose. Provision consists of Coleoptera, Chrysomelidae, Halticinae, e.g. species of Chaetocnema, Crepidodera and Longitarsus, but also smaller species of Cryptocephalinae (Cryptocephalus) are used. In each cell are placed 16-26 specimens. The larva was described by Grandi, 1925 and 1961. When full-grown, it spins a compact cocoon covered on the outer side with sand grains.



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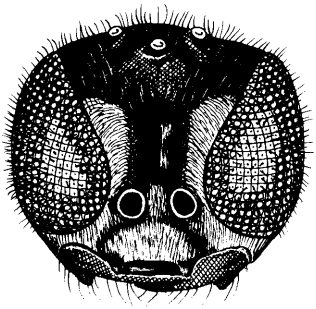

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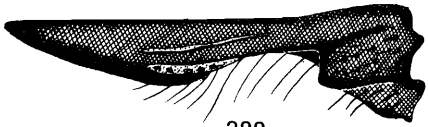

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Figs. 386-388. Entomognathus brevis (v. d. Linden). - 386: female head in frontal view; 387: male head in frontal view; 388: left mandible of female.

Genus *Lindenius* Lep. & Brullé

Lindenius Lepeletier & Brullé, 1835:791.

Type-species: Crabro albilabris Fabricius, 1793.

Comparatively small, strongly built species (Fig. 389). Clypeus often with very characteristic emarginations and teeth in anterior border, observable

when the dense silvery pubescence is partly removed or studied from below, when mandibles are opened. Mandibles ending in a single tooth, on the inner side with a larger or smaller tooth. Ocelli always placed in a very obtuse-angled triangle. Labial palps with four segments, maxillary palps with six segments. Antennae in female with twelve, in male with thirteen segments. On mesopleuron there is always a well delimited epicnemium, the epicnemial carina being very well developed. Thorax broad, robust. Propodeum short, dorsally with a usually well delimited area cordiformis, whose sculpture differs considerably from the surrounding areas. Abdomen short, non-petiolate. Both sexes with pygidial area. Tarsus 1 of females with a very short, transparent tarsal pecten.

The genus is mainly Holarctic. A little over 40 species are described, of which 35 are Palaearctic. Of these 21 occur in Europe. The number of species decreases considerably to the north, and in Denmark and Fennoscandia the genus is represented by only two species.

The species are gregarious and breed in dry, horizontal areas fully exposed

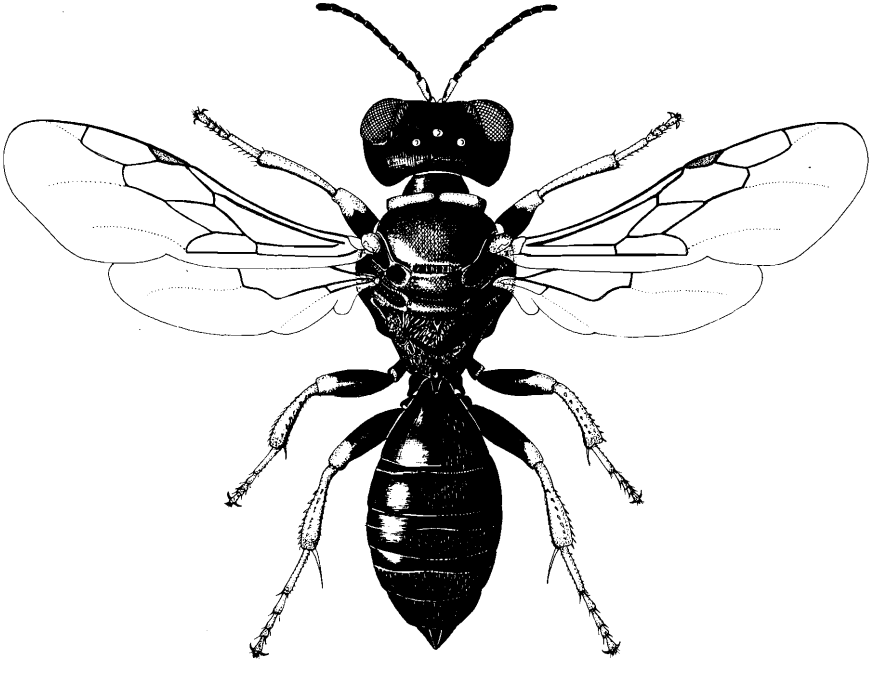


Fig. 389. Female of Lindenius albilabris (Fabr.). Length: 5-8 mm.

to the sun, where the nests are constructed in the ground. The prey consists of small Diptera, Heteroptera and Hymenoptera.

Key to species of Lindenius

1 Mandibles without yellow marks, on the inner side with very small tooth (Fig. 390). Frons without spine. Male without spines ventrally on head ..... 137. albilabris (Fabricius)

- Mandibles usually with extensive yellow markings, on the inner side with stout, triangular tooth (Fig. 391). Frons with a small spine above antennal sockets. Males have a larger or smaller spine ventrally on head 2

2 Area cordiformis with strong, radiating sculpture. Lateral faces of propodeum finely and densely striate ..... 138. panzeri (v.d. Linden)

- Area cordiformis shining, smooth, without sculpture, surrounded by a broad, strongly pitted furrow. Lateral faces of propodeum without or with very weak striae ..... pygmaeus (Rossi)

137. LINDENIUS (LINDENIUS) ALBILABRIS (Fabricius, 1793)

Figs. 389, 390, 392.

Crabro albilabris Fabricius, 1793:302.

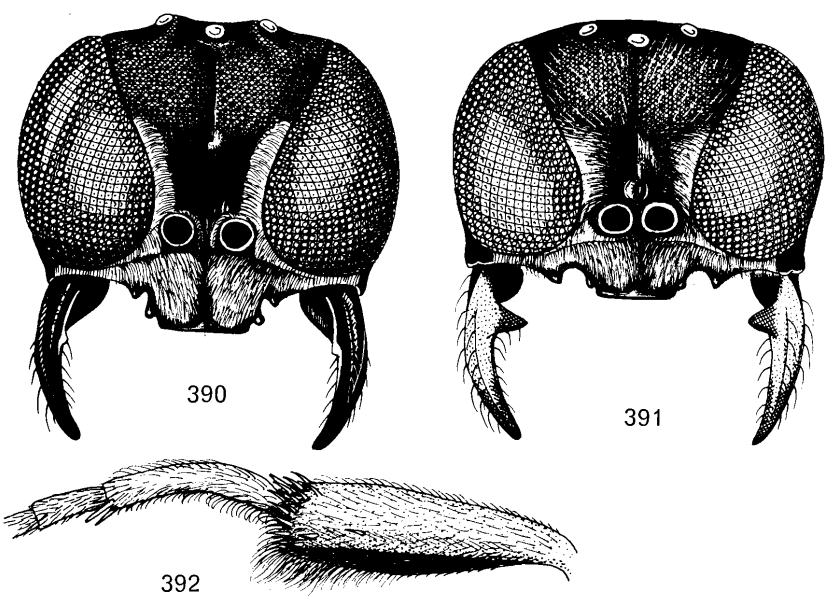
Female: 5-8 mm. Head and thorax, and usually also abdomen, with slight bronze sheen. Clypeus large, median area broad, evenly rounded or squarely truncate, lateral teeth small, rounded (Fig. 390). Facial fovea shining, slightly swollen. Mandibles and antennae black or slightly brownish, completely without yellow markings. Tooth on inner side of mandibles very weak (Fig. 390). Frons without tooth. Thorax black, without yellow pattern. Scutum and mesopleuron with a fine, rather shallow punctation. Area cordiformis framed by a broad, often pitted furrow, with a weak, often very irregular sculpture. Pygidial area rather coarsely and densely punctate, posteriorly with golden pubescence. Legs mainly black, tibia 1 along anterior border with yellow longitudinal stripe, tibiae 2 and 3 with proximal yellow spot. Wings strongly darkened.

Male: 5-7 mm. On average with stronger bronze sheen. Clypeus short, lateral teeth rather well developed. Mandibles black, sometimes with lighter median area. Antennae black, scapus usually paler distally and proximally. Flagellum

ventrally with pale swellings. Head ventrally without spines. Pronotum and usually also humeral tubercle with yellow pattern. Femora black with yellow spot apically. Tibiae mainly yellow, with larger or smaller dark spot on the inner side. Tibia 2 distally with loose tuft of pale, curly hairs (Fig. 392), metatarsus 2 distinctly curved. Pygidial area pale distally, with faintly red-yellow pubescence.

A very common species in Fennoscandia and Denmark. - Denmark: known from all districts except SZ, where it most probably occurs. - Sweden: common, especially in Sk., Sm. and Öl. Found towards the north to Hls. and Med. - Norway: only known from the southern districts. - Finland: common from Al, Ab, N and Ka in the south to Ok and ObS in the north. - Soviet Karelia: Ib and Kr. - The distribution area covers most European countries, North Africa and extends far towards the east in Central Asia (Mongolia and Manchuria).

The tunnel at first descends about 10 cm vertically into the ground, then continues horizontally. From the vertical tunnel several side branches may



Figs. 390, 391. Heads in frontal view of female Lindenius. - 390: albilabris (Fabr.); 391: panzeri (v. d. Lind.).
Fig. 392. Tibia 2 and proximal part of tarsus of male Lindenius albilabris (v. d. Lind.).

issue, each ending in a single cell. In Denmark and Fennoscandia the prey usually consists of Hemiptera, mainly of the family Miridae. Each cell may contain up to about 20 specimens. When returning to the nest, the female flies with the prey directly into the entrance. At least two well separated ecopheno-types seem to occur, of which one - as mentioned above - uses Hemiptera as provision, while the other, apparently a more southerly distributed type, uses smaller Diptera, e.g. Chloropidae, Empididae or Dolichopodidae. According to Adlerz (1910), both types are represented in Sweden, but not sympatrically. Adlerz (l.c.), in addition, describes a population using both Diptera and Hemiptera as provision. As parasitoid is especially known Myrmosa melanocephala Fabr. (Hym., Myrmosidae).

138. LINDENIUS (TRACHELOSIMUS) PANZERI (van der Linden, 1829)

Fig. 391.

Crabro panzeri van der Linden, 1829:70.

Female: 5-7 mm. Head in front view very broad. Clypeus short, its silvery pubescence dense and strong. Mandibles and scapus mainly yellow, mandibles on the inner side with very stout tooth (Fig. 391). Frons above base of antennae with small spine. Facial fovea very indistinct, slightly concave. Pronotum with yellow transverse band interrupted in middle. Humeral tubercle yellow. Often there is also a yellow spot on scutellum. Danish specimens often lack yellow pattern on thorax. Only specimens from SJ are of same colour as those from Central Europe. Scutum densely punctate. Propleuron laterally with sharp, oblique carina. Area cordiformis strongly radiately sculptured. Lateral faces of propodeum with dense and fine transverse striation. Pygidial area rather narrow, slightly red-brown, lateral faces concave, apex with weak, slightly golden pubescence. Femora black, sometimes with a very small apical spot. Tibiae mainly yellow, with larger or smaller brownish spot on the inner side.

Male: 4-6 mm. Yellow pattern not quite so extensive as in female, often absent from humeral tubercle and pronotum. Specimens with yellow markings on scutellum are very rare. Tibiae partly black. Sculpture as in female. Flagellum without swellings ventrally. Head, especially in robust individuals, with downwardly directed spine on ventral face of head, right in front of end of occipital carina. Tibia 2 without hair tuft, metatarsus straight. Pygidial area shining with short, sparse pubescence.

A southern and rather rare species in Denmark, met with in SJ, EJ, F, NEZ and NWZ. - Not found in Fennoscandia. - The species is widely distributed in Europe, but has a rather sparse occurrence. The distribution area also

covers North Africa and extends towards the east to the Urals and Kazakhstan. The subspecies mongolicus Tsuneki occurs in Mongolia.

The nest is often constructed in compact, clayey soil in edge of woods (Abrahamsen, 1950). In northern regions apparently fewer nests are constructed (max. 3) than in southern localities (max. 9) (Bouwman, 1911). Construction of nest very similar to that described in albilabris. The prey consists of Diptera Chloropidae, but species of Trypetidae and Simuliidae are also used.

LINDENIUS (TRACHELOSIMUS) PYGMAEUS (Rossi, 1794)

Crabro pygmaeus Rossi, 1794:124.

Close to panzeri, from which it is separated by the following characters: frontal markings distinct, very finely and densely punctate. Head and scutum with considerably finer sculpture. Clypeus laterally with a small tooth. Area cordiformis shining, smooth. Lateral faces of propodeum with or without weak sculpture. Oblique carinae on propleuron missing. In the male the tooth on ventral face of head may be very reduced. Clypeus of male in the middle, just behind anterior border, with strong depression.

The species is distributed in Central and south-eastern Europe, northwards to England, Holland, and Holstein in North Germany. It may occur in southern Denmark. Not found in Fennoscandia.

Note. The species occurs with two distinct subspecies (Beaumont, 1956), of which armatus van der Linden, 1829 has the northernmost occurrence.

The prey consists of small Hymenoptera, e.g. Chalcidoidea, Braconidae, Ophioninae and Formicidae. Exceptionally Diptera are taken (Grandi, 1961; Maneval, 1937). The larva was described by Grandi, 1961.

Genus *Rhopalum* Stephens

Rhopalum Stephens, 1829:34.

(Euplilis Risso, 1826, sensu American authors).

Type-species: Crabro rufiventris Panzer, 1799 (=Sphex clavipes Linné, 1758).

Small, slender, elongate species (Fig. 393). Head large, seen from above approximately rectangular. Ocelli placed in right-angled or obtuse-angled triangle. Pubescence of face silvery. Mandibles bidentate in both sexes. Labial palps with three segments, maxillary with five. Females with 12 antennal seg-

ments, males with 13. Antennal segments of males often with pronounced secondary sexual characters, i.e. dilations and/or excavations. Thorax shining, smooth, with weak sculpture. Mesopleuron anteriorly with strongly pitted vertical furrow, without carina in front of coxa 2. Propodeum shining, without distinct cordiform area. First abdominal segment strongly elongate, forming a petiolus, dilated distally. Abdomen without yellow pattern. Females usually with distinct pygidial area. Foretarsi often dilated and depressed in males. Tibia 3 clavate.

The genus is widely distributed in all zoogeographical regions, but mainly in the tropics, numbering more than 60 species, of which five occur in Europe.

The species nest in hollow or pith-filled plant stems, e.g. Phragmites, Rosa and Sambucus, in which the cells are either arranged in a row, or placed at the end of short side tunnels in wider stems. The species is often found nesting in the same localities as Passaloecus, Trypoxylon, Psenulus and Crossocerus (Coelocrabro). Diptera, Homoptera and Psocoptera constitute the prey.

Key to species of Rhopalum

1 An obtuse, horn-like process is found between antennal sockets. Abdomen entirely black. Antennal segments of males with strong excavations and dilations. Pygidial area of females shining, surrounded by distinct carina 2

\- Frons without process. Abdomen with more or less extensive red pattern. Antennae of males simple. Pygidial area of females dull, indistinct ..... 139. clavipes (Linné)

2 (1) Female: clypeus in middle with a very sharp, triangular tooth; lateral lobes small, directed obliquely laterally (Fig. 395). Propleuron with strong tooth. Male: foretarsi asymmetrically dilated, as Fig. 399. Occipital carina ending in an acute tooth ..... 140. coarctatum (Scopoli)

\- Female: midpart of clypeus broad, truncate, lateral lobes very small, indistinct (Fig. 397). Propleuron with swelling. Male: foretarsi slightly dilated. Occipital carina abruptly truncate ..... 141. nigrinum (Kiesenwetter)

139. RHOPALUM (RHOPALUM) CLAVIPES (Linné, 1758)

Fig. 394.

Sphex clavipes Linné, 1758:569.

Female: 5-6 mm. Clypeus with strong, silvery pubescence, anterior border in middle with narrow truncate projection, whose width does not exceed width of scapus (Fig. 394). Scapus uniform white-yellow, flagellum black, proximal segments pale ventrally. Mandibles white-yellow with rust-coloured apex. Ocelli placed in a right-angled triangle. Distal part of humeral tubercle yellow or white-yellow. Propodeum short, shining dorsally, sometimes with fine lateral microsculpture. Petiolus thick, 3.5 times longer than its maximum breadth. Abdomen with very extensive red-yellow or red-brown pattern, at least on terga 3 and 6. Pygidial area dull, with distinct microsculpture, slightly concave, only distally surrounded by a weak carina. Legs with extensive white-yellow pattern on coxa 1, trochanter 1, apex of femora 1-2, tibiae 1-2 and tarsi 1-2.

Male: 4-5 mm. Anterior border of clypeus evenly rounded, without conspicuous excavations or teeth. Antennae as in female, but flagellum paler. Segment 6 ventrally slightly excavate. Mandibles distally slightly dilated. Colour pattern as in female, but mandibles may be completely dark, and the red-brown pattern on abdomen absent. Propodeum dull, with fine, longitudinal microsculpture. White-yellow colour pattern on legs best developed in specimens from Central and South Europe.

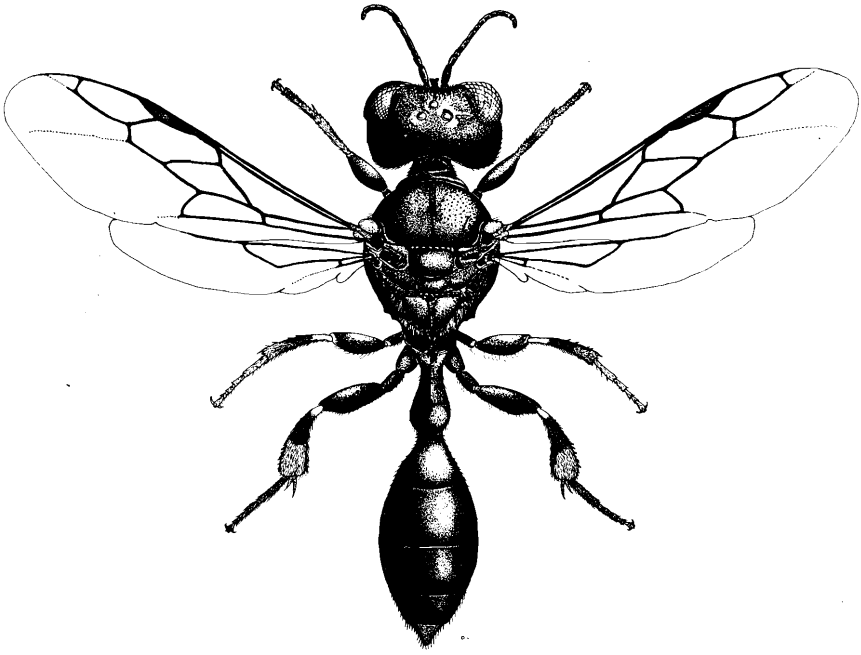


Fig. 393. Female of Rhopalum coarctatum (Scop.). Length: 6-8 mm.

The species is known from most Danish districts, and probably occurs throughout the country. - Sweden: common, known from Sk. in the south to Lu. Lpm. in the north. - In Norway the species has a southern and south-eastern distribution; northernmost localities in HEn. - In Finland the northern distribution limit runs through Ok and ObS. - Soviet Karelia: Kr. Holarctic distribution. In the Palaearctic region the distribution area covers Europe, except the Mediterranean. Additional material from Caucasus, Mongolia and Japan.

The species has been found nesting in the stems of a large number of plants, e.g. Rubus, Sambucus, Fraxinus, Spiraea, Ficus and Phragmites, but empty galls of Cynips kollari Htg. (Hym., Cynipidae), Lipara (Dipt., Chloropidae) and Saperda (Col., Cerambycidae) may also be used. Abandoned xylophagous larva-tunnels in wood are often used. Nielsen (1900) observed that the species - when space is sufficient - gnaws larger cavities in one or several places at the main entrance, from which several short side tunnels are constructed, each ending in a single cell. Each nest may contain up to 13 cells. The prey consists of small Diptera, e.g. Mycetophilidae, Chironomidae, and Culicidae as well as Homoptera, Psocoptera and Psyllidae. According to Danks (1971), the main part of the provision is represented by Psocidae (9 species) in England, whereas Maréchal (1929) from France states that the prey consists mainly of Diptera. In Finland (Merisuo, 1943) the species appears exclusively to use Psocidae as prey. Such ecological (ecophenotypic) variation is also found in Lindenius albilabris. Recorded parasitoids are Diomorus armatus (Hym., Torymidae), Omalus auratus (Hym., Chrysididae), Chaenocryptus macilentus and Ischnurgops fragilis (Hym., Ichneumonidae) and Ptychoneura melaleuca and Pt. rufitarsis (Dipt., Sarcophagidae). The larva was described by Maréchal, 1929.

140. RHOPALUM (CORYNOPUS) COARCTATUM (Scopoli, 1763)

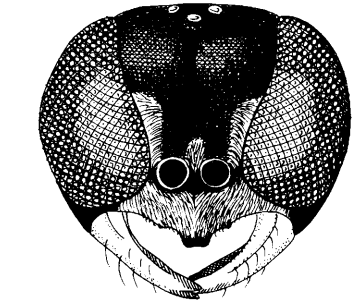
Figs. 393, 395, 396, 399, 400.

Sphex coarctatum Scopoli, 1763:293.

Crabro tibialis Fabricius, 1798:271.

Female: 6-8 mm. Head in front view as Fig. 395. Clypeus with stout central tooth and two weaker lateral teeth. Mandibles black proximally, median area red-brown or red-yellow, apex rusty-coloured. Process between base of antennae truncate. Antennae brown, scapus distally and proximally with larger or smaller yellow spots, which may be yellow-white in Central European specimens, segments 2-7 ventrally often with triangular yellow spots. Ocelli placed in an obtuse triangle. Propleuron on either side with strong, obliquely outwardly directed spine-like dilation. Humeral tubercle distally whitish or slightly yellow-

brown, only exceptionally completely black. Propodeum slightly convex, dorsally shining, smooth, with strong median furrow. Petiolus basally carinate, about 2.3 times longer than broad distally. Abdomen black, but segment 6 usually red-



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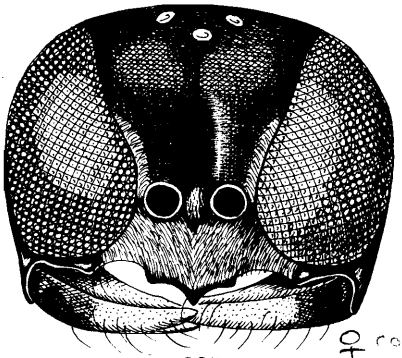

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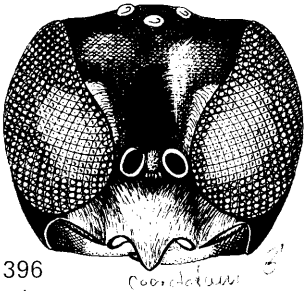

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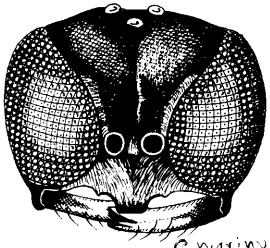

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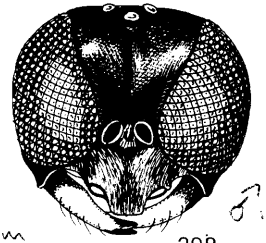

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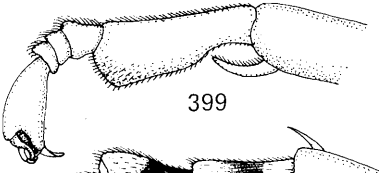

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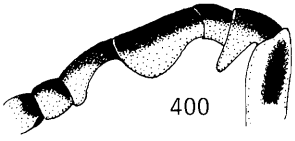

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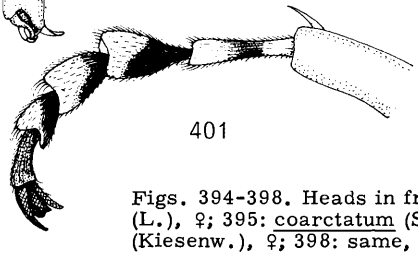

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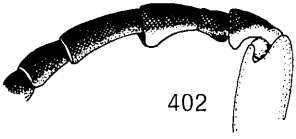

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Figs. 394-398. Heads in frontal view of Rhopalum. - 394: clavipes (L.), ♀; 395: coarctatum (Scop.), ♀; 396: same, ♂; 397: nigrinum (Kiesenw.), ♀; 398: same, ♂.

Fig. 399. Tarsus 1 of male Rhopalum coarctatum (Scop.).
Fig. 400. Proximal part of flagellum of male Rhopalum coarctatum (Scop.).
Fig. 401. Tarsus 2 of male Rhopalum nigrinum (Kiesenw.).
Fig. 402. Proximal part of flagellum of male Rhopalum nigrinum (Kiesenw.).

yellow. Pygidial area shining, smooth, framed by well developed carinae. Legs mainly black. Femora 1-2 distally with small yellow spot. Tibia 1 white-yellow with larger or smaller brown spot on the inner side. Tibiae 2-3 with a dark central area, a proximal white-yellow ring and a distal red-brown pattern. Trochanter 3 usually white-yellow.

Male: 5-7 mm. Clypeus strongly convex, median lobe rounded, triangular, anterior border strongly double-arcuate (Fig. 396). Base of mandibles black, middle white-yellow to pale brown-yellow, apex rust-coloured. Antennae very characteristically shaped and coloured: scapus with larger or smaller yellow spot ventrally. Pedicellus with large, downward-directed tooth. Segments 4 and 5 with strong basal emargination (Fig. 400). Segments 7, 9, 11 and apex of 13 white-yellow. Occipital carina anteriorly ending in an acute tooth (almost as in Crossocerus quadrimaculatus Fabr. (Fig. 425). This character may be vestigial or absent in small individuals. Humeral tubercle usually with yellow pattern posteriorly. Tarsus 1 white-yellow, asymmetrical (Fig. 399). Metatarsus 2 also white-yellow, with a basal cavity with long hairs at the bottom. Metatarsus 3 brown with red-brown base, slightly curved. Knees and trochanters with white-yellow markings. Tibia 3 distally red-yellow. Last abdominal segment red-yellow or red-brown.

The species is common in Fennoscandia and Denmark. Northern distribution limit runs through central Norway (On), Sweden (Jmt. and Ly. Lpm.). - In Finland the northernmost recorded localities are in Ok and ObS. - Soviet Karelia: Ib and Kr. A Holarctic Taiga species, common in Europe except in the Mediterranean region. The distribution area expands eastwards through Central Asia to Japan.

The nests are constructed in sites similar to those of clavipes. A characteristic feature (Danks, 1971) is that the nests are often very long, sometimes containing up to 29 cells. The average number, however, is about six. Where space allows the nest is branched. Old nests are often re-used. The prey consists of smaller Diptera, e.g. Tipulidae, Culicidae, Chironomidae, Mycetophilidae, Empididae, Agromyzidae or Psychodidae. Only exceptionally Psocoptera or even Neuroptera are used. The larva was described by Micheli, 1929 and Evans, 1964. Known parasitoids are Ischnurgops and Demopheles (Hym., Ichneumonidae), Diomorus armatus (Hym., Torymidae), Eurytoma (Hym., Eurytomidae) and Omalus auratus (Hym., Chrysididae). In addition, Ptychoneura rufitarsis (Dipt., Sarcophagidae).

141. RHOPALUM (CORYNOPUS) NIGRINUM (Kiesenwetter, 1849)

Figs. 397, 398, 401, 402.

Crabro nigrinum Kiesenwetter, 1849:91.

Crabro Kiesenwetteri A. Morawitz, 1866:267.

Considerably more slender than coarctatum. Female: 5-6 mm. Clypeus anteriorly broadly truncate, lateral lobes very small, rounded (Fig. 397). Between antennal sockets there is a small, compressed spine. Mandibles almost uniformly brown-yellow. Ocelli placed in right-angled triangle. Antennae brownish, scapus distally and proximally paler. Propleuron laterally with rounded swellings. Humeral tubercle black, posteriorly a little paler. Propodeum dorsally shining, smooth, median furrow broad. Petiolus basally carinate and slightly rugose, about 2.5 times longer than maximum breadth. Pygidial area shining, smooth, very broad, surrounded by distinct carinae. Femora black. Tibia 1 and tarsus 1 mainly white-yellow to brown-yellow. Tibiae 2-3 with pale, basal ring. Tibia 3 only slightly thickened.

Male: 4-6 mm. Anterior part of clypeus strongly convex, median lobe squarely truncate (Fig. 398). Mandibles mainly white-yellow. Scapus entirely yellow. Pedicellus with weak, downwardly directed tooth. Antennae otherwise as Fig. 402, without pale segments. Occipital carina abruptly truncate anteriorly. Propodeum very weakly rugose and punctate, median furrow very deep. Tarsus 1 very slightly dilated, metatarsus with almost parallel sides, transparent. Tarsus 2 rather strongly dilated, bicoloured (Fig. 401). Colour pattern of legs very variable, but usually with the following areas pale yellow: trochanter, femur 1 distally, tibiae 1-2 and tibia 3 basally.

The species seems to maintain isolated populations in Denmark: WJ, round Ringkøbing Fjord; EJ, Anholt, 1 ♀, 8.viii.1975 (E.S. Nielsen); F, Langeland, Keldsnor, 1 ♀, 6.viii.1975 (L.L., O.M. & V.M.). - Sweden: scattered occurrence in Sk., Og., Nrk., and Upl. - Not found in Norway. - Finland: widely distributed, locally, i.e. Ab, Rymättylä, in very large populations. Northernmost findings in Kb and ObS. - Widely distributed in the Palaearctic region, eastwards to Japan. Not recorded from Siberia, but may occur there.

The species is very sporadic and local; it seems mainly to occur near fresh and brackish water. The apparently very scattered occurrence may be due to the fact that it has been overlooked owing to its very narrow ecological niche. It is found nesting in Phragmites (Merisuo, 1968). In addition, it is stated (Valkeila, in litt.) that the species may be found breeding in stems of Elymus arenarius or Solidago occidentalis (Usuba in Tsuneki, 1952). The provision consists of small

Diptera (Chironomidae, Psychodidae, Dolichopodidae and Trypetidae) or Psocoptera. Chrysis cyanea L. (Chrysididae) is a probable parasite.

Genus *Crossocerus* Lep. & Brullé

Crossocerus Lepeletier & Brullé, 1834:763.

Type-species: Crabro scutatus Fabricius, 1787 (=Crossocerus palmipes (Linné, 1767)).

Small to medium-sized species (Fig. 403), often entirely black. Inner orbits very strongly converging ventrally, so that antennal sockets are separated by only a very thin wall. Distance from antennal sockets to inner orbits less than diameter of sockets. The forward-directed ommatids considerably larger than those placed dorsally in the eyes. Ocelli placed in a right or an acute angle. Facial fovea usually weakly marked or missing. Mandibles with or without a weak tooth on the inner side, and bi- or tridentate distally, only in females of Hoplocrabro ending in a single truncate tooth. Clypeus always with a dense, silvery pubescence, anterior border with characteristic teeth and/or emarginations. Antennae in female with 12 segments, in males with 13. Antennae of males often with a row of short, densely placed hairs ventrally. Head and thorax usually very finely sculptured. Mesopleuron generally smooth, but may have a small spine in front of coxa 2 (precoxal carina). Propodeum usually with distinct, shining, smooth area cordiformis, which is surrounded by a coarsely pitted furrow. Last tergum in females always with pygidial area; such an area also occurs in single males (section Stenocrabro Ashmead). Legs rather short and stout, frequently with conspicuous secondary sexual characters in males.

The genus comprises about 140 species, of which the majority is found in the Palaearctic and Nearctic regions. The species occurring in Denmark and Fennoscandia are separated into six subgenera.

The species nest in the soil (Crossocerus s.str. and Hoplocrabro) or in hollow or pith-filled plant stems, old timber, or abandoned larval tunnels of xylophagous insects (Blepharipus, Cuphopterus, Acanthocrabro and Ablepharipus). The prey consists of small Diptera, except in walkeri, which uses Ephemeroptera, and annulipes Hemiptera.

Key to subgenera of Crossocerus

1 Abdomen with yellow markings. These may occasionally be missing in males of quadrimaculatus, which are easily recognizable by the tooth ventrally on the head ... 2

- Abdomen without yellow markings. Head never with ventral tooth 4

2(1) Occipital carina on either side drawn out into a sharp tooth. Mandibles of female with one tooth, of male with two ..... Hoplocrabro Thomson

- Occipital carina of normal shape. Apex of mandibles bidentate (male) or tridentate (female) 3

3(2) Tergum 1 longer than wide. Mesopleuron in front of coxa 2 without tooth. Female: pygidial area plane, triangular. Male: sternum 7 with two small spines. Coxa 3 with a larger or smaller tooth ..... Cuphopterus A. Morawitz

- Tergum 1 wider than long. Mesopleuron with a tooth in front of coxa 2. Female: pygidial area concave posteriorly. Male: sternum 7 and coxa 3 without spines or teeth, respectively ..... Acanthocrabro Perkins

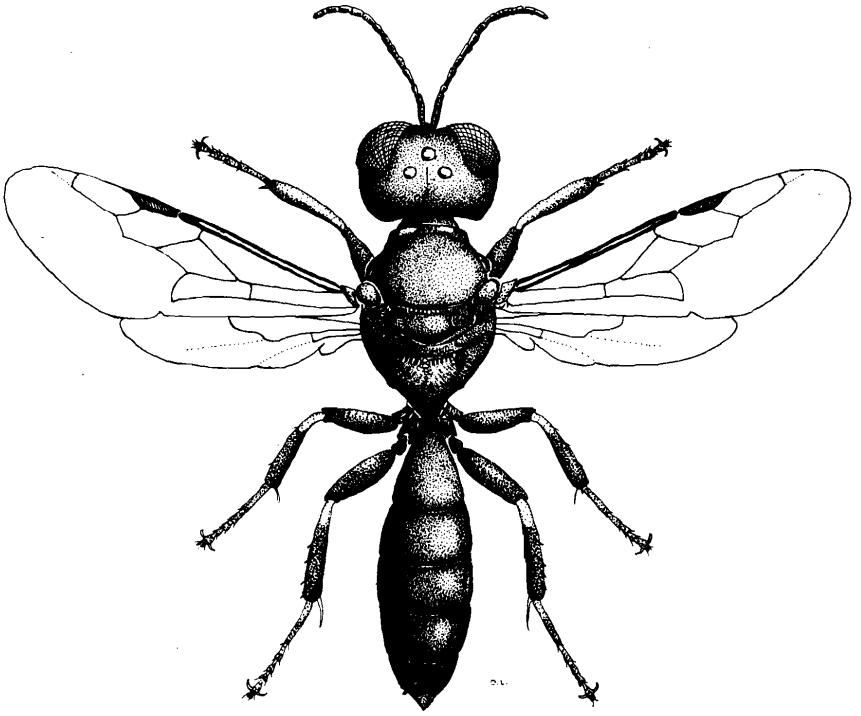


Fig. 403. Female of Crossocerus elongatulus (v.d. Lind.). Length: 5-6.5 mm.

4(1) Integument dull due to the well developed microsculpture. Punctation very weak or missing. Female: pygidial area dull, with a trifoliate or broad T-shaped depression ..... Ablepharipus Perkins

- Integument usually smooth, shining, with distinct punctation. Female: pygidial area shiny, differently shaped .. 5

5(4) Propodeum with distinct area cordiformis. Female: pygidial area plane, triangular, punctate. Male: tergum 7 with distinctly stronger punctation than tergum 6 ..... Crossocerus s. str.

- Propodeum often without well delimited area cordiformis. Female: pygidial area with concave margins, posteriorly excavated in a groove, anteriorly with elevated, strongly sculptured area. Male: punctation on tergum 7 equal to that of tergum 6 ..... Blepharipus Lepeletier & Brullé

Key to species of Crossocerus

Females.

1 Abdomen with yellow markings 2

- Abdomen without yellow markings 6

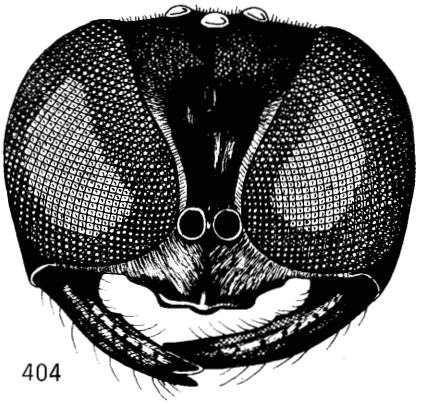
2(1) Occipital carina on either side produced into a stout tooth (Fig. 425). Apex of mandibles simply pointed. Facial fovea slightly convex ..... 142. quadrimaculatus (Fabricius)

- Occipital carina of normal shape. Apex of mandibles tridentate. Facial fovea depressed 3

3(2) Tergum 1 as long as wide. Mesopleuron with small spine in front of coxa 2. Pygidial area convex proximally, coarsely and densely punctate, smooth apically, narrowing into a groove. Facial fovea deeply impressed 168. vagabundus (Panzer)

- Tergum 1 longer than wide. Mesopleuron without tooth in front of coxa 2. Pygidial area plane, triangular. Facial fovea slightly depressed 4

4(3) Longitudinal convexity between lateral ocelli slightly punctate, even. Spines on the outer side of tibia 3 strong, usually not placed in two rows, varying in number between 10 and 15, most often 13. Tibiae 2-3 with brown pattern ..... 169. dimidiatus (Fabricius)



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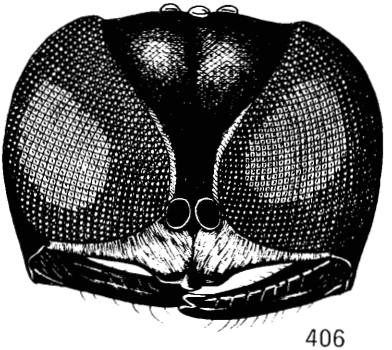

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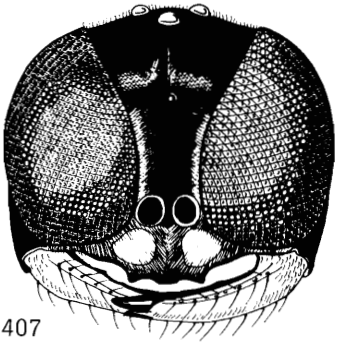

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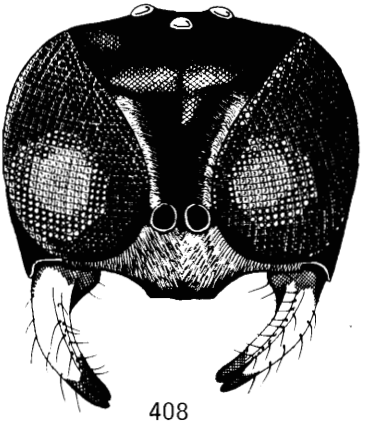

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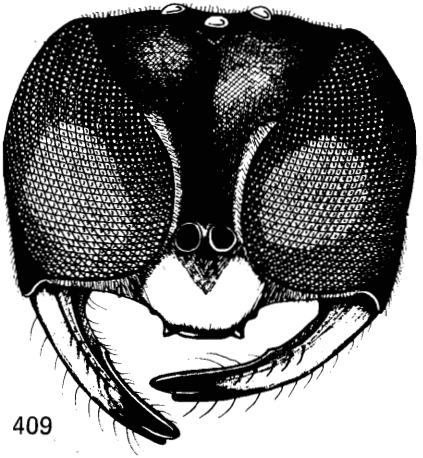

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Figs. 404-409. Heads in frontal view of female Crossocerus. -
404: pusillus Lep. & Brullé;
405: tarsatus (Shuckard), outline of clypeus;
406: lundbladi (Kjellander);
407: imitans (Kohl);
408: denticrus Herr.-Schäffer;
409: palmipes (L.).

- Longitudinal convexity between lateral ocelli densely punctate, posteriorly with a small, attenuate tubercle or tooth. Spines on outer side of tibia 3 weak, often forming paired rows, number varying between 7 and 11, most often 9. Tibiae 2-3 often without brown markings 5

5(4) Inner side of tibia 3 comparatively flattened, distally with a slight swelling proximally to the spur. Hind margin distinctly emarginate (Fig. 461). Area cordiformis often limited by a distinct pitted furrow ..... 171. subulatus Dahlbom

- Tibia 3 rounded, distally without thickening or emargination (Fig. 460). Area cordiformis posteriorly indistinctly delimited ..... 170. binotatus Lep. & Brullé

6(1) Pygidial area dull, with trifoliate or broadly T-shaped depressed figure. Integument dull due to the microsculpture 7

- Pygidial area shining, with or without punctation, always without microsculpture, differently shaped. Integument usually smooth, without microsculpture 9

7(6) Propleuron with an attenuate, tooth-like process. Humeral tubercle black. Area cordiformis very narrowly extended posteriorly (Fig. 430). ..... 156. assimilis (Smith)

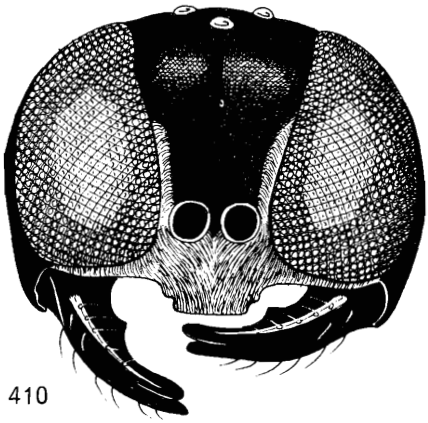
- Propleuron evenly rounded or with small swelling. Humeral tubercle with yellow spot. Area cordiformis posteriorly evenly rounded 8

8(7) Area cordiformis over its whole extent distinctly delimited by a pitted furrow. Occipital carina anteriorly truncate ..... 154. podagricus (v.d. Linden)

- Area cordiformis only anteriorly delimited by a pitted furrow. Occipital carina weak, anteriorly gradually disappearing ..... 155. congener (Dahlbom)

9(6) Lateral margins of pygidial area concave, the surface itself excavated in a groove apically, impunctate, proximally with a punctate, rather sharply delimited elevation (this often concealed by tergum 5) 10

- Pygidial area plane, triangular, with distinct punctation and pubescence 21



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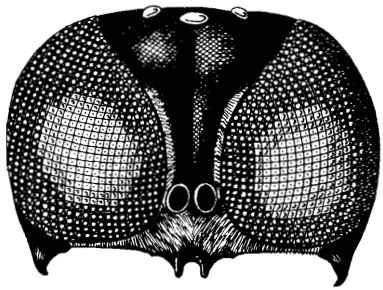

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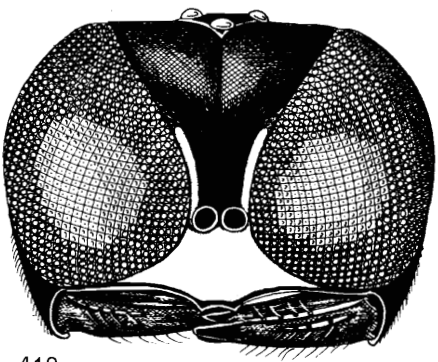

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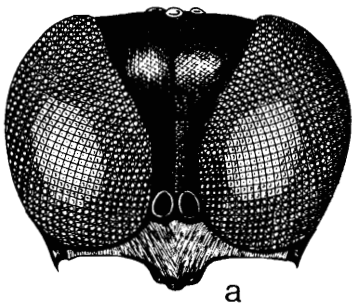

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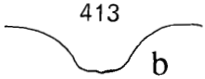

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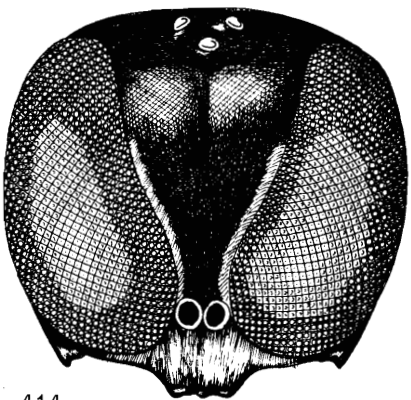


414

Figs. 410-414. Heads in frontal view of female Crossocerus. -
410: assimilis (Smith);
411: annulipes (Lep. & Brullé);
412: walkeri (Shuckard);
413: heydeni Kohl;
414: styrius (Kohl).

10(9) Mesopleuron with a small, attenuate tubercle or tooth in front of coxa 2 11

- Mesopleuron evenly rounded, smooth, without tooth ... 15

11(10) Area cordiformis posteriorly delimited by distinct, pitted furrow 12

- Area cordiformis posteriorly without delimiting furrow 13

12(11) Furrow surrounding area cordiformis very strong, divided into very large, quadrate pits, median groove very broad (Fig. 431). Lateral margins of pygidial area distinctly concave ..... 162. leucostomus (Linné)

- Furrow surrounding area cordiformis weak, sometimes rather indistinct, especially laterally; median furrow narrow. Pygidial area very narrow, margins almost straight (Fig. 438) ..... 159. heydeni Kohl

13(11) Scapus with or without very weak longitudinal keel. Lateral faces of propodeum very finely and densely transversely striate. Sternum 2 on either side with a round, dull spot. Occipital carina truncate anteriorly.. 163. cetratus (Shuckard)

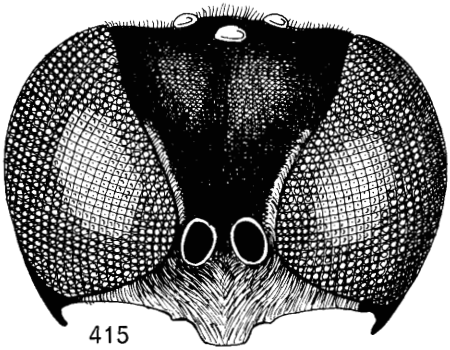
- Scapus with sharp longitudinal keel anteriorly. Lateral faces of propodeum shining, without rugae, at most with very fine, sparse punctation. Spots on sternum 2 shining. Occipital carina gradually disappearing anteriorly 14

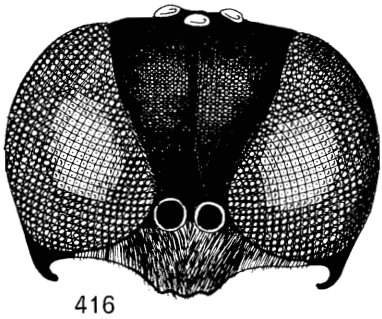
14(13) Median lobe of clypeus centrally and on either side with a small, rounded tubercle. Lateral lobes very small, rounded (Fig. 418). Keel on scapus a little more than half as long as scapus. Tibia 3 usually with a yellow proximal spot ..... 164. nigritus (Lep. & Brullé)

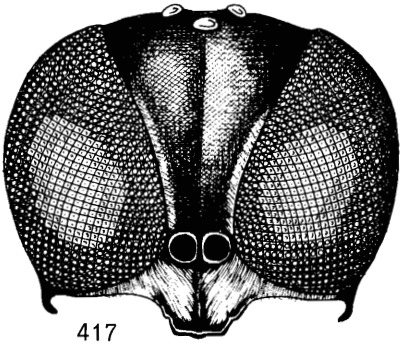
- Median lobe of clypeus forming a very obtuse angle; lateral lobes distinct (Fig. 419). Keel as long as scapus. Tibia 3 completely black or with distal yellow spot ..... 165. megacephalus (Rossi)

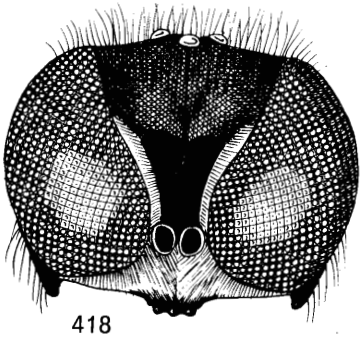
15(10) Clypeus yellow, only anterior margin black (Fig. 412). Inner orbits, scapus, pronotum, humeral tubercle and tibiae 1-2 and tarsi 1-2 also with yellow pattern. Pygidial area narrow, its lateral margins thickened like a pad. Apex with a narrow groove, apically directed upward (Fig. 437) ..... 157. walkeri (Shuckard)

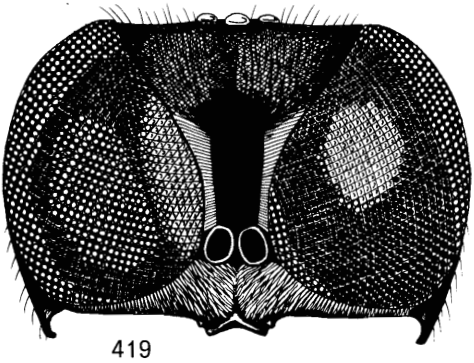
- Clypeus, inner orbits, pronotum, humeral tubercles

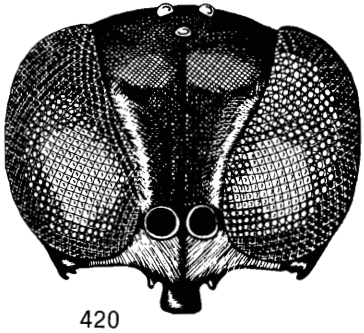












Figs. 415-420. Heads in frontal view of female Crossocerus. - 415: barbipes (Dahlbom); 416: leucostomus (L.); 417: cetratus (Shuckard); 418: nigritus (Lep. & Brullé); 419: megacephalus (Rossi); 420: cinxius (Dahlbom).

and legs black. Apex of pygidial area not upward-directed 16

16(15) Area cordiformis delimited by a complete furrow. Metatarsus 1 with stout, coloured pecten 17

- Area cordiformis only anteriorly delimited by a pitted furrow. Metatarsus 1 usually without true pecten, with only a few longer and pale hairs 18

17(16) Anterior border of clypeus with a deep, semi-circular emargination, on either side bordered by a strong tooth (Fig. 411). Propleuron with downward-directed tooth ..... 158. annulipes (Lep. & Brullé)

- Clypeus with a projecting, truncate median lobe (Fig. 415). Propleuron with at most a swelling ....161. barbipes Dahlbom

18(16) Clypeus with a narrow, almost nose-like projecting median lobe. Tibia 3 strongly clavate, without spines .. 19

- Median lobe of clypeus broad, not strongly projecting. Tibia 3 not strongly clavate, with conspicuous spines on the outer side..... 20

19(18) Vertex very well developed (Fig. 426). Median lobe of clypeus as broad as scapus (Fig. 446). Tibia 1 with yellow stripe anteriorly ..... 167. capitosus (Shuckard)

- Vertex considerably shorter. Median lobe of clypeus almost twice as broad as scapus (Fig. 420). Tibia 1 completely black ..... 166. cinxius (Dahlbom)

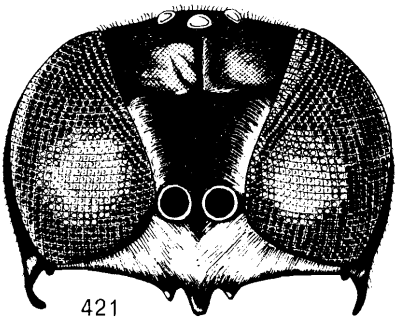
20(18) Median lobe of clypeus with three small rounded tubercles (Fig. 414). Metatarsus 1 with 5-6 pale, weak spines. Vertex relatively well developed (Fig. 424) .... 160. styrius (Kohl)

- Median lobe of clypeus with at most an indication of rounded tubercles (Fig. 417), usually evenly rounded. Metatarsus 1 with 4 very narrow and pale spines. Head evenly narrowed behind eyes ..... 163. cetratus (Shuckard)

21(19) Mesopleuron with a small, attenuate tooth or tubercle in front of coxa 2 22

- Mesopleuron evenly rounded, without tooth 25

22(21) Clypeus yellow, median part slightly arcuately convex, lateral lobes small, directed obliquely outwards (Fig. 409). Facial fovea distinct. Frons densely and finely punctate. Mandibles mainly yellow ..... 153. palmipes (Linné)



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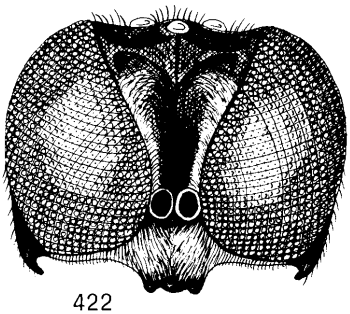

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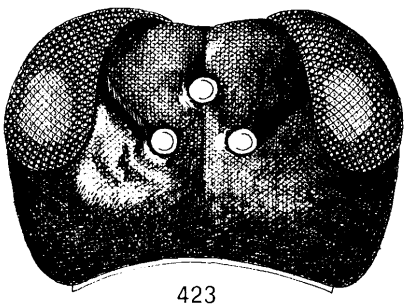

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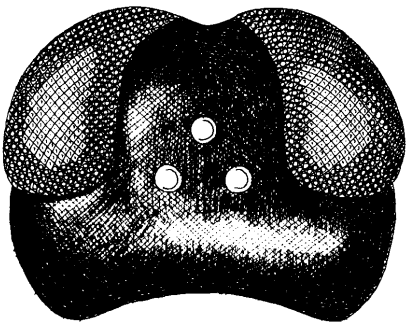

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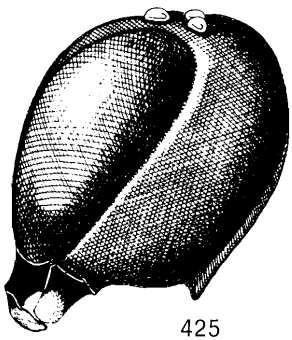

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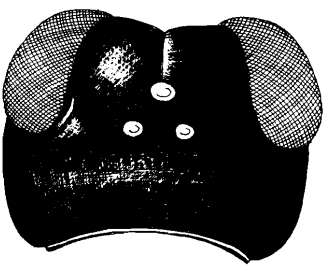

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Figs. 421, 422. Heads in frontal view of female Crossocerus. - 421: capitosus (Shuckard); 422: demidiatus (Fabr.).
Figs. 423, 424, 426. Heads in dorsal view of female Crossocerus. - 423: elongatulus (v.d. Lind.); 424: styrius (Kohl); 426: capitosus (Shuckard).
Fig. 425. Head in lateral view of female Crossocerus quadrimaculatus (Fabr.).

- Clypeus black 23

23(22) Distal third or more of pygidial area of paler colour. Median part of mandibles rust-coloured or red-yellow. Furrow delimiting area cordiformis strong throughout, also in front of the area (Fig. 427) ..... 143. ovalis Lep. & Brullé

- Apex of pygidial area not, or hardly paler than remaining part of area. Mandibles black, with at most paler apex. Furrow delimiting area cordiformis anteriorly less distinct or disappearing 24

24(23) Apical spur of tibia 1 black-brown. Scutellum usually black. Frons in front of ocelli evenly convex ..... 145. tarsatus (Shuckard)

- Apical spur of tibia 1 yellow. Scutellum usually with yellow pattern (small specimens from northern Fennoscandia often have completely black scutellum). Frons in front of ocelli strongly and abruptly convex ..... 144. pusillus Lep. & Brullé

25(21) Scutum smooth posteriorly, without rugae. Facial fovea absent. Facial line from median ocellus vestigial or absent 26

- Scutum posteriorly with short, dense rugae. Facial fovea always distinct. Frontal line distinct 27

26(25) Punctation on lateral faces of mesopleuron of same strength as punctation on scutum. Longitudinal median groove of posterior face of propodeum excavated almost like a pit ..... 151. denticrus Herrich-Schäffer

- Punctation on lateral faces of mesopleuron considerably finer and sparser than on scutum. Longitudinal median furrow of propodeum shallow..... 152. exiguus (v.d.Linden)

27(25) Clypeus with two large grey-yellow spots (Fig. 407). Scutum shining, smooth, with very sparse and fine punctation ..... 149. imitans (Kohl)

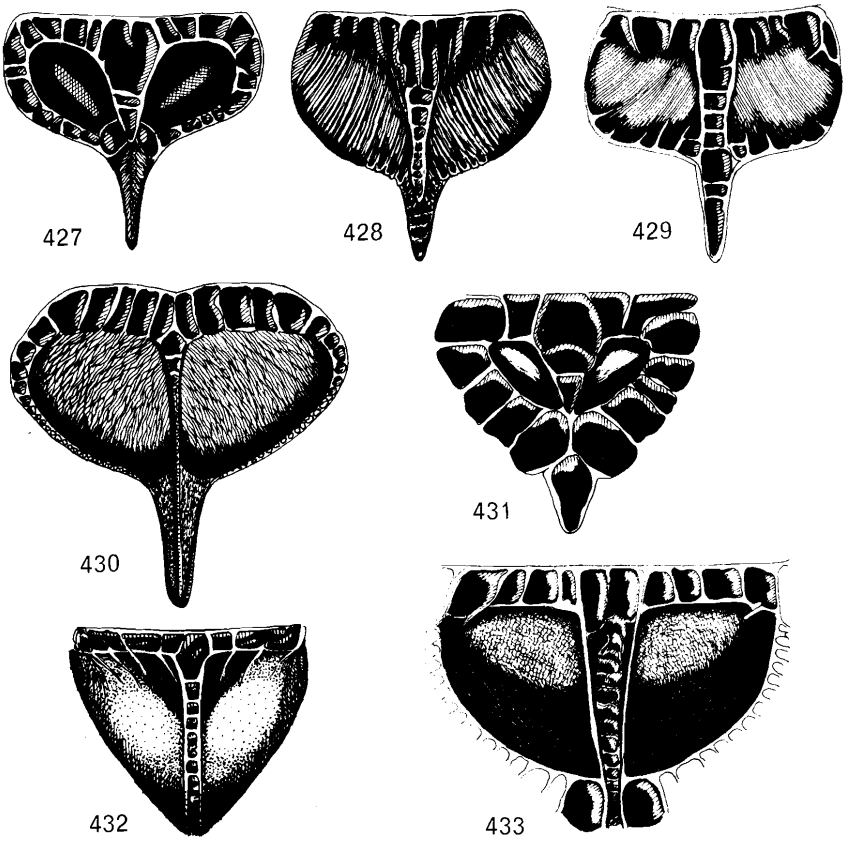
- Clypeus entirely black. Scutum rather dull, densely punctate 28

28(27) Distal half of pygidial area usually red-brown. Femur 1 with a very large, yellow apical spot. Tibia 2 mainly yellow. Scutellum, humeral tubercles and a stripe on pronotum yellow .....147. wesmaeli (v.d.Linden)

- Pygidial area black, only its extreme apex reddish. Femur 1 with or without a very small yellow apical spot. Tibia 2, except in lundbladi, mainly dark. Scutellum usually black. Pronotum often with two yellow spots... 29

29(28) Facial fovea distinctly convex. Frons shining, without microsculpture ..... 146. elongatulus (v.d. Linden)

- Facial fovea entirely flat on level with remaining part of frons. Interstices between punctures on the anterior part of frons with microsculpture (only visible at times



Figs. 427-433. Area cordiformis of female Crossocerus. - 427: ovalis Lep. & Brullé ; 428: pusillus Lep. & Brullé; 429: tarsatus (Shuckard); 430: assimilis (Smith); 431: leucostomus (L.); 432: nigritus (Lep. & Brullé); 433: dimidiatus (Fabr.).

100-150 magnification) 30

30(29) Tibiae 2+3 with large yellow proximal spot, on tibia 2 covering two-thirds on the outer side and on tibia 3 about half of it. Femur 1 often with a yellow apical spot ..... 148. lundbladi (Kjellander)

- Tibiae 2+3 usually each with a small proximal yellow ring. Femur 1 without yellow apical spot ..... 150. distinguendus (A. Morawitz)

Males

1 Abdomen with yellow markings. These may exceptionally be missing in quadrimaculatus, which in that case is easily recognizable by the ventral tooth-like projections on the head 2

- Abdomen entirely black 6

2(1) Occipital carina on either side produced into a tooth (Fig. 425). Last antennal segment truncate. Facial fovea swollen like a blister. Anterior border of clypeus with 4-6 regularly placed teeth, and usually with two yellow spots (Fig. 439). Abdomen in small specimens often entirely black ..... 142. quadrimaculatus (Fabricius)

- Occipital carina of normal shape. Last antennal segment rounded apically. Facial fovea flattened or slightly depressed. Anterior border of clypeus with or without very small, rounded teeth 3

3(2) Tergum 1 as long as broad. Femur 1 with a flat, triangular tooth ventrally (Fig. 456). Mesopleuron with an often indistinct tooth in front of coxa 2 ..... 168. vagabundus (Panzer)

- Tergum 1 considerably longer than broad. Femur 1 without tooth. Tibia 1 flattened ventrally. Mesopleuron without tooth 4

4(3) Femur 3 without tooth. Tooth of coxa 3 very strong (Fig. 464). Tibia 2 on the outer side with a long, transparent dilation. Vertex behind lateral ocelli without attenuate tubercle ..... 169. dimidiatus (Fabricius)

- Femur 3 basally on the inner side with a small, obtuse tooth (Fig. 463). Coxa 3 also with a small tooth. Vertex behind lateral ocelli usually with a small attenuate tubercle 5

5(4) Tibia 3 strongly excavated on the inner side; with two stout teeth apically (Fig. 462) ..... 171. subulatus Dahlbom

\- Tibia 3 normal, without teeth ..... 170. binotatus Lep. & Brullé

6(1) Last tergum with pygidial area (section Stenocrabro) 7

\- Last tergum without pygidial area 9

7(6) Median furrow in area cordiformis anteriorly very deep and wide. Metatarsus 1 rounded, not bicoloured ..... 143. ovalis Lep. & Brullé

\- Furrow in area cordiformis anteriorly shallow and narrow. Metatarsus 1 dilated and flattened, bicoloured ... 8

8(7) Metatarsus 1 more than twice as long as wide, yellow with dark transverse band (Fig. 448) ..... 144. pusillus Lep. & Brullé

\- Metatarsus 1 only slightly longer than broad, remaining tarsal segments also dilated, entirely pale (Fig. 447) ..... 145. tarsatus (Shuckard)

9(6) Tibia 1 and metatarsus 1 strongly flattened and dilated 10

\- Tibia 1 not flattened or dilated 11

10(9) Tibia 1 mainly yellow, the dilation with a black V-shaped apical spot (Fig. 452). Clypeus, lower part of head, coxae and epicnemium with very extensive yellow pattern ..... 153. palmipes (Linné)

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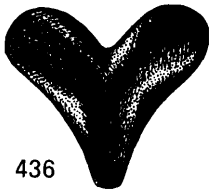
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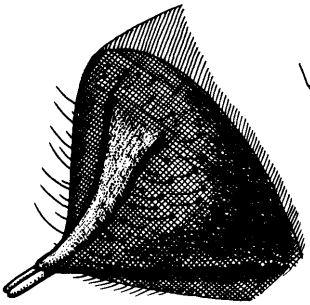
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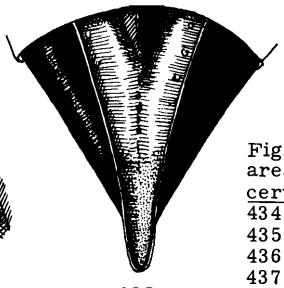
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Figs. 434-438. Pygidial areas of female Crossocerus.
434: podagricus (v.d.Lind.);
435: congener (Dahlbom);
436: assimilis (Smith);
437: walkeri (Shuckard);
438: heydeni Kohl.

- Tibia 1 mainly black, with only narrow, yellowish-white, translucent fringe along the border (Fig. 451). Head and thorax entirely black ..... 163. cetratus (Shuckard)

11(9) Metatarsus 1 flattened and dilated 12

- Metatarsus 1 not flattened or dilated 14

12(11) Metatarsus 1 very wide, pale translucent, with three dark spots. Following segments except pretarsus also pale and flattened (Fig. 450). Tibia 1 slightly obtusely dilated on the inner side. Area cordiformis distinctly delimited ..... 158. annulipes (Lep. & Brullé)

- Metatarsus 1 differently shaped. Tibia 1 not dilated .. 13

13(12) Forelegs with very extensive yellow pattern; metatarsus only slightly longer than wide, remaining tarsal segments pale, distinctly dilated (Fig 447). Trochanter of forelegs and mesopleuron anteriorly with long, white, woolly pubescence ..... 145. tarsatus (Shuckard)

- Forelegs black, metatarsus 1 very slightly dilated, distally usually with a pale zone (Fig. 449). Trochanter 1 and mesopleuron with short pubescence ..... 162. leucostomus (Linné)

14(11) Tibia 2 distally broadly truncate, without spur, length c. 2/3 of femur 2 (Fig. 455) ..... 154. podagricus (v.d.Linden)

- Tibia 2 of normal length, spur present (very short in congener 15

15(14) Last tergum with rather strong punctation, very different from the very weak punctation on tergum 6 16

- Punctation of last tergum weak, not differing in strength from punctation on tergum 6 22

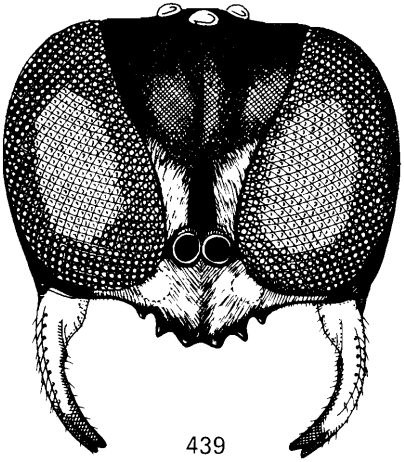
16(15) Femur 2 proximally with a strong tooth (Fig. 454). Mandibles yellow with darker apex. Frontal line weak ..... 151. denticrus Herrich-Schäffer

- Femur 2 without tooth 17

17(16) Clypeus and a larger or smaller area near mandibular articulations yellow 18

- Clypeus and rest of head entirely black 19

18(17) Antennal segment 7 distally with stout, downward-directed tooth (Fig. 458). Whole clypeus yellow, spots on



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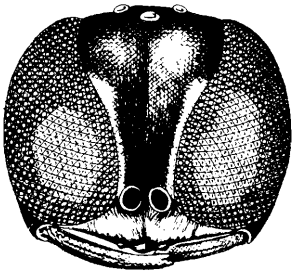

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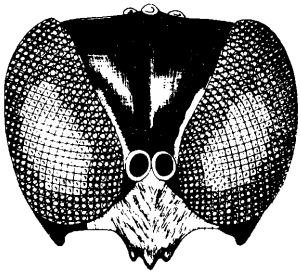

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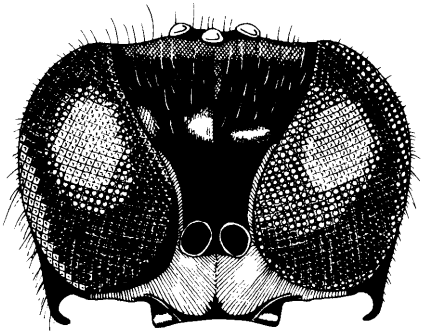

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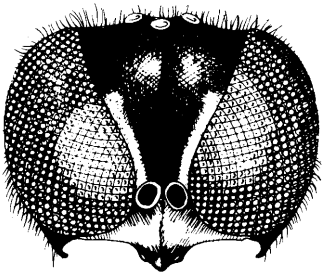

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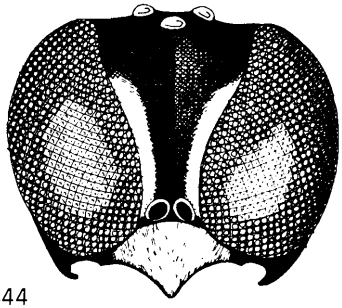


444

Figs. 439-444. Heads in frontal view of male Crossocerus. -
439: quadrimaculatus (Fabr.);
440: lundbladi (Kjellander);
441: styrius (Kohl);
442: nigritus (Lep. & Brullé);
443: megacephalus (Rossi);
444: walkeri (Shuckard).

ventral face of head large. Scutum densely punctate ..... 152. exiguus (v.d.Linden)

- No antennal segments dentate. Clypeus with two large, circular spots. Spots ventrally on head small. Scutum shining, smooth, very sparsely punctate ..... 149. imitans (Kohl)

19(17) Basal part of femur 2 swollen (Fig. 453). Frons between eyes with dense, coarse punctation ... 146. elongatulus (v.d.Linden)

- Basal part of femur 2 not dilated 20

20(19) Mesopleuron laterally and in front of cavity with long, woolly pubescence. Flagellar segments somewhat thickened. Metatarsus 1 dark. Frons between eyes with fine and less dense punctation ..... 150. distinguendus (A. Morawitz)

- Pubescence of mesopleuron short. Flagellar segments not thickened. Metatarsus 1 usually yellow (dark in very small specimens) 21

21(20) Mesopleuron laterally with very fine and sparse punctation. Flagellum ventrally with distinct fringe of hairs, last segment rounded apically. Spines on tibia 3 distinct ..... 147. wesmaeli (v.d.Linden)

- Mesopleuron laterally more strongly punctate, with indication of transverse, rugose sculpture. Flagellum ventrally with only extremely short hairs, last segment truncate apically. Spines on tibia 3 very short and indistinct ..... 148. lundbladi (Kjellander)

22(15) Clypeus on either side with strong, obliquely outward-directed triangular dilation (Fig. 443). Mesopleuron usually with a small tooth in front of coxa 2 ..... 165. megacephalus (Rossi)

- Clypeus without such teeth 23

23(22) Area cordiformis delimited by a distinct, pitted furrow 24

- Area cordiformis very indistinctly delimited, furrow missing posteriorly 27

24(23) Clypeus yellow, with a single, triangular projection centrally (Fig. 444). Inner orbits, pronotum, scutellum, metanotum, and the legs with extensive yellow markings ..... 157. walkeri (Shuckard)

- Clypeus black, differently shaped. Head, thorax and legs black 25

25(24) Mesopleuron with a small tooth or attenuate tubercle in front of coxa 2 26

\- Mesopleuron without tooth, smooth and evenly rounded. Femur 1 and tibia 1 with very long pubescence ..... 161. barbipes (Dahlbom)

26(25) Head and scutum dull, due to the very pronounced microsculpture. Punctation very fine and sparse. Head ventrally, coxa 1, trochanter 1, and mesopleuron ventrally with long, white pubescence ..... 156. assimilis (Smith)

\- Head and scutum shining smooth. Ventral pubescence of normal length ..... 159. heydeni Kohl

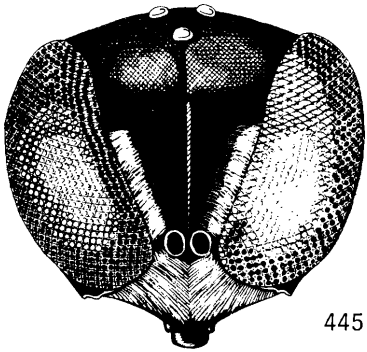
27(23) Sternum 7 with median longitudinal elevation. Tergum 7 with two ventro-lateral, clavate projections, pointing towards the median longitudinal elevation (Fig. 459) ..... 164. nigritus (Lep. & Brullé)

\- Tergum 7 normal, without projections 28

28(27) Coxa 1 and mesopleuron ventrally with rather dense, long, woolly pubescence. Tibiae 1+2 almost entirely yellow. Proximal half of femur 1 brown-yellow. Head and thorax dull due to the well developed microsculpture. ..... 155. congener (Dahlbom)

\- Coxa 1 and mesopleuron with normal, dense pubescence. Head and thorax at most with weak microsculpture 29

29(28) Anterior border of clypeus with three teeth (Fig. 441).



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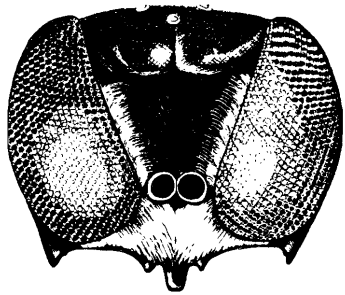

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Figs. 445, 446. Heads in frontal view of male Crossocerus. - 445: cinxius (Dahlbom); 446: capitosus (Shuckard).

Scapus 2.5 times longer than shortest distance between eyes. Tergum 1 1.5 times longer than wide ..... 160. styrius (Kohl)

- Anterior border of clypeus with a projecting median lobe. Scapus at most twice as long as shortest distance between eyes. Tergum 1 shorter 30

30(29) Median lobe of clypeus wide, lateral lobes small and indistinct (Fig. 445). Thorax rather dull due to the fine microsculpture. Tibia 1 with yellow proximal spot ..... 166. cinxius (Dahlbom)

- Median lobe of clypeus narrow, strongly projecting, lateral lobes distinct (Fig. 446). Thorax with at most indicated microsculpture. Tibia 1 with yellow stripe along anterior margin ..... 167. capitosus (Shuckard)

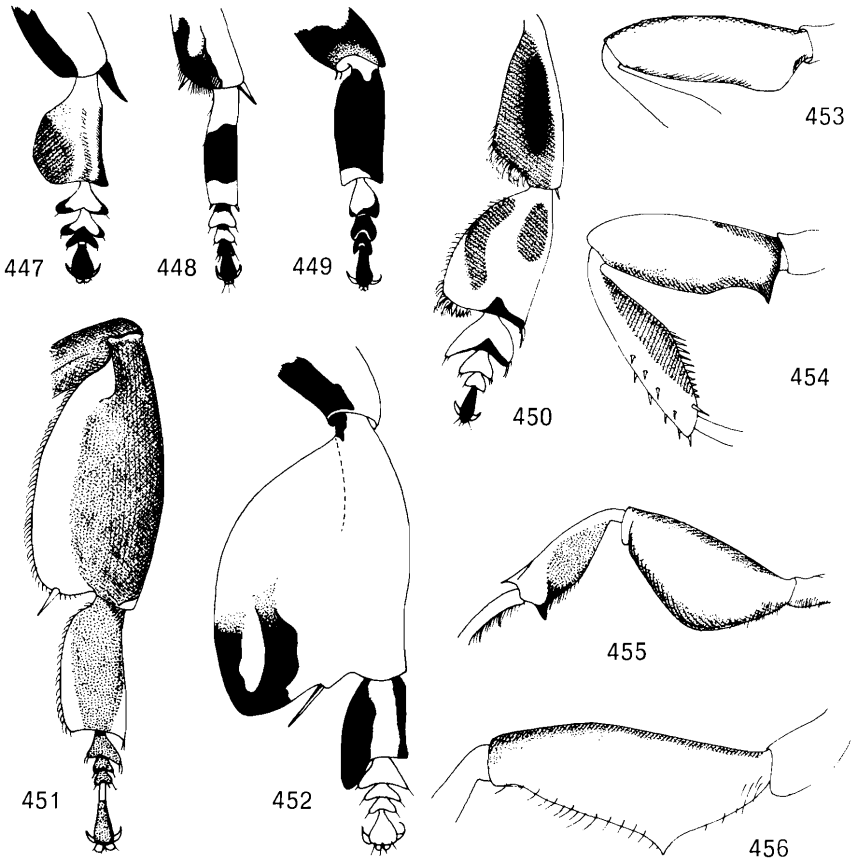
142. CROSSOCERUS (HOPLOCRABRO) QUADRIMACULATUS (Fabricius, 1793)

Figs. 425, 439.

Crabro quadrimaculatus Fabricius, 1793:194.

Female: 7-10 mm. Clypeus with very weak, slightly silvery pubescence. Specimens with a well developed, dense, silvery pubescence on clypeus are known from the Alps and southern Siberia. In a few of these a very weak spine in front of coxa 2 is also found . Clypeus with strong longitudinal keel. Anterior border very variable in outline, but always with two stout median, obliquely outward-directed and two lateral, usually rounded, teeth. Between the two stout teeth the anterior border is either truncate or with a more or less deep emargination, whereby two additional teeth appear (Fig. 439). Proximally on clypeus two yellow spots may be found, whose size varies much. Mandibles simple attenuate, their colour varying from entirely black-brown to pale yellow-brown with darker apex and base. Occipital carina on either side produced into a sharp tooth (Fig. 425). Antennae black, scapus often with a proximal spot. Specimens with almost entirely yellow scapus may occur in Denmark. Frons very densely punctate, interstices between punctures with dense microsculpture. Ocelli placed in right-angled triangle. Facial fovea distinctly convex. Pronotum often with two yellow lateral spots of very variable extent, only in rare cases forming a continuous, transverse band. Humeral tubercle with or without yellow spot. Metanotum usually with yellow markings, either as lateral spots or a transverse band. Propleuron with distal swelling. Area cordiformis shining, sometimes with weak radiating sculpture, surrounded by a strong, pitted furrow. Abdomen with two pairs of yellow lateral spots on terga 2 and 3 and a transverse band on tergum 5. Spots of vary-

ing size may also occur on terga 1 and 4. Pygidial area plane, triangular, dull due to the well developed reticulate microsculpture, with sparse but rather strong punctation. Coxa 1 seen in profile ventrally with a flattened, forward-directed spine. Femora black or brown-black. Tibiae and tarsi pale brown with more or less extensive yellow markings. Tibia 3 on the outer side with strong, dark spines.



Figs. 447-452. Tarsus 1 of male Crossocerus. - 447: tarsatus (Shuckard); 448: pusillus Lep. & Brullé; 449: leucostomus (L.); 450: annulipes (Lep. & Brullé); 451: cetratus (Shuckard); 452: palmipes (L.).
Figs. 453-455. Proximal part of midleg of male Crossocerus. - 453: elongatulus (v.d. Lind.); 454: denticrus Herr.-Schäffer; 455: podagricus (v.d. Lind.).
Fig. 456. Femur 1 of male Crossocerus vagabundus (Panz.).

Male: 5-8 mm. Anterior margin of the somewhat projecting clypeus usually with six teeth, the median lobe generally divided by an obtuse emargination (Fig. 439). Posteriorly on clypeus yellow spots may be present, which only in isolated cases reach the anterior margin. Occipital carina considerably more raised than in female, often almost like a collar, the teeth very well developed. Mandibles bidentate apically, their colour varying from pale brown-yellow to almost black. Scapus usually entirely black, but may have a yellow, longitudinal stripe. Flagellum along ventral margin with a fringe of long, light hairs. Last segment distinctly curved, truncate apically. Frons shining, with rather sparse punctation, without microsculpture. Thorax often without yellow markings, but generally spots are present on pro- and metanotum, and the humeral tubercle may also have a yellow spot. Abdomen generally with yellow lateral spots on terga 2 and 3 and a larger or smaller median spot on tergum 6. Occasional specimens may have yellow markings on tergum 1. Especially small individuals may lack the yellow pattern on the abdomen. Femora mainly black, femora 1+2, however, often with a pale yellow-brown area on the inner side. Tibiae 1+2 with a yellow stripe along anterior margin, tibia 3 with a larger or smaller yellow, proximal ring.

The species is very common in Denmark, occurring in all districts. - Sweden: rather sparse occurrence, but common in the southern districts. Northernmost records in Gstr. - Norway: a few specimens from the southeastern districts. - Finland: only found on Al. Not known from Soviet Karelia. - The distribution area covers large parts of West and South Europe, and extends eastwards through southern Siberia to a little east of Lake Aral. The populations around Lake Bajkal and in Mongolia seem to be completely isolated, and the populations in these areas possibly constitute distinct subspecies.

The species breeds gregariously in sandy slopes or the like, often near streams. It regularly has its nests in similar localities as e.g. Diodontus tristis (no. 25) and Mimesa lutaria (no. 46). The variation in choice of prey is considerable, and an investigation will probably reveal a number of ecophenotypes. Usually representatives of Diptera: Nematocera and Brachycera are used, but small Trichoptera and Lepidoptera may also be taken (Hamm & Richards, 1926; Maneval, 1939). It seems probable that the species occurs in two generations (Adlerz, 1910). The former is found from the beginning of July till the beginning of August, and the latter in the last half of August. The larva was described by Maneval, 1939.

Note. Variation of expansion and distribution of the yellow pattern appears to be geographically-climatically conditioned in a very small degree. The spe-

cies has a conspicuous polymorphy, and extremes of variation may occur even within very restricted populations.

143. CROSSOCERUS (CROSSOCERUS) OVALIS Lepeletier & Brullé, 1834

Fig. 427.

Crossocerus ovalis Lepeletier & Brullé, 1834:780.

Female: 4.5-6 mm, male: 4-4.5 mm. Frons around ocelli convex, both longitudinally and transversely, punctation very fine, microsculpture distinct, sur-

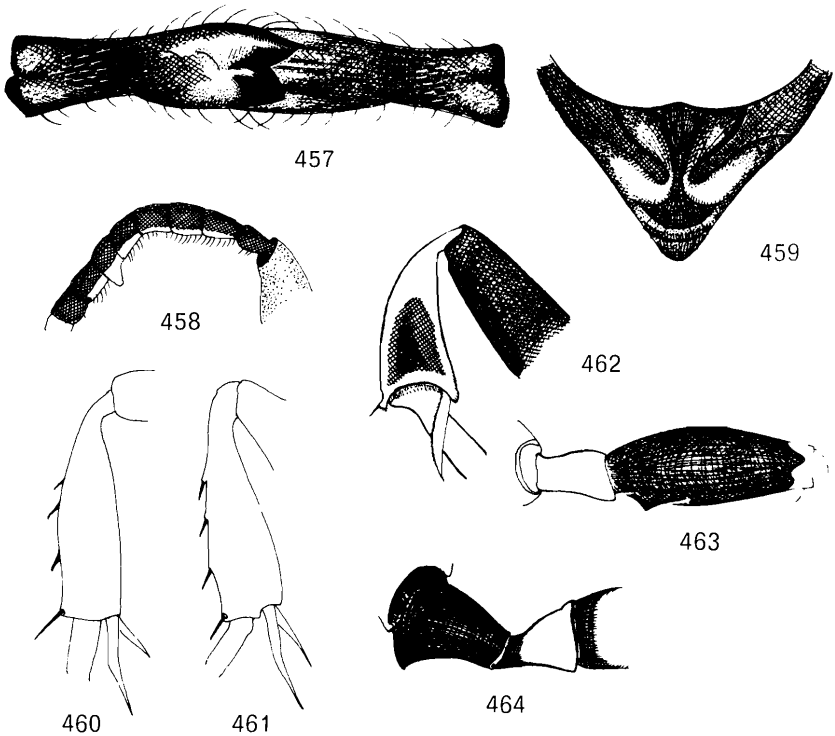


Fig. 457. Mandibles of male Crossocerus elongatulus (v.d. Lind.).
Fig. 458. Proximal part of antenna of male Crossocerus exiguus (v.d. Lind.).
Fig. 459. Ventral view of apex of abdomen of male Crossocerus nigritus (Lep. & Brullé).
Fig. 460, 461. Tibia 3 of female Crossocerus. - 460: binotatus (Lep. & Br.); 461: subulatus (Dahlbom).
Fig. 462. Tibia 3 of male Crossocerus subulatus (Dahlbom).
Fig. 463. Femur 3 of male Crossocerus binotatus (Lep. & Brullé);
Fig. 464. Proximal part of hindleg of male Crossocerus dimidiatus (Fabr.).

face often slightly dull. Facial fovea distinct, dull. Mandibles often with red-yellow middle part. Thorax usually entirely black, but occasional specimens with two small, yellow lateral spots on pronotum occur. Specimens with effaced yellowish spot on scutellum are very rare. Scutum shining, at most with indicated microsculpture. Mesopleuron with a quite small tooth in front of coxa 2, which may be missing in males. Area cordiformis shining, smooth, the surrounding furrow, especially in the males, strong, divided into very coarse pits (Fig. 427). Median furrow widened anteriorly. Pygidial area in female red-yellow or red-brown apically. Tibiae 1+2 with yellow stripe along anterior margin. Basal half of tibia 3 yellow. Males without conspicuous secondary sexual characters. Morphology of forelegs as in females.

The species is widely distributed, but rather rare in Fennoscandia and Denmark. Northern distribution limit in Sweden in Ly. Lpm. - Norway: a few specimens from AK. - Finland: northern distribution limit in Lk and Ks (well north of the Polar Circle). - Soviet Karelia: Ib, Kr. - A Central and North European species. Also recorded from Kazakhstan (Kazenas, 1972).

The species often breeds in sandy localities, but may also be found nesting in very clayey soil near human habitations. The nest, whose tunnel is about five cm long, consists of a single cell. The prey consists of small Diptera, most frequently species of Platypalpus Macq. (Empididae). Only exceptionally of Heteroptera, e.g. Plagiognathus chrysanthemi (Wolf) (Miridae) (Adlerz, 1903, 1910).

144. CROSSOCERUS (CROSSOCERUS) PUSILLUS Lepeletier & Brullé, 1834

Figs. 404, 428, 448.

Crossocerus pusillus Lepeletier & Brullé, 1834:778.

Crossocerus varius Lepeletier & Brullé, 1834:775.

Female: 5.5-6.5 mm. Frons shining, smooth, microsculpture very indistinct, vertex round ocelli almost plane. Facial fovea slightly depressed. Between lateral ocelli a sharp, linear impression is found. Frontal line well developed. Clypeus with rounded median, slightly projecting tooth and two obtuse lateral teeth (Fig. 404). Antennae black, scapus with white-yellow stripe along anterior margin. Mandibles dark, often with a paler area subapically. Pronotum with two yellow lateral spots, which may be fused into a transverse band. Scutum rather densely punctate with very fine intermediate microsculpture. Humeral tubercle as a rule without yellow pattern. Scutellum with larger or smaller median spot usually missing in specimens from northern Fennoscandia. Mesopleuron shining, finely punctate, with a distinct tooth in front of coxa 2. Area cordiformis with dense,

fine, radiating striation. The surrounding pitted furrow may be weak laterally or even missing. Median furrow very wide anteriorly, strongly pitted (Fig. 428). Abdomen with silky, dull lustre with very fine microsculpture. Pygidial area entirely black, rather densely and coarsely punctate, proximally slightly convex; microsculpture indistinct, apically with short, adpressed silvery pubescence. Tibia 1 with a yellow longitudinal stripe. Tibia 2 with a proximal yellow ring and a distal spot. Tibia 3 with proximal yellow ring. Whitish-yellow colour of metatarsi more or less extensive.

Male: 4.5-5.5 mm. Microsculpture of head very variable in strength, usually distinctly reticulate. Punctation sparse, rather shallow. Anterior margin of clypeus with three distinct lobes, stronger than in female. Scapus with a yellow longitudinal stripe, which may be reduced in specimens from the northernmost districts of the distribution range of the species. Mandibles black with slightly reddish apex. Thorax with yellow markings on pronotum, in rare cases on humeral tubercles. Usually a yellow spot on scutellum. The spots on pronotum may form a transverse band or be very reduced. The tooth in front of coxa 2 distinct, mesopleuron anteriorly with fairly long, white pubescence. Area cordiformis dull, with rather strong, dense, radiating striation, the surrounding furrow and the median furrow well developed. On tergum 7 is found a distinct, but short pygidial area. Forelegs of characteristic shape and colour: trochanter and femur ventrally plane, yellow-brown with a fairly long pale, curly pubescence. Femur 1 with also a black and a yellow longitudinal stripe. Metatarsus 1 slightly flattened and dilated, white-yellow with a dark transverse band (Fig. 448). Femur 2 and tibia 2 with yellow longitudinal lines, which, however, may be reduced on femur in Swedish and Finnish specimens. Tibia 3 usually with a proximal yellow ring and a distal spot. These may be connected with each other in Danish specimens. Apical spurs of tibia 3 usually black-brown.

A rather common species in Fennoscandia and Denmark, distributed far towards the north, in Sweden to Ång, in Norway to Nnø, and in Finland to Ks and Ob. - In Soviet Karelia the species is known from Kr. - The species is distributed all over Europe, also recorded from Mongolia, North Japan and Sakhalin. May occur in southern Siberia.

Construction of nest described by Abrahamsen, 1951. The main tunnel descends 10-12 cm into the soil, often undulating. From short side branches on lower part of tunnel up to 9 cells are constructed, which are provisioned with small Diptera, e.g. Empididae, Drosophilidae, Dolichopodidae, Simuliidae and Trypetidae. The larva was described by Maneval, 1939.

145. CROSSOCERUS (CROSSOCERUS) TARSATUS (Shuckard, 1837)

Figs. 405, 429, 447.

Crabro tarsatus Shuckard, 1837:133.

Crossocerus palmipes auctt., nec Linné.

Female: 5-6.5 mm. Vertex round ocelli slightly, but distinctly convex, microsculpture very variable in strength, most conspicuous in robust individuals. Facial fovea shining, distinct. Frontal furrow very well developed, strongly impressed. Lateral teeth on clypeus rather strongly projecting (Fig. 405). Antennae and mandibles as in pusillus. Thorax often entirely black, but yellow markings may occur on pronotum, especially in Danish and South Swedish specimens. Occasionally an effaced yellowish spot may occur on scutellum. Scutum rather densely punctate, often shining, smooth without microsculpture. Mesopleuron with a distinct tooth in front of coxa 2. Area cordiformis with a weak, often partly missing, radiating striation, median furrow very coarsely pitted anteriorly (Fig. 429). Abdomen dull. Lateral margin of pygidial area very slightly concave, the area itself densely punctate, with distinct microsculpture; especially apically with short, silvery pubescence. Tibia 1 with a broad yellow stripe along anterior margin, apical spur dark, usually black-brown. Tibia 2 with a proximal, sometimes also a distal yellow spot. These may be connected in occasional specimens. Tibia 3 with a proximal yellow ring. Metatarsi wholly or partly white-yellow.

Male: 4-4.5 mm. Apart from the morphology of the foretarsi, very similar to pusillus. The yellow pattern on thorax is, however, generally more extensive, and there is often a yellow spot on the humeral tubercles. The spine in front of coxa 2 may be very weak, especially in small individuals. Metatarsus 1 strongly depressed, almost quadrate, with a large, black median spot, second and third segments of tarsus 1 white-yellow, considerably broader than long (Fig. 447). Apical spur of tibia 1 black. Pubescence on anterior ventral part of mesopleuron and on trochanter 1 long and dense.

The northern distribution limit of this species in Fennoscandia lies far towards the south compared with the two preceding species. - Denmark: common throughout the country. - Sweden: found from Sk. in the south to Vrm. and Gstr. in the north. - Norway: a few specimens from Ø and AK. - Finland: a single record from N, Helsingfors. - Not known from Soviet Karelia. - The total distribution pattern resembles that of the two preceding species. Also recorded from Japan. A subspecies, richardsi Beaumont, 1950 occurs in Algeria and Morocco.

The species may be found nesting, often gregariously, on sandy forest paths fully exposed to the sun, but also near human habitations, e.g. in gardens. It is

stated (Hamm. & Richards, 1926) that it may even be found nesting in loose mortar in walls. Abrahamsen (1951) recorded a find of two males in beetle tunnels in a wooden post. Only in a single case (Abrahamsen, l.c.) was a fully provisioned nest described. The main tunnel runs almost vertically to about 5 cm depth. Here 1-3 cells are constructed, of which two may be placed in a row. Each cell contains from 16-21 Diptera, e.g. of the families Empididae, Dolichopodidae, Chloropidae and Agromyzidae.

146. CROSSOCERUS (CROSSOCERUS) ELONGATULUS (van der Linden, 1829)

Figs. 403, 423, 453, 457.

Crabro elongatulus van der Linden, 1829:64.

Crabro sulcus Fox, 1895:187.

Female: 5-6.5 mm. Head well developed, seen from above approximately rectangular (Fig. 423). Frons in front of ocelli shining, very densely and strongly punctate. Interstices equal to or less than diameter of punctures. Facial fovea shining, distinctly convex. Frontal line weak. Anterior margin of clypeus with rather broad, truncate or rounded median lobe and two obtuse lateral teeth. Antennae black, scapus often with a continuous yellow stripe on the frontal side. Mandibles slightly dilated distally, their colour pattern very variable, from almost uniform black-brown to yellow with dark apex and base. Pronotum with rather sharply raised, transverse carina or pad, with two small white-yellow or slightly greenish-yellow lateral spots, which may be absent, especially in specimens from Sweden and Finland. Specimens with yellow pattern on humeral tubercles only very seldom occur in Fennoscandia and Denmark. Scutum shining, densely and finely punctate, posteriorly with dense, shortly striate sculpture. Scutellum always without yellow pattern. Area cordiformis distinctly delimited by a coarsely pitted furrow, median furrow strongly widened anteriorly. The area itself either shining and smooth or with radiately striate sculpture of varying strength. Pygidial area plane, triangular, shining, smooth, with sparse, rather coarse punctation. Inner side of forelegs yellow. Tibia 2 with a proximal and sometimes also a small distal yellow spot. Tibia 3 with a proximal yellow or white-yellow ring.

Male: 5-6 mm. Punctation in front of ocelli as described in female, but a weak microsculpture may occur. Frontal line indistinct. Teeth on anterior margin of clypeus very variable, lateral teeth often sharply projecting, obtuse. Mandibles distally strongly dilated and somewhat flattened (Fig. 457), their colour varying from almost entirely black to completely yellow. Last antennal segment rounded apically. Palps pale yellow. Thorax usually entirely black, but small

white-yellow lateral spots on pronotum may occur. Humeral tubercle pale posteriorly, occasionally bearing an effaced yellowish spot. Thorax sculptured as in female. Mesopleuron ventrally with short pubescence (see note). Sculpture of area cordiformis varying, but usually consisting of a dense and rather strong radiating striation. Tergum 7 truncate. Femur 1 with a broad yellow stripe on the inner side, basally not depressed, with a very thin tuft of light hairs. Tibia 1 extensively yellow. Femur 2 basally swollen (Fig. 453), usually with a somewhat effaced yellow spot on the inner side. Tibia 2 with or without yellow longitudinal stripe. Tibia 3 usually with a small proximal yellowish spot.

Found in most districts in Denmark. - Sweden: a rather common species, especially in the southern districts. Northernmost records from Lu. Lpm. - Norway: a very few records from AK, Tøien. - Finland: not common but widespread northwards to Kb and ObS. - Soviet Karelia: Ib, Kr. - A Holarctic species (Crossocerus sulcus Fox of American authors). The species is rather common all over Europe, towards the east to the Urals, Caucasus and south-eastern Kazakhstan in the U.S.S.R. , towards the south to North Africa. In north-eastern U.S.A.

The natural breeding habitat of the species is in the soil, but in recent decades it has also been found nesting in cavities in brickwork (Spooner, 1946; Leclercq, 1964). This adaptation to urbanization has also been observed in Denmark, where the species has been found breeding in several places in the city of Copenhagen. It is also stated that the species may be found nesting in old timber, see e.g. Leclercq, 1954. Several females may use the same nest entrance. The prey consists of small Diptera, e.g. Chloropidae, Lauxaniidae, Stratiomyidae, Empididae, Dolichopodidae and Agromyzidae. According to Tetens Nielsen, 1933, the prey is brought home impaled on the sting, but this is probably exceptional. As cleptoparasite Macronychia polyodon Meig. (Diptera, Sarcophagidae) is recorded.

Note. In Europe, at least in three distinct subspecies. The Fennoscandian and Danish populations belong to Cr. elongatulus propinquus (Shuckard) together with the English and part of the German and Italian material. This subspecies is recorded also from Argentina, where it was probably introduced (Leclercq, 1968). The nominate subspecies elongatulus s.str. (= berlandi Richards, 1928) is distributed mainly in Central Europe, Holland and Belgium. Cr. elongatulus trinacrius Beaumont, 1959 was described from Sicily. Elongatulus s.str. is separated from propinquus by the following characters:

Female: mesopleuron usually denser and more strongly punctate, often the punctation may change to partly rugose dorsally. Tibia 2 without distal yellow spot.

Male: mesopleuron, especially ventro-laterally, and femur 2 basally with long woolly pubescence (almost as in distinguendus A. Mor.)

147. CROSSOCERUS (CROSSOCERUS) WESMAELI (van der Linden, 1829)

Crabro wesmaeli van der Linden, 1829:65.

Female: 5-6 mm. Head seen from above strongly narrowed behind the eyes. Frons distinctly convex, shining, at most anteriorly with microsculpture. Punctation fine and sparse. Frontal line and line between lateral ocelli weak. Facial fovea shining, rather wide, with extremely fine sculpture. Anterior margin of clypeus evenly rounded or with indistinct very rounded teeth. In a single specimen from Denmark (F, Enebærodde, 4.7.1971) two yellowish spots are found proximally on clypeus. Mandibles with black base, red-yellow or brown-yellow centre and rust-coloured or red-brown apex. Frontal face of scapus yellow. The following area of thorax have yellow markings: pronotum dorsally, humeral tubercles and scutellum. Distribution of pattern very constant, but specimens with reduced pattern occur. Scutum shining, finely, but distinctly punctate, posteriorly densely striate. Pubescence short, greyish. Punctation of mesopleuron finer, pubescence slightly silvery. Area cordiformis shining, sometimes with a very weak, radiately striate sculpture. The surrounding furrow strong, divided into large, almost quadrate pits. Pygidial area broadly triangular, shining, with strong and variable punctation, the extreme third or more usually red-brown or red-yellow. Femora 1+2 with a larger or smaller yellow distal spot. Tibiae 1+2 usually mainly yellow. Tibia 3 with a broad proximal ring, which may extend to the apex of tibia.

Male: 4-4.5 mm. Head in anterior view strongly narrowed ventrally. Interstices between punctures on frons usually without microsculpture. Frontal line very weak. Shape of teeth on anterior margin of clypeus very variable. The colour pattern of the mandibles varies considerably, just as in the female. Flagellum with a row of short, downward-directed hairs ventrally. Last segment rounded apically. Thorax often without yellow spots; if such are present they occur mainly on the humeral tubercles. Specimens from Central and South Europe often have yellow spots on scutellum and dorsally on pronotum. Sculpture on thorax as described in female. Pubescence of mesopleuron ventro-laterally only slightly longer than normal. Furrow surrounding the often radiately or somewhat irregularly rugose area cordiformis very coarsely pitted. Last tergum shining, smooth, rather strongly convex, apex usually pale red-brown, rounded, the surface itself strongly punctate, posterior punctures often coalescing longitudinally. Femur 1 with a large yellow spot on the inner side and also often with an oblong distal spot on the outer side. Femur 2 often without yellow markings, but

may distally have an oblong spot on the inner side. Tibiae 1+2 with extensive yellow markings, tibia 3 with a broad proximal yellow ring, which on the inner side may reach apex of tibia.

The species is very common in Denmark, especially in sandy localities along the coasts. - Northern distribution limit in Fennoscandia in Sweden passes through Nb., and in Finland through Lk. - Norwegian records from AK, HEs, On and Bø. - Soviet Karelia: Ib and Kr. - Like several other species of Crossocerus, this species is distributed in Europe, Caucasus, Kazakhstan, Turkestan, Mongolia, Japan and Sakhalin.

The biotope preference of the species is not particularly well defined, since it may be found nesting both in white dunes very close to the sea, in inland dunes, sandy margins and more or less clayey slopes exposed to the sun, e.g. in gravel pits. It is, however, most often met with in sandy localities, often abundantly. The nest is of simple construction, normally containing 1-2 cells, but may contain up to nine (Tsuneki, 1960). The prey consists of small Diptera, e.g. of the families Chironomidae, Tipulidae, Ceratopogonidae, Agromyzidae, Empididae and Chloropidae, of which about 20 are placed in each cell, depending on size. It is stated that the species, in addition, might also use small Homoptera or Heteroptera as prey.

148. CROSSOCERUS (CROSSOCERUS) LUNDBLADI (Kjellander, 1954)

Figs. 406, 440.

Crabro (Crossocerus) lundbladi Kjellander, 1954:239.

Female: 4-6 mm. More slender than distinguendus. Head in front view as Fig. 406. Mandibles dark red-brown to brown-black. Scutum shining, distance between punctures considerably larger than diameter of the latter, interstices with at most indicated microsculpture. Pronotum and humeral tubercles black, scutellum occasionally with a weak yellow pattern. Area cordiformis without radiating striation. Median furrow anteriorly only slightly excavate. Lateral faces of propodeum with a large median, shining, smooth, completely impunctate area. Tergum 1 extremely finely punctate, seen from above comparatively shorter and wider than in distinguendus. Punctation of pygidial area variable, usually as in distinguendus and elongatulus, but in small specimens the number of punctures may be very reduced. Femur 1 with a small distal yellow spot on the inner side. Tibia 2 dorsally yellow for more than two-thirds of its length. Tibia 3 with a very broad, proximal, yellow ring.

Male: 5.5 mm. Head in front view as Fig. 440. Punctation in front of ocelli very sparse, interstices with very distinct microsculpture. Frontal line and

facial fovea weak. Clypeus with broad, rounded, median lobe. Scapus with yellow anterior face, flagellum yellow-spotted ventrally, without hair fringe, last segment truncate apically. Mandibles brown with slightly paler median area. Thorax without yellow pattern, humeral tubercles distally slightly paler. Scutum and scutellum with shining surface, punctation fine and sparse, anteriorly shallow. Microsculpture missing. Mesopleuron laterally with very slightly rugose sculpture, punctation well developed, ventrally with short pubescence. Area cordiformis shining with very fine striation. Both the surrounding furrow and the median line well developed, strongly pitted. All femora black. Tibiae 1+2 mainly yellow. Tibia 3 with a yellow mark covering its proximal half.

The species seems to be endemic to Fennoscandia, but might also occur in Siberia. - Sweden: Hrj. and Vb. - Finland: Ta, Kb, Om and ObN.

149. CROSSOCERUS (CROSSOCERUS) IMITANS (Kohl, 1915)

Fig. 407.

Crabro (Crossocerus) imitans Kohl, 1915:267.

Female: 5-6 mm. Head shining, smooth, with very fine and sparse punctation, completely devoid of microsculpture. Frontal line and line between lateral ocelli missing or only weakly indicated. Clypeus proximally with two large, grey-yellow spots, anterior margin with obtuse lateral teeth (Fig. 407). Mandibles slender, pale white-yellow with red-brown apex, the upper tooth longer and stouter than lower. Antennae rather long and slender, scapus with green-yellow or white-yellow frontal face. Pronotum with a yellow transverse spot, very narrowly interrupted in the middle. Humeral tubercles and scutellum with yellow markings. Punctation of scutum very fine and sparse, punctation on mesopleuron still finer, hardly visible at 50 x magnification. Episternal scrobe very large, deeply impressed. The oblique suture, issuing ventrally to base of forewings and joining the epicnemial carina, especially coarsely pitted. Area cordiformis shining, smooth, surrounded by a strong, coarsely pitted furrow; median line very narrow, divided into very fine pits. Pygidial area black, distally slightly reddish transparent. Punctation coarse and sparse. Femora 1+2 with a large distal green-yellow spot. Tibiae 1+2 mainly white-yellow with a dark brown spot on the inner side. Tibia 3 with a broad proximal white-yellow ring, like tibia 2 strongly spiny. Metatarsi mainly pale white-yellow, remaining tarsal segments black-brown.

Male: 4.5-5.5 mm. Most of clypeus covered by two large, bright yellow spots. Lateral teeth projecting more than in female. Mandibles as in female. Head ventrally near articulations of mandibles with a triangular, yellow spot. Flagellum

ventrally bicoloured, yellow and brown-yellow, with a row of downward-directed pale hairs. Last segment truncate apically. Transverse spot on pronotum broadly interrupted in the middle. Humeral tubercles with yellow spot, scutellum without. Thorax otherwise as described in female, but the oblique suture on mesopleuron more strongly pitted. Last tergum rather densely and coarsely punctate, distally rounded, often reddish transparent. Femur 1 slightly dilated, almost plane ventrally, tri-coloured, as the dorsal face is almost entirely black. Ventrally with a large yellow spot. Between these markings brown-yellow areas are found. Tibia 1 mainly white-yellow, ventrally brown-yellow with irregularly shaped distal black spot. Fore- and midlegs with same colour as in female, but femur 2 is often brownish on the inner side.

Denmark: WJ, Skallingen. - Not in Fennoscandia. - The species occurs very locally in north-western Europe. The distribution area covers the coastal regions of Germany, Poland and the Friesian Islands. The record from south-eastern Kazakhstan by Kazenas (1972) has proved to refer to another species (Kazenas in litt.).

A pronouncedly littoral species in Europe, which may be found nesting in white dunes among tufts of Elymus and Ammophila. The prey is unknown, but probably does not consist of Diptera, but of Heteroptera (Lomholdt, 1973).

150. CROSSOCERUS (CROSSOCERUS) DISTINGUENDUS (A. Morawitz, 1866)

Crabro (Crossocerus) distinguendus A. Morawitz, 1866:260.

Crabro mucronatus Thomson, 1870:167.

Female: 5-6.5 mm. Close to elongatulus, from which it is distinguished by the following characters: punctation of frons fine and rather sparse, interstices between punctures anteriorly with distinct microsculpture, creating a dull appearance. Facial fovea shining, level with remaining part of frons. Pronotum usually entirely black, but two yellow lateral spots are sometimes present. These spots very seldom coalesce into a transverse band. Furrow surrounding the usually completely smooth area cordiformis strong, extremely pitted. Mesopleuron ventrally with fine microsculpture.

Male: 4-5.5 mm. Easily recognizable by the morphology, pubescence and colour-pattern of forelegs, and pubescence of mesopleuron. Last segment of flagellum truncate apically. Mandibles often almost entirely black, not dilated distally. Mesopleuron ventrally with a long, white woolly pubescence as on the proximal part of forelegs. Last tergum evenly, densely and rather strongly punctate. The basal part of femur 1 plane ventrally, the femur tricoloured,

black with a yellow stripe dorsally and brown-yellow ventrally. Tibia 1 also tricoloured. Femur 2 without basal dilation.

Widespread in Denmark, locally rather common. - Sweden: not common, occurring from Sk. in the south to Gstr. and Ång. in the north. - Apparently absent from Norway, Finland and Soviet Karelia. - The species is rather sporadic in Europe, Japan, China, and on Formosa.

The species is found nesting in dry slopes and the like, but is also associated with human habitations, e.g. gardens and parks, or even in old timber like elongatulus. The construction of the nest is unknown. The prey consists of Diptera, e.g. Dolichopodidae.

151. CROSSOCERUS (CROSSOCERUS) DENTICRUS Herrich-Schäffer, 1841

Figs. 408, 454.

Crossocerus denticrus Herrich-Schäffer, 1841:T.20.

Female: 4-5 mm. Head in front of ocelli evenly convex, frontal line reduced, very indistinct. Frons shining, punctation rather sparse, without indication of microsculpture. Facial fovea missing. Anterior margin of clypeus with strongly rounded lateral angles (Fig. 408). Mandibles pale, usually yellow with red-brown apex. Thorax without yellow pattern, humeral tubercles paler posteriorly. Scutum posteriorly without striate sculpture. Punctation on mesopleuron almost as strong as on scutum. Area cordiformis shining and smooth, surrounding furrow well developed, especially anteriorly. Pygidial area strongly punctate. Femora 1+2 with a distal yellow spot. Tibiae 1+2 mainly yellow, tibia 3 with proximal yellow ring.

Male: 3.5-4.5 mm. Head almost as in female, but punctation on frons somewhat better developed. Median part of clypeus somewhat projecting, anterior margin itself evenly rounded, without teeth. Mandibles yellow with reddish apex. Flagellum ventrally with a row of long, pale hairs, last segment with rounded apex. Thorax as in female, without yellow pattern. Femur 1 basally somewhat dilated, plane ventrally. Femur 2 with stout proximal tooth (Fig. 454), tibia 2 slightly swollen subapically, distal to this dilation with a row of short spines. Fore- and midlegs mainly yellow. Hindleg with a yellow proximal ring on tibia.

Two old specimens from Denmark: SJ, Sønderborg. - Sweden: Sk., Arrie near Malmö. - Not recorded from Norway and Finland. - Widespread, but very rare in Europe. Also known from Manchuria, Korea and Japan.

Only a single observation is available on the breeding biology of the species in Scandinavia (Adlerz, 1912). It was found nesting in a stone wall. The prey

consisted of very small Diptera. Yamada (1973) states that in Japan the species has been found breeding in level as well as in sloping ground. The nest contains a single cell. The entrance is surrounded by the material dug out, in the same way as Lindenius, and the returning female flies directly down into it. The prey consists of Diptera: Lauxaniidae and Dolichopodidae.

152. CROSSOCERUS (CROSSOCERUS) EXIGUUS (van der Linden, 1829)

Fig. 458.

Crabro exiguus van der Linden, 1829:74.

Female: 4-5 mm. Very similar to denticrus. Frons in front of ocelli usually with distinct microsculpture. Facial fovea very small. Mesopleuron shining, punctation considerably finer and sparser than on scutum. Line surrounding area cordiformis less well developed than in denticrus. Tibia 3 with a proximal yellow ring, and a broad, anterior yellow stripe.

Male: 3.5-4 mm. Clypeus almost entirely yellow. Head ventrally near articulation of mandibles with a large yellow spot. Scapus with at most a quite small proximal dark spot. Flagellum with a row of downward-directed pale hairs, the proximal segments yellow ventrally. Antennal segment 7 with a strong, downward-directed projection (Fig. 458). Thorax may have yellow pattern consisting of a spot on epicnemium, and a smaller one just in front of coxa 2. Mesopleuron ventrally with long, white pubescence. Femur 1 almost entirely yellow, slightly dilated, with plane, sharp-edged ventral face, with dense, short, white pubescence. Femur 2 yellow with two brown longitudinal stripes. Tibia 3 with yellow proximal ring and a broad stripe on the outer side.

Two specimens are known in south-eastern Finland: Sa, Salmis. - Soviet Karelia: Ib and Kr. - A very rare and sporadic species. Distributed in Central and East Europe. Additional records from Mongolia.

Nest construction and prey not known in this species. Lepeletier & Brullé (1834), however, state that the species uses small Homoptera as prey.

153. CROSSOCERUS (CROSSOCERUS) PALMIPES (Linné, 1767)

Figs. 409, 452.

Sphex palmipes Linné, 1767:994.

Crabro (Crossocerus) palmarius Kohl, 1915:248.

Female: 6-8 mm. Clypeus with extensive pale yellow pattern, only anterior margin dark. Median lobe on either side with rounded tooth, lateral lobes distinct (Fig. 409). Frons finely punctate, microsculpture vestigial or absent.

Frontal line and line between lateral ocelli weakly developed. Mandibles yellow with red-brown apex, the upper tooth considerably stouter than the lower. Pronotum narrow and short, dorsally often with yellow lateral spots or a transverse band. Humeral tubercles usually pale brownish, but may have a pale yellowish spot. Scutum shining, smooth, usually without microsculpture, punctation fine. Scutellum may have an irregularly-shaped yellow spot. Metanotum generally with a large yellow transverse spot. Mesopleuron very finely punctate, with a distinct tooth in front of coxa 2. Area cordiformis finely radiately striate, the surrounding furrow weakly developed laterally. Median furrow narrow, at the bottom finely pitted. Pygidial area plane, triangular, apically sometimes slightly reddish. Punctation especially well developed laterally. Femora 1+2 may have a small distal yellow spot. Tibiae 1+2 yellow-black on the inner side. Tibia 3 with a broad, yellow, proximal ring. Metatarsus 1 white-yellow, with three short colourless spines. Metatarsi otherwise white-yellow, remaining tarsal segments progressively darker.

Male: 5-6.5 mm. Clypeus entirely yellow. Antennae long and slender, scapus mainly yellow, flagellum pale ventrally, with a fringe of long, strong, downward-directed hairs. Last segment with rounded apex. Mandibles, except apex, and two very large spots on ventral face of head round mandibular articulation, yellow. Pronotum, humeral tubercles, scutellum and metanotum yellow. Mesopleuron has yellow markings on the epicnemium. In addition, a greenish-yellow spot is often found right in front of coxa 2. Mesopleuron laterally with very thin pubescence, ventrally with dense, well developed silvery pubescence. Spine in front of coxa 2 distinct. Area cordiformis with somewhat irregular striation, the surrounding furrow well developed, strongly pitted. Last sternum with a dense, slightly curved golden-brown pubescence, and two lateral, more or less spoon-shaped processes. Penultimate sternum with a small, median thickening and a loose lateral tuft of long, pale, obliquely outward-directed hairs. Forelegs of very striking appearance: coxa yellow, distally with dense, almost felty, white pubescence; femur and trochanter somewhat dilated, plane ventrally, mainly yellow; tibia and tarsi very strongly dilated, as Fig. 452. Coxae 2+3 and trochanter 2+3 with extensive yellow or slightly green-yellow pattern. Femur 2 and tibia 2 mainly yellow. Tibia 3 with yellow proximal ring and usually also with a broad yellow stripe along the inner side, spines on the outer side few and weak.

Uncommon in Fennoscandia and Denmark. In Sweden in Sm., Vg. and Hall. A single record from Dlr. - Norway: a few specimens from AK. - Finland: a southern and south-eastern distribution, northwards to Kb. - Soviet Karelia: Ib. - Widely distributed in Central and East Europe. Additional records from

the surroundings of Lake Baikal in southern Siberia and from North China.

The nests are constructed in sandy ground, level or sloping, e.g. on sandy forest paths. As far as is known, each nest contains only a single cell. The prey consists of Diptera, e.g. Muscidae, Dolichopodidae, Chloropidae or Lauxaniidae. Myrmosa melanocephala (Hym., Myrmosidae) is recorded as a possible parasite.

154. CROSSOCERUS (ABLEPHARIPUS) PODAGRICUS (van der Linden, 1829)

Figs. 434, 455.

Crabro podagricus van der Linden, 1829:62.

Female: 4-6 mm. Head well developed behind the eyes, seen from above approximately rectangular, dull, with distinct, reticulate microsculpture. Punctation very variable, usually fine and very sparse. Distance between lateral ocelli much larger than diameter of one of these. Occipital carina ventrally abruptly truncate. Facial fovea and frontal line well developed. Clypeus with broadly truncate median lobe and very small lateral teeth. Antennae short, scapus with yellow frontal face. Mandibles mainly black, upper tooth larger than lower, tooth on inner side distinct. Pronotum may have two yellow lateral spots, especially in robust individuals. Humeral tubercles only exceptionally without yellow spots. Scutum and scutellum dull, microsculpture finer than on head, punctation dense and very fine. Suture between scutum and scutellum very coarsely pitted. Scutellum usually black, but specimens with yellow median spot are known from Denmark and southern Sweden. Mesopleuron with well developed microsculpture, punctation fine and sparse. In front of coxa 2 is a distinct tooth. Area cordiformis rather shining, its microsculpture usually weakly developed. The surrounding furrow well developed, especially anteriorly. Median furrow very narrow, not divided by transverse rugae. Posterior face of propodeum with irregular, superficial punctation and transverse striation. Lateral areas on propodeum with dense, finely striate sculpture. Pubescence on thorax and propodeum very sparse. Abdomen dull, segments apically with more shining transverse bands. Pygidial area as Fig. 434. Coxa 1 proximally with outwardly directed sharp spine. Femur 1 approximately triangular in cross section, like femur 2 with a small, distal, yellow spot. Tibiae 1+2 yellow with larger or smaller dark spot on the inner side. Tibia 3 with proximal yellow ring, distinctly clavate, spines on the outer side very short.

Male: 4-6 mm. Head and thorax sculptured as in female. Flagellum with strong hair fringe ventrally, last segment truncate distally. Spine in front of coxa 2 may be very weak. Thorax devoid of yellow markings except on humeral tubercles. Mesopleuron strongly excavate ventrally, especially ventro-laterally with long, dense,

whitish pubescence, also ventrally on base of forelegs. Midlegs basally with short, dense, almost felty pubescence. Forelegs mainly yellow, femur 1, however, with a broad, black stripe on the outer side. Femur 2 strongly thickened. Tibia 2 very short, distally somewhat dilated, without apical spur (Fig. 455). Metatarsus 2 slightly curved and depressed. Femur 3 and tibia 3 thickened, spines on tibia very weak. Last tergum with a fairly strong subapical concavity, punctation very indistinct.

The species has a typical southern and south-eastern distribution in Denmark. - Sweden: not uncommon in Svealand, seems to be absent from Sk., Bl. and Sm. - Norway: a few specimens from AAy and HOi. - Finland: rather common on Al. Otherwise only found in Ab. - Soviet Karelia: Ib and Kr. - The species is widely distributed, but uncommon in Europe, eastwards to the Urals, Caucasus and Kazakhstan in the USSR. Southwards to North Africa. It also occurs in Japan.

The nest is constructed in decayed wood, often in connection with abandoned tunnel systems of xylophagous insects. The prey consists of small Diptera, e.g. Chironomidae, Ceratopogonidae, Sciaridae and Scatophagidae. The larva was described by Goidanich, 1928.

155. CROSSOCERUS (ABLEPHARIPUS) CONGENER (Dahlbom, 1845)

Fig. 435.

Crabro (Crossocerus) congener Dahlbom, 1845:335.

Female: 4-5 mm. Very similar to small specimens of podagricus, but may be distinguished from these by the following characters: head seen from above strongly rounded posteriorly, its punctation very reduced. Facial fovea very small and indistinct. Occipital carina anteriorly gradually disappearing. Distance between the lateral ocelli equal to or scarcely larger than the diameter of an ocellus. Lateral lobes on clypeus vestigial. The tooth on the inner side of the mandibles very indistinct. Thorax, except the humeral tubercles, without yellow markings. Area cordiformis only anteriorly delimited by a distinctly pitted furrow. Propodeum laterally with shining and smooth areas. Pygidial area with brown-yellow margins (Fig. 435). Outer side of tibia 3 often with a pale touch.

Male: 4-5 mm. Head, thorax and propodeum sculptured as described in female. The yellow spot on humeral tubercles may be missing. The spine in front of coxa 2 occasionally vestigial. Last tergum with a slight subapical concavity. Mesopleuron without distinct concavity, ventral pubescence uniformly distributed. Midlegs normal, tibia with apical spur.

In Fennoscandia this species is known from Finland, where it has a very

sparse occurrence in the southern districts. - In Sweden it has only been found in Ög. and Upl. - Soviet Karelia: Ib and Kr. - Locally the species may occur in large numbers, but it is rare in Central, East and North Europe. It is fairly widely distributed in Japan.

The nests are constructed in hollow plant stems (Tsuneki, 1960) and the cells are placed in a line. Partitions between them are made of fine sawdust. The prey consists of small Diptera, e.g. Mycetophilidae and Empididae, of which from 22 to 27 are placed in each cell. The number of cells may vary between 5 and 12.

156. CROSSOCERUS (ABLEPHARIPUS) ASSIMILIS (Smith, 1856)

Figs. 410, 430, 436.

Crabro assimilis Smith, 1856:413.

Crossocerus socius Dahlbom, in Thomson, 1870:164.

Crossocerus tirolensis Kohl, 1877:709.

Female: 6-7.5 mm. Head in dorsal view very well developed behind the eyes, rectangular. Punctation dense and very fine, microsculpture well developed, considerably finer than in the two preceding species. Frontal line and facial fovea indistinct. Occipital carina gradually disappearing anteriorly. Clypeus with very broad median lobe, lateral lobes weak (Fig. 410). Mandibles black, tooth on inner side strongly developed. Scapus with yellow front side. Thorax always entirely black, the humeral tubercles may, however, be slightly brownish posteriorly. Sculpture on pronotum and scutellum as on head, microsculpture on mesopleuron weaker. Tooth in front of coxa 2 strong. Propleuron with distal spine. Area cordiformis tapering posteriorly, the delimiting furrow in front of the area divided into coarse pits, which are considerably longer than broad. The remaining part of the furrow narrow, divided into small quadrate pits. The area itself with very fine radiating striae (Fig. 430). Abdomen rather shining. Pygidial area as Fig. 436. All femora black. Tibia 1 with a broad yellow stripe on the frontal side. Tibia 2 with a proximal yellow ring and a shorter or longer yellow stripe on the front side. Tibia 3 with a broad yellow proximal ring, spines on the external side short, dark.

Male:6-7 mm. Punctation of head very sparse and weak, microsculpture distinct. Ventral hairs on flagellum very short, only slightly longer than remaining pubescence. Last segment rounded apically. Head ventrally, as also ventral side of mesopleuron, propleuron and basal part of forelegs, with long, woolly pubescence. Thorax entirely black, sculptured as in female. Mesopleuron without ventral concavity. Last tergum also without concavity. Midlegs without secondary

sexual characters. Metatarsus of hindlegs rounded, slightly thickened.

A single male from Fennoscandia, Norway: AK, Helgø. - The species is rare in mountainous regions in Central Europe. Also recorded from the Caucasus, Mongolia and Japan.

The species has been found nesting in dry twigs of Morus in Japan. Cells provisioned with Diptera.

157. CROSSOCERUS (BLEPHARIPUS) WALKERI (Shuckard, 1837)

Figs. 412, 437, 444.

Crabro walkeri Shuckard, 1837:170.

Female: 5.5-8 mm. Clypeus mainly yellow, only anterior margin black. Median lobe convex, lateral lobes missing (Fig. 412). Occipital carina very weak. Scapus and two bands along inner orbits yellow. Pattern on thorax very variable, even within very restricted geographical areas. However, yellow markings dorsally on pronotum and on humeral tubercles fairly constant. The spot on scutellum may be divided into two lateral spots, in which case transverse spots on metanotum are usually missing. Mesopleuron without tooth in front of coxa 2. Area cordiformis shining, often with a slightly raised, radiately striate sculpture. The delimiting furrow weak. Lateral faces of propodeum shining, smooth, without sculpture. Tergum 1 slightly longer than broad. Pygidial area apically somewhat reflexed, lateral margins proximally thickened (Fig. 437). Propleuron with two truncate projections. Coxa 1 with sharp lateral spine. Femora 1+2 with a larger or smaller distal yellow spot. Tibiae 1+2 mainly yellow. Tibia 3 with a broad, proximal, yellow ring.

Male: 5-6.5 mm. Head in front view as Fig.444.Clypeus yellow, its median part produced into a triangular figure. Two yellow carinae along the inner orbits. Mandibles yellow or red-yellow with darker apex. Scapus entirely yellow. Flagellum without hair fringe ventrally, last segment rounded apically. Pronotum, humeral tubercles and frequently also scutellum and metanotum with yellow pattern. Delimiting furrow of area cordiformis usually stronger developed than in female. Last tergum pale apically. Femur 1 tri-coloured, yellow-brown with a brown longitudinal stripe along upper side and a yellow apical spot. Femur 2 brown with yellow or yellow-brown inner side and a yellow longitudinal stripe along the dorsal side. Coxae 2+3 and trochanters with larger or smaller yellow spots. Femur 3 brown, lighter ventrally, and occasionally with a yellow proximal spot. Tibia 3 with a very broad proximal ring, on the inner side often extending to the apex of the tibia.

From Denmark the species is hitherto only known from NEZ and EJ. - In Sweden it has been found northwards to Upl. and Gstr. - From Finland isolated specimens derive from Ab, Ta, Sa and Kb. - The species is rare. Its area of distribution covers Central, South and East Europe. In addition, it is distributed in Mongolia, eastern China and in Japan.

The nest is constructed in dead branches, stumps and the like, e.g. of Quercus, Fagus, Alnus, Malus or Fraxinus. The tunnel system may be simple or branched. The number of cells varies considerably; a single nest may contain up to 16 cells. The prey consists of Ephemeroptera, often Baëtidae, of which 4 to 7 are placed in each cell. The orientation of the prey is the same as that of the Lepidoptera-collecting Lestica, i.e. the heads pointing towards the bottom of the cell. Often the legs and sometimes even the head of the prey are amputated. It is interesting to note that first a large number of prey is collected, after which they are divided into batches in the cells. Such behaviour is also known in Astata and certain species of Cerceris. The larva was described by Baudot, 1929.

158. CROSSOCERUS (BLEPHARIPUS) ANNULIPES (Lepeletier & Brullé, 1834)

Figs. 411, 450.

Blepharipus annulipes Lepeletier & Brullé, 1834:729.

Crabro ambiguus Dahlbom, 1842:14.

Female: 5-7 mm. Head large, in front view as Fig. 411. Clypeus with semicircular emargination, on either side delimited by a small tooth. Lateral teeth indistinct. Frons shining, punctation very sparse and fine behind ocelli, denser and coarser in front of these. Facial fovea usually distinct, shining and impunctate. Mandibles very strong, tridentate apically. Colour pattern of these very variable, often with an ivory-white spot dorsally. Scapus with white-yellow front side. Occipital carina strongly projecting on either side, abruptly truncate. Thorax completely devoid of yellow markings. Propleuron on either side with a rather sharp, downward-directed tooth. Punctation on scutum and scutellum distinct, sparse and rather fine. Scutum posteriorly with few short rugae. A weak microsculpture may occur. Mesopleuron with very fine, sparse punctation; very robust individuals may have indication of a tooth in front of coxa 2. Area cordiformis shining, delimited by a pitted furrow. Pygidial area slightly depressed like a groove, the proximal, raised and punctate portion very weakly developed. Femur 1 subapically with a slightly concave marginate area ventrally. Tibia 1 with a (sometimes very reduced) yellow stripe along anterior margin, the metatarsus with about five strong spines. Tibia 2 often entirely black, but may

have a small, proximal, yellowish spot. Tibia 3 with a proximal, white-yellow ring.

Male: 4.5-6 mm. Head strongly narrowed ventrally. Anterior margin of clypeus without emarginations, median part projecting, with three small, blunt teeth. Mandibles bidentate, their colour varying from completely black to pale brownish, the white or yellowish spot of the female is usually missing. Scapus generally with a white-yellow longitudinal stripe along the frontal side. Flagellum with a row of light hairs ventrally. Occipital carina strongly projecting anteriorly, ending in a tooth (almost as in quadrimaculatus). Punctation of frons superficial. Punctation on scutum weaker than in female, right in front of the posterior margin there are two to four deep pits, separated by short, sharp carinae. Punctation of mesopleuron hardly visible. Area cordiformis surrounded by a distinctly pitted furrow. The downwardly directed teeth on propleuron well developed. Forelegs (Fig. 450) strongly modified: trochanter with a triangular dilation ventrally; femur with an obtuse proximal dilation; tibia distally slightly depressed, with a rather broad, rounded dilation,ventrally with dense and fairly long pubescence; tarsus strongly depressed, transparent, black-spotted. Metatarsus 2 whitish, very slightly depressed on inner side.

The species is rather sporadic in Denmark and Fennoscandia. Denmark: only found in Jutland and NEZ. - Sweden: very sparse in Götaland and Svealand, northwards to Gstr. - Norway: a few specimens from AK. - Finland: rare, only distributed in the southern districts, Ab, N, Ka and Sa. - Soviet Karelia: Ib and Kr. - It is widely distributed in Europe. From the U.S.S.R. and Asia recorded from Kazakhstan, Mongolia, north-eastern China and Japan. Occurrence in North America: north-eastern U.S.A. and south-eastern Canada.

The species is gregarious. The nests are usually constructed in decayed, deciduous wood, but coniferous wood is also used. Each nest contains up to 20 cells (Hamm & Richards, 1926). These are provisioned with Homoptera, usually Typhlocybidae, but Psyllidae or even small Miridae (Heteroptera) are used. In each cell are placed about 25 specimens. The larva was described by Evans, 1957.

159. CROSSOCERUS (BLEPHARIPUS) HEYDENI Kohl, 1880

Figs. 413, 438.

Crossocerus heydeni Kohl, 1880:216.

Crabro (Coelocrabro) hedgreni Kjellander, 1954:238.

Female: 5.5-7 mm. Head strongly narrowed ventrally (Fig. 413). Frons shining, rather finely punctate, without microsculpture. Facial fovea sharply marked,

small and narrow. Scapus with a sharp, longitudinal keel throughout its length. Clypeus with strongly projecting and rather narrow median part (Fig. 413). Occipital carina weakly developed, anteriorly gradually disappearing. Mesopleuron very finely and sparsely punctate, spine in front of coxa 2 well developed. Area cordiformis shining, often with an indication of reticulate microsculpture. Surrounding furrow rather weakly developed laterally. Median furrow distinctly pitted. Pygidial area very narrow, almost as in cetratus (Fig. 438). Tibiae 2+3 with a weak proximal yellow spot.

Male: 4.5-5.5 mm. Morphology of head almost as described in female, but the face is more strongly narrowed ventrally, and the facial fovea often vestigial. Keel of scapus strong. Flagellum ventrally with light brown-yellow tyloidea, and fringe of very short hairs. Last segment truncate apically. The pitted furrow surrounding area cordiformis very well developed, also laterally. Spine in front of coxa 2 may be indistinct in small specimens. Legs without conspicuous secondary sexual characters, metatarsus 1 with a dark spot on the inner side.

Fron Fennoscandia there are sparse records from Central Sweden: Nrk., Sörby, Örebro; Upl., Björkö; Dlr., Råberga; and southern Finland: Ab, Pargas, Rymättylä; N, specimen lost during the last war; and Ta, Pälkäne, Vanaja. - Soviet Karelia: Ib. - The species is widely distributed in Central and eastern Europe, but very rare. Additional occurrence in Japan.

The biology of the species is unknown. A single specimen has been collected under the bark of a spruce (Picea) stump in Sweden: Nrk., Sörby, 26.VI.1918 (A. Jansson).

160. CROSSOCERUS (BLEPHARIPUS) STYRIUS (Kohl, 1892)

Figs. 414, 424, 441.

Crabro (Coelocrabro) styrius Kohl, 1892:198.

Female: 5.5-6.5 mm. Head large, seen from above as Fig. 424. Facial fovea very small or vestigial. Behind the lateral ocelli two, rather strong, impunctate depressions, between ocelli a short but distinct longitudinal furrow. Anterior margin of clypeus almost as in nigritus (Fig. 414). Frons shining with fine, rather dense punctation and very short pubescence. Humeral tubercles light brown. Scutum shining, with finer and denser punctation than in cetratus, the double median line anteriorly rather strongly impressed. Mesopleuron with very fine sparse punctation, without tooth in front of coxa 2. Area cordiformis shining, only anteriorly delimited by a pitted furrow, median furrow narrow and indistinct. First abdominal segment much longer

than wide. Tibiae 1+2 brownish, tibia 3 rather strongly thickened distally, with a yellowish proximal ring, spines on outer side rather stout.

Male: 4.5-5.5 mm. Head strongly narrowed ventrally, anterior border of clypeus with three rather stout teeth (Fig. 441). Scapus very long, pale brown, slender, without longitudinal keel. Flagellum short, ventrally with well developed hair fringe and tyloidea. Last segment truncate apically. Thorax sculptured as in female. Mesopleuron without tooth in front of coxa 2. First abdominal segment about 1.5 times longer than wide. Tibia 3 strongly clavately dilated distally, on outer side with very weak spines. Metatarsus 3 slightly thickened.

Very few specimens are known from Fennoscandia. - Sweden: Öl. and Upl. - Finland: N. - A very rare and scattered species in Central, East and South Europe. Recorded from England. - Biology unknown.

161. CROSSOCERUS (BLEPHARIPUS) BARBIPES (Dahlbom, 1845)

Fig. 415.

Crabro barbipes Dahlbom, 1845:521.

Female: 6.5-8.5 mm. Frons dull, very finely and densely punctate, anteriorly with distinct microsculpture. Frontal line weak, only slightly impressed. Median part of clypeus rather strongly projecting, broad and rounded (Fig. 415). Lateral lobes present as very small, almost vestigial tubercles. Scapus without yellow markings and longitudinal keel. Thorax dull, finely and very densely punctate. Interstices equal to or slightly greater than diameter of punctures. Mesopleuron shining, smooth, without microsculpture, without spine in front of coxa 2. Thorax without yellow markings, humeral tubercles at most slightly paler posteriorly. Area cordiformis distinctly delimited by a pitted furrow, median furrow broad. The area itself rather dull, with irregular radiate striation. Lateral faces of propodeum with very weak, reticulate microsculpture. Lateral margins of pygidial area strongly concave, area red-brown distally. Legs without yellow markings.

Male: 6-8 mm, considerably more slender than female and easily recognizable by following characters: last segment of flagellum truncate, with a rather weak tooth-like dilation. Ventrally flagellum has a distinct hair fringe. Femur 1 and trochanter brown-yellow ventrally and a stripe dorsally; with long, whitish woolly pubescence. Metatarsus 1 not dilated, white-yellow. Sculpture as in female.

A rare, but widely distributed species in Fennoscandia. - Sweden: known from Bl. in the south to Vb. in the north. - Norway: very sparse occurrence in AK,

Nsi and Nnø. - Finland: rare and very sparse occurrence in Ab, Ta, Ks and Li. - The species seems to have a boreo-montane distribution in Europe. Rare in Central and East European mountainous regions. The species also occurs in Kazakhstan, Mongolia and Japan.

162. CROSSOCERUS (BLEPHARIPUS) LEUCOSTOMUS (Linné, 1758)

Figs. 416, 431, 449.

Sphex leucostoma Linné, 1758:571.

Crabro carbonarius Dahlbom, 1838:34.

Female: 6-8 mm. Frons shining, with fine, sparse punctation; a weak microsculpture may occur on the foremost part. Frontal line rather weakly developed. Median part of clypeus broadly projecting, evenly rounded or with three very indistinct lobes (Fig. 416). Antennae black, scapus without longitudinal keel, proximally paler. Thorax uniform black. Scutum and scutellum shining, smooth, with rather dense punctation. Occasionally a weak microsculpture on anterior part of scutum. Mesopleuron with a strong tooth in front of coxa 2. Pubescence on head and thorax very short. Propodeum dorsally with very characteristic, but strongly varying sculpture (Fig. 431). Often the area cordiformis itself is reduced to a narrow portion between the surrounding, extremely coarsely pitted furrow and the median furrow. Propodeum laterally with transverse striation, which may be only indicated in small specimens. Posterior face with rather strong, transverse ribs. Apical half of pygidial area light red-brown. The basal, strongly punctate area considerably raised.

Male: 5.5-7.5 mm. Head strongly narrowed ventrally. Frons with rather superficial punctation. Median part of clypeus strongly projecting, anterior margin tri-lobate. Antennae entirely black, but flagellum with light brown tyloidea. Hair fringe very short. Last segment truncate apically, with a weak, downward-directed, rounded tooth. Sculpture on thorax as in female, only somewhat more superficial. Tooth in front of coxa 2 may be difficult to discern. Area cordiformis as described in female (Fig. 431). Tibia 1 with strong, distal concavity on inner side. Metatarsus 1 flattened or very slightly dilated, distally as a rule with a whitish spot of same colour as second tarsal segment (Fig. 441).

The species is rare in Denmark, but seems to be more common in the Fennoscandian countries. In Sweden the species has been found from Sk. in the south to Nb. and T.Lpm. in the north. - The records from Norway are very scattered, the northernmost deriving from TR and F. - Finland: found in most districts, from Al, Ab, N and Ka in the south to Lk and Li in the north. - Soviet Karelia:

Kr. - Widespread in Europe, but seems to avoid the Mediterranean region. Also recorded from Kamchatka and Japan.

There are very few records on the biology of the species (see e.g. Adlerz, 1910 and Grömblom, 1925). It breeds in dead wood, e.g. of Betula, Picea and Pinus. The nest is often constructed in abandoned larval tunnels of Scolytus ratzeburgi Jansson (Coleoptera, Scolytidae). The nest tunnel is 3-6 cm long and ends in a single cell, which is provisioned with small Diptera. The nest tunnel is sealed with sawdust, packed together with the apex of the abdomen.

163. CROSSOCERUS (BLEPHARIPUS) CETRATUS (Shuckard, 1837)

Figs. 417, 451.

Crabro cetratus Shuckard, 1837:131.

Female: 7-8 mm. Punctation in front of ocelli fine and sparse, interstices without microsculpture. Frontal line and facial fovea distinct. Occipital carina strongly projecting anteriorly, abruptly truncate. Clypeus in the middle broadly projecting, with or without very weak lobes. Lateral teeth almost vestigial (Fig. 417). Scapus entirely black, with or without indistinct longitudinal keel, Scutum densely punctate, along posterior margin a row of short, dense rugae. Mesopleuron with very fine and sparse punctation. Tooth in front of coxa 2 very small or missing. Pubescence on head and thorax very sparse and short. Area cordiformis marked only by the anterior, coarsely pitted furrow and median line. The latter continues uninterruptedly in the deep furrow on the posterior face of the propodeum. Propodeum dorsally and posteriorly with fine punctation, laterally with dense, fine striation, which may be missing centrally. Pygidial area very narrow, distally pale, proximally with a strongly raised, heavily punctate area. Legs without yellow markings.

Male: 6.5-7.5 mm. Easily recognizable by the morphology of the forelegs (Fig. 451). Femur 1 ventrally strongly flattened, slightly concave, often brown-yellow. Tibia 1 strongly flattened and dilated, with whitish margins. Metatarsus 1 only slightly longer than broad, also with whitish margins. Flagellum with broad, brown-yellow tyloidea, hair fringe very reduced, last segment truncate apically. Mesopleuron with rather strong, ventral concavity. Spine in front of coxa 2 only distinct in very robust specimens.

Denmark: NEZ, Tisvilde Hegn, 1♀, 18.vi.1975 (O. Lomholdt); NEZ, Jægerspris Nordskov, 1♀, 11.vi.1975 (O. Martin); new to Denmark. - Sweden: not common, occurring mainly in the central districts in Svealand and Götaland. - Norway: a few specimens from HOi and SFi. - Finland: rare, found in Al, Ab, N, Ta, Sa, and ObS. - Not found in Soviet Karelia. - Distributed in Central, East and North Europe and in Caucasus, Kazakhstan, eastern China and Japan.

The nest is constructed in similar sites to that of the following species. Diptera, e.g. Stratiomyidae and Bibionidae, are used as prey.

164. CROSSOCERUS (BLEPHARIPUS) NIGRITUS (Lepeletier & Brullé, 1834)

Figs. 418, 432, 442, 459.

Blepharipus nigrita Lepeletier & Brullé, 1834:729.
Crabro pubescens Shuckard, 1837:165.
Crabro (Crossocerus) inermis Thomson, 1870:162.

Female: 6-7.5 mm. Punctation in front of ocelli rather coarse, but superficial and somewhat irregular. Between punctures very weak rugae may be found. Microsculpture at most indicated. Frontal line and facial fovea well developed. The projecting median part on clypeus with three rounded teeth (Fig. 418). Scapus with an often reduced longitudinal carina, on the front side with a larger or smaller pale, longitudinal spot. Head with long pubescence. Punctation dorsally on thorax weak, scutum often with slight microsculpture. Mesopleuron with very fine, sparse punctation laterally, ventrally punctation gradually becomes considerably denser. In front of coxa 2 is a small spine. Pubescence on thorax long and erect. Area cordiformis ill-defined; of the delimiting lines only the anteriormost is present. This, together with the median line, forms a T-shaped figure (Fig. 432). Propodeum otherwise very indistinctly sculptured, almost smooth. Lateral margins of pygidial area strongly concave; a sharp longitudinal keel is found proximally. Legs usually entirely black, proximally on tibia 3 a small white-yellow spot may be present.

Male: 5.5-7 mm. Head with very long pubescence, both dorsally and ventrally. Clypeus strongly projected in the middle, the median lobe very well developed (Fig. 442). Scapus without longitudinal keel, but with a large yellow longitudinal spot. Flagellum with a strong hair fringe ventrally, last segment with rounded apex. Thorax with long pubescence, punctation weaker than in female. Spine in front of coxa 2 very reduced or missing. Propodeum as in female, but sculpture dorsally, on average, somewhat better developed. Sternum 7 with a median convexity. Tergum 7 with two ventrolateral clavate processes, which meet near the convexity on sternum 7 (Fig. 459). Femur 1 and tibia 1 brown-yellow ventrally, tibia in addition with an effaced, yellow, longitudinal spot. On tibia 1, especially distally ventrally, there is a long, slightly curly pubescence. Tarsus without secondary sexual characters. Femur 2 often with brown-yellow pattern on the inner and outer sides. Tibia 3 often with a yellowish proximal spot.

This species is not common in Denmark and only known from a few localities in Jutland and North Zealand. - Distribution in Sweden very sparse, from Sk.

in the south to Ly. and Lu. Lpm. in the north. - Norway: rare and sparse. - Finland: rare, found from Ab and N in the south to Ks in the north. - Soviet Karelia: Kr. - The distribution area covers Europe, and extends eastwards to the Caspian Sea. Additional occurrence in Mongolia, China and Japan.

The nests may be constructed in dead wood or branches, trunks and stems of e.g. Fagus, Quercus, Prunus, Populus, Alnus, Sambucus or Typha, and often associated with old human habitations. The species has also been found nesting in abandoned larval tunnels of Saperda populnea L. and Ceuthorrhynchidius lapathi L. (Coleoptera, Cerambycidae and Curculionidae, respectively). The structure of the nest may be rather complicated (Tsuneki, 1960), since branching may be considerable. The cells are made either at the end of the lateral tunnels or in a row. A single nest may contain up to 11 cells. As provision is used rather small Diptera, e.g. of the families Ceratopogonidae, Mycetophilidae, Empididae, Pipunculidae, Dolichopodidae, Chloropidae and Phoridae. The prey is attacked on leaves in the sun and paralyzed by a sting in the neck region (for details see Tsuneki, l.c.). The larva was described by Baudot, 1934. Diomorus armatus Boh. (Hymenoptera, Torymidae) is recorded as parasite.

165. CROSSOCERUS (BLEPHARIPUS) MEGACEPHALUS (Rossi, 1790)

Figs. 419, 443.

Crabro megacephalus Rossi, 1790:94.
Coelocrabro leucostomoides Richards, 1935:166.
Crabro leucostoma auctt., nec Linné.

Female: 7-9 mm. Large, very robust species. Head large, well developed behind eyes, in front view as Fig. 419. Frons with fine, sparse punctation in front of ocelli, without microsculpture. Frontal line and facial fovea well developed. Occipital carina slightly projecting, anteriorly gradually disappearing. Median part of clypeus not projecting, shallowly convex and very obtusely emarginate. Lateral teeth small (Fig. 419). Mandibles stout, black, with paler apex. Scapus with sharp, longitudinal keel and a larger or smaller yellow longitudinal spot on the inner side. Pubescence of head rather long, light brownish. Thorax entirely black, also with rather long and erect pubescence. Scutum with a somewhat superficial, irregular punctation. Mesopleuron without silvery pubescence, spine in front of coxa 2 well developed, but may be difficult to discern in very small specimens. Propodeum with very reduced sculpture, mainly shining and smooth with very fine punctation. Area cordiformis, however, lacking punctation, but may have a very fine radiating sculpture. Of the delimiting furrows only the anteriormost is present. As in nigritus this, together with the median line, forms

a T-shaped figure. Margins of the pygidial area strongly concave, apex red-brown. Proximally a sharp, longitudinal keel. Legs without yellow markings.

Male: 6-8 mm. Very easily recognizable by the two big, triangular dilations on clypeus (Fig. 443). Scapus with indistinct longitudinal keel, with yellow longitudinal spot. Flagellum entirely black, hair fringe well developed. Last segment with rounded apex. Head and thorax with long pubescence. Sculpture as in female. Sternum 7 with a median convexity. Tergum 7 with two ventro-lateral clavate processes which meet at the convexity. Legs without yellow markings, forelegs without secondary sexual characters.

The species is rather common in Fennoscandia and Denmark. Northern distribution limit in Sweden in Upl. and Vrm. A few specimens from Nb. - Norway: a little material exists from AK, VE and HO. - Finland: not common, distributed northwards to Om and Sb. - Soviet Karelia: Ib. - Widespread and rather common in Europe, eastwards to the Urals and Kazakhstan in the Soviet Union. It seems to be missing from the Iberian Peninsula, the Balkans and Asia Minor. In the south it is recorded from Tunisia. In Asia the species is found in Persia, around Lake Baikal and in northern Japan.

The species nests gregariously. The nests may be found in many kinds of deciduous trees, but also in conifers or in abandoned larval tunnels (galls) of Saperda populnea L. (Coleoptera, Cerambycidae). It seems to be normal for several females to use the same entrance, but the nest system of each individual is usually kept separate. There is evidence that the tunnel systems may join up, since in the discarded saw dust one may find paralyzed Diptera as well as larvae of the species (Abrahamsen, in litt.). The species uses prey from a very large number of dipterous families (Leclercq, 1954). In a single case a specimen of Tenthredinidae (Hymenoptera, Symphyta) (Hamm & Richards, 1926) was found. As parasites were found Endasys analis Grav., Habritys brevicornis (Hymenoptera, Ichneumonidae and Pteromalidae, respectively) and Eustalomyia festiva Zett. (Diptera, Anthomyiidae).

166. CROSSOCERUS (BLEPHARIPUS) CINXIUS (Dahlbom, 1838)

Figs. 420, 445.

Crabro cinxius Dahlbom, 1838:38.

Female: 5.5-7.5 mm. Head and thorax dull, with distinct reticulate microsculpture, which is vestigial on mesopleuron. Punctation on head extremely fine and rather sparse. Clypeus very characteristically shaped, the median lobe considerably broader than scapus, lateral teeth well developed (Fig. 420). Antennae entirely black, scapus without keel. Mesopleuron without tooth in

front of coxa 2, shining. Area cordiformis very indistinct, also anteriorly. Median furrow weak. The area itself shining, with a fine, dense striate sculpture; microsculpture vestigial. Propodeum otherwise very weakly sculptured, posterior and lateral faces only separated by a very strong carina. Lateral faces with a fine, dense, but somewhat superficial striate sculpture. The pygidial area is simple, margins are almost straight, the raised, strongly sculptured part of other species is missing. Legs black, tibia 3 strongly dilated, with indistinct spines, and a white-yellow, proximal ring.

Male: 5-6 mm. Head in front view considerably narrowed ventrally, distance between mandibular articulations smaller than maximum distance across eyes. Frons with rather weak microsculpture, punctation very fine and sparse. Median lobe of clypeus broad, strongly projecting, almost as in female but with more parallel margins (Fig. 445). Median segments on flagellum with sharp-edged tyloidea. Hair fringe very short. Last segment with rounded apex. Scutum with very well developed microsculpture, anteriorly with rather strong longitudinal carinae. Area cordiformis usually with weak striation. Lateral faces of propodeum distinctly striate. Legs black. Tibiae 1+2 usually with a small, yellow, proximal spot, which may be extended to a stripe on tibia 1. Tibia 3 with a yellowish, basal ring.

Not known from Denmark. - In Sweden it is found in Sm., Vg., Dlr., Med., Jmt., Vb. and in "Norrland and Lapland" (Dahlbom, 1840). - A few specimens from Norway: On and NTi. - The species seems to be somewhat more frequent in Finland, where it is distributed from Ab and N in the south to Kb and Ok in the north. - Soviet Karelia: Ib and Kr. - The species has a boreo-montane distribution pattern in Europe. It is also recorded from Kazakhstan, Formosa and Japan.

The species prefers a habitat similar to capitosus, i.e. pith-filled stems and twigs of Sambucus, Symphoricarpus, Spiraea, Rubus and the like. The cells are placed in rows, and each nest may contain up to 17 cells. Mixed nests of Passaloecus singularis (no. 35) and cinxius occur. The choice of food of the species is less restricted than that of capitosus, since rather small Diptera, e.g. Chironomidae, Empididae and Anthomyiidae, Homoptera, e.g. Psyllidae and rather small Heteroptera may all be used. The larva was described by Micheli, 1930. As parasites have been found Diomorus armatus Boh. and Perithous mediator Fabr. (Hymenoptera, Torymidae and Ichneumonidae, respectively) and Oebalia cylindrica Fall. (Diptera, Sarcophagidae).

167. CROSSOCERUS (BLEPHARIPUS) CAPITOSUS (Shuckard, 1837)

Figs. 421, 426, 446.

Crabro capitosus Shuckard, 1837:159.

Female: 5.5-7 mm. Head very large, well developed behind the eyes (Fig. 426). Microsculpture on head rather fine, whereby the surface becomes somewhat more shining than in cinxius. Punctation extremely fine, sometimes hardly visible. Clypeus as Fig. 421, median lobe about equally broad as scapus, lateral lobes distinct, tooth-like. Ventrally on head between the two branches of the occipital carina there is a concave, strongly transversely striate area. Antennae black, scapus without keel. Microsculpture dorsally on thorax more strongly developed than on head, punctation distinct, but sparse. Mesopleuron shining, smooth; microsculpture very indistinct, the tooth in front of coxa 2 missing. Area cordiformis very indistinct, the pits in the anterior delimiting furrow shallow, merging with the surface of the area itself. Median furrow weak, sometimes vestigial. Whole propodeum with uniform, very finely striate or slightly reticulate sculpture. Transition between posterior and lateral faces marked by a short keel on either side of the articulation of the abdomen. Abdomen dull, with transversely striate microsculpture. Pygidial area dull, lateral margins rather strongly projecting, almost linear. The proximal part of the area itself slightly convex, distinctly punctate. Tibia 1 with a yellow, longitudinal stripe. Tibia 2 often with a small proximal yellowish spot. Tibia 3 strongly dilated, spines on outer side very weak, and a broad white-yellow ring is found proximally.

Male: 4.5-6 mm. Median part of clypeus projecting like a narrow nose (Fig. 446). Flagellum ventrally with broad, yellow-brown tyloidea, hair fringe extremely short. Sculpture as described in female, but somewhat weaker.

The species is not common, but widely distributed within Fennoscandia and Denmark. Northern distribution in Sweden in Dlr. and Gstr. - In Finland the species occurs northwards to Sb and Kb. - Soviet Karelia: Ib and Kr. - Like most species of Crossocerus (Blepharipus), this species has a very disjunct distribution in Central, East and North Europe and in Japan.

The species usually nests in pith-filled stems and branches, e.g. of Sambucus, Symphoricarpus, Fraxinus, Syringa and the like, in which the cells are constructed in a linear fashion. Number of cells varies considerably (1-18). In very large nests it seems usual for the number of male cells to considerably exceed that of female ones. Often mixed nests of Rhopalum clavipes (no. 139) and capitosus occur. The partitions between the cells consist of fine pithdust. The prey comprises fairly small Diptera, e.g. Chironomidae, Tipulidae, Empididae, Dolichopodidae and Agromyzidae, and exceptionally Homoptera Psyllidae. The larva was described by Marechal, 1927. As parasites have been found species of Macronychia and Oebalia (Diptera, Sarcophagidae) and Diomorus armatus Boh.

(Hymenoptera, Torymidae). The species very often occurs as distributor of large numbers of Acarina, e.g. Tyroglyphidae (Phoresy).

168. CROSSOCERUS (ACANTHOCRABRO) VAGABUNDUS (Panzer, 1798)

Fig. 456.

Crabro vagabundus Panzer, 1798:H.53, T.16.

Female: 8-12 mm. Frons densely and rather strongly punctate, with indistinct microsculpture. Frontal line slightly depressed, facial fovea large, dull, strongly depressed. Projecting median part of clypeus with a weak, very rounded median tooth, lateral teeth vestigial. Occasionally there are two yellow spots on clypeus. Mandibles usually black with reddish apex, tridentate with obtuse process on the inner side. Frontal face of scapus yellow. Colour pattern on thorax very variable. Danish specimens usually have two yellow lateral spots on pronotum and often a transverse spot on scutellum; these are often missing in Fennoscandian specimens. Humeral tubercle may have a slightly yellowish spot. Scutum with dense and strong punctation, the punctures in robust specimens often having a tendency to fuse longitudinally. Mesopleuron smooth with sparse and rather fine punctation, with a sharp tooth in front of coxa 2. Area cordiformis shining, smooth, sometimes with a very weak radiate-striate sculpture. The area surrounded by a very strongly pitted furrow, median furrow deep. Lateral faces of propodeum shining, with a more or less extensive, finely striate sculpture interspersed with fine punctures. Abdomen with large yellow lateral spots on terga 2 and 3 and a yellow transverse band on tergum 5. In addition often a weak irregular transverse band on tergum 1 and lateral spots on tergum 4. Pygidial area sharp-edged, distally slightly depressed in a furrow-shape, shining, with a few punctures, proximally strongly and rather densely punctate, with a distinct median longitudinal carina. Tibiae 1+2 with yellow front side, tibia 3 may be entirely yellow, but generally a brown area is found distally.

Male: 7-10.5 mm. Median tooth on clypeus well developed, varying from being evenly rounded to having an obtuse emargination. Punctation of head as described in female, only somewhat sparser. Facial fovea rather weak. Mandibles bidentate, distally slightly dilated, tooth on the inner side rather well developed. Colour of mandibles varying from black with reddish apex to predominantly yellow. Scapus with yellow frontal side. Flagellum yellow-brown or yellow-spotted ventrally, hair-fringe very well developed, last segment rounded apically. Pronotum and scutellum only seldom with yellow pattern, as in Danish and Fennoscandian specimens. On the other hand, humeral tubercles and epicnemium often have extensive yellow markings. Tooth in front of coxa 2 often missing. Thorax with finer and

sparser punctation than in female. Sculpture on propodeum on the other hand better developed. Abdomen with yellow lateral spots on terga 2 and 3. Usually also a transverse band on tergum 6. Occasional specimens from Denmark have yellow markings on terga 1, 4 and 5. Sternum 7 with a convexity subapically. Tergum 7 with two ventro-lateral, short, clavate processes which meet at the convexity. Coxa 1 laterally with a sharp spine. Femur 1 with an obtuse tooth (Fig. 456), mainly yellow or yellow-brown. Tibiae 1+2 yellow on the front side. Femur 2 with extensive yellow markings, sometimes with a small distal yellow spot. Tibia 3 either entirely yellow or with a larger or smaller dark-coloured, distal spot.

The species has a southern and south-eastern occurrence in Denmark. - In Sweden it is distributed from Sk. in the south to Dlr. and Ång. in the north. - Only a little material was collected in Norway: AK, AAy and HOi. - A southern distribution in Finland, northwards to Oa and Sb. - Soviet Karelia: Kr. - The distribution of this species follows the taiga belt through Siberia to the Pacific Ocean. It is not recorded from the Iberian Peninsula.

The species constructs its nests in dead wood, often in connection with abandoned larval tunnels of Coleoptera. The nest system is a combination of the linear and the branched type, but only where permitted by space; if not, the cells are constructed in rows. As prey are usually used Diptera, Tipulidae and Limoniidae, also certain Rhagionidae, or even Lepidoptera Tortricidae (Tsuneki, 1960) may be used. It seems to be a common feature that the extremities of the prey animals are amputated.

169. CROSSOCERUS (CUPHOPTERUS) DIMIDIATUS (Fabricius, 1781)

Figs. 422, 433, 464.

Crabro dimidiata Fabricius, 1781:471.

Female: 8-11.5 mm. Frons in front of ocelli with a very large, broad concavity (Fig. 422), which has a very weak and sparse punctation, strongest medially. Punctation between the lateral ocelli dense, but not stronger than on the remaining part of frons, and only very seldom with a small, compressed spine posteriorly. The median projecting part of clypeus with three, more or less distinct, rounded teeth (Fig. 422), two yellow spots proximally may occur. Mandibles tridentate apically, on the inner side is a very obtuse tooth. Their colour pattern varies considerably, often with a large yellow spot, but it is seldom the predominating colour. Specimens from the northernmost regions of the species' range may lack the yellow on the mandibles. Antennae long and slender. Scapus often entirely yellow, but usually a dark spot is found on the inner side. Flagel-

lum may have yellow markings on second and third segments. The variation in the extent of the yellow pattern on thorax seems only in a small degree to be geographically (climatically) conditioned. It is, however, usual to find yellow markings on pronotum, humeral tubercles and metanotum in specimens from Denmark. Sometimes also two small yellow spots occur on scutellum. In a very few cases these may coalesce. Specimens from Fennoscandia may have thorax entirely black. Scutum rather dull, with very dense punctation, interstices equal to or slightly larger than diameter of punctures. Mesopleuron without tooth in front of coxa 2; shining and smooth in that area. Punctation laterally very fine and sparse. Area cordiformis shining, the delimiting furrow indistinct apically and laterally. Median furrow rather narrow (Fig. 433). Propodeum laterally shining, smooth, very weakly sculptured. Yellow pattern on abdomen very variable. Tergum 3 and 4 always with large yellow lateral spots, which may be coalesced. Terga 1 and 5 often with yellow transverse band. Yellow colour on tergum 1 may cover the entire sclerite, except two rounded black spots. Lateral spots on tergum 2 may be present in Danish and South Swedish specimens. Pygidial area yellow, broadly triangular, plane, with sparse and rather strong punctation. Tibiae 1+2 with yellow pattern on the outer side. Tibia 3 with yellow markings of very variable extent.

Male: 7.5-9.5 mm. Median part of clypeus rather narrow, strongly projecting. Just ventral to the mandibular articulations there is a strong, downward-directed spine. Upper margin of mandibles strongly arcuately dilated. Antennae long and slender. Scapus with a yellow longitudinal spot on the posterior face. Flagellum with a strong hair fringe, especially proximally. Thorax shining, smooth, sometimes with a bluish-waxy sheen. Pronotum and humeral tubercles with or without yellow markings. The spots on pronotum only occasionally form a complete transverse band. Punctation on scutum and scutellum considerably sparser than in female. A weak yellow pattern may sometimes occur on metanotum. Mesopleuron sculptured as in female, ventrally with a rather dense, silvery pubescence. The variation in extent of the yellow pattern on abdomen very pronounced. In particular small specimens from the northernmost districts of the range of the species may have two small, lateral spots only on tergum 3. Usually there are also more or less extensive markings on terga 2, 4, 6 and 7. Danish and Fennoscandian specimens often lack the spots on tergum 2. Medially on sternum 7 there is a swelling or a tubercle, bordered by two sharp teeth projecting from tergum 7. Trochanter 1 with a narrow, lamella-like dilation. Femur 1 flattened ventrally, distally sharp-edged and slightly dilated. Tibia 1 also flattened ventrally, with sharply projecting edges. Tibia 2 with a long, transparent, lamella-like dilation on the outer face. Trochanter 3 with a large, sharp tooth (Fig. 464).

Colour pattern of legs very variable. Femora 1+2 with a yellow-brown stroke on inner side. Tibiae 1+2 with a yellow stripe along the outer side. Tibia 3 may be mainly black, but often has a proximal and yellow spot.

The species is common and widespread in Fennoscandia and Denmark. Northern distribution limit in Sweden passes through Lu. Lpm.; in Norway through Nnø; and in Finland through Ob and Ks. - In Soviet Karelia known from Ib and Kr. - Dimidiatus has a northern distribution in Europe. Eastwards it is recorded from the Urals and Kazakhstan. A subspecies, sapporoensis Tsuneki, occurs in Japan.

The nest is constructed in decayed wood. On a single occasion the species was found nesting in Polyporus sulphureus (Wissmann, 1849). The prey consists of Diptera, e.g. of the families Anthomyiidae, Muscidae, Calliphoridae, Stratiomyidae, Syrphidae and Rhagionidae.

Note. Peters (1973) published some biological observations which strongly indicate a display of social behaviour comparable to that of Microstigmus comes, i.e. division of labour among females. This is the first record of true sociality in the Crabronini.

170. CROSSOCERUS (CUPHOPTERUS) BINOTATUS (Lepeletier & Brullé, 1834)

Figs. 460, 463.

Crossocerus binotatus Lepeletier & Brullé, 1834:771.
Crabro monstrosus Dahlbom, 1845:525, syn. n.
Crabro (Blepharipus) confusus Schulz, 1906:207.

Female: 9-11.5 mm. Frons between lateral ocelli very often with a small, acute tooth or tubercle. Median part of clypeus rather narrow, anterior margin with three rather distinct teeth. Two pale yellow spots may occur on clypeus. Mandibles and scapus often with very extensive yellow markings. Pronotum usually with two yellow lateral spots. On metanotum a yellow, transverse band may occur, and scutellum may have two lateral spots. Area cordiformis rather broad, median furrow broad, pits in the anterior delimiting furrow gradually merge with the area itself. The distribution of the yellow markings on abdomen as in dimidiatus. Pygidial area comparatively narrower, lateral margins generally slightly concave. Tibiae usually entirely yellow, tibia 1 generally with effaced brownish spot on inner side. Spines of tibia 3 weak (Fig. 460).

Male: 7-10 mm. Spine at mandibular articulation small, usually acute. Mandibles, clypeus and scapus with very extensive yellow pattern, often entirely yellow. Morphology of forelegs almost as in dimidiatus, but tibia are somewhat more

dilated about the middle. The transparent lamella on the outer side of tibia 2 is weakly developed. Tibia 3 shorter than femur 3, distally slightly dilated, spines on the outer side very reduced or missing. Coxa 3 with a very small proximal tooth. Femur 3 often almost entirely yellow. Femur 3 black or brownish, trochanter and tibia mainly yellow.

The species is not uncommon in Denmark, but seems to have a southern and south-eastern distribution. - Sweden: only known from a few localities in Sm., Hall., Nrk. and Upl. - Not recorded from Norway or Finland. - The distribution area covers Central Europe and Caucasus.

The nests are found in old timber, also in human habitations. The prey consists of Diptera, e.g. Rhagionidae and Lauxaniidae.

171. CROSSOCERUS (CUPHOPTERUS) SUBULATUS (Dahlbom, 1845)

Figs. 461, 462.

Crabro (Blepharipus) subulatus Dahlbom, 1845:525.
Crabro monstrosus Kohl, 1915:214.

Closely related to binotatus, from which it can only be distinguished by the characters mentioned in the key. A few males have a small tooth in front of coxa 2.

A few specimens are known from Denmark: NEJ, Faurholt Hede, and NEZ: Tisvilde. - Sweden: Sk., Nosaby; Öl., Glömminge; Gtl., Ljungarn; Ög., Simonstorp; Upl., Grisslehamn, Värmsdö, Svartsjö. - Not recorded from Norway. - Finland: recorded as Cr. binotatus (=confusus) by Pulkkinen, 1931 and Leclercq, 1954 from Al, Ab, N, Ka, Ta, and Sa. - Not recorded from Soviet Karelia. - The species has a very pronounced disjunct distribution in Fennoscandia, the Urals and in eastern Asia and Japan.

Nests in old timber and use Diptera, e.g. Muscidae, Calliphoridae, Anthomyiidae or Sarcophagidae as provision for the larvae.

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				DENMARK													
		N. Germany	G. Britain	SJ	EJ	WJ	NWJ	NEJ	F	LFM	SZ	NWZ	NEZ	B	Sk.	Bl.
Dolichurus corniculus (Spin.)	1	●			●	●		●	●			●	●		●	●
Sphex rufocincta Brullé	2															
Podalonia hirsuta (Scop.)	3	●	●	●	●	●	●	●	●			●	●	●	●	●
P. affinis (Kirby)	4	●	●	●	●	●	●	●	●	●		●	●	●	●	●
P. luffii Saunders	5	●	●			●	●							●	●	
Ammophila sabulosa (L.)	6	●	●	●	●	●	●	●	●	●		●	●	●	●	●
A. pubescens Curtis	7	●	●	●	●	●	●	●		●		●	●	●	●	●
A. campestris Latr.	8	●		●	●	●	●	●		●			●		●	
Pemphredon (P.) lugubris (Fabr.)	9	●	●	●	●			●	●	●		●	●	●	●	●
P. (P.) montanus Dahlbom	10	●													●	●
P. (P.) lugens Dahlbom	11	●													●	●
P. (P.) flavistigma Thomson	12															
P. (P.) fennicus Merisuo	13															
P. (P.) beaumonti Hellén	14															
P. (P.) balticus Merisuo	15															
P. (Cemonus) mortifer Valkeila	16	●			●				●				●		●	
P. (C.) wesmaeli (A. Morawitz)	17	●	●										●		●	
P. (C.) inornatus Say	18	●	●	●	●	●	●	●	●	●		●	●	●	●	●
P. (C.) lethifer (Shuckard)	19	●	●	●	●			●	●	●		●	●		●	
Ceratophorus morio (v. d. Lind.)	20	●	●		●							●	●			
C. clypealis (Thomson)	21	●	●	●					●				●		●	
Diodontus minutus (Fabr.)	22	●	●	●	●	●	●	●	●				●		●	
D. insidiosus Spooner	23		●													
D. luperus Shuckard	24	●	●													
D. tristis (v. d. Lind.)	25	●	●	●	●	●	●	●	●			●	●		●	
D. medius Dahlbom	26	●			●											
Passaloecus gracilis (Curt.)	27	●	●	●	●	●	●	●		●		●	●		●	●
P. turionum Dahlbom	28	●				●			●				●		●	●
P. borealis Dahlbom	29												●			
P. brevilabris Wolf	30															
P. eremita Kohl	31	●	●										●			
P. corniger Shuckard	32	●	●		●		●		●	●		●	●		●	●
P. insignis (v. d. Lind.)	33	●	●	●	●			●	●		●	●	●	●	●	●
P. monilicornis Dahlbom	34	●	●												●	●
P. singularis Dahlbom	35	●	●	●	●				●	●		●	●		●	●
P. clypealis Fæster	36	●	●			●			●		●					●
Stigmus solskyi A. Morawitz	37	●	●		●				●	●	●	●	●		●	
S. pendulus Panzer	38	●														●

	Hall.	Sm.	Öl.	Gtl.	G. Sand.	Ög.	Vg.	Boh.	Dlsl.	Nrk.	Sdm.	Upl.	Vstm.	Vrm.	Dlr.	Gstr.	Hls.	Med.	Hrj.	Jmt.	Ång.	Vb.	Nb.	Ås. Lpm.	Ly. Lpm.	P. Lpm.	Lu. Lpm.	T. Lpm.
1		●	●	●		●	●	●			●	●		●	●	●												
2				●																								
3		●	●	●		●	●	●	●		●	●		●	●	●												
4	●	●	●	●	●	●	●	●			●	●		●	●	●												
5	●			●																								
6	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●			●	●	●	●			●	●
7	●	●	●	●		●	●	●		●	●	●		●	●	●		●										
8		●	●												●												●	
9	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●			●	●					●			●
10	●	●		●		●	●		●		●	●		●	●	●	●	●	●	●	●	●	●		●		●	
11	●	●	●	●	●	●					●	●	●	●	●	●	●				●	●	●					
12		●				●									●		●			●								
13																									●			
14				●																								
15	●	●				●						●																
16		●	●							●															●			
17			●		●	●	●	●	●		●	●		●	●		●						●					
18	●	●	●	●	●	●		●		●	●	●	●	●	●	●					●	●	●				●	
19	●	●	●	●		●			●		●	●		●		●												
20		●				●	●		●	●		●		●		●	●					●						
21				●		●																						
22			●	●		●		●								●												
23																												
24																												
25	●	●	●	●		●		●		●	●	●				●												
26		●				●			●	●	●	●		●	●	●	●	●		●	●							
27		●	●	●	●	●	●	●		●		●	●															
28		●		●		●	●			●		●	●		●	●	●				●						●	
29		●			●															●					●			
30		●	●	●		●					●					●												
31		●		●		●	●			●	●	●				●				●								
32		●	●	●	●	●	●	●		●	●	●	●	●	●	●	●											
33	●	●	●	●		●	●	●	●	●	●	●			●													
34	●	●	●			●		●		●	●	●		●	●	●	●	●		●	●	●	●		●			
35	●	●	●			●				●	●	●			●	●	●	●				●						
36						●				●		●																
37			●			●	●			●	●	●			●	●	●											
38		●	●	●		●	●					●	●				●											

◐ = Kvamme & Axelrson

		NORWAY														
		Ø + AK	HE (s + n)	O (s + n)	B (ø + v)	VE	TE (y + i)	AA (y + i)	VA (y + i)	R (y + i)	HO (y + i)	SF (y + i)	MR (y + i)	ST (y + i)	NT (y + i)	Ns (y + i)
Dolichurus corniculus (Spin.)	1	◗														
Sphex rufocincta Brullé	2															
Podalonia hirsuta (Scop.)	3	◗								◖	◗					
P. affinis (Kirby)	4	◖						◖		◖						
P. luffii Saunders	5															
Ammophila sabulosa (L.)	6	◖	◐		◐	●		◖	◖	●	●	◗				
A. pubescens Curtis	7				◗				◖							
A. campestris Latr.	8															
Pemphredon (P.) lugubris (Fabr.)	9	◗	◐	◐	◐		◐	◐	◖	●	●	◗			◗	
P. (P.) montanus Dahlbom	10	◗		◐	◐		◗									
P. (P.) lugens Dahlbom	11	◗			◐		◐									
P. (P.) flavistigma Thomson	12		◐													
P. (P.) fennicus Merisuo	13															
P. (P.) beaumonti Hellén	14															
P. (P.) balticus Merisuo	15															
P. (Cemonus) mortifer Valkeila	16															
P. (C.) wesmaeli (A. Morawitz)	17	◗			◗					◗		◗				
P. (C.) inornatus Say	18	●					◐	◖								
P. (C.) lethifer (Shuckard)	19									◖	●					
Ceratophorus morio (v. d. Lind.)	20	◗			◐											
C. clypealis (Thomson)	21															
Diodontus minutus (Fabr.)	22															
D. insidiosus Spooner	23															
D. luperus Shuckard	24															
D. tristis (v. d. Lind.)	25	●														
D. medius Dahlbom	26	◗	◖		◗											
Passaloecus gracilis (Curt.)	27	◗									◗	◗				
P. turionum Dahlbom	28	◗		◗							◗					
P. borealis Dahlbom	29				◐			◐								
P. brevilabris Wolf	30															
P. eremita Kohl	31	◗														
P. corniger Shuckard	32	◗	◗		◖			◖			◗					
P. insignis (v. d. Lind.)	33	◗				●										
P. monilicornis Dahlbom	34	◗	◖		◖					◗	●					
P. singularis Dahlbom	35	◗														
P. clypealis Fæster	36															
Stigmus solskyi A. Morawitz	37	◗						◖								
S. pendulus Panzer	38							◖								

					FINLAND																				USSR		
	Nn (ø + v)	TR (y + i)	F (v + i)	F (n + ø)	Al	Ab	N	Ka	St	Ta	Sa	Oa	Tb	Sb	Kb	Om	Ok	Ob S	Ob N	Ks	LkW	LkE	Le	Li	Ib	Kr	Lr
1						●	●	●		●	●	●		●	●	●	●	●							●		
2																											
3					●	●	●	●		●	●		●	●	●										●	●	
4						●					●														●		
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6					●	●	●	●	●	●	●	●	●	●	●	●	●	●		●					●	●	
7					●	●	●	●	●	●	●	●	●	●	●	●	●	●							●	●	
8							●		●							●		●							●		●
9	◀	●			●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					●	●	
10	◀		▶◀		●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			●	●	●	
11					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●				●	●	
12					●	●	●			●	●		●		●	●	●		●						●	●	
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17					●	●	●	●	●	●	●	●		●	●	●		●		●					●	●	
18					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●					●	●	
19					●	●		●		●	●															●	
20					●	●	●	●	●	●	●		●	●	●	●		●		●					●	●	
21					●	●	●		●	●	●				●					●					●		
22						●	●	●		●	●		●	●	●										●	●	
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26					●	●	●			●	●	●	●	●	●	●		●		●						●	
27					●	●				●																	
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33					●	●				●		●															
34	◀				●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●	●	
35					●	●	●	●	●	●	●	●	●	●	●	●	●	●							●	●	
36					●	●				●	●				●	●											
37					●	●	●	●		●	●			●	●										●	●	
38							●																				

				DENMARK													
		N. Germany	G. Britain	SJ	EJ	WJ	NWJ	NEJ	F	LFM	SZ	NWZ	NEZ	B	Sk.	Bl.
Spilomena differens Blüthgen	39	●	●						●		●		●	●	●	●
S. curruca (Dahlbom)	40															
S. enslini Blüthgen	41		●										●			
S. exspectata Valkeila	42				●										●	●
S. troglodytes (v. d. Lind.)	43	●	●										●		●	
S. vagans Blüthgen	44	●	●		●					●			●		●	●
Mimesa equestris (Fabr.)	45	●	●	●	●	●	●	●	●	●		●	●		●	
M. lutaria (Fabr.)	46	●	●		●	●	●	●	●			●	●	●	●	
M. bruxellensis Bondroit	47	●	●													
M. rufa (Panz.)	48	●	●	●	●	●	●	●	●			●	●		●	
Psen ater (Olivier)	49	●	●													
Mimumesa unicolor (v. d. Lind.)	50	●		●						●		●	●			
M. littoralis (Bondroit)	51		●			●		●								
M. atratina (F. Morawitz)	52	●	●												●	
M. spooneri (Richards)	53		●						●							
M. dahlbomi (Wesmael)	54	●	●	●	●	●	●		●			●	●	●	●	
M. beaumonti (van Lith)	55	●											●			
Psenulus concolor (Dahlbom)	56	●	●	●	●								●		●	●
P. fuscipennis (Dahlbom)	57	●													●	●
P. pallipes (Panzer)	58	●	●	●	●			●	●	●	●	●	●	●	●	●
P. schencki (Tournier)	59	●	●													
Cerceris rybyensis (L.)	60	●	●	●	●				●	●		●	●	●	●	●
C. arenaria (L.)	61	●	●		●	●		●	●				●	●	●	●
C. quadrifasciata (Panzer)	62	●		●	●	●		●				●	●		●	
C. quinquefasciata (Rossi)	63	●	●		●			●					●		●	
C. ruficornis (Fabr.)	64	●	●	●	●	●							●		●	
Philanthus triangulum (Fabr.)	65	●	●		●				●	●	●	●	●	●	●	●
Argogorytes mystaceus (L.)	66	●	●	●	●			●	●	●	●	●	●	●	●	●
A. fargei (Shuckard)	67	●	●	●	●			●		●		●	●		●	●
Gorytes quinquecinctus (Fabr.)	68															
G. laticinctus (Lep.)	69	●	●	●		●	●	●	●	●		●	●		●	
G. quadrifasciatus (Fabr.)	70	●	●	●	●	●	●	●	●	●		●	●	●	●	●
G. neglectus Handlirsch	71															
Dienoplus tumidus (Panzer)	72	●	●	●	●					●			●	●	●	●
D. lunatus (Dahlbom)	73	●		●	●		●						●	●	●	
Bembix rostrata (L.)	74	●											●	●	●	●
Nysson spinosus (Forster)	75	●	●	●	●				●	●		●	●	●	●	
N. interruptus (Fabr.)	76	●	●	●	●					●			●		●	

	Hall.	Sm.	Öl.	Gtl.	G. Sand.	Ög.	Vg.	Boh.	Dlsl.	Nrk.	Sdm.	Upl.	Vstm.	Vrm.	Dlr.	Gstr.	Hls.	Med.	Hrj.	Jmt.	Ang.	Vb.	Nb.	Ås. Lpm.	Ly. Lpm.	P. Lpm.	Lu. Lpm.	T. Lpm.
39		●	●	●	●	●	●	●		●	●	●	●	●		●						●						
40		●				●				●		●										●						
41		●	●			●	●			●		●				●												
42	●	●			●					●	●					●												
43										●	●	●				●												
44		●	●			●	●			●		●			●		●											
45	●	●	●	●		●	●			●	●	●			●	●							●		●			
46		●		●	●	●	●			●	●	●		●		●	●			●		●	●				●	
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65	●	●	●	●		●					●	●		○	○													
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69	●	●	●	●		●	●	●		●	●	●		●														
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72	●	●	●	●		●	●			●	●	●				●	●											
73		●	●				●			●		●			●	●	●						●					
74			●	●							●	●																
75	●	●	●			●	●	●	●	●	●	●		●	●	●	●	●										
76			●	●		●	●									●												

		NORWAY															
		Ø + AK	HE (s + n)	O (s + n)	B (ø + v)	VE	TE (y + i)	AA (y + i)	VA (y + i)	R (y + i)	HO (y + i)	SF (y + i)	MR (y + i)	ST (y + i)	NT (y + i)	Ns (y + i)
Spilomena differens Blüthgen	39	◗														
S. curruca (Dahlbom)	40														◗	
S. enslini Blüthgen	41															
S. exspectata Valkeila	42															
S. troglodytes (v. d. Lind.)	43															
S. vagans Blüthgen	44							◖								
Mimesa equestris (Fabr.)	45	●		●	◑					●	◗	◗◖				
M. lutaria (Fabr.)	46	◗		●	◖					●	◖	●				
M. bruxellensis Bondroit	47															
M. rufa (Panz.)	48															
Psen ater (Olivier)	49															
Mimumesa unicolor (v. d. Lind.)	50															
M. littoralis (Bondroit)	51															
M. atratina (F. Morawitz)	52															
M. spooneri (Richards)	53															
M. dahlbomi (Wesmael)	54	◗			●						◗					
M. beaumonti (van Lith)	55															
Psenulus concolor (Dahlbom)	56	◗														
P. fuscipennis (Dahlbom)	57		◖													
P. pallipes (Panzer)	58	◖														
P. schencki (Tournier)	59	◗														
Cerceris rybyensis (L.)	60	◗		●	◑			◖								
C. arenaria (L.)	61	◑	◖		◑		◗	◖				◗				
C. quadrifasciata (Panzer)	62	◗		◖	◑	●			◑			◗				
C. quinquefasciata (Rossi)	63															
C. ruficornis (Fabr.)	64	◗										◗				
Philanthus triangulum (Fabr.)	65	○														
Argogorytes mystaceus (L.)	66	◗	◖	◗	◑				◖	◖	●	◗◖				◖
A. fargei (Shuckard)	67	●	◖	◗		●										
Gorytes quinquecinctus (Fabr.)	68															
G. laticinctus (Lep.)	69	◗			⊘			◑			◗	◗				
G. quadrifasciatus (Fabr.)	70	●	◖	◗	◑	●			◖			◗				
G. neglectus Handlirsch	71															
Dienoplus tumidus (Panzer)	72	◗							◖	◖						
D. lunatus (Dahlbom)	73			●							●					
Bembix rostrata (L.)	74															
Nysson spinosus (Forster)	75	◗		●		●◖			◖	◖	●					
N. interruptus (Fabr.)	76															

					FINLAND																				USSR		
	Nn (ø + v)	TR (y + i)	F (v + i)	F (n + ø)	Al	Ab	N	Ka	St	Ta	Sa	Oa	Tb	Sb	Kb	Om	Ok	Ob S	Ob N	Ks	LkW	LkE	Le	Li	Ib	Kr	Lr
39					●	●	●	●	●	●					●										●		
40							●			●	●						●								●		
41						●				●	●				●												
42						●			●	●																	
43													●														
44						●	●	●	●	●	●				●										●		
45		◖			●	●	●	●	●	●	●	●	●	●	●	●	●	●		●					●		
46	◖					●	●	●		●	●			●	●	●		●							●	●	
47							●																		●		
48											●									●					●	●	
49																											
50					●	●	●		●	●	●	●		●	●	●		●		●					●		
51							●	●	●		●					●		●							●		
52					●	●	●	●	●	●	●			●	●	●									●		
53							●								●	●											
54					●	●	●	●	●	●	●			●	●	●		●	●	●					●	●	
55						●	●			●					●												
56					●		●																				
57					●	●	●	●	●	●	●	●	●	●	●										●	●	
58						●	●	●		●	●			●	●										●	●	
59																											
60						●	●	●		●	●		●	●	●	●									●	●	
61						●	●	●	●	●	●			●	●	●									●	●	
62					●	●	●		●	●	●		●	●	●	●			●						●	●	
63																									●		
64						●	●	●			●		●	●	●										●	●	
65								●		●	●														●		
66					●	●	●	●		●	●	●	●	●	●		●	●		●					●	●	
67						●	●	●	●	●	●			●	●	●	●	●	●						●	●	
68						●	●			●	●															●	
69						●	●	●	●	●	●	●		●	●										●	●	
70					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●						●	●	
71																			●	●		●				●	●
72					●	●	●	●	●	●	●			●	●		●										
73						●	●	●			●			●	●	●	●	●							●	●	
74															●										●		
75					●	●	●	●		●	●	●		●	●		●			●					●	●	
76						●	●	●		●	●	●		●	●	●									●	●	

				DENMARK												
		N. Germany	G. Britain	SJ	EJ	WJ	NWJ	NEJ	F	LFM	SZ	NWZ	NEZ	B	Sk.	Bl.
Nysson trimaculatus (Rossi)	77	●	●										●		●	
N. niger Chevrier	78															
N. maculosus (Gmelin)	79	●		●	●		●	●	●	●		●	●		●	
N. tridens Gerstäcker	80	●		●	●					●			●		●	
N. dimidiatus Jurine	81	●	●	●	●		●			●	●	●	●		●	
N. mimulus Valkeila	82															
Didineis lunicornis (Fabr.)	83	●	●	●	●						●					
Alysson spinosus (Panz.)	84	●							●							
A. ratzeburgi Dahlbom	85															
Mellinus arvensis (L.)	86	●	●	●	●	●	●	●	●	●		●	●	●	●	●
M. crabronea (Thunberg)	87	●	●	●	●	●	●	●	●			●	●		●	
Astata boops (Schrank)	88	●	●												●	●
A. minor Kohl	89	●												●		
A. stigma (Panz.)	90	●						●							●	
A. pinguis (Dahlbom)	91	●	●		●	●	●	●	●			●	●	●	●	
Dinetus pictus (Fabr.)	92	●	●													
Tachysphex obscuripennis (Schenck)	93	●	●												●	
T. pompiliformis (Panz.)	94	●	●	●	●	●	●	●	●	●		●	●	●	●	●
T. fulvitarsis (Costa)	95	●													●	
T. nitidus (Spinola)	96	●	●		●	●	●	●	●			●	●	●	●	●
T. helveticus Kohl	97	●														●
Miscophus concolor Dahlbom	98	●	●		●	●		●					●		●	
M. spurius (Dahlbom)	99				●			●		●			●		●	
M. ater Lep.	100	●	●		●	●	●	●	●					●	●	
M. niger Dahlbom	101														●	
Nitela borealis Valkeila	102												●		●	
N. spinolae Latr.	103														●	●
Trypoxylon clavicerum Lep.	104	●	●		●			●	●			●	●		●	●
T. attenuatum Smith	105	●	●		●	●	●	●	●			●	●	●	●	
T. figulus (L.)	106	●	●	●	●	●	●	●	●	●		●	●		●	●
Belomicrus borealis Forsius	107															
Oxybelus lineatus (Fabr.)	108	●			●											
O. argentatus Curtis	109	●	●	●	●	●	●	●	●	●		●	●	●	●	
O. mandibularis Dahlbom	110	●	●	●	●	●	●	●				●	●		●	
O. latidens Gerst.	111	●			●								●			
O. uniglumis (L.)	112	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
O. bipunctatus Oliv.	113	●		●					●							
O. trispinosus (Fabr.)	114	●									●	●			●	

	Hall.	Sm.	Öl.	Gtl.	G. Sand.	Ög.	Vg.	Boh.	Dlsl.	Nrk.	Sdm.	Upl.	Vstm.	Vrm.	Dlr.	Gstr.	Hls.	Med.	Hrj.	Jmt.	Ang.	Vb.	Nb.	Ås. Lpm.	Ly. Lpm.	P. Lpm.	Lu. Lpm.	T. Lpm.
77	●	●	●			●	●	●		●		●		●		●												
78				●																								
79			●	●								●				●												
80																												
81		●	●	●		●	●			●	●	●				●												
82																●		●										
83																												
84																												
85		●		●		●				●	●			●	●			●				●			●			
86	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●										
87	●	●	●			●	●	●		●				●														
88	●	●	●	●	●	●	●		●	●	●	●		●	●	●												
89		●	●	●																								
90			●	●		●				●													●					
91	●	●	●	●	●			●		●	●	●		●	●	●		●					●				●	
92																												
93	●	●	●	●		●	●	●			●	●		●														
94	●	●	●	●		●	●	●	●	●	●	●			●	●	●	●		●		●	●					
95			●																									
96	●	●	●	●	●			●							●								●					
97				●		●		●			●																	
98		●	●	●	●						●																	
99	●	●	●			●										●		●										
100	●		●																									
101				●	●		●				●																	
102		●		●	●	●	●			●		●	●	●		●						●						
103			●	●		●	●			●		●	●		●													
104	●	●	●			●	●	●			●	●	●	●	●					●								
105		●	●	●	●	●	●	●		●	●	●				●												
106		●	●	●		●	●	●		●	●	●	●	●	●	●	●		●	●		●			●		●	
107												●			●	●												
108																												
109	●	●	●	●				●																				
110	●	●	●	●	●	●															●							
111																												
112	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●		●	●	●	●					
113																												
114		●		●		●																						

		NORWAY														
		Ø + AK	HE (s + n)	O (s + n)	B (ø + v)	VE	TE (y + i)	AA (y + i)	VA (y + i)	R (y + i)	HO (y + i)	SF (y + i)	MR (y + i)	ST (y + i)	NT (y + i)	Ns (y + i)
Nysson trimaculatus (Rossi)	77	◗				●		◖								
N. niger Chevrier	78															
N. maculosus (Gmelin)	79															
N. tridens Gerstäcker	80															
N. dimidiatus Jurine	81	◗		◗												
N. mimulus Valkeila	82															
Didineis lunicornis (Fabr.)	83															
Alysson spinosus (Panz.)	84															
A. ratzeburgi Dahlbom	85	◗														
Mellinus arvensis (L.)	86	●	◖	●	◐	●		◖	◖	●	●	●	◖			
M. crabronea (Thunberg)	87	◗				●										
Astata boops (Schrank)	88	◗					◖									
A. minor Kohl	89															
A. stigma (Panz.)	90					●			◗							
A. pinguis (Dahlbom)	91								◗							
Dinetus pictus (Fabr.)	92															
Tachysphex obscuripennis (Schenck)	93															
T. pompiliformis (Panz.)	94	◗		◗				◖		◗	●					
T. fulvitarsis (Costa)	95															
T. nitidus (Spinola)	96															
T. helveticus Kohl	97															
Miscophus concolor Dahlbom	98															
M. spurius (Dahlbom)	99															
M. ater Lep.	100															
M. niger Dahlbom	101															
Nitela borealis Valkeila	102	◗														
N. spinolae Latr.	103															
Trypoxylon clavicerum Lep.	104	●								◗	◗	◗				
T. attenuatum Smith	105	◗														
T. figulus (L.)	106	◗		◖	●			◖			◗	◗				
Belomicrus borealis Forsius	107															
Oxybelus lineatus (Fabr.)	108															
O. argentatus Curtis	109															
O. mandibularis Dahlbom	110															
O. latidens Gerst.	111					●										
O. uniglumis (L.)	112	●	◐	◗	●		◖	◖	◖	◖	◗					
O. bipunctatus Oliv.	113															
O. trispinosus (Fabr.)	114															

					FINLAND																			USSR		
	Nn (ø + v)	TR (y + i)	F (v + i)	F (n + ø)	Al	Ab	N	Ka	St	Ta	Sa	Oa	Tb	Sb	Kb	Om	Ok	Ob S	Ob N	Ks	LkW	LkE	Le	Li	Ib	Kr	Lr
77																											
78					●	●	●	●	●	●	●		●	●	●										●	●	
79											●														●	●	
80																											
81						●	●			●	●			●	●	●	●		●								
82					●	●	●			●	●	◐		●	●												
83																											
84																											
85					●				●	●	●				●	●	●	●	●	●				●	●	●	●
86					●	●	●	●	●	●	●		●	●	●										●	●	
87							●																		●	●	
88					●	●	●	●	●	●	●	●		●	●	●									●		
89						●	●	●		●	●														●	●	
90						●	●	●							●	●		●	●						●		
91					●	●	●	●	●	●	●			●	●		●	●									
92											●														●		
93						●	●	●	●	●	●			●	●										●	●	
94					●	●	●	●	●	●	●	●		●	●	●	●	●	●						●	●	
95																											
96					●	●	●	●	●	●	●			●	●	●		●	●	●					●		
97					●	●	●	●																			
98						●	●	●		●	●			●	●	●	●								●	●	
99						●	●	●		●	●			●	●	●	●	●							●	●	
100						●	●	●								●	●	●							●		
101					●	●	●	●		●	●			●	●	●	●	●	●						●	●	
102					●	●	●	●	●	●		●		●	●	●	●								●	●	
103																											
104					●	●	●	●		●	●			●	●												
105					●	●	●	●	●	●	●			●	●	●									●		
106		◐		◐	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●	
107						●				●	●														●		
108																											
109						●	●		●																●	●	
110						●	●	●		●	●		●	●	●	●		●							●	●	
111																											
112					●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●				●	●	
113						●	●	●		●	●			●	●										●	●	
114																											

				DENMARK													
		N. Germany	G. Britain	SJ	EJ	WJ	NWJ	NEJ	F	LFM	SZ	NWZ	NEZ	B	Sk.	Bl.
Crabro cribrarius (L.)	115	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
C. peltarius (Schreber)	116	●	●	●	●	●	●	●	●			●	●	●	●	●
C. scutellatus (Scheven)	117	●	●		●										●	
C. ingricus (F. Morawitz)	118															
C. lapponicus Zett.	119															
C. maeklini A. Morawitz	120															
Ectemnius fossorius (L.)	121	●														
E. cephalotes (Oliv.)	122	●	●						●		●		●		●	
E. lituratus (Panz.)	123	●	●						●	●						
E. sexcinctus (Fabr.)	124	●	●	●	●				●	●			●		●	
E. cavifrons (Thomson)	125	●	●	●	●	●	●	●	●	●		●	●	●	●	●
E. ruficornis (Zett.)	126	●	●		●	●			●	●		●	●	●	●	●
E. lapidarius (Panz.)	127	●	●	●	●					●		●	●		●	●
E. continuus (Fabr.)	128	●	●	●	●	●	●	●	●	●		●	●	●	●	●
E. rubicola (Duf. & Perris)	129	●	●													
E. dives (Lep. & Br.)	130	●	●												●	
E. guttatus (v. d. Lind.)	131	●													●	
E. borealis (Zett.)	132	●	●		●				●	●	●		●		●	
Lestica subterranea (Fabr.)	133	●		●	●	●	●					●	●		●	●
L. alata (Panz.)	134	●														
L. clypeata (Schreber)	135		●							●					●	
Entomognathus brevis (v. d. Lind.)	136	●	●	●	●	●	●	●	●	●		●	●	●	●	
Lindenius albilabris (Fabr.)	137	●	●	●	●	●	●	●	●	●		●	●	●	●	●
L. panzeri (v. d. Lind.)	138	●	●	●	●				●			●	●			
Rhopalum clavipes (L.)	139	●	●	●	●	●	●		●	●		●	●	●	●	
R. coarctatum (Scop.)	140	●	●	●	●		●		●	●		●	●	●	●	●
R. nigrinum (Kiesenwetter)	141	●	●		●	●									●	
Crossocerus quadrimaculatus (Fabr.)	142	●	●	●	●	●	●	●	●	●		●	●	●	●	●
C. ovalis Lep. & Br.	143	●	●	●	●							●	●	●	●	
C. pusillus Lep. & Br.	144	●	●	●	●	●		●		●		●	●		●	
C. tarsatus (Shuckard)	145	●	●	●	●	●	●	●	●		●		●		●	
C. elongatulus (v. d. Lind.)	146	●	●	●	●	●		●	●			●	●	●	●	
C. wesmaeli (v. d. Lind.)	147	●	●	●	●	●	●	●	●	●			●	●	●	
C. lundbladi (Kjellander)	148															
C. imitans (Kohl)	149	●				●										
C. distinguendus (A. Morawitz)	150	●		●	●	●		●	●		●	●	●		●	●
C. denticrus Herrich-Schäffer	151			●											●	
C. exiguus (v. d. Lind.)	152	●	●													

	Hall.	Sm.	Öl.	Gtl.	G. Sand.	Ög.	Vg.	Boh.	Dlsl.	Nrk.	Sdm.	Upl.	Vstm.	Vrm.	Dlr.	Gstr.	Hls.	Med.	Hrj.	Jmt.	Ång.	Vb.	Nb.	Ås. Lpm.	Ly. Lpm.	P. Lpm.	Lu. Lpm.	T. Lpm.
115	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		●	●							
116	●	●	●	●	●	●	●	●		●	●	●		●	●	●		●		●	●	●	●					
117		●	●	●		●	●			●		●		●		●												
118																												
119											●				●	●	●	●	●	●		●	●	●	●			●
120																												●
121		●				●		●		●	●	●			●	●				●	●							
122		●	●	●		●	●	●		●	●	●	●	●	●	●												
123																												
124																												
125	●	●	●	●		●		●		●	●	●	●	●	●	●												
126	●	●	●	●		●		●	●	●	●	●		●	●	●	●			●	●		●	●	●		●	●
127	●	●	●	●		●	●	●		●	●	●		●	●	●	●				●	●						
128	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●		●		●	●	●	●				●	●
129		●	●	●		●	●				●	●				●												
130	●	●	●	●		●	●			●	●	●		●	●	●												
131	●	●	●	●		●	●			●	●	●		●	●	●						●						
132	●	●	●	●		●	●	●		●		●		●	●	●	●	●	●	●	●	●	●	●	●		●	●
133		●	●	●		●		●	●	●	●	●		●	●	●	●	●				●	●					
134							●																					
135						●				●		●			●	●												
136	●	●	●	●		●	●	●	●	●	●	●		●	●													
137	●	●	●	●		●	●	●	●	●	●	●		●	●	●	●	●										
138																												
139		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●		●						
140		●	●	●		●	●	●		●	●	●			●	●	●			●					●		●	
141						●				●		●																
142	●	●	●			●	●			●	●	●				●												
143		●	●			●	●	●		●		●		●	●	●						●			●			●
144	●	●	●	●	●	●	●			●	●	●		●	●	●					●							
145	●	●	●	●		●	●	●	●	●	●	●		●	●	●												
146	●	●	●	●		●		●		●	●	●		●	●	●											●	
147	●	●	●	●	●					●					●								●		●		●	
148																			●			●						
149																												
150		●	●	●		●				●						●					●							
151																												
152																												

		NORWAY															
		Ø + AK	HE (s + n)	O (s + n)	B (ø + v)	VE	TE (y + i)	AA (y + i)	VA (y + i)	R (y + i)	HO (y + i)	SF (y + i)	MR (y + i)	ST (y + i)	NT (y + i)	Ns (y + i)
Crabro cribrarius (L.)	115	●		●	◐	●		◖	◖	●	●	◗	◖			
C. peltarius (Schreber)	116		◖		◖			◖	◖	◖						
C. scutellatus (Scheven)	117	◗			◐											
C. ingricus (F. Morawitz)	118															
C. lapponicus Zett.	119				◖		◗			◗	◗			◗		●
C. maeklini A. Morawitz	120															
Ectemnius fossorius (L.)	121	◗														
E. cephalotes (Oliv.)	122	◑			◖											
E. lituratus (Panz.)	123															
E. sexcinctus (Fabr.)	124															
E. cavifrons (Thomson)	125	●							◖	●	◗					
E. ruficornis (Zett.)	126	◗	●	◗	◗						●	◗				◗
E. lapidarius (Panz.)	127	◗	◖		◐	●	◖			◗	●	●				◗
E. continuus (Fabr.)	128	●	◖	◖	◐	●	◖	◖	◖		●	◗	◖			
E. rubicola (Duf. & Perris)	129	◗		◖	◖	●										
E. dives (Lep. & Br.)	130	◗														
E. guttatus (v. d. Lind.)	131	◗		◗					◖							
E. borealis (Zett.)	132	◗	●	◖	◖											●
Lestica subterranea (Fabr.)	133							◖				◗				
L. alata (Panz.)	134															
L. clypeata (Schreber)	135															
Entomognathus brevis (v. d. Lind.)	136	◗		◗												
Lindenius albilabris (Fabr.)	137	●		◖				◖			◗					
L. panzeri (v. d. Lind.)	138															
Rhopalum clavipes (L.)	139	◗	◗						◖	●	●					
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C. pusillus Lep. & Br.	144	●	◗	●	◖		◖			●	●	◗	◖	◗		
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					FINLAND																			USSR		
	Nn (ø + v)	TR (y + i)	F (v + i)	F (n + ø)	Al	Ab	N	Ka	St	Ta	Sa	Oa	Tb	Sb	Kb	Om	Ok	Ob S	Ob N	Ks	LkW	LkE	Le	Li	Ib	Kr	Lr
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				DENMARK												
		N. Germany	G. Britain	SJ	EJ	WJ	NWJ	NEJ	F	LFM	SZ	NWZ	NEZ	B	Sk.	Bl.
Crossocerus palmipes (L.)	153	●		●	●	●			●	●			●		●	●
C. podagricus (v. d. Lind.)	154	●	●	●	●				●	●		●	●		●	
C. congener (Dahlbom)	155															
C. assimilis (Smith)	156															
C. walkeri (Shuckard)	157	●	●		●								●		●	
C. annulipes (Lep. & Br.)	158	●	●		●	●		●				●	●		●	
C. heydeni Kohl	159															
C. styrius (Kohl)	160		●													
C. barbipes (Dahlbom)	161	●														●
C. leucostomus (L.)	162	●	●	●	●		●						●		●	
C. cetratus (Shuckard)	163	●	●										●		●	
C. nigritus (Lep. & Bl.)	164	●	●	●	●							●	●		●	●
C. megacephalus (Rossi)	165	●	●		●		●	●	●	●		●	●		●	
C. cinxius (Dahlbom)	166	●														
C. capitosus (Shuckard)	167	●	●	●	●		●						●		●	
C. vagabundus (Panzer)	168	●	●		●				●		●	●	●	●	●	●
C. dimidiatus (Fabr.)	169	●	●	●	●	●		●			●	●	●		●	●
C. binotatus Lep. & Br.	170	●	●	●	●				●	●		●	●			
C. subulatus Dahlbom	171							●					●		●	●

	Hall.	Sm.	Öl.	Gtl.	G. Sand.	Ög.	Vg.	Boh.	Dlsl.	Nrk.	Sdm.	Upl.	Vstm.	Vrm.	Dlr.	Gstr.	Hls.	Med.	Hrj.	Jmt.	Ång.	Vb.	Nb.	Ås. Lpm.	Ly. Lpm.	P. Lpm.	Lu. Lpm.	T. Lpm.
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167		●	●	●			●	●		●	●	●			●	●												
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170	●	●								●		●																
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		NORWAY															
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C. congener (Dahlbom)	155															
C. assimilis (Smith)	156	◗														
C. walkeri (Shuckard)	157															
C. annulipes (Lep. & Br.)	158	◗														
C. heydeni Kohl	159															
C. styrius (Kohl)	160							◖								
C. barbipes (Dahlbom)	161	◗			◖											◗
C. leucostomus (L.)	162	◗			D				◖		●					
C. cetratus (Shuckard)	163										◗	◗				
C. nigritus (Lep. & Br.)	164		●		◖						◗					
C. megacephalus (Rossi)	165	◗				●					●					
C. cinxius (Dahlbom)	166			◗											◗	
C. capitosus (Shuckard)	167	◗									◗					
C. vagabundus (Panzer)	168	◗						◖			◗					
C. dimidiatus (Fabr.)	169	●		●	◗	●			◖	●	●	◗				●
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Nye arter																
Dolichurus bicolor Lep. 1845	1b															
Spilomena beata Blüthg.	42b															

					FINLAND																				USSR		
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171					●	●	●	●		●	●																
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58. Psenulus pallipes. Ø, Dypeklo, Onsøv, 1 ♀, 7.vii.1958 (A. Løken). New to Norway.

143. Crossocerus ovalis. Nsi, Saltdal, Vensmoen, 2 ♀, 8.viii.1955 (A. Løken).

160. Crossocerus styrius. AAy, Birkenes, 2 ♂, 4.v.1961 (A. Bakke). New to Norway.

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