BEES OF THE FAMILY HALICTIDAE (excluding Sphecodes) OF POLAND

taxonomy
ecology
bionomics

Yu. A. Pesenko, J. Banaszak, V. G. Radchenko & T. Cierzniak

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Preface

The Halictidae is one of the greatest bee families, both in terms of species richness, and in those of individual abundance. Density of halictid populations is especially high in steppes and deserts. Halictids are also remarkable in that many members of the family live in colonies (families).

Until presently the information on Polish halictids has been very scanty and partly questionable. The list of Polish bees compiled by BANASZAK (1991a) included many species of the Halictidae, which were known only from literature, so their occurrence in Poland requires confirmation. The distribution of halictids in Poland was almost unknown. Sometimes it is a difficult task to distinguish one halictid species from another because of the great number of species and existence of only very subtle morphological differences between many of them. There was no key to the Polish halictids, so that Polish entomologists had to use partly obsolete and incomplete keys to the fauna of Central Europe (BLÜTHGEN, 1931a), to the fauna of Austria (EBMER, 1969-1974), to the fauna of the European part of Russia (OSYTSHNJUK et al. 1978), or modern but too large keys to the Palaearctic species created only for some relatively small genera or subgenera: Nomia s. l. (Warncke, 1976), *Dufourea* (EBMER, 1984c), *Halictus* subg. *Platyhalictus* (PESENKO, 1984d), *Halictus* subg. *Protohalictus* (PESENKO, 1984b), *Halictus* subg. *Monilapis* (PESENKO, 1985), *Rophites* (EBMER & SCHWAMMBERGER, 1986), *Halictus* subg. *Tytthalictus* (PESENKO, 1986b), *Lasioglossum* (PESENKO, 1986a; only to females), and *Seladonia* (EBMER, 1988a).

The main objectives of this study has been (1) to assess the Polish fauna of halictids and their distribution within the country; (2) to describe the zoogeographical status of the Polish halictid fauna against the background of the European and the Palaearctic faunas; (3) to create illustrated keys for identification of Polish halictids based on the up-to-date knowledge of the morphology, taxonomy and phylogeny of bees; (4) to establish the trophic relationships of halictid bees with flower plants, their biotopic preferences, abundance and phenology.

Except for the Apidae, the Halictidae are the only family including social bees. Moreover, only among halictids there are colonies with different levels of eusociality: from small unstable colonies without caste differentiation to highly organised, annual and even perennial colonies composed of many hundred individuals, with a complex caste system and parent manipulation. After the issue of the monographs by SAKAGAMI & MICHENER (1962) and MICHENER (1974) no surveys on the bionomics of Halictidae were published in the world, with the only exception of the book '*The biology of bees*' by RADCHENKO & PESENKO (1994), published in

Russian and therefore hardly available. For this reason an analytical review of the subject is made.

The comprehensive investigation conceived naturally implied participation of specialists of several profiles. The internationality of the authors' collective is explained by extreme rarity of specialists in the fields of the taxonomy and biology of bees in Europe. Dr Yuriy A. PESENKO works in the Zoological Institute of the Russian Academy of Sciences (St. Petersburg), Dr Vladimir G. RADCHENKO in the Institute of Zoology of the National Academy of Sciences (Kiev, Ukraine), Prof. Józef BANASZAK and Dr Tomasz CIERZNIAK in the Institute of Biology and Environment Protection of Pedagogical University in Bydgoszcz (Poland). Contributions of authors to the work are as follows. PESENKO has determined halictids in the major bee collections of Poland (in total about 12, 000 specimens), written keys and other taxonomic texts, and made all morphological figures (excepting 12 figures reproduced from papers by MICHENER and EBMER). RADCHENKO has written the texts on the biology. BANASZAK and CIERZNIAK have created the database of Polish halictids and written the texts on distribution and ecology of halictids in Poland.

In contrast to "The key for identification of Polish insects. Bees of the family Halictidae" (PESENKO, BANASZAK & CIERZNIAK, in preparation) being printed in Polish, in this book the keys to species for females and males are made combined. Such a form of keys gives more possibilities of recognition of natural species-groups. The authors hope that this book, especially due to its Chapter II containing an analytical review of the taxonomy and biology of the Halictidae, can be of interest not only to Polish entomologists.

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Abstract

The morphology of the Halictidae is described, and some terms are discussed. A synopsis of classification this family is given. Phylogenetic relationships between its members are shown. An analytical account of bionomics of halictids is made, including different kinds of social life. On the basis of the study of the main entomological collections of institutions as well as private ones and original materials, the Polish fauna of non-parasitic halictids is established. It includes 81 species belonging to 10 genera: *Dufourea* (4 species), *Rhophitoides* (1), *Rophites* (3), *Systropha* (2), *Nomiapis* (2), *Nomioides* (1), *Halictus* (6), *Seladonia* (6), *Lasioglossum* (13), *Evylaeus* (43). Three species are recorded for the Polish fauna for the first time: *Seladonia gavarnica* (PÉREZ), *Evylaeus marginellus* (SCHENCK), and *E. obscuratus* (MORAWITZ). The occurrence in Poland of the following rare species is corroborated by new materials: *Dufourea halictula* (NYLANDER), *Rophites algirus* PÉREZ, *R. hartmanni* FRIESE, *N. femoralis* (PALLAS), *Seladonia semitecta* (MORAWITZ), *Lasioglossum prasinum* (SMITH), *Evylaeus brevicornis* (SCHENCK), *E. convexiusculus* (SCHENCK), *E. cupromicans* (PÉREZ), *E. glabriusculus* (MORAWITZ), *E. euboeensis* (STRAND), *E. intermedius* (SCHENCK), *E. limbellus* (MORAWITZ), *E. minutulus* (SCHENCK), *E. nigripes* (LEPELETIER), *E. nitidulus* (FABRICIUS), *E. quadrisignatus* (SCHENCK), *E. semilucens* (ALFKEN), *E. setulellus* (STRAND), *E. setulosus* (STRAND), *E. tarsatus* (SCHENCK), *E. tricinctus* (SCHENCK). All species recorded from Poland and also 14 species that may be found in Poland (rather in its south-eastern part), are characterised in this book in distributional, ecological and bionomical aspects. The distribution of halictids within the country is mapped and analysed. The zoogeographical status of the Polish halictid fauna against the background of the European and the Palaearctic faunas is described. Trophic links of halictid bees with flower plants, their biotopic preferences, abundance and phenology in Poland are presented. Original illustrated keys for identification of Polish halictids have been created. The book contains the following chapters: I. Introduction, II. General characteristics of halictid bees, III. Study on halictids in Poland, IV. Halictid fauna of Poland: illustrated keys, characteristics of taxa. The bibliography includes 824 titles. The book is illustrated by 596 figures.

Chapter I
Introduction: on bees and terms

Bees (subfamily Apoidea): general characteristics

Origin, position in the system. The bees (Apoidea) belong to stinging hymenopterous insects (Aculeata) and are one of the largest superfamilies of order Hymenoptera. The bees are derivatives of sphecid wasps (Sphecoidea), from which they, besides feeding of larvae by a plant food (pollen and nectar), differ by availability of a various structure of a vehicle of hairs for pollen collecting and transportation (so named scopa), details of the structure of proboscis (labiomaxillary complex) and flattened metabasitarsus (the first segment of the tarsus of hind legs). The latter bears a special brush for brush off pollen grains from a body and formation of them in "loads".

The time of appearance of bees in geological chronology remains under a question. The majority of the authors agree with opinion, that the bees have arisen in the Upper Cretaceous. It coincides with a time of flourishing of the angiosperm, pollen and honey from flowers of which are a food for imagoes and larvae of bees. The dating of the Upper Cretaceous as a time of appearance of bees does not contradict also palaeontological data – the earliest finds of fossil bees are dated by Eocene. It is necessary to underline that all known fossil bees, mainly described as inclusions in the amber pieces of Oligocene and Eocene ages) belong to recent families, and majority of them to recent tribes and even to genera.

The genuine scientific sensational event appeared with the description of *Trigona* (*Trigona*) *prisca* from the Upper Cretaceous amber in the state New Jersey (USA), having 80 millions years age (MICHENER & GRIMALDI, 1988a; GRIMALDI et all., 1989). As has turned out, the *T. prisca* is very similar to *T. cilipes*, a species which at present is widespread in tropical America. The fact, that such an old fossil bee belongs not only to a recent genus and subgenus of the subfamily Meliponinae, higher bees with advanced social life, but also to one of advanced groups of this subfamily, in principle should result an revision of former sights on a time of origin and earlier evolution of bees, essentially having increased the age of Apoidea, probably, up to 130 millions years (Lower Cretaceous) (MICHENER & GRIMALDI, 1988a, 1988b). However, later MICHENER (in RASNITSYN & MICHENER, 1991) noted that the age of this amber needs verification. Moreover, RASNITSYN in the paper cited above supposed that this fossil should be belonged to the late Eocene.

Diversity, composition and distribution. At present there are not less than 21 thousand currently recognised species of bees belonging to 520 genera of nine families (ALEXANDER & MICHENER, 1995): Colletidae, Stenotritidae, Andrenidae, Halictidae, Melittidae, Dasypodidae, Meganomiidae, Megachilidae, and Apidae. The bees are relatively well investigated insects. It is possible to believe that the number of undescribed species is not more than 20% of known species, and the increase is expected in the main owing to the tropics.

The bees make up an appreciable element of the earth-bound biota. They are found overland actually everywhere, where entomophilous plants are available, i.e. up to a zone of eternal ice in prepolar regions and up to the line of snow in highlands. So, the bumble bees (genus *Bombus*) as the most cold-resistant group of bees are penetrate to the north up to 82° 30' N. in Canada (the Island Elsmira, Alert) and 81° 50' in Greenland (cape Schmelke), in Himalayas at height 5000 m are discovered.

The taxonomic diversity of the bee fauna is the highest in the Neotropical region (315 genera and subgenera, 43 tribes and taxa of a higher category, not divided into tribes). The Nearctic (accordingly 260 and 40) and Palaearctic (243 and 36) faunas are poorer. The least number of tribes (18) is recorded from the Australian region. The diversity of tropical bee faunas on superspecific level in comparison with faunas of temperate zones shaded by that fact that many taxa, e.g. richly represented in tropics, only hardly penetrate in the southern parts of the temperate zoogeographical regions, but are also taken into account under calculating. Especially vastly it is showed in the number of bee families, recorded from each of zoogeographical regions. For example, the Afrotropical subfamily Fideliinae is represented in the Palaearctic region only by a single species inhabiting in Morocco; the Palaeotropical tribe Allodapini by two species occurring in the Middle East and Asia Minor. The opposite cases are relatively rare: the Andrenidae, Rophitinae and Bombini are mostly Holarctic in occurrence.

The comparison of regional and local faunas on the species level shows another picture. On this level, the bees distinctly display themselves as predominant inhabitants of arid and semiarid areas in temperate and subtropical zones. The richest bee fauna is discovered in the American State of California (1985 species), Mediterranean basin (not less than 1700 species) and Central Asia (above 1500 species). These numbers of species are comparable with the number of species in Australia as whole (1618 species; MICHENER, 1965a; CARDALE, 1993) and, for example, in 2.0-2.5 times more than in very well investigated Central Europe (716 species; WARNCKE, 1986). The bees mainly adapted to the dry warm territories. This is distinctly displayed in theirs very high abundance in steppes and savannahs by both the number of individuals (up to 20 thousand bees/ha) and by the number of species.

The bee faunas of the Old and New World are approximately equivalent in the number of species, genera and suprageneric taxa, but each of them has many specific features. For example, the family Stenotritidae, subfamilies Euryglossinae and Apinae (natural range), tribes Nomioidini, Promelittini, Sambini, Pararhophitini, Ancylini, Ammobatoidini and Allodapini inhabit only the East Hemisphere. Not less taxa of the bees of suprageneric level are limited in distribution by the New World: the subfamilies Diphaglossinae, Xeromelissinae, Oxaeinae, and Euglossini and 16 tribes (Augochlorini of the family Halictidae and 14 tribes of the family Apidae). The considered faunas are still more distinctive on the generic and, especially, on specific levels.

There are only thirty Holarctic species: *Hylaeus bisinuatus* (apparently delivered from Europe to district Fargo, North Dakota, before 1912), *Andrena clarkella, A. wilkella* (probably delivered to America from Europe), *Halictus rubicundus, Seladonia confusa, Lasioglossum leucozonium, L. zonulum, Evylaeus rufitarsis, Anthidium manicatum* (relatively recently come to North America from Europe and occurring now very limited area in the State of New York; delivered also to Argentina, Brazil and Uruguay), *Hoplitis anthocopoides* (relatively recently come to America from Europe and occurring now only in some localities in the State of New York), *H robusta, Chelostoma campanularum, Ch. fuliginosum* (both species relatively recently come to America from Europe, and recorded only from a number of localities in the State of New York), *Osmia bucephala, O. coerulescens, O. cornifrons* (purposefully introduced from Japan to Utah in 1965 for pollination of fruit-trees), *O. inermis, O. nigriventris, Lithurgus chrysurus* (recently delivered to New Jersey, apparently from the Mediterranean basin), *Megachile apicalis* (rather accidentally delivered from Europe), *M. centuncularis, M. concinna* (rather delivered in the beginning of XIX to West Indies whence, after 1945, penetrated into North America, where it is widespread), *M. rotundata* (delivered accidentally to North America from Europe in 1940-50th and subsequently in 1970th introduced to Argentina and Chile as pollinator of alfalfa), *Chalicodoma lanata* (relatively recently delivered to West Indies from Europe, whence penetrated into southern Florida), *Clisodon furcatus, Ceratina dallatorreana* (introduced into California from South Europe), *Bombus lucorum, B. balteatus, B. hyperboreus, B. polaris, Apis mellifera*. Hense, most species of bees, inhabiting at present both the Palaearctic and Nearctic regions, were accidentally delivered to North America from Europe within various building and other materials during the last 100 years. The list of the Holarctic species, probably, will soon be increased owing to some North-American species of the genus *Coelioxys* delivered from Canada to Europe in 1980th together with consignments of cells of *Megachile rotundata*.

Life history. In their mode of life the bees are divided into three main groups: solitary, social and cleptoparasitic. For rearing of their brood non-parasitic bees build nests, as a rule containing cells in which females store forage for larvae. The preimaginal development of the brood till the emergence of the imago runs within the cells. Similarly to other hymenopterous insects, bees exhibit haplodiploid mechanism of sex determination, or arrhenotokic parthenogenesis: males emerge from unfertilised (haploid) eggs, females from fertilised (diploid) ones. As an exception, some bees develop in the manner called thelytokic parthenogenesis, i.e. in complete absence of males: the Nearctic populations of *Ceratina dallatorreana*, *C. acantha*, the Japanese *Nomada japonica*. As well, one of races of the honey bee, *Apis mellifera capensis*, exhibits thelytokic reproduction in the presence of males. Another type of sex determination, called diplotetraploidy, has been discovered in some stingless bees.

Fertilisation of the egg occurs during its movement inside the ovariotube immediately before it is laid. Thus the female undoubtedly has the ability of controlling the sex of the brood, since sexual dimorphism is typical of the majority of species, so that an egg of either sex can be laid depending on the amount of forage available. New-laid eggs of bees vary in form from strongly curved up to almost straight. However, till the conclusion of embryo development bent eggs usually become more or less straightened. Eggs of many cleptoparasitic bees have unusual forms. Depending on the body size, the length of eggs varies from 1 mm in *Nomioides* up to 9-10 mm in *Chalicodoma pluto* and great species of *Xylocopa*.

The duration of the egg phase varies considerably in different species of bees from 1.7 days in *Megachile rotundata* up to 21-35 days in *Colletes cunicularius*. The duration of egg development as well as of all preimaginal phases depends on the temperature. In bees, as well as in other Apocrita, the embryo develops through the dorsal surface of egg yolk and leaves the egg as a larva of the first instar. After hatching, larvae of the most of non-parasitic bee species are immovable. The hind end of their body during the first two or three instars remains fixed in the same place. For all the time larvae are eating their forage from one side of the pollen ball. As they grow, larvae become C-shaped, and curl up into a ring that provides for them the best access to forage. By the end of feeding larvae usually more or less straighten, but there are some exceptions. For instance, larvae of *Systropha planidens* and *S. curvicornis* after hatching from eggs crawl downward to lie under the pollen ball and bend around its base with the ventral part of their body. After this, larvae begin feeding. The larval body has projections, which promote moving around pollen ball. From this moment on, the larva is being increased in size and is still more curved around the pollen ball; in result the last is wholly lying on its body and does not already contact the cell walls. In other bee species nesting in soil but not covering the cell walls with secreted lining larvae also demonstrate high mobility, such are halictids *Rhophitoides canus* and *Rophites hartmanni*, as well as some dasypodines. Unusual mobility is characteristic of the larvae of parasitic bees, since at once after hatching they normally must reach and destroy the host egg or young larva with the help of great elongated mandibles, which they have in the first instar.

Most bees have four larval instars, although five instars are observed in *Hylaeus*, *Stelis*, *Lanthanomelissa*, *Trigona*, some *Nomia* and *Exomalopsis*. During the first instars, the larva feeds slowly and only on reaching the last one it consumes the major part of the forage, sharply increasing in size. Larvae of most bees normally eat up the entire forage storage in one to three weeks. The longest duration of larval development, 60 days and more, is recorded for *Braunsapis sauteriella* and *Colletes cunicularius*. Usually a bee larva defecates after the finish of nutrition. However, in some groups of bees, e.g. in the Megachilidae and Anthophorinae, larvae begin excreting feces in the third or at once after reaching the fourth instar. In such cases, the excrement is placed at the part of the cell opposite to the location of food. Excrements of larvae of different species vary in its shape and size. It can have the form of small balls, small sausages, strips etc.

Larvae of many bees spin cocoons of different structure and form using a secret produced by salivary glands. Cocoon spinning is usually done in those species, females of which do not make secreted lining of cells. In their structure, cocoons of different species vary from thin translucent parchment-like to very thick multilayered ones. Besides inter-species differences, the density of cocoons depends upon the amount and quality of food eaten by larvae. The shape of the cocoon usually corresponds to that of the cell, but cocoons of some bees have a nipple-shaped appendix or other structural peculiarities.

Depending on the phenology of bees, the development of preimaginal phases goes either without delay, then the young brood emerges in the same season, or with diapause, usually for the period of unfavourable weather conditions (for the winter in temperate zones; usually for the rainy period in tropics). Most bees pass diapause at prepupa or pupa phase. Some early spring species fall into winter diapause being imagoes and do not leave their cells. Females of social and solitary Halictinae and Xylocopinae usually hibernate after their exit from cells.

The most of solitary bees are proterandric, i.e. their males emerge earlier than females, usually by several days. Young females of non-parasitic bees have underdeveloped ovaries, which reach the normal size only after a certain period (usually four or five days) of consuming pollen and honey. As a rule, females copulate the first days after their emergence. Copulations occur at various places: on flowers, on stems and leaves of plants, on the ground, in flight, inside nests, etc. Behaviour of males of many species is ‘territorial’. Those males mark and then protect certain territories within which they copulate with females. In the capacity of a mark, males secrete a sexual pheromone, which serves as an attractant of females. In the time of patrolling males turn back other ones of the same species, and sometimes of other bees, including females.

Solitary bees inhabiting temperate zones are divided into two main phenological classes: (1) univoltine (including the following groups: early-spring species, spring-summer, summer, late summer species, and species that fly during a long period); (2) bi- and polyvoltine. In the Palaearctic region, more than half of solitary bee-species is univoltine. The class of bi- and polyvoltine species is characterised by loss of obligatory diapause. Most of social species of bees fly for all the season.

long, sometimes with short interruptions between the emergence of their brood. In tropical conditions many species fly for all the year round.

The females of solitary bees are usually active for no more than two months. During this time they construct one or several nests containing at the most 20-30 cells with the brood, then they die. The females of some subsocial species as well as a number of eusocial species can live two and more years. The maximal longevity is indicated for queens of *Evylaeus marginatus* – six years (PLATEAUX-QUÉNU, 1960), and one queen of *Apis mellifera* lived for seven years (DIETZ, 1982).

Nesting. According to the sites and the ways of nest construction, the bees can be divided into the following groups: (1) burrowing in soil, (2) gnawing within plants, (3) using natural cavities, (4) constructing nests on exposed surfaces (open sites). In many respects such a classification is arbitrary, as far as intermediate forms exist (species with plastic nesting).

The burrowing in soil is characteristic of the most of modern bee species, the same as it was typical of their ancestor (RADCHENKO & PESENKO, 1994a). The bees dig a nest loosening soil by mandibles and moving it by the front legs under mesosoma. In the process of excavation they periodically throw accumulated soil lump out from the nest to the surface making use of the middle legs and, partly, of the abdomen bent under the thorax. In some cases for softening very dense soil, the female brings water in its crop. Many species of bees prefer soil of a certain type and density. Essential importance for the choice of a place for nest construction is attached to the relief of ground surface, exposition of slopes, presence and density of vegetative cover, soil humidity and some other factors. Some species which usually dig the nests in soil can settle in clay or sandstone house walls.

It is possible to divide plant materials, in which the bees build their nests, into three groups: (1) rotten wood, which in its structure only insignificantly differs from soil; (2) rotten wood which has yet retained its fibrous structure and soft pithy stems of grassy and shrub plants; (3) dense wood (as a rule the trunks of dried trees). The first group of materials is prevalently used by many representatives of the tribe Augochlorini and some Halictini, e.g. *Evylaeus coeruleus*, and sometimes *Halictus rubicundus*. In soft plant stems, many of Hylaeinae, Megachilidae, Xylocopinae, *Clisodon* (Anthophorinae) and some Exomalopsini gnaw their nests. In dense wood, nests can be hollowed only by some *Xylocopa*, which are called 'carpenter bees'. They possess very powerful mandibles and have various thorn-like projections on their body, which provide strong fixation of the body in the course of hollowing out the nests.

The species that construct the nests in ready cavities exhibit a wide taxonomic variety. They include all of the investigated Xeromelissinae, Ctenoplectrini, the most of Megachilinae, many Hylaeinae and Apidae, some *Colletes* (Colletinae), Tetrapediini, Xylocopinae, and probably separate Exomalopsini. As cavities the bees use hollow burrows of larvae of xylophagous insects in woods, hollow stems of plants, hollows under tree barks, old empty nests of burrowing bees and wasps, cracks in stones, and other cavities in various materials.

Construction of nests on exposed surfaces is known only in the Megachilidae and Apidae. Such nests are placed on stones, stalks, and sometimes even on leafs of plants. Besides that, some of *Bombus* and Euglossinae place nests on the surface of ground. For construction they use strong materials resistant to adverse weather conditions. As for unusual sites of nest placement, it is necessary to note the settlements of *Chalicodoma pluto, Eufriesea laniventralis, Centris derasa,* and some representatives of subfamilies Meliponinae and Euglossinae inside the nests of termites. The bee *Trigona moorei* builds its nests in the nests of ants of the genus *Crematogaster*.

The majority of bees prefer to build the nests on open places well warmed by sun. However, separate species, for example *Osmia cornuta* and *O. rufa*, on the contrary, choose shadowed sites, in which they hide the nests from the sun. In result the sun does not heat up their nests in winter and does not provoke too early emergence of bees.

The nests of bees consist of the following basic elements: the entrance, the main burrow, the lateral, the blind burrow, the chamber and the cell. Each nest, as a rule, has only one *entrance*, although at separate species that build compound nests, e.g. *Evylaeus galpinsiae* (BOHART & YOUSEFF, 1976), sometimes there are two entrances, which lead to one main burrow. In burrowing bees near the nest entrance frequently there is a soil *tumulus* formed in the course of digging of burrows by female. The tumuli of each species usually have their specific form, size and disposition in relation to the nest entrance. Females of some species of Halictidae and Anthophorinae make *turrets* at the nest entrance. The bees often skilfully mask the nest entrance making it under fallen leaves, stones, and bushes or in thick grass, in cracks of ground, etc. Some species of burrowing bees, such as *Dieunomia triangulifera* (STEPHEN et al., 1969), constantly keep the nest entrance closed, whereas the majority of other bees close it only in the case of rain and for the night. On having completed the nest building, the bee seals the nest entrance with a *plug*. Such a plug, on the one hand, serves for putting a physical barrier against enemies, and on the other provides masking of the nest for all of the period of the brood development.

The *main burrow* is usually round in its cross-section; it goes from the substrate surface deep into the earth, and directly or through laterals connects the nest entrance with brood cells (see below). In their space orientation the main burrows are classified into *vertical*, *horizontal*, *inclined*, and *curved* types. The bends of the main burrow can be connected with specific features of nest architecture, and with necessity of bypassing stones and other dense inclusions in soil. The length of the main burrow in different species varies from 3 cm in some *Nomadopsis* up to 3 m in *Andrena haynesi* and some *Ctenocolletes*. Apart from the specific differences, its length depends on density of soil. The diameter of the main burrow in solitary bees is as a rule hardly more than the width of the body of the female foundress of the nest.

The *lateral burrow* presents an offshoot from the main burrow that conducts directly to a cell. Such burrows, found out in the nests of many burrowing bees, can begin at different levels of the main burrow or from its deeper end. Laterals are oriented perpendicularly or are inclined in relation to the main burrow and frequently have a smaller diameter. They have different length: from very great, in many instances exceeding the cell length (which is the case with the majority of burrowing bees), up to very little, less than that of the cell, e.g. in *Lasioglossum majus*. In the nests of the solitary bees each lateral remains open only for the period of cell construction and foraging. After oviposition and sealing the cell with a cap the bee fills the lateral burrow with soil, therefore during the nest construction there can be found only one lateral.

The *lower blind burrow* represents the utmost part of the main burrow, deprived of either laterals or cells. The presence of such a burrow is one of the characteristic features of nests of Halictinae (SAKAGAMI & MICHENER, 1962), although it is also described at some species from other groups. The blind burrow is of the same diameter as the main one. From the lower blind burrows the bees usually receive a material for construction of cells. Besides or instead of the lower blind burrow, some bees also make a *lateral blind burrow*.

In some species of burrowing bees, which arrange their cells in clusters the nest has a *chamber* surrounding the group of cells. Such a chamber is formed in result of digging around the cell clusters. While digging the chamber the bee leaves 1-2 small columns of soil, which support the group of cells. Sometimes cells have no contact with the walls of the chamber at all, and are in suspended position. In such a case, they hold owing to plant roots which pass through the cell clusters, which, for example, is recorded for *Halictus quadricinctus* (VERHOEFF, 1987). The construction of nest chambers is characteristic of a number of species of Halictinae and of some of Nomiinae, also it is observed at other taxa of bees.

The *cell* is a small cavity made by a bee for rearing the brood. As a rule, only one larva develops in each cell. The most of bee species do not use the same cells repeatedly. For cell building the bees use different materials: those of substrate, or secretory origin, or those brought into the nest from the outside. The substrate materials are used more often. Their utilisation is typical of the majority of species burrowing nests in soil or gnawing them in plants. As a rule, the substrate (soil or plant) is mechanically processed by the female, and is often covered with secretory lining. The majority of the Apinae, excepting Euglossini, use secreted building material – wax. As building (not simply lining) material the thick cellophane-like pellicle made by *Colletes*, Xeromelissinae, and many Hylaeinae, can also serve. The materials transported into the nest from the outside can be of mineral (soil, pebbles, stones), plant (pieces of leafs, petals, masticated plant mass, plant oils, resin, stem fibres, etc.), animal (hair, feathers, excrement), and mixed origin.

There are three methods of constructing cells and treating their walls by bees: pygidial, mandibular, and glossary. *Pygidial* method is the most widely spread (it is known for eight of nine families of bees). The cells are built with the use of pygidial plate at the sixth metasomal tergum of females. Bees making cell walls from a secreted polymer material apply the *glossary* method of construction (using a widely bifurcated glossa). This method does not require mechanical treatment of substrate and therefore enables some bees (many Hylaeinae, all investigated Xeromelissinae, and some *Colletes*) to build their nests in natural cavities. The *mandibular* method of constructing cells is applied only by Megachilidae and Apinae, and, probably, by some Xylocopinae. These bees build cells by mandibles.

The most of burrowing bees make secretory lining of cells, which plays a significant role in the protection of provision and brood from soiling, drying out and partially against microbial invasion. Dufour's gland and/or salivary glands secrete this lining constantly. Some bees, e.g. *Macropis nuda*, make analogous lining from plant oils. The majority of bees put at once into each cell the full supply of food necessary for development of the larva, and having finished provisioning the cell and laying eggs seal the cell with a cap. This method of food supply is called '*mass provisioning*'. Another method '*progressive* or *successive provisioning*', is applied by many eusocial Apinae and Allodapini. These bees add small portions of food into the cell as the larva grows.

The architecture of bee nests is determined by arrangement of cells vis-à-vis one another and the main burrow of the nest. Straight cells are almost always the indispensable and the main parts of a nest, whereas other elements of nest structure can be completely or partially lacking. Only in the majority of eusocial allodapines and in the east-European populations of *Metallinella brevicornis* (RADCHENKO, 1978) the nests have no cells at all. The complete set of all the nest elements mentioned above is constructed only by some of Halictinae. In opposite, some of Megachilinae, for example *Dianthidium clypeare* and *Anthidiellum strigatum*, construct only cells located at open places. For such species a cell and a nest are synonyms (STEPHEN et al., 1969). Nests of bees can be classified into the following main types: (1) simple branched nests, (2) twice-branched nests, (3) linear nest, (4) linear-branched nests, (5) nests with 'sessile' (placed in the main burrow) cells, (6) chamber nests with the main burrow, (7) nests consisting of "free" cells without the main burrow, (8) nests without cells.

In the *simple branched nest* to each cell a separate lateral leads that directly communicates with the main burrow. In their architectural plan, the branched nests can belong to the following three main varieties: (1) nests with laterals opening at different places along the main burrow, (2) nests with laterals opening at different places of the horizontal part of the main burrow, (3) nests with laterals opening at the bottom end of the main burrow.

The *twice-branched nest* consists of the main burrow and laterals, having each of them additional branches with one cell at the end, e.g. in *Andrena labialis, Nomioides minutissimus, Perdita lingualis.*

In the *linear unbranched nest* the cells are arranged into linear series inside the main burrow. The linear nests are characteristic of the majority of bees that gnaw the burrows in plant materials or settle in ready cavities, i.e. many Megachilidae, some Colletidae and Anthophorinae. Sometimes the nests of this type are constructed by burrowing bees, which dig them in soil.

The *linear-branched nests* are branched nests in which all or at least some laterals have linear series of cells at the end. They are registered among separate representatives of diverse groups of bees.

In the *nest with 'sessile' cells* the last through a cell neck directly communicate with the main burrow. In most species that build such nests the cells are usually grouped into clusters, for example in *Andrena flavipes, Nomia triangulifera, Evylaeus marginatus,* and *Lasioglossum xanthopus.*

In the *chamber nest* with the main burrow the last is extended to the cell cluster, which is surrounded by complete or partial chamber. Such nests can be found among Halictinae, for example in *Halictus quadricinctus,* Nomiinae, some *Proxylocopa.*

Bees construct the *nests with 'free' cells* at open places or inside spacious cavities. In these nests the cells are usually arranged in a group. They are proper to the majority of Apinae (except for separate Euglossini), and some Megachilinae, in particular many species *of Chalicodoma, Dianthidium, Anthidiellum, Anthocopa,* and some *Osmia.*

Cleptoparasitic bees. The cleptoparasitism of bees consists in that females lay their eggs into the cells of nest-building species. Distinctly from truly parasitic insects (or, more exactly, 'parasitoids'), the offspring of a cleptoparasite develops at the cost of the food provisioned for the larvae of the host. Cleptoparasitic species are presented in three from nine bee families (Halictidae, Megachilidae and Apidae). In the world fauna, there exist over hundred parasitic bee genera. In local faunas, at least in those of arid and semiarid zones, the proportion of parasitic species, as enumerated in the published lists, amounts to about 20%. According to the modern conception of the phylogeny of bees, within the superfamily Apoidea cleptoparasitism arose no less than 34 times. This process already started at the early stages of the evolution of bees. In all the cases the switch to parasitism was accompanied by essential morphologic changes. In females the collecting apparatus and frequently the major part of the rest pubescence underwent reduction, the structures associated with nest building disappeared. In females of many species that break through the walls of the host's cell in order to oviposition, the end of metasoma is elongated and pointed. Those larvae of cleptoparasites, which after their emergence kill the egg or the larva of the host bee, in the first instar have corresponding morphologic structures, being more movable and possessing powerful pointed mandibles.

The transition to cleptoparasitism occurs in bees as well nowadays. This is suggested both by the existence of separate parasitic species in those genera embracing mostly nest-building bees, and by poor morphologic specialisation for new mode of life observed even in some genera of parasitic bees. For instance, in *Paralictus* even the already unnecessary scopa on its hind legs is almost unreduced (MICHENER, 1978b), to say nothing of its general similarity to its nest-building predecessor, the genus *Evylaeus*.

Wide distribution and high taxonomic variety of cleptoparasitic bees have resulted in that the most nest-building bees suffer their pressing. The bees, that switched to cleptoparasitism relatively recently and therefore have not achieved a high taxonomic rank, are typically linked only to genera or subgenera from which they originated. Thus, *Echthralictus* parasitises exceptionally in the nests of *Homalictus* subg. *Homalictus, Paralictus* in *Evylaeus*; *Parathrincostoma* in *Thrinchostoma*; *Ctenoplectrina* in *Ctenoplectra*, *Effractapis* and *Nasutiapis* in *Braunsapis*, *Eucondylops* in *Allodapula*, *Inquilina* in *Exoneura*, *Aglae* in *Eulaema*, *Psithyrus* in *Bombus*, and so forth. The parasitic genera *Temnosoma, Radoszkowskiana, Protostelis*, *Exaerete*, and *Cleptotrigona* have 'conquered' the nests of several genera of the tribes they belong to themselves. Only *Sphecodes*, *Coelioxys* and *Stelis* s. l., the most large and widespread of those genera not entering into parasitic tribes, have among their hosts bees from totally unrelated taxa, although usually having a similar biology. A specific place in the pattern of host-parasite relationships in bees is occupied by the subfamily Nomadinae. Only few, and sufficiently generalised, its representatives, the genera *Melanomada, Paranomada, Triepeolus*, and partly *Nomada*, have retained their original links with Exomalopsini. All the rest have switched to parasitising in the nests of unrelated bees of different families. Cleptoparasitic species rarely limit their connections to a single host species, but often to a single genus. Characteristically each of them parasitises in nests of several taxonomically and biologically close species.

Although cleptoparasitism arose among bees frequently and independently, its peculiarities are similar enough in many of even not closely related groups. In their modes of parasitising, cleptoparasitic bees are classed with one of the following main types: 'nomadoid', 'sphecodoid', and 'social' (RADCHENKO & PESENKO, 1994: 61).

The 'nomadoid' type is characterised by that the parasitic female lays its eggs into a cell without entering in conflict with the host female and inflicting damage on its offspring. The cleptoparasite's eggs are laid either at the time of filling the cell with food, when the host female is absent for foraging, or after sealing the cell by the host. In the first case the cleptoparasitic female hides its eggs into special indentations made in the cell walls in such a way that eggs are partly or completely located inside of them; occasionally they are hidden into the food provisioned by the host bee. The 'nomadoid' parasite larva kills the egg or the young larva of the host, biting its skin through with mandibles. Such cleptoparasitic larvae possess high mobility provided by protuberances at the last metasomal segment and long sharp mandibles, which after the sloughing get replaced by ordinary-sized mandibles.

'Sphecodoid' parasitic females kill the host's brood before their own oviposition. For this reason 'sphecodoid' larvae have no morphologic features determined by search for and killing of those of the host. Females of such parasites often struggle with the host female, repulsing it from the nest or killing. Violent intrusion into nests is typical of many *Sphecodes*, parasitising in nests of halictine bees; as well it is recorded for *Euaspis*, parasites of *Megachile* (IWATA, 1933), and *Hoplostelis*, parasites of *Euglossa* (BENETT, 1965).

The 'social' cleptoparasitism consists in that parasitic females penetrate into families of social bees, replace their queens, killing or expelling them from the nest, and force the workers to rear the parasite's reproductive offspring. Social parasitism is found in Allodapini, Bombinae, and also recently established in the Halictini (WCISLO, 1997b). In all of such cases, it is the species leading the social mode of life that were the ancestors of social cleptoparasites.

Modes of social life. The superfamily Apoidea is one of five groups of insects – being the other groups presented by termites (the order Isoptera), ants (the superfamily Formicoidea), the most of vespoid wasps of the subfamily Vespinae, and the sphecid wasp *Microstigmus comes* – among which the true social life exists. In each of these groups social life arose independently. Moreover, eusociality among bees appeared repeatedly. Nowadays, different forms of sociality are observed in bees, including those occupying intermediate position between solitary and eusocial modes of life. For this reason, the study of bees' biology promotes reconstruction of the main ways and factors of the rise of sociality among Aculeata.

By the true sociality, or *eusociality*, the most of modern authors understand such cases of inhabitation of the same nest by adult individuals where, firstly, they are presented by two generations; secondly, there exists co-operation in doing various works; third, the reproductive functions are distributed between individuals, i.e. castes exist. MICHENER (1969a, 1974) and WILSON (1971) divide eusocial colonies into *primitive* and *advanced* ones. In the latter type, unlike the former, the castes are morphologically differentiated, and the queens cannot lead independent existence and establish nests.

Apart from the true sociality, a series of other forms of social relationships is found in bees. The simplest ones consist in formation of aggregations of individuals and nests. Thus, many bee species constantly form on stems and branches night clusters consisting of several, and occasionally of several dozen, or even hundreds of bees, which spend the night in a close contact, clutched with each other by their mandibles and/or legs. Females of many bees often build their nests in close proximity of each other, resulting this in formation of nest aggregations. One of the obvious reasons of their rise consists in the paucity of places suitable for establishment of nests. Under such conditions even females of the species normally avoiding close neighbourhood of nests are forced to settle nearby. Another reason of aggregation formation is bees' propensity to settling close to their maternal nests (the so-called *philopatry*).

Some solitary bee species, belonging to various taxonomic groups, create *communal nests*. Such essentially combined nests are inhabited by several, occasionally by several dozen of females of the same generation, which use a common entrance. All of these females have normally developed ovaries, they are fertilised, and every one independently builds and provisions the cells where it lays eggs. In many instances the formation of such nests is due to that jointly emerged females begin to jointly use the main burrow of their maternal nest, or a burrow made by one of the sisters, which other individuals later join. Nevertheless, in some species, for example in *Lasioglossum* (s. l.) *hemichalceum*, communal nests are formed only by unrelated females (KUKUK & STAGE, 1994).

All of the above mentioned forms of sociality (viz., the night clusters, nest aggregations, communal, i.e. compound, nests) have no direct relation to the rise of the true sociality (eusociality). The only intermediate link on the way to eusociality is presented by subsocial colonies. According to the original interpretation of the term *subsociality* coined by WHEELER (1923: 10), all the species belong to the group of subsocial insects, in which there exists parents' care for their offspring in its developmental period, i.e. in which parents feed their offspring, or at least protect it till its emergence. Therefore, WHEELER considered subsocial all manifestations of care occupying the middle position between solitary mode of life (implying that a female is indifferent to its offspring after oviposition), and true sociality – regardless of whether or not direct feeding of larvae exists. Unlike the majority of solitary bees, among which every female can establish several nests, a female of subsocial species always builds one nest only, and as a rule constructs in it much fewer cells than it is typical for females of solitary species with similar nest architecture. As well, subsocial species importantly differ from solitary bees in that their females forming subsocial colonies are essentially less worn. This enables them to at least protect their brood after its establishment. A salient feature of the nests of subsocial species lies in that their cells are disposed within the nest in such a manner that provides the mother an access to all the ones with developing brood.

The next, more advanced form of sociality in bees, which directly leads to the rise of the true sociality involving the caste differentiation, consists in temporal joint inhabitation of a nest by the mother and its daughters, which for some time help the former, and later establish their own nests. To name such a community, SAKAGAMI & MAETA (1977) suggested the term *eosociality*.

For denotation of any intra-nest communities where adult individuals belonging to a single generation live, MICHENER (1969a) proposed the term *parasocial colonies*. He has classed with the last the so-called communal, quasi-social and semi-social colonies. The introduction and specification of these terms were preceded by discovery of eusocial life in halictines, whose females, unlike the most of other eusocial insects, do not additionally feed the emerged larvae yet provide them in advance with complete food storage, doing that even before the oviposition.

Anthophily in bees. Bees belong to anthophilous insects. Their relationships with flowers are obligatory and diversified, although the basis of dependence between bees and flowers is constituted by trophical links. The main components of the food of bees are pollen and nectar produced by flowers of entomophilous angiosperm plants. The main source of protein in the food is pollen. The exception is presented by the group of species *Trigona hypogea* of the subfamily Meliponinae, one of the most advanced groups of bees having highly developed social life; the workers in colonies of these species feed their larvae with processed tissues of dead animals. Normally bees stock the forage for larvae in the form of pollen and nectar mixture. The proportion of the components varies widely, which results in that in its consistency the food may be from paste-like to almost liquid. Many bees add secretions of Dufour's gland and mandibular glands to the larval food. Females of some bee genera of the families Colletidae, Melittidae, and Apidae collect (usually instead of nectar) oils excreted by flowers of the plants visited.

Also such unusual connections of bees with flowers are discovered as 'pseudo-copulation' of males of some bee species with orchid flowers and collection of flower aromatic substances serving among bees the function of sexual attractant. The most stable relationships exist between the Palaearctic Eucerini (*Eucera* and *Tetralonia*) and many species of the genus Ophrys, whose flowers, due to their structure and form, are adapted to being pollinated by males of these, and not other, bees.

The unique benefit of anthophily, which is proper to only very few groups of insects other than bees (e.g., to vespoid wasps of the family Masaridae), has given bees almost unlimited by competition and environment conditions possibility of expansion all over the world, to every place where forage resources – angiosperm plants – are available. The bees actually entered in symbiotic relationships with plants at the moment of their own appearance. Mutual selection between bees and plants, although occurring, as it seems, dispersally and sporadically enough, still during their joint evolution resulted in colossal diversification of this symbiotic system both in terms of the number of species involved into the system and their morphological diversity, and in terms of the specificity of concrete pollinator-flower relationships, including behaviour of bees when on flowers, and modes of pollination. In illustrating morphological variety of bees, it suffices to mention their body size, which varies from 2 up to 40 mm.

Bees seriously differ in the range of the plants visited. Pollen is typically collected from narrower set of plants than nectar, and bees often exhibit preference to a certain taxon of plants. According to the type of their trophical links bees are divided into two main groups – *polylectic* and *oligolectic* ones. Females of the former collect pollen from a large number of plants (*wide polyleges*), or from few species of plants, however belonging to different botanical families (*narrow polyleges*). The sources of pollen for females of oligolectic species are the plant flowers prevalently (in the case of *wide oligoleges*) or exclusively of a single family. Sometimes pollen is taken from the flowers of one or several closely related genera (*narrow oligoleges*), or even of one and the same species (*monoleges*). The highest ratio of oligoleges is in arid faunas – in steppes and deserts they cover nearly a half of bee species. However the average abundance of oligoleges is lower than that of polyleges, so that even in arid areas polyleges vastly prevail. In boreal forests, the bumble bees dominate, which as well as all other eusocial bees (Apinae, Meliponinae, a part of the Halictinae, and some others) visit a wide range of plants; but even among solitary species oligoleges are very scarce. Generally oligoleges inhabit narrower areas than polyleges. Usually the distributional range of oligoleges is limited to a single landscape zone only. This is mostly due not to unavailability of food plants in other areas but rather to narrow diapason of external conditions in which the advantages of trophic specialisation tell. The presence and the number of oligolectic bee species is usually almost independent of either the species richness of the botanical family to whose pollination the bees are adapted, or of abundance of their food plants.

Importance of bees as pollinators of entomophilous crops. The overwhelming majority of more than 500 species of plants cultivated are entomophilous, i.e. their yield (or their seed-growing) directly depends on pollination activity of insects, in the first place representatives of the superfamily Apoidea. Entomophilous cultures occupy more than a half of areas cultivated, and they yield about one third of agricultural products. The most of these plants get successfully pollinated by the honey bee, *Apis mellifera*. Important but often disregarded role in pollination of agricultural plants is also played by so-called ‘wild’ bees – solitary and social species of Apoidea (especially, bumble bees and many halictines). Activity of wild bees is almost absolutely necessary for cultivation of such plants which, because of peculiarities of structure or functioning of their flowers, cannot be effectively pollinated by honey bees. Such plants are, first of all, red clover and alfalfa – representatives of the family Fabaceae, which are grown for hay and green mass used for feeding livestock, and secondly apple-tree.

Red clover (Trifolium pratense L.) is mostly cultivated in the woodland zone of the Northern Hemisphere, and in the corresponding belts of mountain regions.

The correlation between the yield of red clover and the activity of bumble bees is known for such a long time that it is even reflected in the old English parable about the influence of spinsters on the milk production. The length (depth) of the flower corolla varies from 7.5 to 12.4 mm (10 mm on the average), but the nectar excreted mostly at the base of the flower usually fails to go up higher than 1.35-1.47 mm. In this connection only those bees can regularly consume it, which have proboscis longer than 8.5 mm. Honey bees having that of 5.9-6.25 mm can extract nectar only from the less deep red clover flowers, on the condition of its maximal rise, and partly sticking its head into the corolla. The most effective pollinators of red clover are bumble bees, which being numerous enough provide considerably higher yield of seeds. Among the 'clover' species *Bombus hortorum*, *B. subterraneus*, *B. pascuorum*, *B. distinguendus*, *B. lapidarius*, *B. derhamellus*, *B. silvarum*, *B. equestris* are typically mentioned.

Alfalfa (Medicago sativa L.) is widely cultivated in the forest-steppe, steppe, and more arid (here only on the condition of irrigation) zones in more than 80 countries of the world. The peculiarity of alfalfa flower consists in that after its opening the so called column – the stamen tube consisting of 9 fused stamens (being the 10th stamen separate) – and the thin pistil placed inside of it remain inside the keel in a tense state. The column is held by two internal protrusions of the keel and long finger-like shoots of wing petals deepening into the hollow of the keel. The column is set free not before the pollinator insect, deepening its proboscis into the aperture of the corolla and setting its head firmly against the banner, moves the wing petals apart by its hinder legs. The column, becoming unhitched from the shoots of wing petals, by force of turgor pressure springs up and, moving towards the banner hits against the body of the insect. Mucous film on the stigma gets destroyed, and the latter becomes ready to acceptation of pollen. The 'explosive' mechanism of opening of alfalfa flowers was called 'tripping'. The pollination of alfalfa flowers is successfully realised by great or middle-sized body wild bees of many species. The main alfalfa's pollinators in Europe are *Andrena flavipes*, *A. labialis*, *A. ovatula*, *Melitturga clavicornis*, many halictines of the genera *Halictus*, *Lasioglossum*, *Evylaeus* and *Seladonia*, *Rhophitoides canus*, *Nomiapis diversipes*, *Melitta leporina*, *Anthidium florentinum*, *Megachile argentata*, *M. centuncularis*, *M. rotundata*, *M. willughbiella*, *Osmia coerulescens*, *Eucera clypeata*, *E. longicornis*, *E. pollinosa*, *Tetralonia tricincta*, as well as some species of *Anthophora* and *Bombus*. Under normal conditions, *Apis mellifera* is ineffective pollinator of alfalfa, since this bee is poorly adapted to foraging on its flowers. Honey bees take nectar not through the aperture of the corolla but rather from the side of the flower, through the split between the wing petal and the banner, typically without opening and pollinating the flower.

For example, economical effect of pollination of seed plantations of alfalfa and red clover by wild bees only in Poland is 23 million US $ per year (BANASZAK & CIERZNIAK, 1995).

Morphological terms

General remarks. In accordance with the terminology of classic anatomy, we use the terms *apex* and *base*, *apical* and *basal* (end, part, etc.) only for description of such structures as protuberances, processes, projections, teeth, tubercles, lobes etc. The terms *distal* and *proximal* (end, part, etc.) are used for description of articulated structures and appendages, such as antenna, leg, gonostylus etc. and also their parts: the scapus, pedicel, flagellum, flagellomere, labial palpus, tibia, femur, tarsus, tarsomere, etc. The terms *anterior* and *posterior* (also *median* and *lateral*) are used for characterisation of main sclerites of the body: pronotum, mesoscutum, scutellum, metanotum, mesepisterna, propodeum, metasomal terga and sterna etc., e.g. posterior margin of the mesoscutum, anterior hair bands on terga, posterior areas of sterna.

Bees are hypognathous insects. So for characterisation of the general form of the head in frontal view and such its subdivisions like the clypeus, supraclypeal area, we use the terms *height*, *high* (not *length*, *long*) and also *upper* and *lower* (margin, part etc.).

In accordance with the current tradition, surfaces and margins of femora, tibiae and tarsomeres are described in their orientation when legs are directed downward; antennae considered as oriented forward. Natural borders do not mark all margins of some traditionally distinguished parts of the body surface. For description of these parts, with the exception of the frons and vertex, the term *area* is used, e.g. paraocular areas, supraclypeal area, genal areas, posterior areas of terga, etc. For description of the main, central part of a sclerite, the term *disc* is used, e.g. punctation on mesoscutal disc, pubescence on disc of tergum II, etc.

In his classic manual *Principles of Insect Morphology*, SNODGRASS (1935) wrote:

> <Sclerites primarily may be intrasegmental and intersegmental and may occupy any of the several regions of an individual segment. A major segmental plate of the dorsum is a *tergum*, or *notum*; a major segmental plate of venter is a *sternum*; plates of the pleural areas are designated *pleural sclerites*. Subdivisions of a principal segmental plate or the component sclerites of a major area of sclerotization, then, become *tergites*, *sternites*, and *pleurites* respectively, since the suffix *-ite* has a fractional significance.> (p. 71).

After 1940 most entomologists, especially writing in English, name main sclerites of the thorax and abdomen just as *terga*, *sterna*, *pleura*. We follow this practice and also the terms *mesosoma* and *metasoma* introduced by MICHENER (1944) in his classic monograph *Comparative External Morphology, Phylogeny, and a Classification of the Bees*. He wrote:

> <In all Clistogastra the first abdominal segment or propodeum is immovably united with the thorax so that the median tagma of the body consists of four rather than the three segments. It is, therefore, preferable for morphological purposes to use the term *mesosoma* instead of thorax when

referring to all four segments together. The *metasoma*, then, consists of the second and following abdominal segments, and is separated from the mesosoma by a strong constriction.> (p. 167).

For taxonomic purposes, terga and sterna of the metasoma are usually named just as metasomal and given with Roman numbers, to distinguish them from the strictly morphological, i.e. abdominal numbering. On the whole, the morphological terms used in this book are those proposed by MICHENER (1944, 1965) became a standard. A few changes will be indicated in respective places. The accompanying illustrations (diagrammatic views of *Halictus rubicundus*) show the structures characterised in the taxonomic parts of this book.

Head. Parts and sutures of the head capsule are shown in Figs. 1 and 2. The *face*, not labelled in these figures, is all the frontal surface of the head (except for eyes).

In the structure of the head, the Rophitinae distinctly differ from other halictids: antennal sockets are spaced on the lower half of the face, the clypeus is short and greatly convex. Also they differ in the shape of the labrum, which is broadly rounded or truncate distally, without a longitudinal keel or process possessed by other halictids. The direction of the upper end of subantennal sutures varies among the Halictidae: in the Nomiinae it is directed towards the inner margin of antennal sockets, in Nomioidini towards the outer margin of sockets, in other halictids towards the lower margin of sockets. Lateral parts of the clypeus in the Nomiinae and Sphecodina are not bent or are bent gently backward, in other halictids they are bent back about 45° relative to the median part of the clypeus. The Nomioidini differ from other halictids by three-lobed upper margin of the clypeus.

The following measurements of the head capsule are used in the keys:

Head height, the distance from the upper margin of the vertex to the lower margin of the clypeus;

Head width, the largest distance between the outer margins of eyes;

Head thickness, the largest distance from the surface of the face to the posterior margin of the genal area, perpendicular to the surface of the face in lateral view of the head;

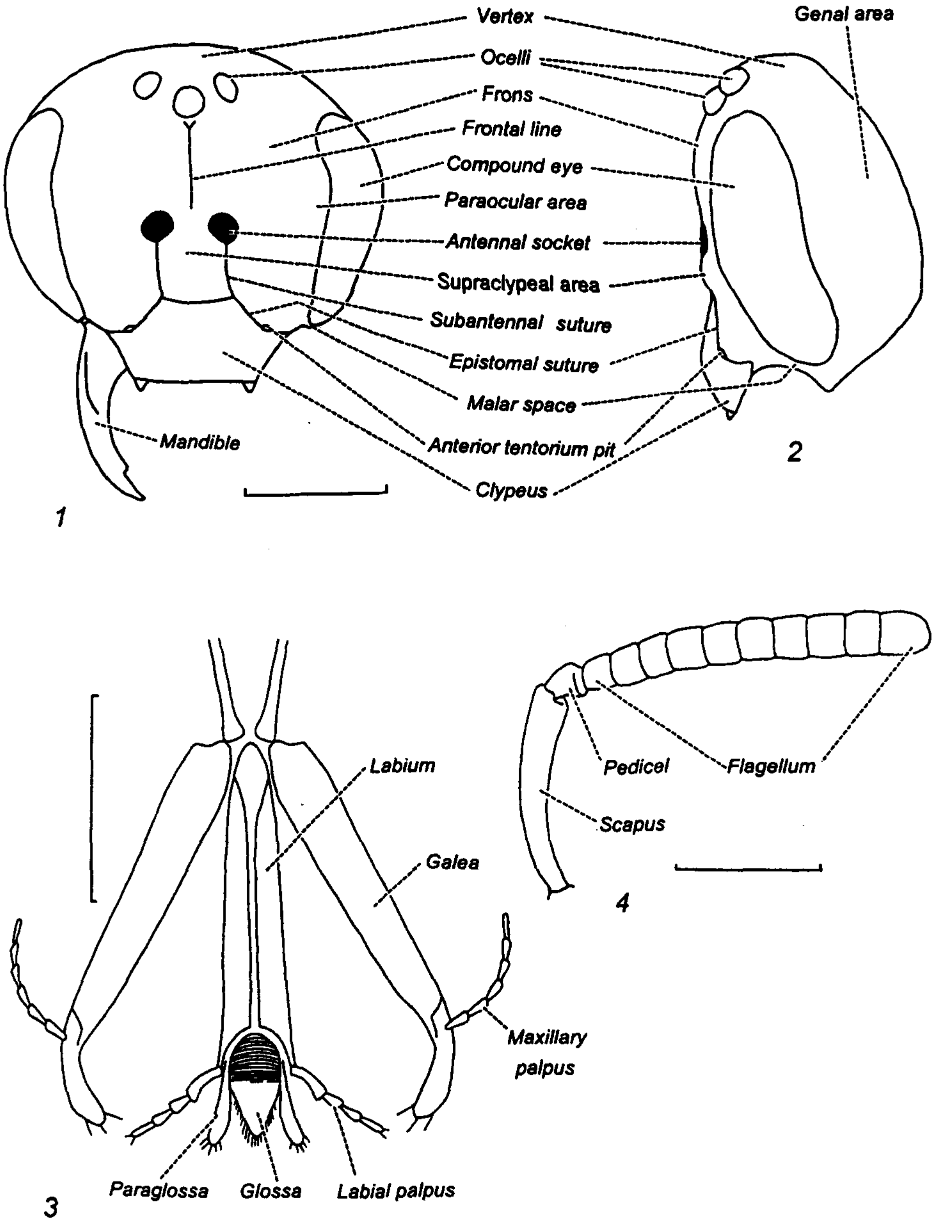
Clypeal length, the distance between the upper and the lower margin of the clypeus medially;

Clypeal width in the Halictini, the distance between apices of lower lateral tubercles of the clypeus,

Malar space length, the shortest distance from the eye to the mandible.

Other distances and their ratios are explained in the text.

The *proboscis* of bees consists of the composed *labium* and *maxillae*. In this book, only the shape and relative size of segments of labial and maxillary palpi varying within the Rophitinae are described; these palpi are labelled in Fig. 3. The main parts of the antenna are shown in Fig. 4.



Figs. 1-4. Diagrams of the head and its appendages of a halictid bee (*Halictus rubicundus*). *1*. Frontal view of the head. *2*. Lateral view of head. *3*. Labiomaxillary complex (proboscis). *4*. Antenna of a female. Scale lines represent 1 mm.

Mesosoma. Thoracic and propodeal sclerites and sutures are labelled in Figs. 5 and 6. The sclerite, occupying most the dorsal surface of the propodeum and usually marked laterally and posteriorly in the Halictidae by a ridge, carina, depressed line, or change of sculpture, is the *metapostnotum* (see BROTHERS, 1975, 1976), i.e. is not morphologically a part of the propodeum. Therefore, we use the term above, instead of such morphologically noncommittal terms as "median area of propodeum", "propodeal enclosure", or "propodeal triangle".

The variation of main morphological features of the metasoma within the European Halictidae is as follows. The Nomiinae differ from other halictids in strongly enlarged tegulae, the partly reduced pre-episternal groove and the vertically oriented dorsal surface of the propodeum. The Nomiinae and Halictidae are characterised by the absence of the scrobal suture.

The following measurements of the mesosomal capsule are used in the keys:

Mesosomal length, the largest median distance from the anterior end to the posterior end in lateral view,

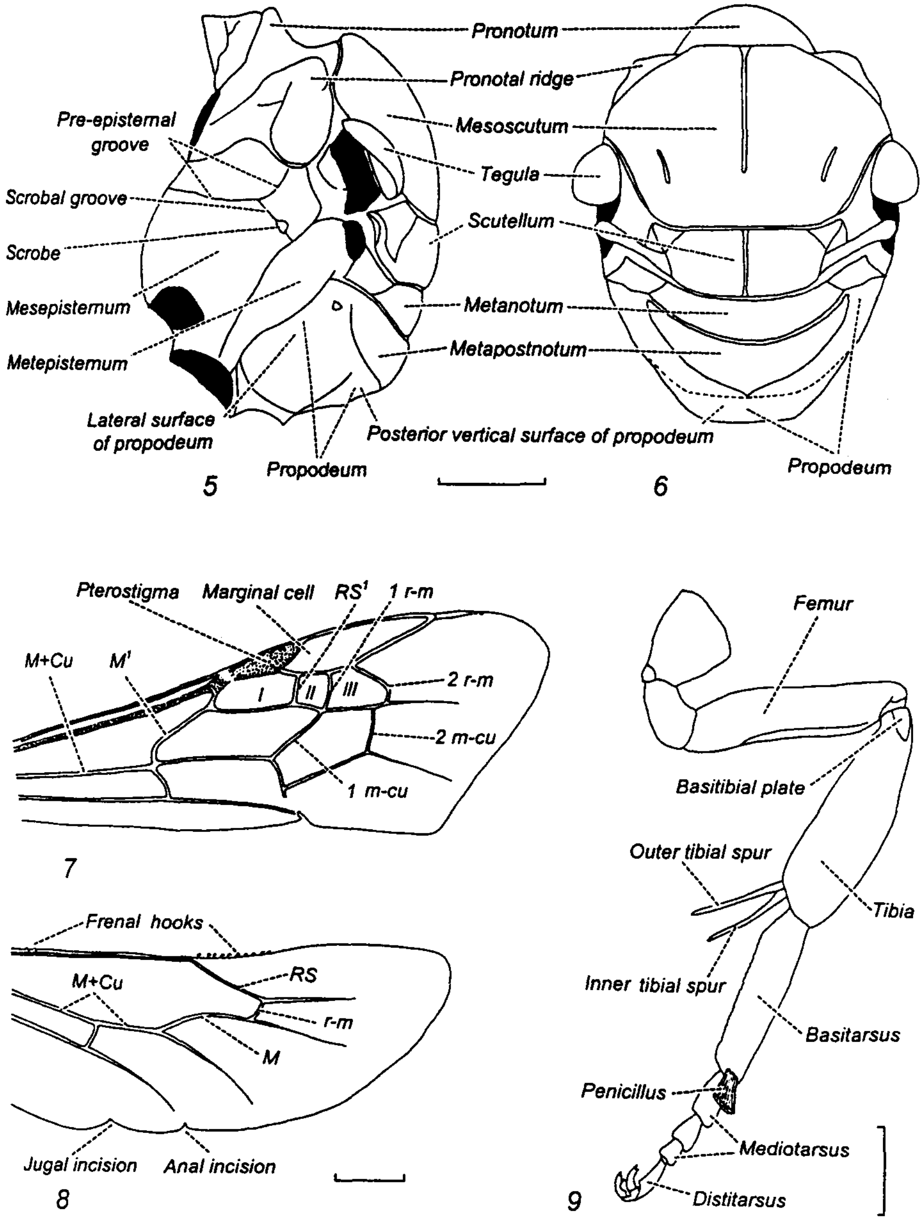
Mesosomal width, the largest distance between lateral margins in dorsal view,

Length of scutellum, *metanotum*, *dorsal surface of propodeum*, the largest median distances from their anterior to posterior margins.

The main veins and cells of the forewing, which are characterised in the keys, are shown in Fig. 7. The veins are marked by shortened symbols in accordance with the morphological terminology and morphologically noncommittal terms in brackets.

The following features of forewings vary between the main group of the European Halictidae. The basal vein is strongly convex proximally in Nomiinae and Halictidae, while it is straight in the Rophitinae. The Nomioidini differ from other halictids by the widely truncate marginal cell distally. The number of submarginal cells varies from three to two within the Rophitinae. Only in the Halictinae, the first submarginal cell is larger than the third one. The Gastrohalictina differ from other halictids by weak (thinner and usually lighter than the more proximal) distal transverse veins.

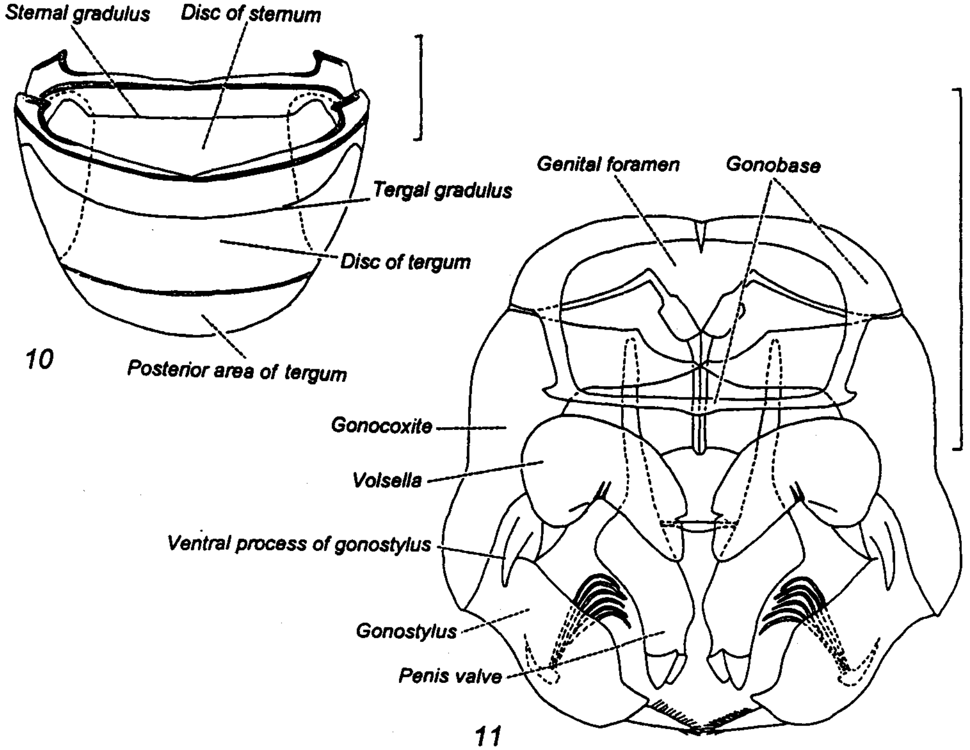
The main parts of the hind legs are shown in Fig. 8. The Rophitinae differ from other nonparasitic halictids by the absence of the penicillus in hind basitarsi of females. The penicillus, metatibial scopa, and metabasitibial plate were lost by females of the Sphecodina. The hind tibiae in males of most Nomiinae are strongly inflated and provided modified hairs on the inner surface.



Figs. 5-9. Diagrams of the mesosoma and its appendages of a halictid bee (*Halictus rubicundus*). *5*. Lateral view of the mesosoma. *6*. Dorsal view of the mesosoma. *7*. Forewing. *8*. Hind wing. *9*. Female hind leg. Scale lines represent 1 mm. lorphologically uncommitted names of veins and cells of the forewing: *M+Cu*, medial vein; M^1, asal vein: RS^1, first transverse cubital vein; *1 r-m*, second transverse cubital vein; *2 r-m*, third transerse cubital vein; *1 m-cu*, first recurrent vein; 2 *m-cu*, second recurrent vein; *I*, first submarginal cell; '. second submarginal cell; *III*, third submarginal cell.

Metasoma. The schematic structure of the typical metasomal segment is shown in Fig. 9. The non-parasitic Halictini differ from other halictids by a medially interrupted *prepygidial fimbria* (on tergum V) of females and by a modified tergum VII of males. This tergum in the Nomioidini is internal and hairless. The *pygidial plate* (on tergum VI) of females was lost by Sphecodina. Among the European halictids, the metasomal sterna IV and V of males are modified in the Nomiinae and in some members of other subfamilies. All subfamilies and tribes distinctly differ from each other in the structure of sterna VII and VIII of males (see the keys below).

The main parts of the male genitalia are labelled in Fig. 10. The structure of genitalia varies widely between and within the halictid families and tribes. In the Nomiinae and Nomioidini the gonostylus is indistinguishably fused to the gonocoxites; the resulting structure is called by *gonoforceps*. The gonostylus in the Gastrohalictina is provided with the *membranous retrorse lobe*.



Figs. 10, 11. Diagrams of structures of the metasoma of a halictid bee (*Halictus rubicundus*).
10. Anterodorsal view of the fourth metasomal tergum and sternum.
11. Ventral view of the male genitalia. Scale lines represent 1 mm.

Description of the sculpture. Terms for description of sculpture in keys are mostly in accordance with EADY (1968) and HARRIS (1979):

Aciculate, appearing as if irregularly scratched with a needle,

Areolate, divided into a number of small, irregular spaces,

Carinate, having keels or carinae,

Colliculate, continuously covered with low, rounded elevations, not as pronounced as acinose (granulation like on blackberry) or granulate,

Foveate, pitted, with numerous, regular, depressions or pits (foveae),

Granulate, covered with or made up of very small grains or granules,

Punctate, set with fine, impressed points or punctures appearing as pin-pricks,

Reticulate, superficially net-like or made up of a network of lines,

Rugose, wrinkled,

Rugulae, small rugae, wrinkles,

Rugulose, minutely rugose,

Scabrous, irregularly and coarsely rugose,

Shagreened, covered with a closely set roughness, like the rough surface of horse leather, or like shark leather,

Striate, longitudinally marked with impressed parallel lines or furrows,

Strigate, transversely marked with raised or depressed parallel lines,

Strigulate, finely strigate,

Striolate, finely striate.

Additional comments: Smooth vs. Roughened, not Shagreened, as the last term has a narrower sense (see above).

For description of punctation the formula proposed by EBMER (1969) is used in keys: the average diameter of punctures in µm / the average distance between punctures expressed as the number of puncture diameters.

Description of the vestiture. Pubescence (vestiture) of halictids is mostly formed by true *hairs*. Nevertheless, *bristles* (setae), having another kind of attachment to integument, sometimes also form fringes, usually marginal. In this book, the following terms are used for description of pubescence and hairs:

Pilose pubescence, delicate, thin,

Plumose hairs, pinnate, branched like as a tree,

Pruinose surface, covered with a fine dust or coarse powder,

Simple hairs, not branched,

Tomentose pubescence (tomentum), felt-like.

In their orientation in relation to the surface of a body sclerite, hairs can be *erect*, *appressed*, or *inclined*. They can form *brushes*, *bunches*, *bands*, *fimbriae*, *fringes*, and *tassels*.

Chapter II
General characteristics of halictid bees

Family Halictidae

Diversity and distribution. The family Halictidae is a very large and nearly cosmopolitan group of bees. This family, together with families Colletidae, Andrenidae and three families formerly considered as subfamilies of the Melittidae, belongs to more primitive (generalised) group conditionally named short-tongued bees. The Halictidae exhibit both solitary behaviour and nearly every degree of sociality, ranging from subsocial to eusocial behaviour; some members of this family are cleptoparasites in nests of halictids and other bees. The family contains about 5,000 currently recognised species; the number of halictid genera varies in classifications by different authors from 50 to 80.

Diagnosis (according to ALEXANDER & MICHENER, 1995 and PESENKO, 2000a). One pair of antennal sutures. Facial foveae absent. Wall of proboscidial fossa fused to tentorium forward almost to clypeus. Cardo attached to articulatory process of head just behind clypeus. Base of galea tapering gradually to point of extending to base of stipites. Lacinia finger-shaped, stretched up anterior surface of labiomaxillary tube. Labial palpus with segments similar and subcylindrical, not flattened (except in *Rophites*). Glossa pointed apically, without flabellum; annular hairs of glossa usually branched or bifid at tips. Metanotum horizontal. Metabasitibial plates and pygidial plate on metasomal tergum VI present in female except in parasitic genera. Volsellae present.

Taxonomy [main general papers]: DALLA TORRE, 1896: 1-13, 51-98, 163-173 (Halictidae in catalog of bees in the World); MICHENER, 1944: 247-253 (classification); 1953: 987-1102 (larvae); 1954: 63-70 (pupae); 1954: 13-16, 38-97 (Halictidae of Panama); 1965: 151-183, 338 (Halictidae of Australia); 1986: 219-234 (family-group names); 1997: 1-81 (genus-group names, type species); MITCHELL, 1960: 331-521 (keys to Halictidae of the eastern United States); HURD, 1979: 1932-1978 (catalog of Halictidae in America north Mexico); EBMER, 1987b: 59-148 (key to genera of the Palaearctic Halictidae); MOURE & HURD, 1987: 1-401 (catalog of Halictidae in the New World); CARDALE, 1993: 167-235 (Halictidae in catalog of bees in Australia); MICHENER et al., 1994: 134-140 (halictid genera of North and Central America); ALEXANDER & MICHENER, 1995: 377-424 (phylogeny and classification of Halictidae); PESENKO, 2000a (revised phylogeny and classification of Halictidae).

Phylogeny. The family Halictidae is a strictly monophyletic (holophyletic) group. Its monophyly is supported by five synapomorphies (ALEXANDER & MICHE-

NER, 1995). The phylogenetic reconstruction of this family, according to PESENKO (2000a), is shown in Fig. 1; all characters established as synapomorphies of sister-taxa are listed in Table 2. Main conclusions of the analysis of the phylogenetic relationships between suprageneric taxa of the Halictidae are as follows. All the three subfamilies, Rophitinae, Nomiinae and Halictinae (including Nomioidini), are strictly monophyletic. The subfamily Rophitinae is a sister-group in relation to the Nomiinae and Halictinae combined. All the three tribes of the subfamily Halictinae, Nomioidini, Augochlorini and Halictini, are strictly monophyletic. The tribe Nomioidini is a sister-group in relation to the Augochlorini and Halictini combined. Two of the three subtribes of the tribe Halictini, Sphecodina and Gastrohalictina, are strictly monophyletic. The subtribe Halictina is paraphyletic in relation to the two other subtribes.

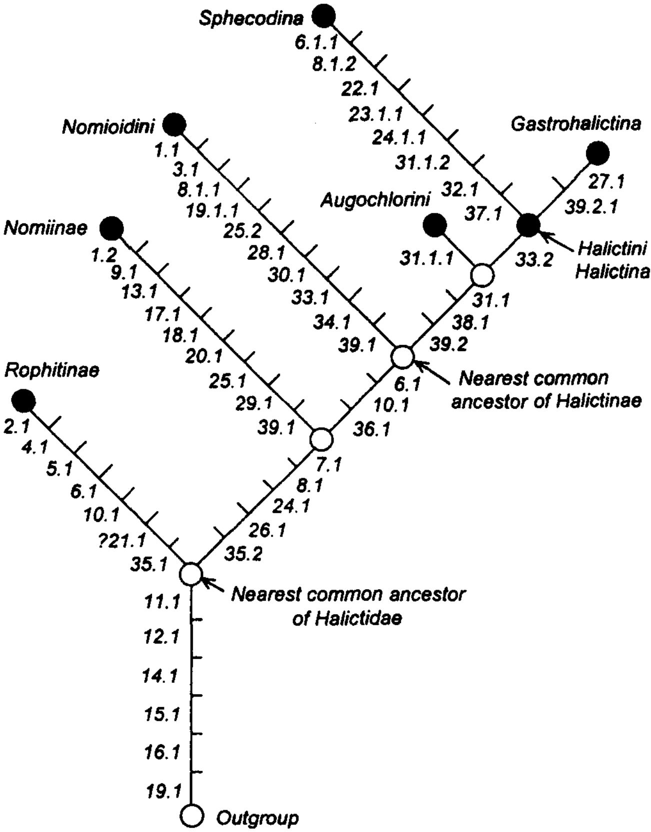


Fig. 12. The phylogenetic relationships between subfamilies, tribes and subtribes of the family Halictidae (from PESENKO, 2000a).
All characters established as synapomorphies of sister-taxa are listed in Table 2.

Table 1. Characters established as synapomorphies of sister-taxa in the Halictidae

Character	Plesiomorphic state	Apomorphic state (AS)	Taxon with AS
6. Lower lateral parts of clypeus	6.0. Not or gently bent backward	6.1. Bent back about 45° relative to median part of clypeus	[Rophitinae], Halictinae
7. Anterior surface of labrum of female	7.0. Largely bare and elevated, but with narrow depressed hairy apical area	7.1. With basal elevated, largely bare area, clearly delimited from substantial	Nomiinae + Halictinae
8. Distal part of labrum of female	8.0. Broadly rounded, or truncate, not keeled	8.1. Ending in a process with a strong, laterally compressed keel	Nomiinae + Halictinae
10. Attachment of secondary tentorial bridge to posterior wall of head	10.0. Above and separate from hypostoma	10.1. Close above hypostoma or fused to hypostoma	[Rophitinae], Halictinae
11. Wall of proboscidial fossa fused to tentorium	11.0. Forward to middle part of head	11.1. Forward almost to clypeus	Halictidae
12. Attachment of cardo to articulatory process of head	12.0. In middle third of head or behind	12.1. Just behind clypeus	Halictidae
14. Base of galea	14.0. Not tapering to point, usually extending to less than half length of stipes	14.1. Tapering gradually to point or extending to base of stipes	Halictidae
15. Position of lacinia	15.0. At base of galea	15.1. Stretched up anterior surface of tube	Halictidae
16. Form of lacinia	16.0. Scale-like	16.1. Finger-shaped	Halictidae
19. Annular hairs of glossa	19.0. Acutely pointed, simple to lanceolate	19.1. Branched or bifid at tips	Halictidae
24. Hind basitarsus of female	24.0. Without an apical brush	24.1. With a dense apical brush (penicillus)	Nomiinae + Halictinae
26. 'Basal' vein (M^1) of forewings	26.0. Straight or weakly curved	26.1. Greatly curved	Nomiinae + Halictinae
35. Metasomal sternum VII of male	35.0. Of ordinary form, although smaller than sternum VI	35.2. Internal, membranous, transverse, without lobes	Nomiinae + Halictinae
36. Metasomal sternum VIII of male	36.0. Sclerotized, with apical projection and usually moderate basolateral arms	36.1. Membranous, without an apical projection	Halictinae
38. Ventral lobe of gonocoxite	38.0. Absent	38.1. Present	Augochlorini + Halictini
39. Gonostylus	39.0. Articulated to gonocoxite, single	39.2. Double, two independent gonostylar structures arising from gonocoxite	Augochlorini + Halictini

KEY TO SUBFAMILIES OF THE HALICTIDAE

1. Clypeus short, usually not longer than labrum, greatly convex and extending ahead of level of flat supraclypeal area in lateral view. Labrum of female broadly rounded, truncate in apical extremity. Antennal sockets placed on lower half of face. Basal vein (M^1) of forewings straight or slightly curved. Basitarsus of hind legs in female without distal brush. Metasomal sternum VII of male sclerotized laterally, usually with additional structures .... **Rophitinae**

– Clypeus longer than labrum, weaker convex and not extending ahead of level of supraclypeal area in lateral view. Labrum in females of non-parasitic forms with a strong apical process. Antennal sockets placed in middle or on upper half of face. Vein M^1 of forewing greatly curved. Basitarsus of hind legs in female with a distal brush (*penicillus*). Sternum VII of male membranous, much reduced 2

2. Lower lateral parts of clypeus in female not bent or gently bent backward. Pre-episternal suture absent or not recognisable below scrobe. 1st submarginal cell of forewings equal to 3rd one, contrasting with much shorter 2nd submarginal cell; marginal cell usually broadly rounded at distal end. Metasomal sternum VIII of male sclerotized .... **Nomiinae**

– Lower lateral parts of clypeus in females of non-parasitic forms bent back about 45° relative to median part clypeus. Pre-episternal suture full. 1st submarginal cell larger than 3rd one; marginal cell usually narrowly rounded or sharply pointed at distal end, rarely broadly truncate. Sternum VIII of male membranous .... **Halictinae**

Subfamily Rophitinae

Diversity and distribution. The subfamily is chiefly Holarctic in distribution. It is also represented in the Ethiopian, Oriental and Neotropical regions by few species. No species inhabit Australia. A brief diagnosis of the Rophitinae is given in the key above. The subfamily includes about 200 known species of 14 genera. Almost a half of the species are described from the Palaearctic region. Palaearctic species belong to seven genera: Holarctic *Dufourea*, mostly Palaeotropic *Systropha* and endemic *Trilia*, *Morawitzella*, *Rophites*, *Rhophitoides*, and *Morawitzia*.

In Europe the subfamily is represented by 30 species of *Dufourea* (17 species), *Rophites* (8), *Rhophitoides* (2) and *Systropha* (3). Ten species of the Rophitinae have been recorded from Poland.

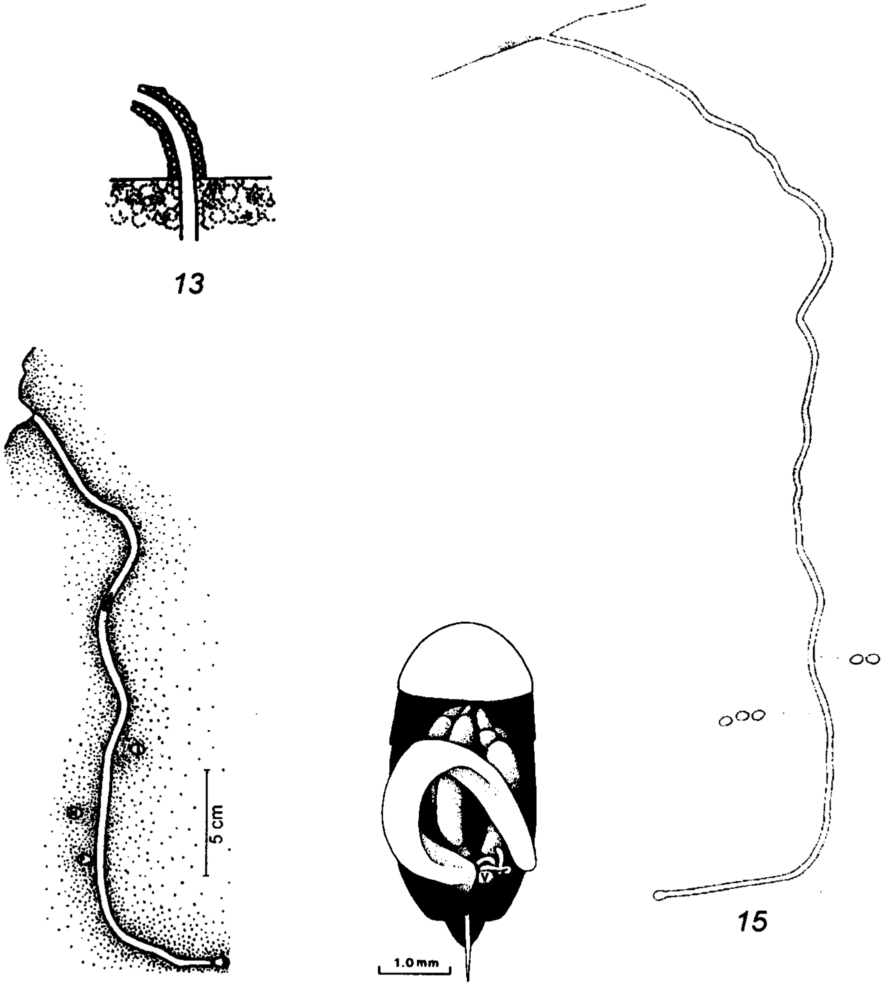
Taxonomy [supplementary references]: Friese, 1901: 33-79; 1902: 380-381; Cockerell, 1916: 61-63; Blüthgen, 1930a: 771-773, 776; Dusmet, 1935: 161-163; Popov, 1957: 916-924; 1958: 47-51; 1959: 225-237; Michener, 1965b: 321-326; Ponomareva, 1967: 677-698;

SCHWAMMBERGER, 1971: 578-584; 1975: 57-63; 1976: 225-229; EBMER, 1976b: 179-203; 1978a: 217-219; 1978b: 85-89; 1978c: 317-318; 1979: 141-143; 1984a: 46-48; 984c: 313-379; 1987a: 43-56; 1987b: 91-95; 1989: 193-210; 1993a: 3-14; 1993b: 15-42; 1994: 807-821; EBMER, 1999: 183-228; WARNCKE, 1976: 93-97; 1979a: 65-70; 1979b: 111-155; 1980a: 37-52; 1980b: 375-378; 1982b: 167-169; 1992: 741-746; WU, 1983b: 344-347; 1987: 187-201; 1990: 466-475; EBMER & SCHWAMMBERGER, 1986: 271-304; BAKER, 1996: 1527-1547; BOHART & GRISWOLD, 1996: 177-184; PESENKO, 1998: 669-686.

Bionomics. Contrary to other halictid subfamilies, the Rophitinae include only solitary and mostly oligolectic forms; no cleptoparasitic forms exist. Pollen is transported primarily on the hind femur, tibia and basitarsus, and in many taxa also on sides of the propodeum, and in *Systropha, Systrophidia,* and others, also abundantly on sides and the lower surface of the metasoma. Of about 200 currently recognised species of the Rophitinae, nests only of 16 species are described: in *Conanthalictus conanthi*, six species of *Dufourea*, *Protodufourea eickworti*, *Rhophitoides canus*, three species of *Rophites*, *Sphecodosoma dicksoni*, three species of *Systropha*, and *Xeralictus timberlakei*. Nests are usually occupied by single females, whereas in some Nearctic species sometimes each one is occupied by two or more females. For Palaearctic species, especially for *Rhophitoides canus* (BODNARCHUK & RADCHENKO, 1985), also the cases of joint work done by two females in a single nest are registered, but such situations were caused by errors in orientation of bees, and in fact each of them had its own nest. The most of Rophitinae appear to often nest in small loose aggregations, yet it is rare that any species make large aggregations with higher density of nests.

All species build relatively shallow (from 10 up to 30 cm deep) nests in soil. Substrate texture is widely variable, from hard places on the earth road to almost quicksand. Nest entrances are placed on horizontal or sloping, or even on almost vertical surfaces, e.g. in *Systropha punjabensis* (BATRA & MICHENER, 1966). Around the nest entrance there is a tumulus of excavated soil, which is usually eccentric or acentric and bilaterally symmetrical. As a rule, turrets are absent, but they often occur in nests of *Rhophitoides canus* (Fig. 13). Nests are branched or linear branched and seem to always have progressive disposition of laterals (Figs. 14, 15). The last are short and subhorizontal; they are filled with soil after being completely constructed. Blind burrows are absent. The main burrow at nests of many species goes down into the ground at oblique angles, bending considerably at its upper part, and descending more vertically and with less meandering at the lower one.

Cells usually are of spherical or ovaloid form, they are disposed at the ends of laterals. Most species do not plaster any lining on cell walls, but the last are sometimes distinctly harder than, or different in their texture from the substrate. In some species, the cell walls are coated with thin and essentially invisible lining, making this the cell surface at least semi-waterproof. The cell closure is of the shape of more or less concave spiral of three or four coils.

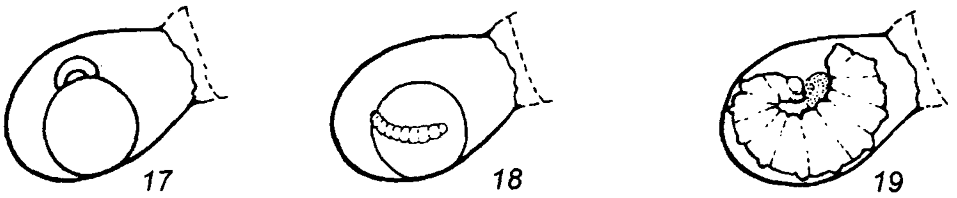


Figs. 13-16. Nests and Dufour's gland in the Rophitinae.
13. Nest turret of *Rhophitoides canus* (from BODNARCHUK & RADCHENKO, 1985: Fig. 1). *14.* Simple branched nest of *Systropha punjabensis* (from BATRA & MICHENER, 1966: Fig. 10), scale line represents 5 cm. *15.* Linear-branched nest of *Sphecodosoma dicksoni* (from ROZEN, 1993: Fig. 20). *16.* Dissected metasoma of the female of *Dufourea novaeangliae*, dorsal view (from EICKWORT et al., 1986: Fig. 9), scale line represents 1 mm).

A female forms already the first loads of pollen into small spheres, and while more loads are added, the pollen ball still always remains spherical. In some species, e.g. *Sphecodosoma dicksoni* (ROZEN, 1993), food masses get coated with a thin transparent and nonreflective waterproof coating. Such a lining is probably produced from the secret of Dufour's gland, which is well developed in the Rophitinae (CANE, 1983a). Also Dufour's gland secretions serve as a component added to the forage, e.g. in *Dufourea novaeangliae* (EICKWORT et al., 1986). For this reason, such females have saliently enlarged glands (Fig. 16).

Eggs are usually hard curved, they are located on the top of the food mass (Fig. 17). The young larvae are elongated, able to crawl around the pollen balls when feeding (Fig. 18). The larval body is provided with projections, and it is knobby (Figs. 19, 20), which promotes movement around the pollen ball, so that the latter reduces in size remaining spherical. The older larvae grasp food mass while feeding on it and pull it away from the cell wall. In this manner they prevent the surface of the forage from growing mouldy, which is very probable in their cells with hygroscopic walls. Adult larvae spin cocoons of salivary silk. The exception is *Conanthalictus*, which do not spin cocoons (ROZEN, 1993). Cocoon fabric (except at the front end) is thin, normally consisting of two layers of silk (except in the case of nonhibernating larva of *Sphecodosoma dicksoni*; ROZEN & MCGINLEY, 1976), between which there is a layer of feces. Defecation commences after all the food is consumed and the outer layer of the cocoon is produced. Feces are accumulated at the rear part of cocoon; the inner layer of silk covers the feces. The front of the cocoon is often made of specialised thicker fabric consisting of several silk layers separated by air spaces, without macropyle (Fig. 21).

All the studied species in Europe are univoltine. Polivoltive species are known in the Nearctic region, e.g. *Sphecodosoma dicksoni* (ROZEN, 1993). The bees overwinter as quiescent prepupae in cocoons. In Europe different species of Biastes parasitise at nests of *Rophites*, *Systropha*, and *Dufourea* (POPOV, 1933), and *Sphecodes divisus* in *Dufourea*.



Figs. 17-19. Cell, egg, larva and pollen ball of *Dufourea mulleri* (from TORCHIO et al., 1967: Figs. 2-4). *17.* Cell containing an egg and pollen ball. *18.* Feeding larva. *19.* Mature larva.

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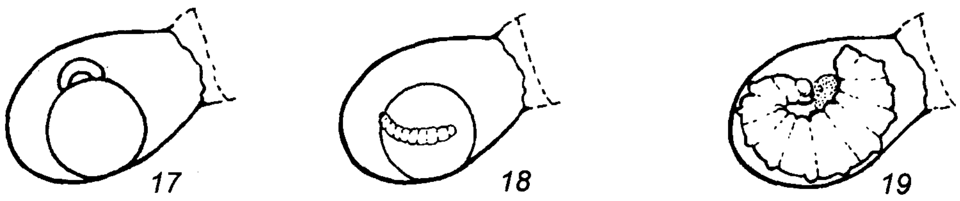
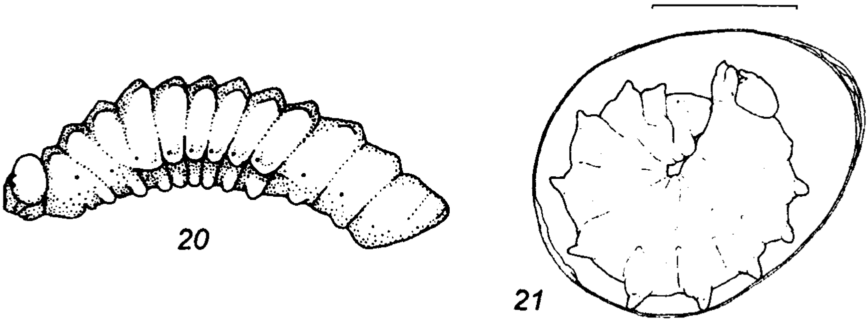


Figs. 17-19. Cell, egg, larva and pollen ball of *Dufourea mulleri* (from TORCHIO et al., 1967: Figs. 2-4). *17.* Cell containing an egg and pollen ball. *18.* Feeding larva. *19.* Mature larva.



Figs. 20, 21. Larva and cocoon of the Rophitinae.
20. Mature larva of *Systropha punjabensis* (from Batra & Michener, 1966: Fig. 13). *21.* Cocoon of *Sphecodosoma dicksoni* (from Rozen, 1993: Fig. 20). Scale lines represent 1 mm.

Main reference: Enslin, 1921: 59-65; Stöckhert, 1922: 381-392; Malyshev, 1925a: 21-26; 1925b: 105-110; 1936: 201-309; Torchio et al., 1967: 132-146; Stephen et al., 1969: 81-109; Rozen & McGinley, 1976: 1-6; Eickwort et al., 1986: 103-120; Rozen, 1993: 1-28; Radchenko & Pesenko, 1994: 14-17.

Subfamily Nomiinae

Diversity and distribution. Members of this family are especially numerous in deserts, subtropics and tropics of the Old World, including Australia. They are relatively poorly represented in the Holarctic region, and are absent in South America. A brief diagnosis of the Nomiinae is given in the key above. The family includes over a thousand currently recognised species. For reasons of tradition and insufficient research on African and Asiatic species of the Nomiinae, for a long time all species of the subfamily were considered as belonging to a single genus, *Nomia* Latreille. Only relatively recently *Nomia* s. l. was divided by Pauly (1990, 1991) into about three dozen genera.

Members of at least nine genera inhabit the Palaearctic region: *Austronomia*, *Crocisaspidia*, *Clavinomia*, *Hoplonomia*, *Lobonomia*, *Nomia*, *Nomiapis*, *Pseudapis*, and *Rhopalomelissa.*. Five species occur in Europe. All of them belong to the genus *Nomiapis*: *N. equestris* (Gerstäcker), *N. monstrosa* (Costa), *N. unidentata* (Olivier), *N. diversipes* (Latreille), and *P. femoralis* (Pallas). The last two species inhabit Poland.

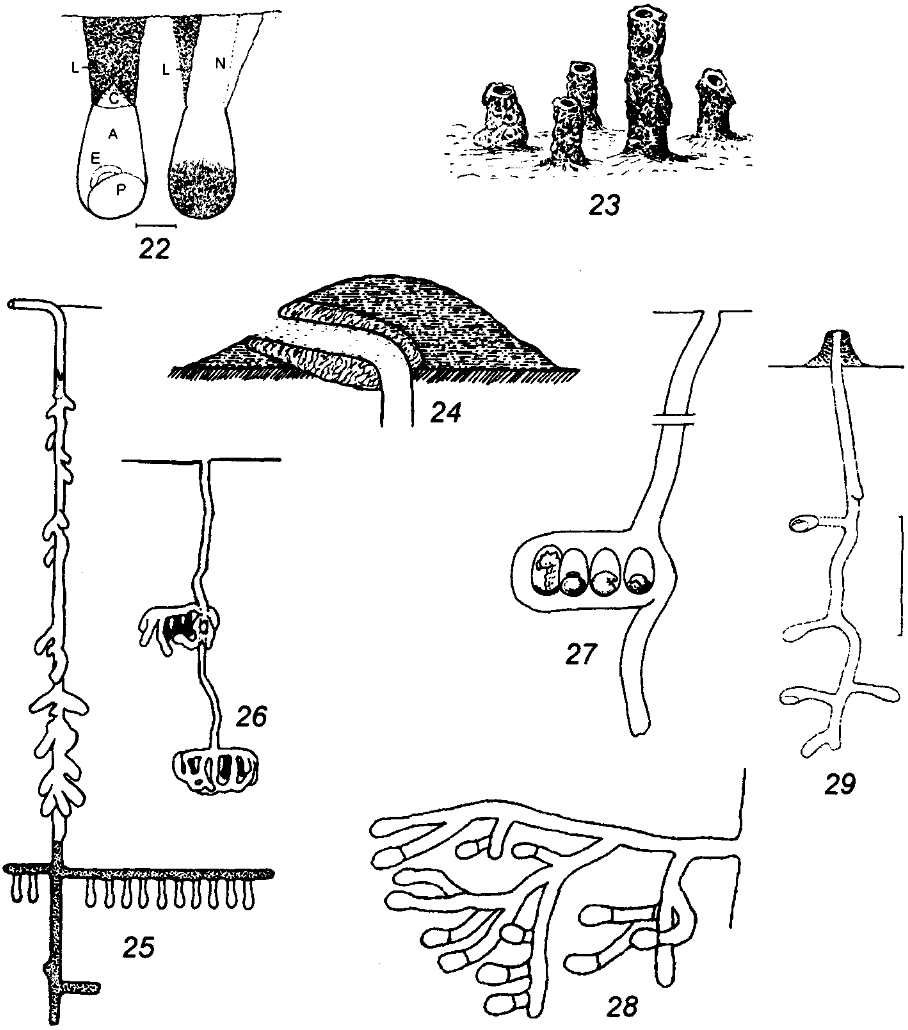
Taxonomy [supplementary references]: Gerstäcker, 1872: 298-308; Friese, 1897: 45-84: Cockerell, 1910: 289-298; 1915: 177-179; 1919: 1-8; 1930: 15-17; 1931b: 213-215; 1931c: 265-283; 1932a: 159-165; 1933: 171-182; 1935a: 161-183; 1935b: 321-329; 1935c: 409-426; 1935d: 333-350; 1939: 123-132; 1944: 46-49; 1946b: 63-67; 1947: 624-641; Blüthgen, 1930a: 768-769;

HIRASHIMA, 1956: 29-30; 1961: 241-303; 1978: 89-101; MICHENER, 1961: 239-240; RIBBLE, 1965: 277-359; WARNCKE, 1976: 93-120; 1980b: 369-372; WU, 1982: 275-279; 1983a: 274-279; 1985: 57-68; PAULY, 1984a: 693-702; 1990: 1-206; 1991: 287-321; PESENKO, 1997: 477-508.

Bionomics. Of about a thousand of nomiine species, nests are known only of 20 species (see review: WCISLO & ENGEL, 1997: Table 1): one-three species in each of the following genera *Acunomia*, *Afronomia*, *Austronomia*, *Curvonomia*, *Dieunomia*, *Hoplonomia*, *Leuconomia*, *Nomia* (sensu lato), *Nomiapis*, *Pseudapis*, and *Rhopalomelissa*. All species nest in soil; many species form dense nest aggregations. Some species built communal nests with multiple females. The most multi-female associations in the Nomiinae comprise very few bees per nest, although up to 12 cohabiting females are recorded for *Nomia* (s. l.) *capitata* (BATRA, 1966a), and up to 20 for *Curvinomia tetrazonata* (WCISLO, 1993).

All behaviourally known nomiines are solitary. A single exception is the Indian *Nomia* (s. l.) *capitata*. It may possibly represent a more saliently hierarchical society, with the division into reproductive and non-reproductive individuals, although further studies are needed to confirm this hypothesis. As BATRA (1966a) justly points out, it is not excluded that *Pseudapis ruficornis* are social, which is suggested by their cell clusters illustrated by GUTBIER (1916) which seem too large to be constructed and provisioned by a single female. At the same time, separate species of the Nomiinae considered solitary probably lead subsocial life. Thus, BATRA & BOHART (1969), who conducted their investigation using artificial nests of *Acunomia melanderi*, have was found that the mother bee partially controls the growth of larvae, and in many cases re-opens the cell with the dead or dying brood attacked by certain fungi and packs it with soil (Fig. 22). In this way the bee creates a barrier to the spread of the mould and blocks sporulation, possibly due to relatively anaerobic conditions. Apart from that, females of *Rhopalomelissa esakii* live in their own burrows for a comparatively long period after the nesting activities have been concluded (Hirashima, 1961); for this reason we suppose that this species possibly exhibits subsocial behaviour (as understood in: RADCHENKO & PESENKO, 1994).

The nest entrances of many nomiines are not noticeably constricted (WCISLO & ENGEL, 1997), unlike those of many halictine nests, which have nest entrances narrowed to approximately the width of a bee's head. The nests of many species have turrets. Usually such turrets are vertical (Fig. 23), but rarely, for example at *Dieunomia triangulifera*, the turrets are placed under the tumulus that functions as a horizontal passage leading from the true tunnel entrance to the edge of the tumulus (Fig. 24). The bees of the last species always plug the entrance both when leaving or entering the nest (CROSS & BOHART, 1960). The nest of *Acunomia melanderi* often has a vertical turret, which serves as a protection against rubbish getting from the surface into the main burrow (STEPHEN, 1960a, 1960b). Differently from the Halictinae, the most Nomiinae do not build a lower blind burrow, although some species, for example *Dieunomia triangulifera* are an exception to this rule (CROSS & BOHART, 1960; Fig. 25).



Figs. 22-29. Nests and their parts in the Nomiinae.

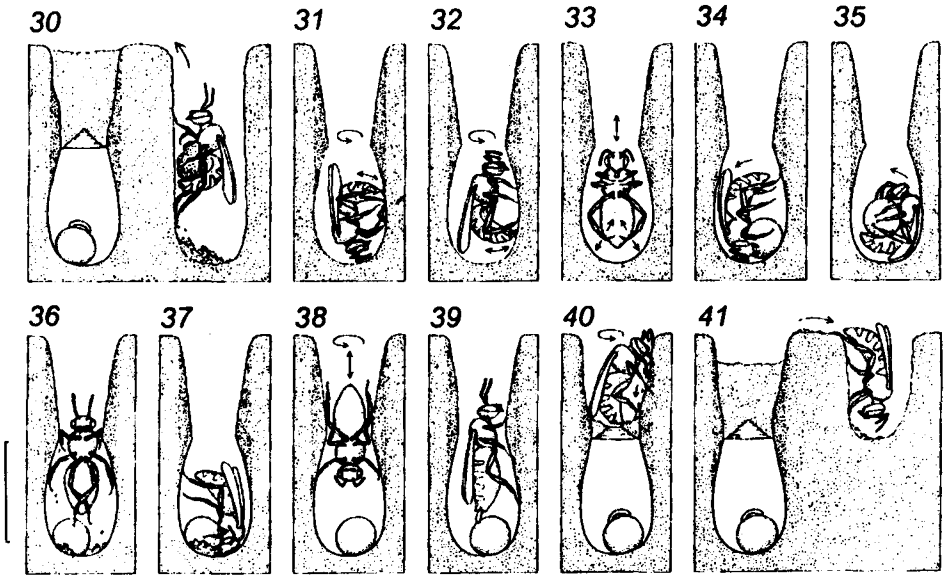
22. Normal (at left) and fungus infected (at right) cells of *Acunomia melanderi* (from BATRA & BOHART, 1969: Fig. 1): A – airspace; P – provision; E – bearing egg; C – cap; L – lateral, which filled loosely with soil; M – fungus micelium that grown over the brood; N – a new lateral that made by female and then filled with compact soil. Scale line represents 1 cm. *23.* Vertical nest turrets of *Rhopalomelissa esakii* (from HIRASHIMA, 1961: Fig. 76). *24.* Curved nest turret of *Dieunomia triangulifera* (from STEPHET et al., 1969: Fig. 255). 25. Nest of *Dieunomia triangulifera* with lower blind burrow (from CROSS & BOHART, 1964: Fig. 6). *26.* Nest of *Pseudapis oxybeloides* (from BATRA, 1966: Fig. 2). *27.* Nest of *Hoplonomia punctulata* (from HIRASHIMA, 1972). *28.* Nest of *Afronomia sjostedti* (from MICHENER, 1969). *29.* Nest of *Rhopalomelissa esakii* (from HIRASHIMA, 1961; Fig. 77), scale line represents 5 cm.

Almost all of the studied species make more or less vertical cells arranged in clusters. Such clusters are placed either at the end of the vertical main burrow or at the extremities of laterals, being often surrounded by at least partial chamber (Figs. 26, 27). However, for such species as Nomia (s. l.) nasicana (Batra, 1966a), *Afronomia sjostedti* (MICHENER, 1969b), *Rhopalomelissa esakii* and *Rh. yasumatsui* (Hirashima, 1961), there are indications of horizontal orientation of cells which are scattered along the main burrow or arranged at the ends of laterals (Figs. 28, 29). The cells of the most of the known nomiines are radially symmetrical. The inner cell walls are smoothed and lined by secreted material produced by Dufour's gland. The lactone composition of Dufour's gland secretions of nomiines is different from that in two other halictid subfamilies (Duffield et al., 1982, 1984). The evidence available shows that nomiines apply the lactones in a manner similar to that of halictines (Batra, 1970). The neck of the cell has embedded soil walls. The order of cell construction is described in detail by BATRA (1970, 1984), who carried out observations of nests of Acunomia melanderi located in special observational constructions (Figs. 30-41). Pollen is formed in a little ball from the very beginning of its storage (BATRA, 1984). The shape of food masses in the Nomiinae vary from species to species (CROSS & BOHART, 1960; STEPHEN et al., 1969). Many Nearctic species are characterised by unusual form of the pollen ball, which has thin equatorial rim (Fig. 42). It is interesting that in the form of pollen balls even the subspecies differences are found out, especially in *Dieunomia nevadensis* (Figs. 43, 44). For *Nomiapis diversipes* a re-use of old cells after their re-lining is indicated (ROZEN, 1986). Such a behaviour is extremely rarely met among solitary bees. In different species the eggs are placed either on the top of the pollen ball or on one side of it, e.g. in *Austronomia australica* (Fig. 45). Among nomiines at least *Acunomia melanderi* has five larval stages (HACKWELL & STEPHEN, 1966); for other species such data are remain unknown. Adult larvae are disposed in vertically oriented cells, being as well vertically oriented, their heads up. The head part of larvae is hard curved and perpendicular to the rest of the body (Fig. 46). BIENYENU & ATCHION (1968) found microbial inhibition in prepupae of A. melanderi, but they could not establish such an activity in the cell lining of this species. Larvae of all the studied species do not spin cocoons. Prepupae hibernate in the cells.

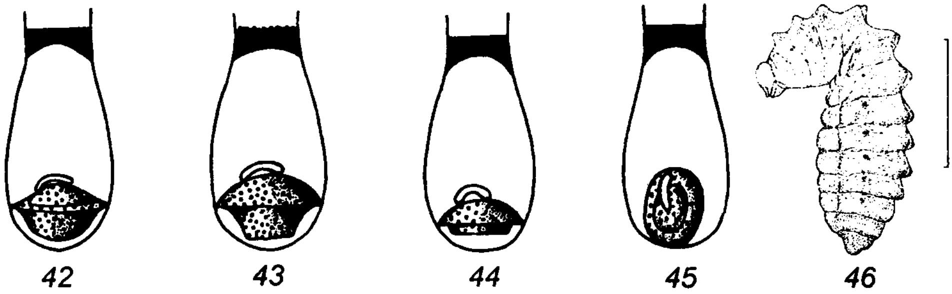
The most of species are oligoleges of Fabaceae. *A. melanderi* are artificially reared in USA for alfalfa pollination (BOHART, 1958; STEPHEN, 1960a, 1960b), and for the same reason were even introduced to New Zealand (STARK, 1975, DONOVAN, 1980).

In Europe, the bees of genera *Pasites* and *Triepeolus* are usual cleptoparasites of nomiines.

Main references: CROSS & BOHART, 1960: 761-792; HIRASHIMA, 1961: 241-303; BATRA, 1966a: 145-154; MICHENER, 1969b: 473-497; STEPHEN et al., 1969: 83-115; WCISLO, 1993: 813-821; RADCHENKO & PESENKO, 1994: 74-109; WCISLO & BUCHMANN, 1995: 1015-1027; WCISLO & ENGEL, 1997: 158-167.



Figs. 30-41.Cell construction by *Acunomia melanderi* (from BATRA, 1984 after BATRA, 1970: Fig. 4). *30*. Female finished one cell and begun excavating another. *31*. Female smoothes the inside of the cell with her pygidial plate and makes the cell neck by addition of soil to new cell. *32*. Tamping the cell. *33*. Application of waterproof lining by glossa and penicilli of the hind basitarsi. *34*, *35*. Pollen ball manipulation. *36*. Pollen ball grooming. *37*. Removal of debris from the cell. *38*. Rubbing cell neck and more polishing of the cell walls. *39*. Oviposition. *40*. Cell cap construction. *41*. Cell closure and initiation of a burrow for new cell. (Arrows indicate direction of movements.)



Figs. 42-46. Cells with pollen balls and preimaginal phases of the Nomiinae.
42. Cell of *Dieunomia triangulifera* (from CROSS & BOHART, 1960: Fig. 4; with additions). *43*. Cell of *Dieunomia nevadensis arisonensis* (from CROSS & BOHART, 1960: Fig. 4: with additions). *44*. Cell of *Dieunomia nevadensis bakeri* (from KERFOOT, 1964: Fig. 1; with additions). *45*. Cell of *Austronomia australica* (from RAYMENT, 1956). *46*. Mature larva of *Hoplonomia punctulata* (from HIRASHIMA, 1961: Fig. 67), scale line represents 5 mm.

Subfamily Halictinae: taxonomy

Diversity and distribution. This is a very large and nearly cosmopolitan subfamily. It includes certainly over four thousand species. A brief diagnosis of the Halictinae is given in the key to the subfamilies of the Halictidae above. The subfamily Halictinae was subdivided by Michener (1978b) into three tribes: Nomioidini, Augochloni and Halictini. Later, ALEXANDER & MICHENER (1995) considered the nomioidines as a separate subfamily basing on their phylogenetic analyses (see above). PESENKO (2000a) has reanalysed phylogenetic relationships in the family Halictidae and proposed a renovated classification of the subfamily Halictinae in which the nomioidines are restored as a tribe within the Halictinae. Also the tribe Halictini was subdivided by him into three subtribes. Brief diagnoses of all the tribes and subtribes are given in the key below. This key was compiled from MICHENER (1978b) and PESENKO (1983, 2000a).

Taxonomy [supplementary references]: STRAND, 1909: 1-62; 1910: 179-211; 1921: 305-322; BLÜTHGEN, 1918-1961 (see "Literature cited"); FRIESE, 1916: 25-34; MEYER, 1920: 161-244; 1922: 165-174; 1925: 1-12; PERKINS, 1922b: 46-52, 94-101, 167-174; SANDHOUSE, 1924: 1-43; 1933: 78-83; 1941: 23-39; COCKERELL, 1925: 1-12; 1932b: 247-248; 1937a: 1-6; 1937b: 1-12; 1937c: 42-108; 1938: 1-9; 1942: 191-194; 1945a: 119-125; 1945b: 153-156; 1945c: 129-135; 1946a: 7-10; 1946c: 15-18; 1946d: 42-44; 1946e: 88-89; 1946f: 158-161; 1946g: 177-184; ŠUSTERA, 1959: 169-180; EICKWORT. 1969a: 652-660; 1969b: 325-524; EBMER, 1969-1997 (see 'Literature cited'); HIRASHIMA. 1957: 1-30; MÓCZÁR. 1967: 1-116: ROBERTS, 1972: 437-590; 1973a: 1-23; 1973b: 1-23; WARNCKE. 1973a: 23-26: 1973b: 277-295; 1975a: 81-128; 1982a: 67-166; 1992a: 9-64; MICHENER, 1978a: 291-339; 1978b: 501-538; 1980: 1-21; OSYTSHNJUK, 1978: 370-415; PAULY, 1980a: 11-28; 1980b: 1-10; 1980c: 119-125; 1981: 263-274; 1984b: 121-156; 1986: 1-58; 1989: 41-49; 1999: 137-196; PESENKO, 1983: 1-199; 1984a: 340-356; 1984b: 446-481; 1984c: 16-32; 1984d: 33-48; 1985: 77-105; 1986a: 113-151; 1986b: 618-632; 1988: 126-141; 1996: 493-516; MCGINLEY, 1986: 1-294; ROBERTS & BROOKS, 1987: 357-392; SAKAGAMI & EBMER, 1987: 301-357; 1996: 899-916; FAN, 1990: 92-97; 1991: 478-482; 1992: 346-349; FAN & WU, 1991: 89-93; PESENKO & WU, 1991: 454-458; 1997a: 202-206; 1997b: 287-296; SAKAGAMI, 1991: 169-178; FAN & EBMER, 1992: 234-240; SAKAGAMI & TADAUCHI, 1995: 177-200; SAKAGAMI et al., 1996: 143-189.

KEY TO TRIBES AND SUBTRIBES OF THE HALICTINAE

1. Clypeus divided into three lobes by anterior tentorial pits lowered to lower margin of clypeus. Labrum in female with a broad trapezoidal apical process flattened dorsoventrally. Fimbria of metasomal tergum V of female not divided by a longitudinal specialised area. Metasomal tergum VII of male hidden by tergum VI, flattened and hairless .... Tribe **Nomioidini**

– Clypeus entire, anterior tentorial pits placed on level of middle or upper half of clypeus. Labrum in female apically ending in a process with a strong laterally compressed keel. Fimbria of tergum V in females of nonparasitic forms divided by a longitudinal median minutely pilose area. Tergum VII of male outer, not hidden by tergum VI 2

2. Longitudinal median specialised area of metasomal tergum V in females of non-parasitic forms divided by a deep cleft in posterior tergal margin. Metasomal tergum VII of male usual, without a transverse premarginal ridge or carina forming a false apex .... Tribe **Augochlorini**
– Longitudinal median specialised area of tergum V of female not divided by a cleft. Tergum VII of male with a transverse ridge, usually carinate, forming a false apex beneath which the tergum is strongly reflexed to morphological posterior margin; surface above this transverse ridge usually with a recognisable hairless pygidial plate. (Tribe **Halictini**) 3
3. Median apical process of labrum in female broad, not sharp at end, without a longitudinal keel. Metabasitibial plates absent. Hind tibia of female without scopa. Hind basitarsus of female without penicillus. Fimbria of metasomal tergum V of female not divided by a longitudinal specialised area .... Subtribe **Sphecodina**
– Median apical process of labrum narrow, sharp or narrowly rounded at end, with a strong longitudinal keel. Metabasitibial plates in female well defined laterally and distally. Hind tibiae of female with a scopa of plumose hairs. Hind basitarsus of female with a penicillus. Fimbria of tergum V of female divided by a longitudinal median minutely pilose area 4
4. Venation of forewings "strong": distal transversal "cubital" veins (*r-m* and *m-cu*) having same thickness and coloration as more proximal veins. Gonostylus large, not less than one third of gonocoxite, often double or bifid .... Subtribe **Halictina**
– Venation "weak": at least distal transversal veins *2 r-m* and *2 m-cu* half as wide or thinner than proximal veins; this character better manifesting in females). Gonostylus simple, usually less than one third of gonocoxite .... Subtribe **Gastrohalictina**

Tribe Nomioidini. The tribe contains 62 species inhabiting only the Old World, mostly arid and semiarid areas; in Australia it is represented by a single species. The tribe includes three genera (PESENKO, 1993, 1996, 2000b): *Cellariella* STRAND, endemic of Afrotropical Region and Madagascar, and widely distributed in warm territories of Africa, Europe and Asia *Ceylalictus* STRAND (with three subgenera) and *Nomioides* SCHENCK (with three subgenera).

Tribe Augochlorini. It contains over 500 species belonging to 31 genera (see: EICKWORT, 1969b; MOURE & HURD, 1987; with additions from MICHENER, 1995; ENGEL, 1995a, 1995b, 1996, 1997a, 1997b, 1999; ENGEL et al., 1997; ENGEL & KLEIN, 1997; MICHENER & POINAR, 1997; BROOKS & ENGEL, 1998, 1999) including the cleptoparasitic *Temnosoma* SMITH and two fossil genera. Members of this tribe inhabit only the New World.

Tribe Halictini. This, the most tribe of the subfamily Halictinae, was subdivided by PESENKO (2000a) into the three following subtribes: Halictina, Gastrohalictina and Sphecodina.

Subtribe Halictina. This subtribe corresponds to the group of genera of the Halictini with strong venation by MICHENER (1978b), but does not include *Sphecodes* and allied genera (MICHENER, 1978a) which are distinguished here as a separate subtribe. The subtribe Halictina is nearly cosmopolitan in occurrence. It contains two groups of genera.

The first group includes the genera inhabiting only the Western Hemisphere (see: MOURE & HURD, 1987): *Habralictus* MOURE, *Mexalictus* EICKWORT and eleven genera of the *Agapostemon* group.

The second group contains the genera occurring only (or mostly, e.g. *Halictus* and *Seladonia*) in the Eastern Hemisphere: *Archihalictus* PAULY, *Glossodialictus* PAULY, *Halictus* LATREILLE (also represented in North America by five species; including 12 subgenera), *Madagalictus* PAULY, *Pachyhalictus* COCKERELL (with two subgenera), *Paraseladonia* PAULY (cleptoparasitic), *Parathrincostoma* BLÜTHGEN (cleptoparasitic), *Patellapis* FRIESE (with three subgenera), *Seladonia* ROBERTSON (also represented in North America by seven species), *Thrinchostoma* SAUSSURE (with three subgenera), *Thrincohalictus* BLÜTHGEN, *Vestitohalictus* BLÜTHGEN, and *Zonalictus* MICHENER.

Subtribe Gastrohalictina. This subtribe corresponds to the group of genera of the Halictini with weak venation by MICHENER (1978b: 502). It may be subdivided into three conditional generic groups in accordance with distributions of their members.

The first group includes two nearly cosmopolitan genera (both absent in Australia): *Evylaeus* ROBERTSON (including *Dialictus*) and *Lasioglossum* CURTIS (mostly Holarctic; with 10 subgenera only in the Palaearctic fauna).

The second group contains four New World genera (see: MOURE & HURD, 1987) including the cleptoparasitic *Paralictus* ROBERTSON.

The third group consists of the following Old World genera, mostly Palaeotropical: *Afrodialictus* PAULY, *Ctenonomia* CAMERON, *Echthralictus* PERKINS et CHEESMAN (cleptoparasitic), *Homalictus* COCKERELL, *Ipomalictus* PAULY, *Lucasiellus* COCKERELL, *Mediocralictus* PAULY, *Oxyhalictus* COCKERELL et IRELAND, *Paradialictus* PAULY (cleptoparasitic), *Parasphecodes* SMITH, *Rubrihalictus* PAULY, *Sellalictus* PAULY, *Sudila* CAMERON, and *Urohalictus* MICHENER. This group includes certainly also seven endemic Australian genera considered by MICHENER (1965) as subgenera of *Lasioglossum*.

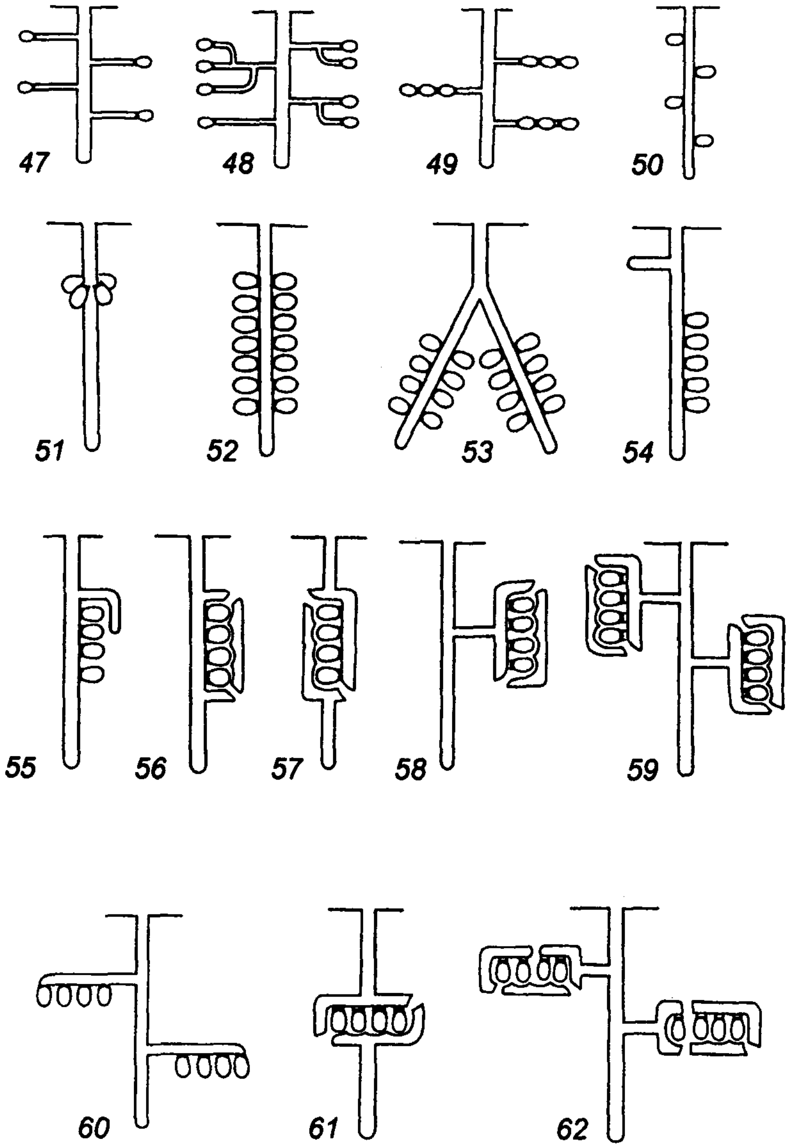
Subtribe Sphecodina. This subtribe, cosmopolitan in distribution, contains only cleptoparasitic forms and corresponds to the *Sphecodes* genus-group by MICHENER (1978a). It includes five genera: *Austrosphecodes* MICHENER (Neotropical), *Eupetersia* BLÜTHGEN (Palaeotropical, with three subgenera), *Microsphecodes* EICKWORT et STAGE (Neotropical), *Ptilocleptis* MICHENER (Neotropical), and *Sphecodes* LATREILLE (nearly cosmopolitan but absent in South America, with two subgenera).

The following genera of the Halictinae inhabit the Palaearctic region: *Ceylalictus*, *Nomioides*, *Halictus*, *Pachyhalictus*, *Seladonia*, *Thrincohalictus*, *Vestitohalictus*, *Evylaeus*, *Lasioglossum*, *Ctenonomia*, *Lucasiellus*, *Sphecodes*. In Europe, 268 species of almost all the genera listed above occur (except for large Palaeotropic genera *Pachyhalictus* and *Ctenonomia*; each of which is represented in the Palaearctic region by few species). Only six genera (including *Sphecodes*) are represented in Poland where 92 species of the Halictinae are recorded.

Subfamily Halictinae: bionomics

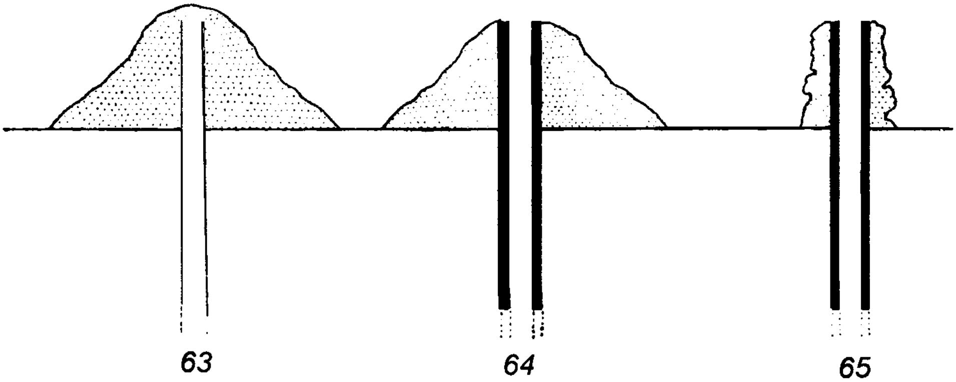
Main kinds of nest patterns. The nest architecture of the Halictinae was studied in detail by SAKAGAMI & MICHENER (1962), with taking into account the most of data existent by that time. These authors have distinguished 8 types and 11 subtypes of halictine nests. In those groups one finds almost all known nest types proper to burrowing bees (Figs. 47-62). The most species build their nests in soil, although some of them sporadically or constantly settle in rotten wood, e.g. some Augochlorini. Some species exhibit a great plasticity in the choice of place for nest construction. For example, nests of *Halictus rubicundus* were registered both in ground (BONELLI, 1967b; BATRA, 1968; and some others), and in rotten wood (MICHENER & WILLE, 1961).

Halictine nests are as a rule characterised by the presence of nest turrets, which are formed in result of cementation of soil particles on the walls of the entrance passing through a conical tumulus. Due to that, after the tumulus gets washed away by rains there remains a vertical turret on the surface (Figs. 63-65). The most species make the lower blind burrow constituting one of the most salient peculiarities of halictine nests. For the brood rearing the bees construct cells usually ellipsoid in their form and bilaterally symmetrical. In most species the cells are oriented horizontally, and their lower part is always flatter than the rest of the walls. Halictines, which build inclined or vertically oriented cells, make one of the cell walls flatter than others. At this wall the pollen ball is usually placed, being sometimes attached to it. Considering such a peculiarity of the cell structure, MICHENER (1964) has come to a conclusion about primary nature of horizontally oriented cells. In each species the form and the size of cells are constant, with the exception of some differences in size that are closely associated with sexual dimorphism. At the same time in species leading advanced social mode of life and having female castes, cells that produce workers are of smaller average size than those producing queens. Even to a greater degree such distinctions are exhibited in the size of pollen balls prepared for the brood rearing by different castes.



Figs. 47-62. Main kinds of nest patterns.

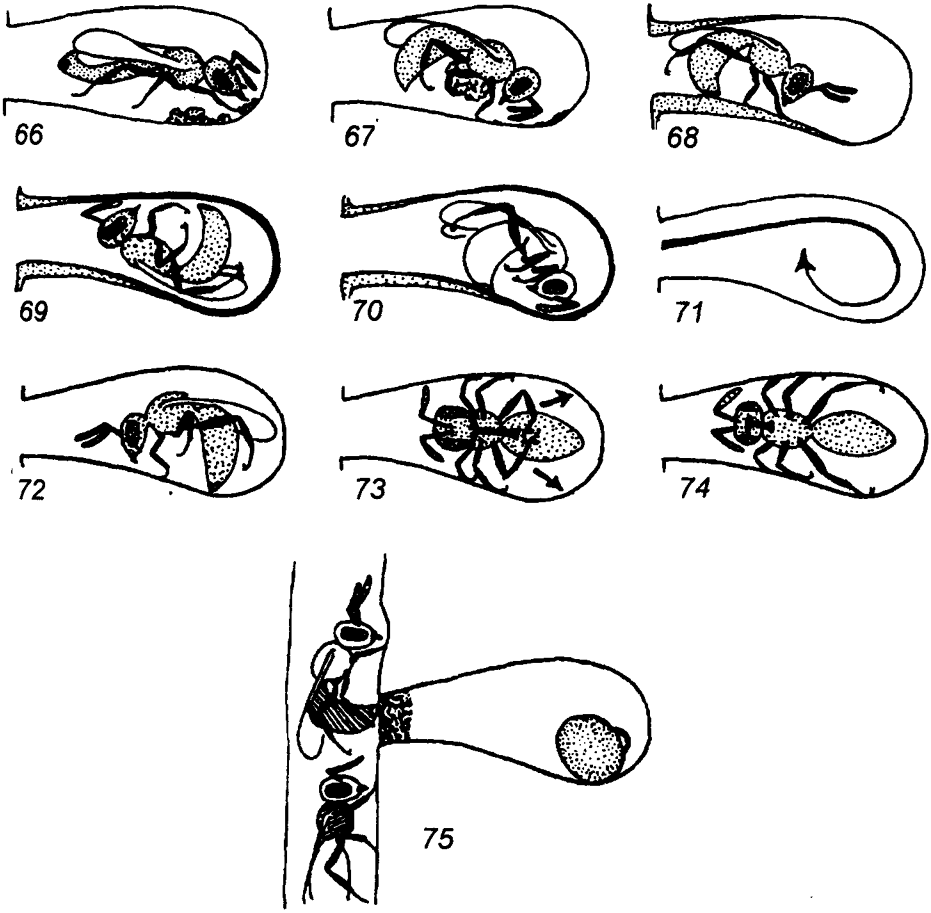
47. Simple branched nest. *48.* Twice-branched nest. *49.* Linear-branched nest. *50.* Nest with sessile cells dispersally deposited along the main burrow. *51.* Nest with sessile cells deposited along the main burrow. *52.* Nest with sessile cells forming clusters. *53.* Branched nest with sessile cells forming clusters. *54.* Nest with lateral blind burrow and sessile cells deposited at one side of the main burrow. *55.* Nest with partly formed chamber. *56.* Nest with complete chamber deposited near the main burrow. *57.* Nest with complete chamber deposited within the main burrow. *58.* Nest with complete chamber deposited at the end of the main burrow. *59.* Brunched nest with chambers. *60.* Brunched nest with vertically oriented cells. *61.* Chamber nest with vertically oriented cells. *62.* Chamber branched nest with vertically oriented cells.



Figs.63-65. Nest tumuli and turret of *Evylaeus marginatus* (from PLATEAUX-QUÉNU, 1960b: Fig. 5a-c).
63. Tumulus around the entrance of the nest. *64*. Tumulus with forced walls. *65*. Nest turret.

Stages of nest construction. All halictines apply pygidial method of cell construction (after the nomenclature adopted in RADCHENKO & PESENKO, 1994). The representatives of the tribes Augochlorini and Halictini, with the exception of the species of *Agapostemon* (ROBERTS, 1969) during the cell construction dig a cavity of a size larger than the final size of the cell. The bees coat the inner walls of such a cavity with thin layers (up to 1-2 mm thick) of sift soil obtained in another place of the nest; usually it is taken from blind burrows. As a result the thin inner layer of cell walls differs in structure, and sometimes in colour from the soil surrounding them. The picture of such cells construction was clarified in every detail owing to the results of observations of artificial nests of *Evylaeus zephyrus* which were carried out by BATRA (1964, 1966b) (Figs. 66-75). Similarly to the species that have built-in cell walls of transported soil, some representatives of Augochlorini settling in rotten wood cover the cell walls with layers of sawdust (STOCKHAMMER, 1966).

Females smooth and ram the inner cell walls with the help of the pygidial plate and then cover it with water-proof lining made of secreted material, which is produced by Dufour's gland (BERGSTRÖM, 1974; MAY, 1974; HEFETZ et al., 1978; CANE, 1981, 1983; DUFFIELD et al., 1981, 1982; HEFETZ, 1987). The bee puts the lining on the wall with a brush on the top of its metabasitarsus. The main functions of the cell lining are seen in the maintaining the optimum humidity and in the additional fixation of the cell walls. As well, the lining has fungicide and bactericide properties (MAY, 1974). The burrowing bees never destroy the cells with the growing brood, although their burrows frequently pass very close to cells, especially in dense nest aggregations. The safety of cells is also ensured by secreted lining. At the same time abandoned cells, from which bees are emerged, can be destroyed by the digging bees. In difference from most bees, some species of Halictinae, in particular *Evylaeus seabrai* (SAKAGAMI & MOURE, 1967), occasionally re-use the old cells after their preliminary re-lining.

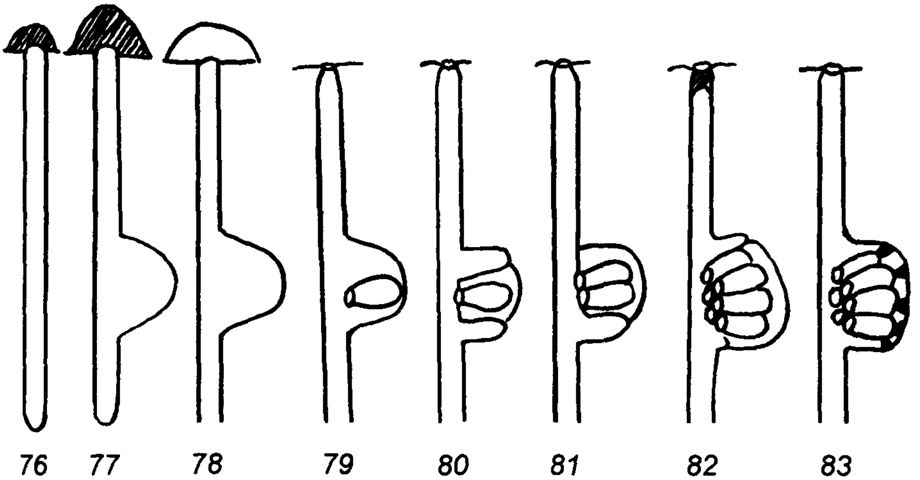


Figs. 66-75. Sketches showing methods of cell construction by *Evylaeus zephyrus*. Different individuals are indicated by different patterns of shading (from BATRA, 1964: Figs. 15a-i, 17f).
66. Cell excavation. *67*, *68*. Excavated soil is carried back and used to form the narrow neck of the cell. *69*, *70*. Soil taken from burrows is used to line cell - here it is being packed down with the pygidial plate. *71*. Diagram of route commonly taken by bees while working in cell. *72*. Bee rubbing with apex of abdomen, presumably depositing secretion of Dufour's gland. *73*, *74*. Sequence in use of tongue and penicilli in spreading waxlike cell lining, at least part of which probably comes from Dufour's gland. *75*. Egg-layer plugs cell with soil.

Many of halictines characteristically construct nest chambers inside of which the cells are placed. The ways of the chambered nest construction are essentially different in different species. Thus, females of *Evylaeus linearis* at first build all the group of cells, and then dig it around with numerous burrows forming the chamber. Females of *Halictus quadricinctus* begin to form the nest chamber earlier – in the course of the building of cells. The uppermost cells, which are built first, are at once separated from the surrounding soil, whereas new cells of a given group, which are built later, remain tightly imbedded into the substrate (KNERER & PLATEAUX-QUÉNU, 1970). BONELLI (1965a, 1968) has informed that in *Evylaeus* calceatus the cell clusters are most probably formed not by excavation, being erected inside of a spacious chamber previously constructed by the bee, because in the nests he studied the females constructed chambers before the beginning of cell construction. BONELLI's supposition has been supported by MICHENER (1974) and PACKER (1983), who do not see an essential difference between the construction of an inner layer from substrate material inside of an excavated cell and independent erection of all cell walls inside the free space of a large nest chamber. Still this opinion seems to us to be erroneous. Such a method of construction can be realised only with the use of mandibles. In fact, the halictines construct cells (including embedding of their inner walls and cap) in chambers filled with soil, and applying only the pygidial method.

So, females of *Evylaeus calceatus, E. malachurus* and some other halictine species can excavate the nest chamber before the beginning of cell construction, however after this they re-fill such a chamber with sift soil transported from another place of the nest, usually from the blind burrows. Only afterwards the female excavates a cell inside the brought soil (Figs. 76-83). Such an unusual method of cell construction permits to avoid possible obstacles (which can be presented by large stones and other soil inclusions) to forming a dense cluster of cells with very thin built-in walls. In distinction from the nests, in which the group of cells is excavated in intact soil and usually increases progressively downwards (for example, this is the case with *Halictus quadricinctus*), in species which build the cells in chambers filled with soil (for example, *Evylaeus nigripes*; KNERER & PLATEAUX-QUÉNU, 1970), the group of cells can grow only upwards and asides. The group of cells in such nests is almost always surrounded by chambers, which grow as the size of the group grows. The inner walls of a chamber are as a rule rough and not submitted to any special treatment, being the exception of *Evylaeus duplex* (SAKAGAMI & HAYASHIDA, 1960) and *Megommation insigne* (MICHENER & LANGE, 1958c), in which they are smoothed.

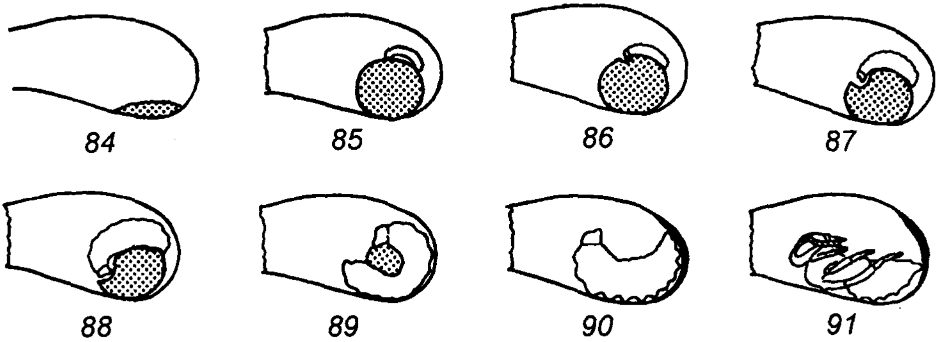
Evylaeus malachurus usually builds a chamber around the cells only for rearing the first brood of workers. SAKAGAMI & HAYASHIDA (1968) suppose that this is due to difficulties presented by construction of a chamber around immense cell cluster with reproductive offspring, and by holding it on thin soil columns. Construction of chambers is possibly a mode of adaptation to nesting in slowly drying soil (KNERER, 1980b; PACKER, 1983). However it is unlikely that there exists distinct correlation between the soil characteristics of the substrate and the appearance of chambers among various groups of Halictinae (SAKAGAMI & MICHENER, 1962).



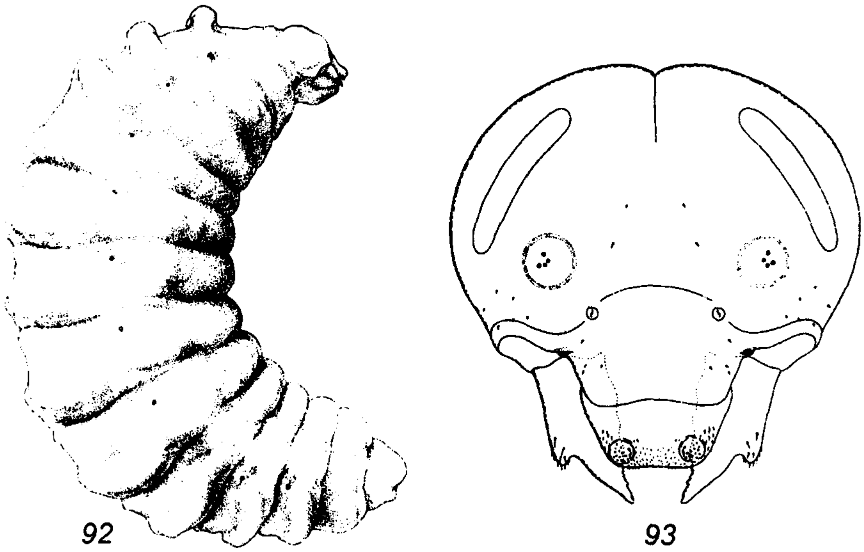
Figs. 76-83. Sequence of cell construction and forming of nest chamber by *Evylaeus malachurus* (from KNERER & PLATEAUX- QUÉNU, 1967b: Figs. 1-7, 9).
76. New nest with alone main burrow. *77.* Nest with empty chamber. *78.* Nest with chamber that filled with a fine soil. *79, 80, 81, 82.* Construction of the cells in the chamber with filled soil. *83.* Cells cluster surrounded by air space.

The ways of constructing chambers vary among different species. Thus, some species, for instance *Evylaeus calceatus*, build a cluster of several cells at the end of the additional (secondary) burrow. In the sequel this cluster gets dug around with burrows forming a chamber (PLATEAUX-QUÉNU, 1964; SAKAGAMI & MUNAKATA, 1972). Other species, e.g. *Evylaeus nigripes* (KNERER & PLATEAUX-QUÉNU, 1970) and E. laticeps (PACKER, 1983), construct a chamber at once after building the first cell; this chamber grows as the number of cells increases. In clusters the cells are disposed close to each other, so that the distance between them usually amounts to several millimetres and occasionally, e.g. in *Evylaeus duplex*, to merely 1 mm (SAKAGAMI & HAYASHIDA, 1960).

The forage usually is deposited at the bottom of the cell and usually has a form of small spherical loaf more or less flattened at the poles (Figs. 84, 85). The egg lies on the top of the forage. In most species of halictines (except for some eusocial species, see below) cells are plugged with a cover. Larvae feed on the top of the pollen ball, without moving around it (Figs. 86-89). Having concluded its feeding, the larva lies on its back at the bottom of the cell and throws out excrement, which is put on the upper distal part of the cell (Figs. 90-91). Adult larvae of halictines have a thick worm-like body (Fig. 92) with a small rounded head possessing chitinised mandibles (Fig. 93). Larvae do not spin cocoons. Larvae pupate and transform into imagoes within one season. All the species except Nomioidini hibernate in the imago phase, having the imagoes already emerged and copulated.



Figs. 84-91. Growth of immature *Evylaeus imitatus* (from MICHENER & WILLE, 1961).
84. Cell being provisioned. *85*. Complete pollen ball with egg. *86-89*. Stages in larval feeding and growth. *90*. Prepupa. *91*. Pupa.



Figs. 92, 93. Mature larva (*92*) and its head (*93*) of *Halictus scabiosae*
(from GRANDI, 1961: Figs. 355, 356).

The discovery and study of social life in halictines. The existence of eusociality in halictines was supposed by many authors as early as in the XIX century. However, colonies of halictines were regarded then rather as communities where every individual was able to produce offspring, even if some division of labour between them was not totally excluded. The proof that in halictine colonies there is authentic non-reproductive caste of working individuals appeared only in the works of NOLL (1931), who was the first to undertake artificial management of halictine bees (in particular, *Evylaeus malachurus*), and in his investigation of ovaries of different females from the same nest discovered sharp differences between the degree of their development in the queen and the workers.

Large-scale investigations of eusocial colonies of halictines were launched in the late 50's of the XX century by PLATEAUX-QUÉNU in France, MICHENER with his colleagues and students in America, and SAKAGAMI with his fellows in Japan. The majority of numerous studies on nesting in halictines issued after the simplified method of their artificial rearing in observational nest constructions, which permits to see the internal world of underground nest, was introduced (MICHENER & BROTHERS, 1971; BELL et al., 1974). Regrettably, these investigations concerned the artificially created so called 'semisocial' colonies, where one of the workers functioned as the queen. Such a female is considerably different from a true queen in many of its behavioural, physiological, and often also morphological traits. Apart from that, in a large part of relevant experiments artificial colonies composed of unrelated individuals were unintentionally used, which unfortunately often fails to be clearly stated in the publications. Another source of confusion is the extended use of the term 'queen' for the egg-laying female dominating over its sisters and contemporaries in 'semisocial' groups. Thus conclusions obtained due to experiments carried out in artificial colonies partly call for supporting evidence to be provided by investigations of natural halictine colonies.

In 50-90s investigators of halictines, in spite of certain defects of the methods applied, obtained superb results and made a number of discoveries concerning different aspects of within-nest behaviour of the bees. Particular interest held in halictines is due not only to the fact of their eusociality itself, but even more to the existence in halictines of several sociality levels, from that of solitary species up to primitively-eusocial colonies; moreover, even closely related species happen to be far distant on this scale. This has made halictines a promising object for searching for intermediate phases leading to eusocial organisation. Halictine colonies have provided a sort of field data for verification of various consequences and predictions following from different hypotheses on the origins of eusociality in Hymenoptera. Some of the discoveries directly confirm predictions of the HAMILTON's (1964) haplodiploidy hypothesis of the origin of eusociality: 'insubordination' of the workers to the egg-laying female unrelated to them (SMITH, 1987); workers' ability in primitively-eusocial species of controlling the sex ratio in the brood (PLATEAUX-QUÉNU, 1983); prevention of multiple mating of females due to chemical marker left by males on the body of females after copulation (KUKUK, 1985). In addition, being established the fact of obligatory control over the brood's development in eusocial halictine species (BATRA, 1968; KNERER, 1969a), it is clear that subsocial organisation constitutes the only way of the rise of eusociality. Nevertheless, the data concerning eusocial halictine species remain to be rather scarce. Apart from the general reasons (presently we know something about the nesting of only 3 % of the species of the world Apoidea fauna), this is also caused by the relative lateness of the discovery of eusociality in halictines, which makes it imperative to carry out profound and specific investigations in order to establish the fact of solitary/eusocial mode of their life.

Distribution of eusocial species among halictine taxa. In the present time, solitary mode of life is unequivocally established for only 25 halictine species. In this connection the list of halictine taxa in which eusocial species fail to appear, as well as the ratio of social and solitary species in other taxa, is a matter of debate. With sufficient confidence one may presently state that there is no eusocial life in the tribe Nomioidini, as well as in such a great and relatively well studied genera of the tribe Halictini as *Caenohalictus*, *Habralictus*, *Homalictus*, and *Lasioglossum*[1], in *Agapostemon* group of genera, and in some others. By contrast to the Halictini, in the tribe Augochlorini, the genera, which include only solitary species, seem to be very few. In total, eusocial life is discovered in 74 species of 100 halictine species whose biology is sufficiently studied (these species are listed by RADCHENKO, 1993; RADCHENKO & PESENKO, 1994; EICKWORT et al., 1996).

In the tribe Halictini, which includes 44 genera of non-parasitic bees, eusocial species are found in three genera: *Evylaeus* (*+Dialictus)*, *Halictus*, and *Seladonia*. In the genus *Seladonia* all of the well-studied species lead eusocial life. Only for *S. virgatellus* the possibility of solitary life is admitted (PACKER et al., 1989). Eusocial life appears to be characteristic of the most species of the genus *Halictus*. Thus in this genus out of 17 well-studied species eusocial life is established in 14 ones, while only three species, namely *Halictus quadricinctus* (GROZDANIĆ, 1969), *H. sexcinctus* (KNERER, 1980b), and *H. tsingtouensis* (SAKAGAMI, 1980), definitely lead solitary life. Judging by such indirect indications as the males' flight at the end of the season only, and overwhelming female predominance in collections, it is likely that many other species of the genus *Halictus* also lead eusocial life. In the most numerous and well-studied halictine genus *Evylaeus* eusociality is already attested for 35 species. Solitary mode of life is uncontroversially established in 17 species only: *Evylaeus opacus* (MICHENER & LANGE, 1958b), *E. oenotherae* (KNERER & MACKAY, 1969), *E. villosulus* (PLATEAUX-QUÉNU et al., 1989), *E. allodalus*,

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[1] PACKER (1997, 1998), basing on indirect data, believes that *Lasiglossum aegyptiellum*, inhabiting the Mediterranean basin and Central Asia, is possibly eusocial.

E. nitidiusculus, *E. parvulus* (SAKAGAMI et al., 1985), *E. quadrinotatulus* (SITDIKOV, 1987), *E. nupricola* (SAKAGAMI, 1988), and several others.

Of 30 non-parasitic genera of the tribe Augochlorini, eusocial species are detected in seven. The overall picture of distribution of eusociality in the Augochlorini is far from being clear. For instance, from 131 species of the genus *Augochlora* and 138 species of *Augochloropsis*, eusociality is established in two species of each, while the data concerning the rest of the species of these genera remains to be extremely poor. However, in some great genera eusociality is established in considerable number of species.

Foundation of nest. In temperate regions eusocial colonies are usually founded by overwintered single foundresses. As well as those of other primitively eusocial species, halictine foundresses, having been fertilised in autumn, early in the spring leave their hibernating quarters. In this period their ovaries are underdeveloped. Two to four weeks later the ovaries develop due to nectar and pollen nutrition, and young foundresses start the foundation of nests. In some species new nests are normally founded at the place of, or close to the matrifilial nest, which results in rise of nest aggregations, while in other ones young foundresses dissipate over considerable territory building isolated nests. Sometimes several individuals take part in the nest foundation, with the outcome of a polygynous colony coming into existence (see below).

In tropics young foundresses also happen to fall into diapause similar to the winter diapause in temperate areas, which falls on the dry, or inversely, the rainy season, depending on the concrete species and the region (MICHENER, 1974), but typically no diapause occurs, being the nests founded all over the year. After the death of the foundress its place is often taken by a working female which morphologically and physiologically can be not different from the foundress. The duration of nest foundation may vary territorially within one and the same species.

Polygynous colony foundation. Among many halictine species several young females co-operate in the nest foundation; also cases are noted where a bee, which has solitarily founded a nest, is joined by one or two other females. The view of polygynous colony foundation as a necessary phase of development of the majority of halictine eusocial colonies, held by some authors (Michener, 1958, 1969a, 1974; KNERER & PLATEAUX-QUÉNU, 1966a), was not supported by the later comparative studies (PACKER & KNERER, 1985). Characteristically polygynous foundation is realised by sisters overwintered together in their mother's nest. In construction of the new nest, the main burrow of the maternal one is made use of. However, the connection between joint wintering and foundation of polygynous nest is not obligatory. First, only two or three individuals usually co-operate for nest foundation, whereas much more spend the winter in the same nest; consequently, remaining females found their new nests in different places and by themselves. Second, in a few instances the nest is founded by females, which did not hibernate together. Third, in some species, e.g. in *Evylaeus marginatus*, future foundresses always winter jointly in the maternal nest, but afterwards every of them independently founds a new nest (PLATEAUX-QUÉNU, 1962).

In a short time the members of jointly founded colony divide into castes according to their ovarian development. In polygynous nests typically there is only one female with normally developed ovaries which lays eggs; other females serve the function of working individuals, although they are fertilised and potentially reproductive. In polygynous nests normally the largest individual becomes the egg-laying female. However the body size not always predetermines the position of a female in the caste hierarchy. Thus, if into a colony of *Evylaeus zephyrus* founded by a solitary female one or two days later young females are introduced, then it is the older female which becomes the egg-layer, regardless of its size (BROTHERS & MICHENER, 1974). This is evidently due to more advanced ovarian development in the bees that emerge earlier and feed for a longer time. In our opinion, among overwintered females having founded nests the caste determination may depend on when a specific individual leaves its wintering place: the earlier it happens, the more advanced is ovarial development, which increases the female's chances of becoming an egg-layer. Only in case the jointly hibernating females emerge almost simultaneously, the body size acquires the decisive importance.

Only at the initial stages the egg-laying female of polygynously founded colony takes part in all nest building, cell construction and cell provisioning works. Later it spends most of time within the nest, being only busy forming the pollen ball, laying eggs and sealing the cells with caps, if they are available. All the rest of the work about construction, protection and foraging of the cells are carried out by female co-foundresses, which serve the function of working individuals. Among the advantages of polygynous nest foundation as compared to the monogynous one, we should name, first, the opportunity of organising almost constant protection of the nest against various enemies; second, higher productivity of the polygynously founded colony as calculated per one female foundress (for the relevant data on *Evylaeus zephyrus* see KUKUK, 1983); third, less wearing of the egg-laying individual; fourth, earlier establishment of cells for the first brood of workers.

In polygynously founded nests females serving the worker function usually either die even before the first brood of workers emerges, or get banished from the nest by the egg-laying female. Anyway, by the emergence of the first brood only one female is typically left in the nest. The banished females either die, or possibly excavate new burrows for their nests, or – as noted with respect to *Halictus scabiosae* (KNERER & PLATEAUX-QUÉNU, 1967a) – occupy the nests formerly built by females of other bee species.

Structure of the foundress nest. The foundress nests of eusocial halictine species in their location and structure are similar to the nests of related species leading solitary or subsocial mode of life. The main restrictions on the nest architecture of eusocial (as well as subsocial) halictines, obligatory both for the foundress nests and family nests, consist in non-linear arrangement of cells, and in absence of long laterals leading to the cells. After the cells are sealed, the laterals that lead to them must be filled with soil. Linear cell arrangement and long lateral burrows exclude the mother's contacts with its offspring, therefore they are met in the nests of only a few solitary halictine species. Having chosen the place for the nest, the foundress excavates all the initial depth of the main burrow, including the lower blind burrow. As far as the spring nest is normally built by one foundress, its depth is moderate as against that of the summer eusocial nest, which is excavated by several (or many) working individuals of the already existent eusocial colony. The soil brought out during burrow excavation gets piled at the nest entrance. The soil tumulus appearing in result of this usually encircles the nest entrance like a ring.

The foundress does not construct a nest tube or a turret, and does not make the entrance opening and the adjacent part of the main burrow narrowed in comparison with the diameter of its rest. Here is the difference between the foundress nest and the one into which it will be re-constructed by workers. By contrast to the family nest, among the majority of species in the foundress nest the walls of the upper part of the burrow do not get cemented. On having excavated the main burrow, the foundress starts constructing the cells. In their architecture the foundress nests of halictines may be of two main types. In the first, simpler one, the cells are located at the sides of the main burrow, extending up or down by groups, or being scattered along it (Figs. 50-52, 54). The cells either adjoin the burrow or communicate with it through very short laterals, whose length characteristically does not exceed that of the cell. The second, more complex, type of halictine nest is presented by chambered nests where the cells group into honeycomb clusters surrounded by a full or partial chamber (Figs. 55-58). The ways of construction of chambered nests vary considerably.

In the majority of eusocial halictine species the cells are oriented more or less horizontally, which, in our view, makes unsealing the cells easier for females and less dangerous for feeding larvae; this procedure is occasionally carried out by females in order to monitor the development of the brood. Only in *Evylaeus laticeps* cells sometimes happen to be deflected from the horizontal by 45° (PACKER, 1983). The structure and form of cells are similar enough among all of the halictines.

Acting alone, the foundress usually constructs only four to six cells, e.g. in *Evylaeus marginatus* two to six cells (PLATEAUX-QUÉNU, 1962), in *E. duplex* three to nine cells (SAKAGAMI & HAYASHIDA, 1961) are constructed. For separate halictine species larger number of cells established by the foundress for the first brood is indicated in the literature. In our view, such an information most certainly concerns the former polygynous nests in which by the moment of their inspection the egg-laying female has already lost its assistants. On having completed the works about establishing the cells for the first brood, the foundress immures itself within the nest.

The functioning of its ovaries stops or sharply slows down, being resumed not before the offspring emerges (GOUKON et al., 1987). Evidently the foundress spends this time immobilised, although it is not excluded that sometimes it activates in order to inspect the development of the offspring. Direct observations of the foundress' behaviour in the preimaginal period of the first brood are virtually absent.

Occasionally the question of incubation of offspring by halictines is raised in the literature. The hypothesis of incubation of cells located within chambers was spelled by VERHOEFF (1897), and later supported by MICHENER (1974: 198). In our belief, it is unconvincing assumption, since incubation of brood implies great energy loss, which is possible only on the condition of active feeding of the foundress. Therefore during the development of the first brood it should either periodically leave the nest, or accumulate forage therein. But neither actually happen.

Composition of the first and the following broods. The development of the first brood at the majority of eusocial halictines is relatively fast, taking only 1-1.5 month, and soon there appear young bees in the nest. At once after leaving the cells, they meet with their mother, which from this moment on becomes a queen. The vacated cells and chambers are filled with soil by young bees, to the exception of rare instances where they are used again.

The composition of the first brood differs seriously among different species of eusocial halictines; it may include either working individuals only, or a compound of workers and males, sometimes with an admixture of future foundresses. Great proportion of males in the first brood is typically linked to low development of social life among a given species. Thus, in species with lower level of eusociality males form a considerable part (in some cases even a half) of the first brood. For example, in *Evylaeus laticeps* this parameter averages 23.8% (PACKER, 1983), in *Halictus rubicundus* 25% (fluctuating in different years from 17.7 to 32.4%; YANEGA, 1988), in *Evylaeus rhytidophorus* 41% (MICHENER & LANGE, 1958c), and in *E. albipes* more than 50% (PLATEAUX- QUÉNU, 1988).

In halictines with higher eusociality level, males are either absolutely absent in the first brood, e.g. in *Evylaeus marginatus* (PLATEAUX-QUÉNU, 1962; POURSIN & PLATEAUX-QUÉNU, 1982), *E. imitatus* (MICHENER & WILLE, 1961), and *E. rohweri* (BREED, 1975a), or their proportion in the total number of the bees emerged in the first brood does not exceed 5-10%, e.g. in *Evylaeus duplex* (GOUKON et al., 1986), *E. malachurus* (NOLL, 1931), *E. nigripes* (KNERER & PLATEAUX-QUÉNU, 1970), and *E.umbripennis*; WILLE & OROZCO, 1970).

PLATEAUX-QUÉNU's (1983) experiments carried out on artificial nests of *Evylaeus calceatus* have shown that the sex of eggs which a female lays to produce the first brood depends on the weight of pollen balls. As their weight gets experimentally increased, the proportion of fertilised eggs yielding workers considerably rises. The results of this experiment demonstrate that the foundress can always control the sex of its offspring. It is not excluded that production of males in the first brood of eusocial halictines has to do with an early start of rearing a part of future foundresses, which have a long diapause. This can be concluded judging by the information on Halictus rubicundus (Yanega, 1988). In the nests of this species about a half of the first brood females copulate at once after their emergence, and shortly leave the maternal nest hiding till the next spring. In result, a part of the females of the species population permanently lead quasi-solitary mode of life.

At the vast majority of well-studied eusocial halictines only one brood of workers is reared before the production of future foundresses. To be sure, working individuals occasionally happen to appear in the second brood too. However, the formation of the second brood is usually vastly extended in time, so that the workers which mostly emerge first manage to participate in rearing of the reproductive offspring. Only in *Evylaeus malachurus* (LEGEWIE, 1925a; BONELLI, 1948; POURSIN & PLATEAUX-QUÉNU, 1982) and in *E. pauxillus* (SMITH & WELLER, 1989; PACKER, 1991) during a season two consecutive broods, and in southern regions in the former species sometimes even three consecutive broods of workers are produced, after whose rearing the production of future reproductive offspring begins.

A specific perennial life cycle is proper to *Evylaeus marginatus* (see description of its bionomics in Chapter IV).

Caste differentiation. Sufficiently distinct dimorphism in females (reflected even on the taxonomic level), being queens always by 15-20% larger than workers, is established for only the following eight species, which have probably reached the highest social organisation among halictines: *Evylaeus malachurus* (KNERER & PLATEAUX-QUÉNU, 1967b), *E. linearis* (KNERER, 1983), *E. pauxillus* (PACKER & KNERER, 1985), *E. cinctipes* (KNERER & ATWOOD, 1966; see another opinion in PACKER et al., 1989), *E.exiguus* (PACKER, 1986b), some populations of *E. umbripennis* (WILLE & OROZCO, 1970; for different data see EICKWORT & EICKWORT, 1971), *Halictus latisignatus* (SAKAGAMI & WAIN, 1966), and *Seladonia hespera* (BROOKS & ROUBIK, 1983; PACKER, 1985). It is *S. hespera* that exhibits the most pronounced morphologic caste differentiation – apart from greater body size, its queens have disproportionately huge hypostomal tooth. In addition, in the above species only insignificant part of working individuals have relatively developed ovaries, and as a rule all of the workers are unfertilised. Thus, in *E. linearis* only 3.2 to 13.6% of workers have more or less developed ovaries, while the fertilised ones number 0.5% only (KNERER, 1983). It should be also noted that among the species with non-overlapping caste polymorphism the average body size of workers usually increases during the season.

In the most eusocial halictines the castes are under-differentiated due to a large size overlap between queens and workers. Usually caste affiliation of a female can be established not before its functions in the family are revealed, although for certain species it is possible to uncontroversially identify the queen by the presence of sperm in its spermatheca and by the degree of its ovarian development.

In many halictines working individuals not only fail to exhibit morphologic distinction from queens, but often also have developed ovaries and are typically fertilised. Such are the species *Augochlorella striata, A. persimilis* (MICHENER & LANGE, 1958c; ORDWAY, 1965), *Seladonia confusa* (DOLPHIN, 1966; cited after MICHENER, 1990), *Halictus rubicundus* (YANEGA, 1988), *Evylaeus breedi* (MICHENER et al., 1979), and other halictines with low level of sociality. Among these species castes can be distinguished not so much by differences in the ovarian size as by the number of developed ovarioles and by the presence therein of mature oocytes. Nevertheless, the mere fact of fertilisation in a series of instances also fails to play the decisive role in the caste determination. It is possible that in halictines, similarly to other eusocial bees, the caste differentiation is determined, apart from the body size and fertility, by the titre of the juvenile hormone, on which the ovarian development is dependent.

Mechanisms for supporting of caste structure. Such mechanisms remain extremely under-studied: the pheromone control over the workers on the part of the queen is established for neither of halictine species; unclear is also the question as to its behavioural dominance. One variety of the latter is impeding the copulation of workers by the queen. The simplest way of doing it is decreasing, down to full cessation, the production of males in the first brood, which however rather reflects only the general rise of the level of eusocial life among halictines (see above). As well, several other modes of workers copulation prevention are revealed.

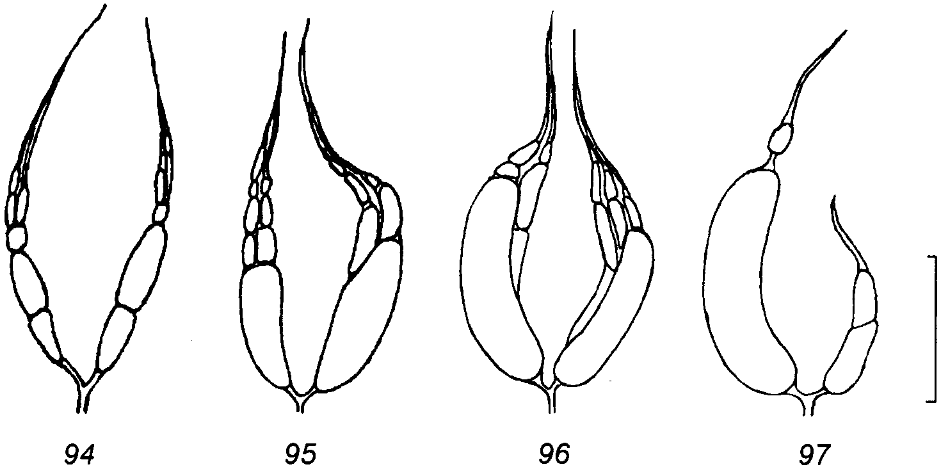
The queen's aggressive behaviour directed at suppressing the ovarian development in workers (Figs. 94-97), which is proper to other primitively eusocial bees (e.g., bumble bees), as the main mechanism of the queen's behavioural dominance in its overt form was attested in true eusocial colonies of neither of the studied halictines: *Evylaeus zephyrus* (BATRA, 1966b; MICHENER et al., 1971a; BREED et al., 1978), *E. calceatus* (PLATEAUX-QUÉNU, 1974), *E. duplex* (SAKAGAMI & HAYASHIDA, 1968), *E. versatus*, and *E.imitatus* (BATRA, 1968). All the data on the aggressive behaviour whereby the dominant halictine female preserves the caste structure of the family (see MICHENER et al., 1971b; BROTHERS & MICHENER, 1974; MICHENER & BROTHERS, 1974; BREED & GAMBOA, 1977; GREENBERG & BUCKLE, 1981, BUCKLE, 1982a, 1982b, 1984; SMITH, 1987) concern the artificially composed 'semisocial' groups comprised of only young females of one generation of the first (summer) brood. The role of the queen in such groups is usually served by the most robust and active female with the most fully developed ovaries which in the experiments was provided the opportunity of copulation.

Clearly, the behaviour of the female dominating over its sisters or contemporaries must widely differ from that of an authentic queen having experienced diapause and being the mother of all the rest of the colony members. In artificial colonies one observes high aggressiveness of the egg-laying female that seeks to inhibit the ovarian development among its sisters or contemporaries. In the capacity of behavioural patterns leading to such an inhibition, the following types of interaction between the female and the working individual are distinguished (MICHENER & BROTHERS, 1974; BROTHERS & MICHENER, 1974; MICHENER, 1977; SMITH, 1987):

nudging – the face-to-face contact with the worker; realised by a short fast movement and possibly accompanied by inflicting slight trauma on the worker;

backing – leading the worker after itself, backing the female deep into the nest; realised with slightly raised head and antennae stretched forward; after each short 'backing' the dominant female waits for the worker, and in case of its stopping 'pushes' it;

lunge – a sharp forward movement without contacting the worker.



Figs. 94-97. Dissected ovaries of workers of *Evylaeus nigripes* in a matrifilial (*94*, *95*), queenless (*96*), and own nest (*97*) (from KNERER & PLATEAUX- QUÉNU, 1970: Figs. 22-25). Scale lines represent 1 mm.

Replacement of queens by workers and usurpation of nests by other females. In the most studied halictines the queens that in the spring successfully established the nest and reared the first brood, live at least till the autumn. Only for a few species, e.g. for *Evylaeus zephyrus* (BATRA, 1965), it is noted that queens often die shortly after the emergence of the first brood, being the place of the dead queen occupied by one of its daughters.

Halictine workers, in spite of their relatively high reproductive status, do not reveal aggression against the true queen and evidently never banish it from the nest (with the exception of cases where it totally switches to production of non-fertilised eggs). In case the queen dies, it is normally replaced by the oldest working bee, regardless of its body size. The older bees' higher chances to replace the queen are probably due to their more advanced ovarian development. Throughout several days after the replacement occurs, the ovaries of the new queen rapidly develop and on the average reach the size of the ovaries of the true queen. However, if the first female replacing the queen gets removed, in the next dominant individual the ovarial development proves to be slower. Unlike authentic queens living for a year or more, the queen-replacing females are shortly worn. For example, those of *Halictus rubicundus* live no more than three weeks (YANEGA, 1989).

Apart from the above described intra-familiar queen replacement, sometimes one observes in halictines the usurpation of alien nests by females from the same, and occasionally another species. Thus, described is facultative cleptoparasitism exhibited by females of *Halictus scabiosae*, which occupy both the nests of their own species and those of *Evylaeus nigripes*. They kill the host bee and lay eggs into the cells already provided with the pollen ball (KNERER & PLATEAUX-QUÉNU, 1967a). PACKER (1986a) noted the existence of intra-specific cuckoo-like caste among the females of subtropic populations of *Halictus ligatus*. Unfortunately his work fails to present unequivocal data on the behaviour of such individuals inside of alien nests, so that one can make only a guess of their cleptoparasitic behaviour.

Within-nest behaviour and general division of labour. After the emergence of the first brood the foundress, which from this moment on becomes the queen, enters into active state, but occupies itself only with inspecting the cells, concluding the formation of the pollen ball, and laying eggs. All other works, including those about constructing and foraging the cells, are carried out now by working individuals. After their emergence the queen spends all, or almost all the time within the nest, leaving it not even for its own feeding. The latter is realised inside the nest by consummation of a part of forage from the cells while they are being filled with provision. Inside the nest the bees are normally arranged in chain along the main burrow, occupying the queen the lowest position.

Among non-reproductive members of colonies, in many halictines one finds a division of functions: some workers are responsible for the protection of the nest, while others for foraging. Occasionally even morphological differentiation of subcastes is exhibited. At the same time, typical of such species as *Evylaeus politus* and *E. glabriusculus* is constant division of workers according to the kind of work fulfilled, although these subcastes have no external differences (KNERER, 1981). A part of workers are not functionally specialised, and at different times realise either nest protection, or foraging the cells. Such individuals usually have more developed ovaries than other workers, but they are scarcely active, or even not inclined to do any work whatever (KUKUK, 1980). These bees are likely to be the first candidates for replacement of the dead queen.

Division of labour in halictines – to which it is proper – can be observed even in colonies comprising no more than three individuals, being the first of them the queen, the second a guard, and the third a forager (BROTHERS & MICHENER, 1974).

Still, in a number of species the division of functions between workers is not established. For instance, in colonies of *Evylaeus nigripes* (KNERER & PLATEAUX-QUÉNU, 1970) and *E. linearis* (KNERER, 1983) working individuals occupied with nest protection are lacking. Functional specialisation among workers arises several days after their emergence. The concrete specialisation, as well as the general behaviour of an individual, is tightly linked to its reproductive status.

Apart from protecting the nest, constructing and foraging the cells, separate workers assist the queen with inspecting the cells with the developing offspring. The queens of certain eusocial halictines keep the cells almost constantly open for supervision over the developing offspring, as well as for removal of excrement and larval sloughs. The cells with dead or anomalous individuals being at preimaginal stages of development get immured by workers (KNERER, 1969a). In *Evylaeus malachurus* the cells remain unclosed only in the period of larval feeding; they are opened shortly after the emergence of the larva from the egg and get closed again when the feeding is concluded. At other species, e.g. in *Evylaeus imitatus, E. versatus*, and *E. zephyrus*, whose cells are sealed with caps, monitoring is realised by periodical opening of the caps. In the course of inspection the cells with normally developing larvae get immediately re-closed, while those with dead offspring get tightly filled with soil (BATRA, 1968).

Construction works. After the emergence of workers new cells are typically established at a greater depth as compared to those set up by the female foundress. Such a deepening of nests can last for all the season long. Unlike the nests established in the spring by a solitary female, at the period of workers' activity the family nests have narrower entrance (as against the rest of the main burrow), which plays an important role in the nest protection (see below). Workers narrow down the entrance by means of creating built-in walls of the soil excavated from the inside of the nest. As well, some species line the upper narrowed part of the burrow with secreted materials. Often the narrowed part of the burrow protrudes above the ground in a form of a turret (Fig. 65), which was not yet present in the nest when built by the foundress.

Normally several bees take part in the construction of the burrow, yet each one works independently of others. Only during removal of soil from the excavation place co-operation is possible: loose soil is transported to a short distance, then another bee picks it up. Different halictines use different ways of soil transportation inside the nests. As the family grows, so does the number of the cells constructed. Typically, in its architecture the family nest does not differ radically from the one built by the female foundress, with the natural reservation as to a greater depth, ramifiedness, and a larger number of cells. It is worth noting that, unlike, e.g. *Evylaeus duplex* (SAKAGAMI & HAYASHIDA, 1960), *E. laticeps* (PACKER, 1983), and E. calceatus (Bonelli, 1965a), which for all the season long construct chambered nests. The workers of *E. malachurus* fail to make chambers in their summer nests, although during solitary nest establishment their queens often excavate chambers around the cell clusters (Bott, 1937; Knerer & Plateaux-Quénu, 1967b; GROZDANIĆ & VASIĆ, 1970).

In eusocial colonies the cells are usually constructed co-operatively by several workers shifting one another in execution of separate procedures. Halictines do their construction works mainly at the night-time. Besides intranidal workers, some part in cell construction is taken also by forager workers that at different times can be occupied both with supplying the nest with provisions for pollen ball formation, and with constructive work. According to BATRA's (1964) observations, the cells of *Evylaeus zephyrus* which fail to get filled with larval forage on the very day they are constructed, on the next day get re-lined with secretory material. Older cells, unused for several days after their construction, get not only re-lined with secretory film but preliminarily covered with a new thin layer of soil. Therefore, the bees storage pollen only in newly lined cells.

Foraging. The food collection is realised by halictine workers without co-operation with each other (MICHENER, 1974). Moreover, they seem not only to forage independently but also to have no adequate notion of the family's forage necessities. Not infrequently a foraging bee returned with its load of pollen fails to find any cell open for putting the food into it. In result the forager rambles for a long time within the nest in search for a vacant cell, and having not found it leaves the pollen at the end of the blind burrow, as far as halictines do not accumulate whatever other food reserves. Adult individuals which do not fly out from the nest for feeding eat pollen from partly provisioned cells (BATRA, 1968).

Provisioning of every cell is realised co-operatively by several working individuals. Normally for the formation of one pollen ball, the amount of food brought in 6-8 trips is enough, and in *Evylaeus umbripennis* creation of the pollen ball often takes just 5 pollen loads. In provisioning one cell of *Evylaeus zephyrus* sometimes up to 6 females take part (Batra, 1964), but still every forager usually prefers to fill one and the same cell. If at the moment of the forager's return the cell is occupied by another bee, the former one passes on to the next cell, and later brings new portions of pollen directly to it. Foraging workers, e.g. those of *Evylaeus imitatus*, make daily up to 7 trips (MICHENER & WILLE, 1961).

Nectar usually gets added to pollen not before its supply is already sufficient for formation of a pollen ball. On its return to the nest, the forager can leave pollen in one cell while regurgitating nectar into another. Pollen and nectar mixture is formed into a pollen ball consecutively by several bees. Aside from foragers, a part in this process is taken also by intranidal workers and the queen, which realises the final treatment of the pollen ball immediately before laying an egg. After doing so, the queen at once seals the cell with a soil cap (being exception those species failing to make caps). If no egg is laid on the pollen ball in two days, workers fill such a cell with soil.

Batra (1964) and Knerer (1969a) made suggestion that in halictines 'progressive' larva feeding is possible, being pollen and nectar periodically added to the cells with feeding larvae. This view finds its support in the facts that, first, workers now and again unseal the cells with the brood, and second, the weight of grown larvae palpably exceeds that of the initially formed pollen ball together with the egg itself. However, as has been shown later, the cell unsealing is realised in order to only control the larval development, and the increase of the weight of larvae is due to absorption of moisture by pollen balls (May, 1970; Batra & Bohart, 1970). To be sure, it is not excluded that provision in the cells gets wet with nectar in the species which do not produce cell caps (in particular, *Evylaeus malachurus* should be mentioned here) and therefore cannot keep up high humidity inside of cells. Still, in certain more recent works (Butler, 1975; Dietz, 1982; Popova & Blagoveschenskaya, 1989) erroneous indications of 'progressive' larvae's feeding in halictines continue to appear.

Nest protection and identification of colony members. Guards spend all the day at the entrance part of the nest in a head-up position, being their heads approximately level with the ground surface. In the narrowed entrance part of the nest there is enough room for one individual only, so that in order to let a forager pass the guard moves down to the wider part of the burrow. Only the colony members are let into the nest. The guard bee both blocks the way for all other insects and turns them back threatening them with its mandibles. The guard never abandons the entrance opening. If the undesirable object fails to move away or, on the contrary, demonstrates aggression at its attempt at penetrating into the nest, then the guard bee rapidly moves down to the wide part of the burrow, turns around and goes up blocking the entrance with its metasoma. In such a position it holds so strongly that it can be barely moved even with considerable effort. If such a bee nevertheless gets extracted from the burrow, another worker instantly takes its place. In case of consecutive removal of all guards, their role is played by foragers.

The guard bee easily enough turns out various smaller enemies and parasites, but its resistance does not present a serious obstacle to a cleptoparasitic bee of the genus Sphecodes that, being in its size comparable with halictines, easily does away both with guards and the rest of the family members, which fact is reported for many halictine species (Marèchal, 1890, 1894; Ferton, 1898; Nielsen, 1903; Blüthgen, 1923; Legewie, 1925c; Ordway, 1964, Radchenko & Pesenko, 1994).

At most halictines the nest protection is realised only during the daylight ours. For the night, as well as at the days of unfavourable weather conditions the est entrance gets stopped up with a plug, for whose construction loose soil and mall stones are used (Knerer, 1969b). Only separate species, belonging all of hem to those constructing turrets, in particular *Evylaeus linearis* and *E. marginatus*, leave the nest entrance open and unprotected for the night (Knerer &

PLATEAUX-QUÉNU, 1970). However these species' nests, as well as nests of some other halictines, e.g. *E. nigripes*, have no constant protection even in the day.

Guard bees identify the members of their own nest by their smell (BARROWS et al., 1975; MICHENER, 1982). The sources of odours used for identification are most probably macrocyclic lactones secreted by Dufour's gland (SMITH & WENZEL, 1988). These smells are genetically determined; they seem to be very unstable and, evaporating, do not communicate from one individual to another during joint keeping of bees from unrelated colonies (GREENBERG, 1979). At the same time, in artificially mixed groups bees remember and freely admit to the nest not only those group members unrelated to them yet also alien individuals related to the latter ones (BUCKLE & GREENBERG, 1981). Still, in isolation bees soon forget the smells of the colony members. Thus, after 12 days isolation guard bees of *Evylaeus zephyrus* let pass only about 10% of the members of their group (KUKUK et al., 1977).

GREENBERG (1979) establishes distinct positive correlation between the quotient of the relatedness of the guard bee to a bee artificially introduced into the nest, and the frequency with which the guard lets this bee enter the nest. However special experiments of BUCKLE & GREENBERG (1981) have demonstrated that actually the guard bee admits all the bees which are genetically related to the members of its nest, not to this bee itself.

Rearing of sexual forms. The start of rearing reproductive females in eusocial halictines with annual families depends both on external factors (air temperature and day duration), and on the size of colony and the average size of bees (KAMM, 1974; KUMAR, 1975; see also: KNERER & PLATEAUX-QUÉNU, 1967d; PLATEAUX-QUÉNU & PLATEAUX, 1979, 1980a). The concrete mechanisms of a halictine family's switching to production of reproductive individuals remain to be unclear. It is known only that in the species whose castes differ in size, appearance of future queens is determined by increase of size of pollen balls stocked.

In what concerns the majority of those halictine species having no considerable difference between the size of workers and queens, it is more accurate to speak not of appearance of reproductive females but of disappearance of workers in broods, due to the fact that as time goes more and more emerged females have the opportunity of copulation. The males' percent goes up especially sharply in the last brood where their number no less than 50%. The males emerge first, and copulate with practically all emerging females, which evidently plays the key role in becoming the latter reproductive.

Among some species, e.g. in *Evylaeus zephyrus*, the early, i.e. occurring already in the first brood, rearing of males is explained by frequent perishing of female foundresses, which makes it imperative that workers replacing them have the opportunity of copulation and laying eggs producing females (BREED, 1975a). The emergence of future female foundresses from eggs laid by fertilised workers was observed also in *E. calceatus* (PLATEAUX-QUÉNU, 1985). Besides that, early rearing of males leads to appearance of such future female foundresses that fall into diapause long before the autumnal break-up of the colony. This phenomenon is recorded, in particular, for *Halictus rubicundus*. The most of unfertilised eggs bearing males are laid in halictine colonies by working individuals (NOLL, 1931; PLATEAUX-QUÉNU, 1960a, 1962; BATRA, 1964, 1968; MICHENER, 1974; SAKAGAMI, 1974). Such an egg laying is often accompanied by cannibalism. Great workers of *Evylaeus* marginatus and E. zephyrus unseal the cells, eat the eggs, lay eggs of their own, and re-seal the cells (PLATEAUX-QUÉNU, 1960a; BATRA, 1964). Interestingly, some workers of E. zephyrus and E. versatus, having laid eggs, on the same day fulfil their routine functions of providing forage (BATRA, 1968). These data are also curious in the respect that usually foraging workers have the lowest reproductive status in the colony.

Copulation. Males of eusocial halictine species can copulate with females at different places both inside and outside of nests: on flowers, on the ground surface etc. (see reviews in BARROWS, 1975, 1976a, 1976b; ALCOCK et al., 1978). Only in *Evylaeus marginatus*, males copulate solely inside of nests, since young foundresses do not leave their maternal nests till the next spring. In the flight period of males, the nests of *E. marginatus* where there are young reproductive females remain constantly open, so that males easily penetrate into them, visiting different nests with unrelated individuals.

Males of some species, in particular *Evylaeus rohweri* possess patrolled areas where they wait for females (BARROWS, 1976b). Besides that, in the first 2-8 days of their life females of many species excrete pheromones attracting males. The role of the sexual pheromone is at least partly served by one of the substances that Dufour's gland produces (SMITH et al., 1985). Thus, in KUKUK's (1985) experiments males of *Evylaeus zephyrus* were effectively attracted by imitations of females presenting a stick wrapped around with nylon covered with an extract from female Dufour's gland. Males reacted energetically to such models, and made attempts at copulation. It is interesting that after the male's contact with a female dummy on its surface there probably remained a chemical marker, which made the imitation unattractive to other males. Regardless of whether or not chemical markers are left, the male is capable of remembering the smell of the individual it copulated with, since it avoids further contacts both with this female and with its virgin sisters having the same smell (SMITH & AYASSE, 1987). According to some data males in general prefer copulation with females from alien nests (GREENBERG, 1982b; WCISLO, 1987). Females are as well able to recognise the smell of their brothers, escaping copulation with them (MICHENER & SMITH, 1987).

PACKER (1986a) has made observations showing that males of *Halictus ligatus* in tropics, where they fly jointly with females virtually for all the season long, prefer copulation with young and robust females. The reason for such a selectivity, as MICHENER & SMITH (1987) suppose, lies in males' natural drive to avoidance of senseless loss of time and sperm on the females that most probably will become non-reproductive workers. In temperate regions the above problem gets solved by means of phenological segregation in the course of the emergence of workers and males, and/or by means of various behavioural adaptations that exclude or reduce the possibility of copulation between males and working individuals. Among the most graphic examples one may point out the behavioural peculiarities of Evylaeus marginatus, whose males emerge simultaneously with workers but copulation between them is prevented by that in the period of males' flight queens keep the nests with emerged workers constantly closed (PLATEAUX-QUÉNU, 1962).

The size of the family and duration of its existence. The size of families varies widely in eusocial halictine species, on the account of both different number of individuals in different broods, and different number of broods themselves, which to a large extent depends on for how long the family exists. It should be born in mind as well that under natural conditions extremely high mortality of female foundresses is observed. Many of them fail to establish colony, or to leave offspring. Thus, in a series of areas investigated the total number of individuals reared among halictines in the first brood often fails to exceed that of females which established nests in spring (MICHENER, 1974). Later many newly arisen families perish from various enemies and diseases. For this reason one can estimate the size of families only by those having successfully developed and reared reproductive brood.

In tropics, due to that the period when active family life is possible is longer than that in other zones, colonies of some halictines number several hundred individuals. Thus, one of the nests of *Seladonia lutescens* found in Costa Rica contained several males and 342 females, the most of which were probably workers (WILLE & Michener, 1970); this provides grounds for expectation of further increase of bees reared in the colony. Indeed, in Guatemala in a nest of the same species 589 females were detected (Sakagami & Okazawa, 1985). To be sure, the queens of other tropical halictines, in particular *Evylaeus breedi* and *E. seabrae*, produce only 1-3 working individuals, switching at once after that to rearing of reproductive forms (MICHENER et al., 1979).

In temperate zones among the most of halictines families exist for one season only, during which 2-3 broods, totalling on the average 50, or occasionally 100 individuals are reared. Only at *Evylaeus marginatus* the colony lives for 5-6 years, annually growing in size. Thus, according to PLATEAUX-QUÉNU's (1962) information, the brood reared the last before the break-up of the colony numbers up to 590 individuals, and in total the individuals reared throughout the colony existence period number up to 1458. Moreover, in the nests of this species GROZDANIĆ (1956, 1966) has found 676 to 897 individuals in the last brood alone. BONELLI (1965a) admits that among *Evylaeus calceatus* perennial colonies also exist, living their queens at least for two seasons. It has been demonstrated that in laboratory conditions, under constant relatively high temperature and with a long day, colonies of *Evylaeus* *zephyrus* can be kept in active state, but as the queens grew old they were consecutively replaced by new females selected from those not falling into diapause (GREENBERG, 1982a).

Evolutionary stages of eusociality. The main initial conditions of the rise of eusociality appear to be similar in all the Aculeata, to the exclusion of specific requirements connected with differences in the biology of species and their groups, in particular with peculiarities of nesting. The number of levels of eusociality development (evolutionary stages of eusociality) in the halictines is higher than in any other group of bees. Those stages are as follows:

I. *Transitional* (to eusociality) stage – the rise of facultative and very primitive eusociality: (1) only a part of females in population lives eusocially; (2) the help afforded by daughters to their mother is very limited; (3) the proportion of males in the worker brood is large; (4) polygynous foundation of colonies often occurs. The species being at this stage are *Evylaeus albipes* (PLATEAUX-QUÉNU, 1988), *Seladonia confusa* (KNERER & PLATEAUX-QUÉNU, 1967b), *Augochlorella striata* (PACKER et al., 1989), *Augochloropsis sparsilis* (MICHENER & LANGE, 1959), *Pseudaugochloropsis nigerrima* (MICHENER & KERFOOT, 1967) (as well as some non-halictine species from genera *Ceratina*, *Xylocopa*, *Euglossa*).

II. *Lower primitive-eusocial stage* – stabilisation of eusocial life and its expansion to the whole population or species: (1) all wintered females seek to found a reproductive brood using help of worker daughters; (2) the number of individuals in the first 'worker' brood is reduced; (3) the proportion of males in the worker brood decreases; (4) facultative division of labour and initial morphological differentiation of castes appear. The species being at this stage are *Evylaeus laticeps* (PACKER 1983), *E. versatus* (MICHENER, 1966), and *E. zephyrus* (BATRA, 1966) (as well as many of Allodapini).

III. *Middle primitive-eusocial stage* – colony integration: (1) males in the worker brood disappear; (2) the queen exhibits distinct behavioural or/and pheromone control over its daughters (parental manipulation); (3) non-overlapping morphological differentiation of castes appears. The species being at this stage belong only to the halictines; they are: *Evylaeus cinctipes* (KNERER & PLATEAUX-QUÉNU 1967a), *E. linearis* (KNERER, 1983), *E. umbripennis* (WILLE & OROZCO, 1970), and *Seladonia hespera* (BROOKS & ROUBIK, 1983; PACKER, 1985).

IV. *Mature primitive-eusocial stage* – increase in the life efficiency of the colony: (1) the number of worker broods grows; (2) all colonies are founded monogynously. This stage is presented only by the halictines: *Evylaeus malachurus* (NOLL et al., 1931) and *E. pauxillus* (KNERER & PLATEAUX-QUÉNU 1967b).

Stage IV is the highest in the halictines. The superior stages of the evolution of eusociality in bees are presented by *Bombus* (V. Higher primitive-eusocial stage), Meliponini and *Apis* (VI. Advanced eusocial stage).

Along with progressive development of eusociality, as well reversions occurred. In particular, it is supposed that return to solitary life has occurred in *Halictus quadricinctus*, *H. sexcinctus* and *H. tsingtouensis*. Under severe conditions, where successful rearing of two broods within one season is improbable, even some bee species, whose colonies are close to the middle stage of social life, switch to solitary existence; for example, this is the case with *Evylaeus calceatus* and *Halictus rubicundus*. Sometimes such a reversion has a partial character; for instance, in *E. imitatus* in the Canadian province of Ontario (KNERER & PLATEAUX-QUÉNU, 1967b) the 'working' brood includes many (up to 45%) males, whereas males are absolutely absent in it in the southern parts of the geographical range of this species (MICHENER & WILLE, 1961; MICHENER, 1969).

Even in the species that achieved the highest (among the halictines) stages of sociality (for example, in *Evylaeus malachurus* and *E. marginatus*) the colony nests almost fail to be different from those of solitary halictine species, except for a larger number of cells (the colonies of *E. marginatus* often comprise hundreds of individuals), and frequent complication of the structure of the nest entrance, making it better protected by guard bees. The conservative stability of halictine nest architecture is due both to retention of the former nesting substrate (i.e., soil), and to morphobiologic peculiarities of these bees, unable to construct cells in any manner other than excavating them in soil, with later building in and lining their inner walls.

Existing two main ways of arranging cells in the nests of eusocial halictines (implying the first that cells are placed at the extremities of very short laterals or close to the main burrow, and the second that they are arranged in groups inside of chambers), the second looks more progressive, since it promotes more frequent contacts between individuals, which is important for development of communication among colony members, and in principle provides opportunity for the rise of nest thermoregulation. Nevertheless, the prospective of that even colonies of the halictines, which construct chambered nests, would evolve to the social organisation level achieved by bumble bee families (stage V) may be estimated as nil.

One of fundamental factors limiting the evolution of sociality in the halictines is non-plasticity of the building material used. Non-plasticity of soil impedes creation of sufficiently large nest chambers, and most importantly, considering the way of cell construction adopted by the halictines (i.e., excavation, rather than modelling), excludes the simultaneous work of several working individuals in building one cell, which is necessary for development of communicational links and complication of social behaviour, including the functional specialisation of workers observed in the colonies of advanced eusocial bees. As well, non-plasticity of building material prevents re-use of cells. In addition, hygroscopicity of soil, along with typically horizontal orientation of cells, deprives bees of the possibility of accumulating a stock of nectar (or honey) in the nest for feeding imagoes, which renders unrealisable thermoregulation and incubation of the brood.

However, the variety of halictine colonies in the level of social life and wide distribution of eusociality in many genera, subgenera, and even groups of species of this subfamily show that biologic features of the halictines offer fairly good possibilities of independent and repeated rise of eusociality, which is observed in some species even at present.

Cleptoparasites. Obligatory cleptoparasites of eusocial halictines are presented by related to them parasitic bees of the genera Austrosphecodes, Echthralictus, Eupetersia, Microsphecodes, Paradialictus, Paralictus, Parathrincostoma, Ptilocleptis, and Sphecodes, belonging to the tribe Halictini, Temnosoma to the tribe Augochlorini, as well as Nomada belonging to the family Anthophoridae. To be sure, the Nomada, which do not kill the host bee, seemingly can lay eggs only into the nests of halictine foundresses. There exist data to the effect that the species Microsphecodes (Eickwort & Eickwort, 1976), some species of Sphecodes (Knerer, 1980), and Paralictus asteris (Wcislo, 1997b) behave as social cleptoparasites. The main cleptoparasites of nest-building halictines in the Palaearctic region are representatives of the genus Sphecodes.

Main reference: FABRE, 1902: 1-27; MALYSHEV, 1936: 201-309; SAKAGAMI & MICHENER, 1962: 1-135; KNERER & ATWOOD, 1966: 1337-1339; EICKWORT, 1969: 652-660; PLATEAUX-QUÉNU, 1972: 1-200; MICHENER, 1974: 261-313, 1990: 77-121; SAKAGAMI, 1974: 257-293; EICKWORT & SAKAGAMI, 1979: 28-87; PACKER, 1991: 153-160; 1993: 215-233; RADCHENKO, 1993: 1-60; RADCHENKO & PESENKO, 1994: 171-195; KNERER & WCISLO; 1997: 316-332; DANFORTH & EICKWORT, 1997: 270-292; WCISLO; 1997a: 316-332; YANEGA, 1997: 293-315.

Chapter III
Study of halictids in Poland

Geographical and ecological characteristics of Poland[1]

Geography. Within the European continent, two parts are distinctly distinguished: the western and the eastern part. The central part, where Poland is situated, has a transitional character with all its consequences in the climate, vegetation and fauna. The transitional character of the natural environment with a gradient of different factors from the west to the east is intensified by the fact that there are no natural borders either from the west or from the east. In the north, the border of Poland is the Baltic Sea. In the south, the Sudeten and Carpathian Mts. divide Poland from the warmer regions of southern Europe.

In the vertical configuration of Poland, there dominate lowlands occupying the whole northern and central part of the country In the southern part, there lie uplands and mountains (Fig. 98). Areas with absolute height up to 300 m occupy as much as 90% of the total area of the country. The upland areas reaching 300-500 m a.s.l. occupy less than 6% of the area, and the mountain terrains above 500 m cover only 3% of the country. Therefore, Poland is primarily a lowland country where mountains play a comparatively small role. A characteristic feature of the surface relief of Poland is the belt-like configuration of lowlands and elevations that run parallelly to the parallel of latitude.

At the sea-shore of the Baltic, there extends a belt of seaside lowlands. A diversity is supplied by the elevations of terminal moraines, or the upland of the ground moraines reaching up to 115 m a.s.l. To the south from the sea-side lowlands, there stretches the Belt of Lakelands with an average height of 100-300 m a.s.l. The landscape of the Lakelands was formed during the last glaciation. The ground moraines create mild and wavy elevations, with lakes located in some hollowings. In the places, where the continental glacier stayed for a longer time, terminal morraines were formed creating the highest elevations and post-glacial gullies filled with tunnel-valley lakes. On the foreland of terminal morraines, there lie flat areas of fluvioglacial soils, sands and outwash plain gravels.

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[1] Elaborated on the basis of MEDWECKA-KORNAŚ (1959) and STARKEL (1999).

Fig. 98. The main geographical provinces of Poland.

The central part of Poland is occupied by the Belt of the Great Valleys. Here, the average elevation above sea level is 50-100 m. Typical for this part of the country is the occurrence of great proglacial stream valleys stretching parallelly to the parallel of latitude and are partially utilized by the present rivers. The slopes of the proglacial stream valleys are frequently overgrown by xerothermic vegetation, and in the fauna, southern elements can be frequently encountered. Over the proglacial stream valleys, there lie plains of ground moraines originating from the last glaciation or that before the last one. From the south, the Belt of Great Valleys is closed by the Belt of Old Mts. and Uplands differing significantly from the lands discussed before. The average elevation here oscillates between 200 and 600 m a.s.l.

and in the Sudeten Mts., it reaches up to 1500 m. The pleistocene cover originating from the oldest, the so called Kraków glaciation, is comparatively thin and torn up in the uplands, while in the valleys it is up to 100 m thick. The rocks of older origin rise over the surface and contribute to a diversified relief of the terrain. The whole belt has a very varied'shape. A distinguishing feature is created by the Sudeten Mts. They are characterized by flat ridges and steep cavities. The maximal elevations of the particular ranges reach 1424 m a.s.l. (East Sudeten), 1115 m (Central Sudeten) and up to 1603 m a.s.l. (West Sudeten). Going further to the east, there are in succession the following uplands: the Silesian Upland (maximal elevation 350 m) divided from the Sudeten and the Sudetic Tectonic Foreland by the Silesian Basin, Krakowsko-Wieluńska Upland (500 m), Małopolska Upland with the Holy Cross Mts. (611 m) and the Lubelska Upland.

From the south, the Polish territory is bordered by the Carpathian Mts. raising gradually from the Racibórz-Oświęcim Basin, and Sandomierz Basin separating the Carpathians from the Belt of the Old Mts. and Uplands, through the Carpathian Plateau (350-450 m a.s.l.), the Beskiden Mts. (900-1700 m a.s.l.) to the Tatra Mts. (2663 m). The Carpathian Plateau is an upland-and-hummocky land cut up by wide river valleys. The Beskiden Mts. are typical medium mountains. Their summits are domed and they frequently combine into long mountain ranges cut by deep valleys of rivers and streams. The Tatra Mts. create the highest massif within the bow of the Carpathians. The mountain relief has an Alpine character. The summits rise with their rocky walls reaching the height of over 2500 m.

Climate. The vertical configuration and the geographic positions determine the general climate of Poland. A characteristic feature of the Polish climate is its transitional character between the oceanic climate of West Europe and the continental climate of East Europe. Another basic characteristic feature of the Polish climate is the high variability of weather depending on the direction of the incoming air masses. The polar-marine moist air coming from the northern Atlantic brings in winter thaws, increased cloudiness, snowfall and sometimes rainfall. In summer, the inflow of this air brings coolness with an increase of cloudiness and precipitation. In the annual course, the maximum occurrence of the polar-and-marine air falls to the summer, reaching in July 70% of all days (the average for the whole year is 65%). The polar-continental air, a comparatively dry one, comes from the east, usually during high pressure. In winter, it brings frosty weather without precipitation, while in summer, it brings a sunny and dry weather. This type of air mass appears mainly in spring and autumn with its maximum in March. The average frequency of polar-continental air in Poland per year is 29%. The meridional circulation brings the inflow of polar air from the north, or the tropical circulation from the south. Masses of arctic air most frequently appear in Poland in spring (April 21% of days, May 18% of days) and in autumn (October 11% of days). The inflow of these masses of air causes a variable weather with significant coolness and ground frost. The least frequent in Poland are the tropical air masses, their frequency o occurrence is 2% of days in the year. The inflow of these air masses brings sudden warming up in winter and strong heat in summer.

The distribution of mean annual temperature is shown in Fig. 99. The highest annual mean temperatures are recorded in the southwestern part of Poland. In the Lower Silesia, they are over 8.5°C. Lower values in reference to the lowland part of the country occur in the north-eastern part of Poland being as low as 6°C. This general tendency to the drop of the mean annual temperature from the south-west to the north-east is disturbed in the mountain areas because the temperature drops with the decrease of altitude. This phenomenon is responsible for the significant climatic separateness of the mountains and the development of climatic zones. The annual mean air temperature in the Carpathians decreases by about 0.5°C with each 100 m elevation.

Fig. 99. Annual mean air temperatures (°C)
in the period 1881-1960
(from the Climatic atlas of Poland, 1973)

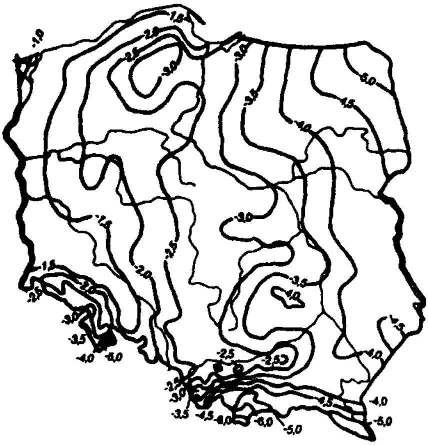

Fig. 100. Mean air temperatures in January (°C)
in the period 1881-1960
(from the Climatic atlas of Poland, 1973).

In the coldest month, January, the mean temperature is -1 to -5°C in the lowland part, and to -8°C in the mountains. The distribution of the isotherms of January is shown in Fig. 100. The isotherm distribution of this month' shows a meridional course. The direction of isotherms indicates a mildening influence of the Atlantic, and particularly of the Gulf Stream. The mean temperature of the warmest month, July, is on the lowlands from +17 to 18.5°C. The summer isotherms show a belt-like distribution with a course more or less even with the parallel of latitude, but with deviations connected with the sculpture of the terrain (Fig. 101). The coldest areas include the Carpathians and Sudeten. Aside of the mountains, cooler regions include the Holy Cross Mts. and other elevated parts of the terrain, like the Krakowsko-Wieluńska Upland and the Lakeland, as well as the western part of the seacoast. The comparatively warmest summer occurs in the Belt of the Central Lowlands, in the valleys of bigger rivers in the Belt of the Southern Uplands, and in the valleys of the Carpathian Submontane District.

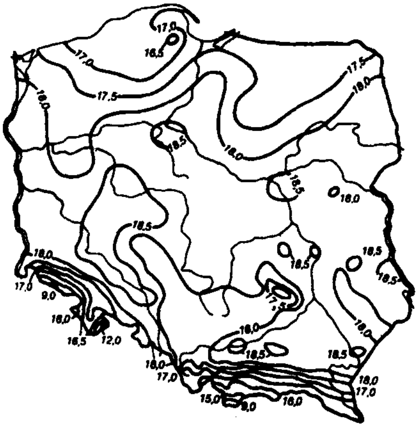

Fig. 101. Mean air temperature in July (°C) in the period 1881-1960 (from the Climatic atlas of Poland, 1973).

Fig. 102. Mean time of the thermal summer (in days) in the period 1881-1930 (from the National atlas of Poland, 1973/1978).

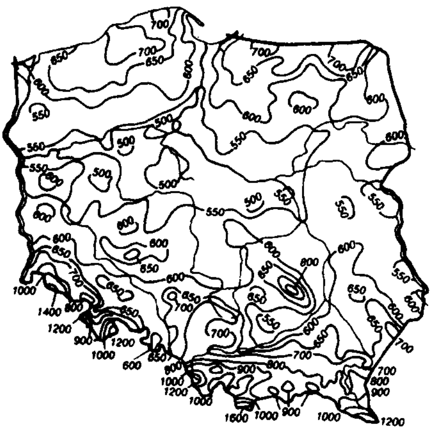

Fig. 103. Sums of annual atmospheric precipitations (mm) in the period 1931-1960 (from Climatic atlas of Poland, 1973; with changes).

The annual course of the mean day-and-night air temperature is determined by the sequence of the seasons. ROMER (1949) distinguished in Poland six thermal seasons of the year: early spring, spring, summer, autumn, early winter and winter, taking into consideration the average dates when the air temperature passes the defined treshold values. As soon as the mean day-and-night temperature rises above 0°C, the winter ends and early spring begins. In the same way, the next thermal seasons start when the mean day-and-night temperature exceeds: 5°C in spring, 15°C in summer, drop below 15°C in autumn, drop below 5°C in early winter, drop below 0°C in winter. The occurrence of heterothermic animals including insects depends on the length of the vegetation season, and for many groups, high air temperatures are essential. Therefore, a map is presented below showing the average time of the thermal summer counted in days (Fig. 102). The period of thermal summer in Poland is very differentiated, from almost four months in the Carpathian Submontane District and the Sandomierz Basin, to less than two months in the Lakelands and the Holy Cross Mts. In the Carpathians, above 800 m a.s.l., the average day-and-night temperatures do not exceed 15°C, it means that in the thermal understanding, there is no summer time.

The atmospheric precipitations on the territory of Poland depend in a high degree on the relief of the terrain and the map of their distribution (Fig. 103) overlaps to a high extent with the hypsometric map (Fig. 98). The greatest precipitations occur in the Sudeten and Carpathian Mts. (from 1000 to 1200 mm per year). Aside of the mountains, a lot of atmospheric precipitations is received by the Belt of the Southern Uplands and the Lakelands. The smallest amount of precipitations occurs in central Poland, in Mazovia and the Great-Poland (Wielkopolska), partially in Kuyavia (Kujawy) , and in the region of the Lower Vistula. The distribution of precipitations in Poland is irregular. The greatest precipitations occur in the summer, as a rule in July, the smallest in winter, particularly in February.

Soil types. The most important soil types distinguished on the area of Poland include: limestone soil, chernozem, hydromorphic soils (peat soils, half-bog soils and black soil), biologically active soils, warp soils, brown soils (brown soil 20% and grey-brown podzolic soil 30%), podzolic soils (brown podzolic soil 10%, podzolic soil). Among the mentioned types of soils, the greatest areas in Poland are covered by podzolic soils, and in the second place there are the brown soils. The other types of soils participate in a comparatively small degree. The podzolic soils cover actually 25% of the territory in Poland and they most probably developed in the cool and moist climate of the interstadial of late Pleistocene. They most frequently develop from poor loose quartz sands, less frequently from coarse sandy soil with the participation of aci-dophilic vegetation, mainly from needle forests and moorland. The podzolic soils are spread mainly in central Poland and northern Poland. The brown soils were developed on the area of our country in the conditions of a moderate moist climate of rocks rich in aluminosilicates and frequently abounding in calcium carbonate with the participation of deciduous forests. They occur on the lowland as well as in the upland and mountains. They cover about 50% of the total territory in Poland.

Vegetation cover. The vegetation cover of Poland reflects both the conditions of the physiogeographic environment as well as the numerous effects resulting directly or indirectly from the socio-economic activity of man.

The potential vegetation of Poland consists primarily of mesophilic deciduous forests. The forests cover 58.1% of the area of the country. This number includes 41.6% of oak and hornbeam forests biotopes being the most common and most spread natural plants communities. Actually, these areas are occupied by arable land due to their fertile soils. The beech forests biotops cover 13.6% of the territory of Poland, concentrating in the west and in the south of the country. Stenothermal bright oak forests occupy a potentially small area (2.9%). The second place in reference to the size of the occupied area belongs to the mixed forests (19.1%). In the western suboceanic part of the country, they occur in the form of the so-called philic oak forests. Floristically, they represent poor oak forests, birch-oak forests and beech-oak forests with a natural admixture of pine. In the more continental areas of the central and eastern parts of Poland, the mixed forest type is represented by oak and pine forests with the participation of asp that increases the further we go to the east; and with an admixture of spruce in the north-eastern part. The proper coniferous forests occupy potentially in Poland 11.4% of the area. In the majority, they are pine forests. In the Uplands and the Plateau, there are fir-spruce forests with the participation of pine and spruce forests occurring in the upper montane zone and in some enclaves in the north-east. The azonal communities remaining under the influence of ground and surface waters play an important role in the natural landscape in Poland. Their joint potential habitat covers 10.9% of the total area of the country. The greatest area is covered by willow-and-poplar forests (5.5%). The valleys of slowly flowing rivers with a tendency to become marshy create a habitat for the ash and alder forest (3.4%). The marshy alder forests are a potential natural community on biotops with a high level of ground water. We must also mention raised peat, seaside vegetation and alpine vegetation occupying a total of 0.5% of the Polish area (MATUSZKFEWICZ, 1999).

The synthesis of the studies on the vegetation cover is the regionalisation of the country on the geobotanical basis. We are going to use one of the best known divisions proposed by SZAFER (1972; Fig. 104). According to their division, Poland from the botanical point of view is a Holarctic country in the Eurosiberian Region, and almost in its whole extent it belongs to the Middle-European provinces: the Lowland-and-Upland province and the Mountain province. Only a negligible part of the country belongs to the Pontic-Pannonian Province.

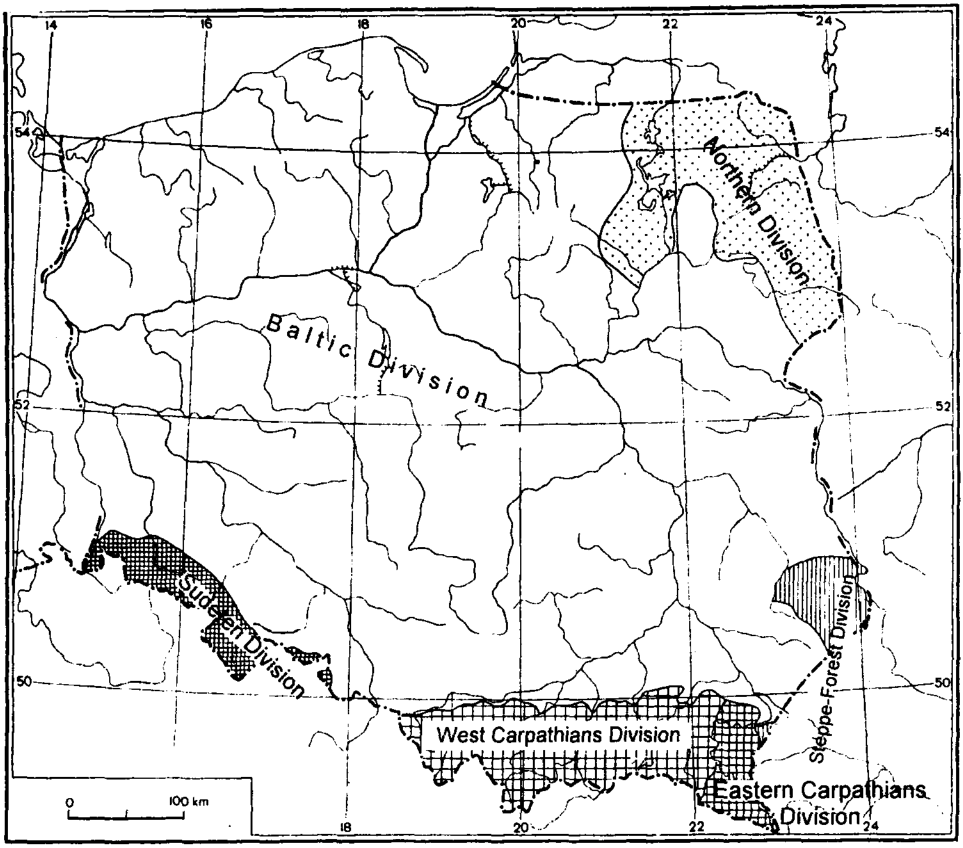

Fig. 104. Geobotanical regionalisation of Poland (from SZAFER, 1972).

Main food plants of bees. The resources of honey supplying flora are differentiated on the area of Poland and next to the natural distribution of plants, the anthropological transformations exert here a significant influence. A survey of the main nectar and pollen supplying plants is given by JABŁOŃSKI & KOŁTOWSKI (1992). According these authors, in total, about 500 species of entomophilous plants belonging to hungred families are recorded from Poland.

In dry wood communities (dry pine forests), the basic nectar and pollen supplying plants in Poland include: Vacinium vitis-idaea, V. myrtillus, Thymus serpyllum, Sedum acre and Calluna vulgaris. In fresh coniferous forest, in the undergrowth, there can be found: Vaccinium myrtillus, V. vitis-idaea, and Melampyrum pratense. In the shrub layer, the following ones should be mentioned: Crataegus sp., Frangula alnus, Rubus idaeus, Rhamnus cathartica, Sorbus aucuparia, Salix acutifolia, S. daphnoides, S. caprea and Corylus avellana. The latter one gives pollen only.

In shadowed places and on clearings, there grow Calluna vulgaris, Chamaenerion angustifolium, Solidago virga-aurea, Jasione montana, Thymus sp., Campanula sp., Hieracium pilosella, Genista sp., Hypericum perforatum and Knautia arvensis. In the marshy coniferous forests, there may be found: Frangula alnus, Rubus idaeus, R. fruticosus, Salix aurita, and in the herbaceous plant layer there are: Vaccinium myrtillus, V. uliginosum, Ledum palustre, Calluna vulgaris and Melampyrum pratense. Next to the coniferous forests that occupy in Poland 81.6% the forest area, numerous species supplying food to bees occur in deciduous forests. In the forest undergrowth, there appear spring geophytes: Ajuga reptans, Cardamine impatiens, Asperula nivalis, Pulmonaria obscura, Viola silvestris, Lathyrus vernus, Anemone nemorosa, Hepatica nobilis. In the bush layer, there occur: Frangula alnus, Rubus idaeus, R. fruticosus and Viburnum opulus. Also trees creating the coniferous forests provide sources of pollen and nectar. In the marshy river valley forests (willow and poplar) and in alder forest, in the spring, there bloom numerous species of Salix sp. supplying pollen and nectar. On clearings and in less shadowed places, there bloom in summer: Heracleum sphondylium, Cirsium oleraceum, Mentha longifolia, Epilobium hirsutum, Solidago canadensis, S. serotina.

Meadow communities include a long list of plant species supplying food to bees. The most important ones are the following: Trifolium repens, T. hybridum, T. pratense, Lotus corniculatus, L. uliginosus, Lathyrus pratensis, Vicia cracca, Taraxacum officinale, Glechoma hederacea, Prunella vulgaris, Lychnis flos-cuculi, Viscaria vulgaris, Tragopogon pratensis, Leontodon autumnalis, Centaurea jacea, C. scabiosa, Geranium pratense, Geum rivale, Succisa pratensis, Scabiosa columbaria, Campanula spp., Symphytum officinalis, Sylvia pratensis, Heracleum sphondylium. On wet meadows, the following plants can be met: Polygonum bistorta, Lythrum salicaria, Cirsium oleraceum, C. palustre,. Mentha spp., Cardamine pratensis, Lycopus europeus, Epilobium hirsutum, Valeriana officinalis, Filipendula ulmaria and Thalictrum aquilegifolium.

In the pastures, the main nectar and pollen supplying plants include: Trifolium repens, Lotus corniculatus, Vicia cracca and weeds not consumed by animals such as: Centaurea jacea, Carduus sp., Cirsium arvense, Echium vulgare, Geranium pratense, Odontites rubra, Mentha spp., Hieracium pilosella, Solidago spp.

Agricultural lands cover in Poland 17 mln ha. Some cultivations supply a rich source of food for wild bees. rape, red clover, buckwheat, mustard and some vegetables: cabbage, onion, garden carrot, some industrial plants and medical plants like: Coriandrum sativum, Carum cavi, Sisymbrium marianum and others. On the agricultural fields, there occur some weeds supplying food to bees, among others: Centaurea cyanus, Raphanus raphanistrum, Cirsium arvense, Stachys palustris, Sonchus arvensis, Sinapis arvensis. Many food supplying plants are found on ruderal areas, roadsides and other waste land. Among the most important ones, we should mention trees like: Salix spp., Acer spp, Sorbus aucuparia, Aesculus hippocastanum, Robinia pseudacacia, Tilia spp., shrubs: Prunus cerasifera,. Caragana arborescens, Crataegus spp., Cotoneaster spp., Lonicera spp., Cornus mas, Symphoricarpos albus; herbaceous plants: Taraxacum officinale, Lamium album, Trifolium spp., Lotus spp., Prunella vulgaris, Glechoma hederacea, Echium vulgare, Anchusa officinalis, some species of Centuarea spp., Cichorium intybus, Melilotus albus, Leontodon autumnalis, Impatiens glandulifer and others.

On phenology of flowering. The first plants starting a flowering in early spring (March) are (in brackets average dates of flowering are given): Corylus avellana (II-III), Cornus mas (III-IV), Salix acutifolia (III-IV), Salix daphnoides (III-IV), Salix caprea (III-IV), Anemone nemorosa (III-V), Hepatica nobilis (III-V), Pulmonaria obscura (III-V).

In April many forest species start flowering: Lamium album (IV-XI), Lathyrus vernus (IV-V), Prunus cerasifera (IV-V), Salix aurita, (IV-V), Ajuga reptans (IV-VI), Cardamine pratensis (IV-VI), Glechoma hederacea (IV-VI), Vaccinium myrtillus (IV-VI), Viola silvestris (IV-VI) and some others.

May is the month in which the largest number of plants starts flowering: Aesculus hippocastanum (V), Sorbus aucuparia (V), Anchusa officinalis (V-X), Hieracium pilosella (V-X), Prunella vulgaris (V-X), Caragana arborescens, (V-VI), Cardamine impatiens, (V-VI), Crataegus sp., (V-VI), Geum rivale, (V-VI), Ledum palustre, (V-VI), Lychnis flos-cuculi (V-VI), Raphanus raphanistrum (V-VI), Rhamnus cathartica (V-VI), Robinia pseudacacia (V-VI), Rubus idaeus (V-VI), Symphytum officinalis (V-VI), Taraxacum officinale (V-VI), Vaccinium uliginosum (V-VI), Viscaria vulgaris (V-VI), Salvia pratensis (V-VII), Sedum acre (V-VII), Tragopogon pratensis (V-VII), Vaccinium vitis-idaea (V-VII), Viburnum opulus (V-VII), Sinapis arvensis (V-VIII), Thalictrum aquilegifolium (V-VIII), Centaurea cyanus (V-IX), Knautia arvensis (V-IX), Lotus corniculatus (V-IX), Trifolium hybridum (V-IX), Trifolium repens (V-IX), Trifolium pratense (V-IX).

In early and middle summer, such entomophilous plants bloom as: Echium vulgare (VI-X), Geranium pratense (VI-X), Leontodon autumnalis (VI-X), Sonchus arvensis (VI-X), Filipendula ulmaria (VI-VII), Lathyrus pratensis (VI-VII), Epilobium hirsutum (VI-VIII), Hypericum perforatum (VI-VIII), Symphoricarpos albus (VI-VIII), Valeriana officinalis (VI-VIII), Vicia cracca (VI-VIII), Centaurea jacea (VI-IX), Frangula alnus (VI-IX), Heracleum sphondylium (VI-IX), Jasione montana (VI-IX), Melampyrum pratense (VI-IX), Thymus serpyllum (VI-IX), Solidago canadensis (VII), Tilia cordata (VII), Cirsium arvense (VII-X), Melilotus albus (VII-X), Scabiosa columbaria (VII-X), Lythrum salicaria (VII-VIII), Polygonum bistorta (VII-VIII), Carduus acanthoides (VII-IX), Centaurea scabiosa (VII-IX), Cichorium intybus (VII-IX), Cirsium oleraceum (VII-IX), Cirsium palustre (VII-IX), Lycopus europeus (VII-IX), Mentha longifolia (VII-IX), Solidago virga-aurea (VII-IX), Stachys palustris (VII-IX), Succisa pratensis (VII-IX).

In late summer Odontites rubra (VIII-X), Solidago serotina (VIII-X), Calluna vulgaris (VIII-IX) start flowering.

In various regions of Poland schedule of flowering is different. The difference in flowering of main food plants between southern and northern Poland is changing during the vegetation season. In spring and early summer this difference reaches to two-three week. For example, the distinction between the beginning of blooming of selected plants in north-western (Suwałki) and southern Poland (Kraków) is as follow: Corylus avellana – 13 days, Tussilago farfara – 27, Salix caprea – 16, Ribes grossularia – 19, Brassica napus – 14. In summer and late summer, the differences are smaller and even some plants start flowering earlier in the north than in the south of the country. For example, in the average Robinia pseudacacia starts flowering in northern Poland on 11th June and in southern Poland on 4th June, Centaurea cyanus starts flowering on 9th June both in northern and southern Poland. Tilia cordata starts flowering on 6th July in the north and on 9th July in the south of Poland and Calluna vulgaris respectively on 14th August and 18th August. The dates of flowering above are based on 40-years observations (GROMISZ, 1993).

History of the study of the Polish fauna of the Halictidae

The borders of Poland changed many times in its history. At the time when first entomological investigations were carried out on the territory of the present-day Poland, a part of northern regions (Pomerania, and Mazurian Lakeland, 'West and East Prussia'), as well as the western and the southern ones (the northern Great Poland, and Lower Silesia) were within the borders of Germany. On the other hand, western Byelarus and Ukraine belonged to Poland. After the World War II, the Polish borders were shifted westwards, embracing the above-mentioned northern, western, and north-western territories, which earlier belonged to Germany, whereas the eastern regions entered into the territories of Ukraine and Byelarus.

Faunistic studies before the World War II. Below we give all faunistic papers on bees of current Polish (or partly Polish) territories published before the War II by German authors in chronological order with indication of the regions studied in original writings: SCHILLING (1840, 1849, Schlesien); SIEBOLD (1850, West- und Ostpreußen); BRIESCHKE. (1863, 1864, 1886, 1887, 1888a, 1888b, 1889, 1892, 1894, West- und Ostpreußen); DITTRICH (1884, discovering *Nomioides minutissimus* in 'Carlowitz bei Breslau'; 1903, 1909, Schlesien); DUCKE (1898, 1900, österreichisch Schlesien); BAER (1904, Preußischen Oberlausitz, Görlitz); ALBIEN (1905, Westpreußen); SPEISER (1906a, Ostpreußen; 1906b, Ost- und Westpreußen); ALFKEN (1909, 1912, Westpreußen; 1910, 1913, Östpreußen); SCHOLZ (1912a, Schlesien); TORKA (1913, 1916, 1933, Provinz Posen; 1925, 1926, Oberschlesien);

BLÜTHGEN (1919, 1942, Pommern); BISCHOFF (1925, Lithauens und angrenzender Gebiete); BANZHAF (1930, Pommern); MÖSCHLER (1938, Ostpreußen).

In 19^{th} century, also a single paper on the Polish insects, including several halictids, was published by a Russian author: the NASONOV's (1894) list of insects in the Zoological cabinet of the Imperator's Warsaw University.

Before the War II, the most papers published by Polish authors were connected with the Proceedings of the 'Physiogeoraphical' Commission in Kraków. The following Polish authors had published faunistic lists of bees, including halictids: WIERZEJSKI (1868, 1874, different localities in Poland); ŚNIEŻEK (1910, 'Galicja' [Galicia]); NOSKIEWICZ (1918, 'Galicja' [Galicia]; 1920b, 'Kałusza'), ŁOZIŃSKI (1920, Kraków). Also some faunistic papers were published above before the War II outside the program: KISS & OLASZ (1907, the Babia Góra Mt.); NOSKIEWICZ (1920a, the Tatra Mts.; 1922, 'Małopolska' [Little Poland]; 1924a, 1926, different localities in Poland; 1924b, Kraków), DROGOSZEWSKI (1932, 1934, different localities in Poland), ADOLPH (1934, 'Wileńszczyzna' [the Wilno district]), MINKIEWICZ (1935, different localities in Poland).

Faunistic studies after the World War II. After the War, Polish entomologists very actively have worked in the field of faunistic study of Polish bees, including halictids: SZULCZEWSKI (1948, the Wielkopolski National Park), NIESIOŁOWSKI (1949, northern Poland), NOSKIEWICZ (1949, the valley of Barycz; 1950a, Polish Prussia; 1950b, 1959b, the Silesian Lowland; 1950c, Pomerania; 1953, Małopolska Upland; 1957, 1959a, different localities in Poland; 1958, the Wapienna Mt. near Stolec (Lower Silesia); 1960, Wrocław; review of his papers see below, in separate subsection), KRYSIŃSKI (1957, Przemyśl), DYLEWSKA & NOSKIEWICZ (1963, the Pieniny National Park), DYLEWSKA (1966, the Babia Góra Mt., 1989, the Ojców National Park, 1991, the Tatra Mts.), DYLEWSKA & ZABŁOCKI (1972, different localities in Poland), SZYMCZAKOWSKI (1972, the Pieprzow Mts.), BANASZAK (1973a, Rzeszów region; 1973b, Poznań; 1973c, the Wolin National Park; 1975, the Lower Vistula; 1976a, 1979, 1984, different localities in Poland; 1976b, Poznań; 1980, the valley of Vistula; 1982a, Warszawa and Mazovia; 1982b, the Wielkopolsko-Kujawska Lowland; 1982c, the Polish coast of Baltic sea; 1987a, the Wielkopolski National Park; 1987b, the Wielkopolsko-Kujawska Lowland; 1988, Łódź; 1989, the Mazovian Lowland; 1991a, a checklist of the Polish bees; 1991b, the Mazovian Lowland; 1992, a red list of bees), WÓJTOWSKI & SZYMAŚ (1973, Poznań), KOSIOR & FIJAŁ (1992, the Zamość district), BANASZAK & CIERZNIAK (1994a, the Wielkopolski National Park; 1994b, the lower Vistula river), CIERZNIAK (1994b, Żuławy Gdańskie, depression near Gdańsk), BANASZAK & KRZYSZTOFIAK (1992, forests of Poland; 1996, the Wigry National Park), BANASZAK & PLEWKA (1981, the Kampinoski National Park), CELARY (1986, discovering *Evylaeus bava-*

ricus in Poland; 1989, the Będkowska Valley, the Krakowsko-Wieluńska Upland; 1991, an annotated list of Polish *Sphecodes*; 1998, the Babia Góra Mt.), PAWLIKOWSKI (1992a, Toruń Basin; 1992b, a revised checklist of Polish Halictidae); KRZYSZTOFIAK (1994, the Wigry National Park), KRZYSZTOFIAK & PAWLIKOWSKI (1995, northeast Poland).

After 1950th in the field of ecology of bees and pollinators of lucerne, red clover, rape and some other entomophilous crops, also the followings persons have worked: A. ANASIEWICZ, M. BILIŃSKI, J. BANASZAK, T. CIERZNIAK, A. DOMAGAŁA-LIPIŃSKA, H. FELISZEK, H. GAŁUSZKOWA; B. JABŁOŃSKI, J. KARCZEWSKI, A. KOSIOR, A. KRZYSZTOFIAK, B. MICZULSKI, T. PAWLIKOWSKI, A. RUSZKOWSKI, S. SOWA, J. WENGRIS, Z. WILKANIEC, F. WÓJTOWSKI, S. WRONA, H. ZIÓŁKOWSKI. The authors above combined have published nearly a thousand of papers; in about 170 papers of them, halictids are indicated.

Polish halictid were mentioned in the following taxonomic papers: MORAWITZ (1876); ALFKEN (1897, 1899); STRAND (1909); BLÜTHGEN (1918, 1919, 1920, 1924, 1930, 1935, 1951); STOECKHERT. (1933, 1954); EBMER. (1969-1971, 1984, 1987a, 1988a, 1988b); WARNCKE (1976, 1979, 1980); EBMER & SCHWAMMBERGER (1986). The most important records, i.e. concerning rare species, are cited in Chapter IV.

Jan Noskiewicz. Especially important role in study of the Polish halictids belongs to Professor Dr Jan W. NOSKIEWICZ (1890-1963). JWN was one of the most outstanding Polish zoologists and entomologists. He started studying natural sciences in the Jagiellonian University in Kraków; in 1910-1913, his studies were continued in the field of geology, botanics and zoology in the Lwów University. In 1913-1939, JWN worked as a teacher in grammar-school schools. In 1920-1922, he performed the duties of an assistant in the Department of Zoology of the Lwów University. In 1929-1939, JWN worked as a researcher and librarian in the Dzieduszyckis' Museum in Lwów. In 1927, JWN obtained the degree of PhD, and in 1937, he made his habilitation in the Lwów University in the field of systematic zoology and zoogeography. During the World War II, JWN was being a lecturer of zoology in the Lwów Pedagogical Institute and Lwów University. After the invasion to Lwów by the Germans, until 1944, JWN worked in the Prof. R. WEIGEL's Institute for studies on Typhus Fever; he performed there the function of a louse breeder [sic!]. In 1944, JWN moved to Wrocław where he was nominated to a professor of animal systematics and zoogeography of the Wrocław University. In 1951-1963, JWN was the editor of the 'Polish Entomological Papers'.

The scientific output of JWN includes mainly faunistic studies with zoogeographical considerations; he published over 100 scientific papers. JWN conducted studies in Podolia (at present, western Ukraine) and southern Poland, especially the Lower Silesia. The main subjects of his scientific interest were bees (Apoidea), sphecid wasps (Sphecidae) and gold wasps (Chrysididae). The faunistic research work carried out in Podolia has resulted in an extensive work written by JWN in cooperation with Dr Roman KUNTZE under the title: 'Outline of the zoogeography of the Polish Podolia' (KUNTZE & NOSKIEWICZ, 1938). This work represents an extensive (538 pages) carefully elaborated treatise that may serve as well as a manual of practical faunistics and zoogeography. Among others, it contains lists of many bee species including also halictids.

Professor Dr Jan W. NOSKIEWICZ (1890-1963)

Besides faunistic studies, JWN developed works in the field of the taxonomy of bees. His greatest work in this field is a monograph on the Palaearctic bees of the genus *Colletes*. The book comprises 532 pages and 249 original drawings, contains keys and descriptions of 125 species including 61 new ones for science. JWN described also new species in the following bee genera: *Andrena*, *Camptopoeum*, *Dasypoda*, *Dioxys*, *Halictus* s. l., *Nomada*, *Sphecodes*, and *Stelis*. Of four halictid species described by JWN, three ones are currently recognised as separate species: *Sphecodes zangherii*, *Halictus lissonotus*, and *H. podolicus* (now both latters in the genus *Evylaeus*).

In his faunistic studies on bees, JWN devoted his attention to the representatives of the Strepsiptera, being parasites of imagoes of *Andrena* and *Halictus* s. l. In association with Dr Gustaw POLUSZYŃSKI, JWN described little-known embryonic development of *Stylops* and discovered the polyembryonic development in *Halictoxenos* (NOSKIEWICZ & POLUSZYŃSKI, 1924, 1926a, 1926b, 1935).

Material and methods

Collections examined. All main collections of Polish bees were studied. Total almost 12,000 halictid specimens were examined and included into a database (Table 2). We have found many wrongly identified halictids, especially many (over 50%) in old collections of P. ŁOZIŃSKI, J. ŚNIEŻEK, and A. WIERZEJSKI (all they are stored in KRA). On this reason, our further analyses are based only those materials that were examined by us.

Unfortunately, some Polish apidologists, among them Dr T. PAWLIKOWSKI (the University Nicolai Copernici, Torun), in some form or other refused to make the collections of bees available for our study and inclusion into our database, in spite of their official status (since they belong to institutions). These persons actively work in the field of the fauna and ecology of bees and thus might be expected to show interest in that their materials would be identified by a specialist in the taxonomy of the Halictidae. One of the present authors, Yu. A. PESENKO, believes that what underlies this refusal is a desire to avoid publicity of the errors present in certain papers issued and stemming from wrong identifications of species.

Table 2. Collections in which the Halictidae (excluding *Sphecodes*) were examined

Institution or person	Abbreviation	Number of specimens	Number of species
1. Museum and Institute of Zoology PAN, Warsaw	WAR	1, 211	68
2. Institute of Systematic and Experimental Zoology PAN, Kraków	KRA	4, 541	63
3. Natural Museum of University in Wroclaw; collection of NOSKIEWICZ (N) and collection of DITRICH (D)	WRO	325 (N) 210 (D)	74 (N) 46 (D)
4. Division of Apiculture, Institute of Pomology and Floriculture, Pulawy	PUL	1, 327	51
5. Personal collection of Prof. J. BANASZAK, Bydgoszcz	BAN	2, 286	58
6. Personal collection of A. KRZYSZTOFIAK, Suwalki	KRZ	1, 331	30
7. Personal collection of J. KOWALCZYK, Lodz	KOW	136	23
In total		11, 707	81

On problems of identification of localities. The places of collection of specimens were identified according to labels. The most labels that have come down from the 19th century are written by hand, which occasionally made it impossible to identify the collection locality. The major problem of locality identification consisted in that only the name of a small village was stated in a label, lacking its localisation in relation to points indicated in geographical maps (towns, mouthes of rivers etc.). The fact that several, sometimes several dozens of villages by the same name exist or existed, has rendered it unrealisable to precisely establish the collection locality. If literature data on the territorial scope of investigations do not permit the identification of the collection localities, such data were not used in creating the distributional map. In a similar fashion, the labels were not used, which indicate the collection locality very non-specifically, e.g. 'Pommern, Silesia'. In total, of 651 collection localities most probably belonging to Polish territory, 85 have remained unidentified. Labels of halictids caught by German entomologists in northern and western Poland, were deciphered with the use of the Polish-German-Polish onomastic dictionary (BATTEK & SZCZEPANKIEWICZ, 1998).

Database. The data obtained in the course of analysing the museum collections have been pooled into a database with the use of the Microsoft Excel 97 program. As well, information on 11, 707 individuals of Halictidae is accumulated in the database. The information concerning each specimen comprises the following items: the species, sex, catch locality, date of catch, species of the plant on which the specimen was caught, biotope in which the specimen was caught, collection where the specimen is kept. The data on the species, sex, and locality are available for all specimens included into the database. Information on the date of catch is obtained for 11, 457 specimens (97.9%); information on the visited plant for 3, 800 specimens (32.4%), on the biotope for 3, 500 specimens (29.9%). Only on the basis of the data accumulated, the maps of the distribution of species in Poland are created, the seasonal dynamics of flight activity of species, their biotopic and trophic preferences are established.

In the sections 'Polish data' of Chapter IV, occurrences of common species in Poland are represented only in the form of distributional maps and general characteristics of their localisation in the country. For rare species, which were caught in less than eight localities, the full information available in labels is given. On the distribution maps, only those localities are indicated, which have been confirmed on the basis of the analysis of collections studied (see Table 2) and included into the database. Literature data on the occurrence in Poland are given in the section 'Polish data' only for very rare species and only published by taxonomists and some authoritative specialists. The diagrams of the seasonal dynamics of flight activity are given for all species excepting rare species.

Mapping of species occurrence. The occurrence of all species are presented on a contour map of Poland. The place of the localities is based on the geographic co-ordinates and the UTM network (Fig. 105); the Gnomon program created by R. BAJACZYK was used in their identification. In total, 566 habitation localities of halictid species in Poland is included. These localities are presented in Fig. 106 and listed below:

District Biała Podlaska: Kodeń, Konstantynów, Lipa, ad. Rozwadów, Mielnik, Rozbitówka.

District Białystok: Białowieża, Czerlonka, ad. Białowieża.

District Bielsko-Biała: Babia Góra Mt., Cieszyn, Górki, ad. Wiślica, Harbutowice, ad. Skoczów, Haźlach, ad. Cieszyn, Międzybrodzie Bialskie, Oświęcim, Pogwizdów, Poręba, Przyborów, Skoczów.

District Bydgoszcz: Bydgoszcz, Folusz, ad. Szubin, Gruczno, Jaszcz, ad. Świecie, Kierzkowo, ad. Żnin, Łęgnowo, Sępólno Krajeńskie, (Gr. Lutauer Fors, distr. Zempelburg), Ślesin, Witosław, ad. Wyrzysk.

District Chełm: Bezek, Chełm, Izbica, ad. Krasnystaw, Kamionka, Kukawka, Żmudź.

District Ciechanów: Płońsk.

District Częstochowa: Częstochowa, Janów, ad. Myszków, Kamienica, Kusięta, Olsztyn, Podlesice, Podlesie, ad. Koniecpol, Potok Złoty, Trzebniów.

District Elbląg: Biała Góra, ad Sztum, Borowiec, ad. Pruchnik, Czemin (Hokendorf), ad. Sztum, Kępa Rybacka, Kierpajny Wielkie (Gros Korpen), Krynica Morska, Minięta (Menthen), Orłowo Morskie. Uśnice (Usnitz).

District Gdańsk: Chałupy, Hel, Gdańsk, Gdynia, Jastarnia, Jurata, Kuźnica, Sopot.

District Gorzów Wielkopolski: Dobiegniew, ad. Strzelce Krajeńskie, Gorzów Wielkopolski (Landsberg), Serbów, ad. Słubice, Strzelce Krajeńskie, Templewo, ad. Międzyrzecz, Wysoka.

District Jelenia Góra: Jagniątków (Agnetendorf), Nowy Kościół (Neukirch), Przesieka (Hain), Szklarska Poręba (Schreiberhau), Wilka (Wilke), Wojków (Hohenwise).

District Kalisz: Rozdrażew, Syców (Gross Wartenberg).

District Katowice: Bolesław, ad. Olkusz, Bytom, Chorzów, Golczowice, ad. Olkusz, Gołonóg, ad. Dąbrowa, Jaroszowiec, Karniowice, Mętków, Mszana, Ogrodzieniec, Olkusz, Pomorzany, Rabsztyn, Rodaki, Ryczów, Ryczówek, Smoleń, Zawiercie, Żelazko, Błędowska Desert.

District Kielce: Biskupice, ad. Miechów, Bodzentyn, Bogucice, ad. Pińczów, Chotel Czerwony, ad. Pińczów, Dębno, Dosłońce, ad. Miechów, Gacki, ad. Busko, Grabowiec, ad. Pińczów, Helenówka, ad. Jędrzejów, Klonówka Mt., ad. Klonów, Kotuszów, ad. Szydłów Krzemionki, Krzyżanowice, ad. Pińczów, Mlodzawy, ad. Pińczów, Mokra, ad. Jarosław, Nowa Słupia, ad. Opatów, Ostrowiec Świętokrzyski, Pacanów, ad. Busko-Zdrój, Pieczonogi, ad. Proszowice, Pińczów, Podlesie, Podłysica, Pogorzele, Łysogóry Mts., Racławice, Skorocice, ad. Pińczów, Skowronno Dolne, ad. Pińczów, Sobków, ad. Jędrzejów, Stawiszyce, ad. Kazimierza Wielka, Suchedniów, Świętokrzyski National Park. Chełmowa Mt., Święty Krzyż, Wola Zagojska Dolna, ad. Pińczów, Wymysłów.

District Konin: Bugaj, ad. Miłosław, Dąbroszyn, Dobroszyn, Honoratka, Kleczew, Konin, Modlica, Rychwał, Żarzyn.

District Koszalin: Dębsko, ad. Kalisz Pomorski, Kalisz Pomorski, Kołobrzeg, Koszalin, Mielno, Ostre Bardo (Wustebartch). Sarbinowo, Unieście, Ustronie Morskie, Czaplinek (Tempellburg), ad. Szczecinek, Polne, ad. Szczecinek.

District Kraków: Będkowska Valley, Kobylańska Valley, Kraków, Maków, Mirów, Murownia, Niepołomice, Ojców, Ostrężnik, Podgórki Krakowskie, Przegorzały, Skała, Tenczynek, Tyniec, Wieliczka, Zawadka, ad. Myślenice.

District Krosno: Ustrzyki Dolne, Cisna, Głowienka, Puławy, ad. Rymanów, Stara Wieś, ad. Brzozów, Średnia Wieś, ad. Lesko, Ustrzyki Górne.

District Legnica: Barycz (Baritch), Jawor (Jauer), ad. Legnica, Jenków, ad. Środa Śląska, Jerzmanice-Zdrój (Hermsdorf), Lipiny, Małuszów (Malitz), Myślibórz (Moisdorf), Podgórnik (Saiffenau), Proboszczów (Probsthain), Targoszyn, ad. Jawor.

District Leszno: Daleszyn, ad. Pniewy, Gołębin Stary, ad. Kościan, Kaczkowo, ad. Rydzyna, Krzywiń, Leszno, Rąbin, ad. Kościan, Rogaczewo, ad. Kościan, Turew, ad. Kościan, Wyskoć, ad. Kościan, Zbęchy, ad. Kościan.

District Lublin: Bochotnica, ad. Puławy, Bronowice, ad. Puławy, Chlewiska, ad. Strzebrzeszyn, Elizówka, Fajsławice, ad. Krasnystaw, Gołąb, ad. Puławy, Janowiec, ad. Puławy, Jaroszyn, ad. Puławy, Kazimierz Dolny, Konopnica, Końskowola, ad. Puławy, Leokadiów, ad. Puławy, Lublin, Łęka, ad. Puławy, Nałęczów, Parchatka, ad. Puławy, Piaski, Piskorów, ad. Leokadiów, Puławy, Szczekarków, Trzcianki, ad. Puławy, Włostowice, ad. Puławy, Wojszyn, ad. Puławy, Zbędowice, Żyrzyn.

District Łódź: Bukowiec, Chełmy, Dąbrowa, Helenów, ad. Błonie, Janinów, ad. Łódź, Józefów, Kalonka, Łagiewniki, Łódź, Niecki, Nowosolna, Rogi, Stoki, ad. Łódź, Wiączyń Dolny.

District Nowy Sącz: Antałówka, ad. Zakopane, Bukowina Tatrzańska, Chabówka, ad. Rabka, Czarny Dunajec, Głodówka Mt., ad. Zakopane, Gorce Mts., Hucisko, ad Turbacz Mt., Kiry, ad. Zakopane, Krynica, Lipowe, Nowy Targ, Pieniny Mts, Poronin, Rabka, Stary Sącz, Szczawnica, Bukowina Tatrzańska, Jaszczurówka, Kalatówki, Kuźnice, ad. Zakopane, Łysa Polana, Poronin, Zakopane, Żegiestów, Tatra Mts: Chochołowska Valley, Głodówka, Gubałówka Mt., Hala Chochołowska meadow, Hala Kondratowa meadow, Hala Ornak meadow, Hala Smytnia meadow, Hala Smytnia Niżna meadow, Hala Smytnia Wyżna meadow, Hala Strążyska meadow, Iwaniacka pass, Jaworzynka Valley, Kira Miętusia meadow, Kobylarz Mt., Kominy Tylkowe Mt., Kościeliska Valley, Mała Łąka Valley, Miedziane Mt., Morskie Oko Lake, Opalone Mt., Ornak Mt., Polana Rusinowa meadow, Polana Zachradziska meadow, Przysłop Miętusi , Siwe Sady slopes, Toporowa Cyrhla Mt. , Wodogrzmoty Mickiewicza waterfall, Żar slope, Boczań Mt.

District Olsztyn: Orzyny, Warkały, ad. Jankowo.

District Opole: Babice, ad. Głubczyce, Bliszczyce, distr. Głubczyce, Głuchołazy, Górażdże, ad. Strzelce, Górki (Kleinberg), Kamienica, ad. Paczków, Kamień Śląski, Komaszyce, ad. Opole Lubelskie, Lubrza, ad. Prudnik, Moszczanka (Langenbruche), Namysłów (Namslau), Nysa, Otmuchów, Pawłowiczki, ad. Koźle, Sucha, ad. Strzelce Opolskie, Tarnów Opolski, Tarnów Śląski, Zawiszyce, ad Głubczyce.

District Ostrołęka: Łączki.

District Piła: Ciążyń, ad. Czarnków, Krzyż (Kreutz), Nakło nad Notecią (Nakel), Ryczywół.

District Piotrków Trybunalski: Bełchatów, Białobrzegi, ad. Tomaszów Mazowiecki, Dąbrówka, ad. Brzeziny, Dobryszyce, ad. Radomsko, Dubie, ad. Widawa, Tomaszów Mazowiecki, ad. Białobrzegi.

District Piotrków Trybunalski: Grocholice, Inowłódz.

District Płock: Kielniki.

District Poznań: Augustówka, ad. Wierzenica, Chłapowo, ad. Września, Daleszynek, ad. Pniewy, Dziewicza Góra Mt., Gaj Mały, ad Szamotuły, Gniezno, Grodzisk Wielkopolski, ad. Kościan, Janikowo, ad. Poznań, Kicin, ad. Poznań, Kobylnica, Koziegłowy, Krzyżowniki, Latalice, ad. Pobiedziska, Łysa Góra, ad. Kicin, Mechowo, Mieczewo, Morasko, Mosina, Owińska, Poznań, Promno, Puszczykowo, Rogalin, Rogalinek, Strykowo, Strykówko, Szamotuły, Tulce, Ujazd, ad. Grodzisk Wielkopolski, Uzarzewo, Wielkopolski National Park, Wierzenica.

District Przemyśl: Babice, Bolestrarzyce, Cisowa, Jarosław, Kowalówka, ad Lubaczów, Krzywcza, Łętownia, Nowa Grobla, ad. Lubaczów, Płazów, ad. Bełżec, Przemyśl, Reczpol, Węgierka, ad. Jarosław, Wola Krzywiecka, Wola Węgierska, ad. Próchnik, Zadąbrowie, ad. Radymno.

District Radom: Bąkowiec, ad. Kozienica, Kuźnia, distr. Radom, Radom, Załazy, ad. Zwoleń.

District Rzeszów: Kamień, ad. Nisko, Rudnik.

District Siedlce: Radzików, Trzebieszów, ad. Łuków.

District Skierniewice: Chylice, ad Grodzisk Mazowiecki, Polesie, Rogów, ad. Brzeziny, Skierniewice.

District Słupsk: Mokrzym (Petersdorf), Przechlewo, ad. Człuchów.

District Suwałki: Bachanowo, Borki (Adlig J.), ad. Pisz, Bryzgiel, Czarna Hańcza Lake, Czarna Hańcza Valley, Sobolewo, Gawrychy, Jastrzębna, Kamionka Stara, ad. Suwałki, Królówek, Krusznik, Krzywe, ad. Suwałki, Leszczewek, Leszczewo, Maćkowa Ruda, Magdalenowo, Mikołajewo, Piotrowa Dąbrowa, Sobolewo, ad. Suwałki, Stary Folwark, Szymanowizna (Klein Guja), Wiatrołuża, Czerwony Krzyż, Wigierski National Park, Wigry Lake, Wigry, Woźna Wieś, Augustowska Forests, Rosochaty Róg.

District Szczecin: Barnisław, Bezrzecze (Brünn), Bielinek n. Odrą, Goleniów, Gryfice (Greifenburg), Karpin fresh-water bay (Carpin), Klucze (Klutz), Kredownia, Wolin Island, Międzywodzie (Heidebrink), Międzyzdroje, Nowe Warpno, (Neu Warp), Pniewo (Pinnow), Police (Jasenitz), Stargard Szczeciński, Szczecin, Świna river, ad. Świnoujście, Trzciągowo, Wicko, Wolin.

District Tarnobrzeg: Bochnia, Buda Stalowska, Daromin, Goźlice, ad. Sandomierz, Janów Lubelski, Kleczanów, ad. Sandomierz, Klimontów, Latoszyn, ad. Dębica, Lubasz, ad. Szczucin, Nisko, Pieprzowe Mts., ad. Sandomierz, Rudnik, ad. Rozwadów, Sandomierz, Skowierzyn, Sobótka, ad. Sandomierz.

District Tarnów: Dąbrowa Tarnowska.

District Toruń: Kiełp, Otłoczyn, Płutowo, Starogród, Świętego Wawrzyńca Mt, Toruń.

District Wałbrzych: Bardo (Wartha), Bobolice, Dzierżoniow, Dzików Stary, ad. Łubaczów, Jodłownik, ad. Bielawa, Klecin (Klettendorf), Muszkowice, ad. Ząbkowice, Opolnica, Stolec, ad. Ząbkowice Śląskie, Świebodzice, Tarnów, ad. Ząbkowice Śląskie, Ząbkowice Śląskie.

District Warszawa: Brwinów, ad. Warszawa, Chojnów, ad Góra Kalwaria, Dąbrowa, Dąbrówka Dziekanów Leśny, Kampinos, Kampinoski National Park, Lużowa Góra, ad. Warszawa, Sieraków, ad. Warszawa, Klembów, ad. Wołomin, Konstancin-Jeziorna, Modlin-Twierdza, Pociecha, Podkowa Leśna, Pruszków, Rembertów, Świder, ad. Otwock, Warszawa, Warszawa-Łazienki, Warszawa-Ogród Botaniczny, Zaborówek, Zbójna Góra, Sulejówek-Ratajewo.

District Włocławek: Ciechocinek, Kulin, Lutobórz, Raciążek.

District Wrocław: Bukowiec (Pathendorf), Czernica (Langenau), Dobrzeń, Klęka, ad. Brzeg Dolny, Książęca Wieś, Milicz, Mirków (Mirkau), Oborniki Śląskie (Obernigk), Oleśnica, Oława, (Ohlau), Wrocław-Osobowice (Oswitz), Piekary (Beckern), Piotrkowiczki, Rożnów (Rosen), Ruda Żmigrodzka, Sobótka, Sułów, Szewce (Schebitz), Trzebnica, Wilczyce, Wojnarowice (Wernersdorf), Wrocław, Wrocław-Kalina, Wrocław-Karłowice (Carlowitz), Wrocław-Leśnica (Lissa), Wrocław-Nowy Dwór (Neuhof), Wrocław-Ogród Botaniczny, Wrocław-Oporów, Wrocław-Popielów (Popelwitz), Wrocław-Psie Pole (Hundfeld), Wrocław-Rędzin (Ransern), Wrocław-Zalesie (Leerbeuthel).

District Zamość: "Gliniska" reserve, Gliniska, Antoniówka, Bereźnica, Biłgoraj, Cichobórz, ad. Hrubieszów, Czechówka, Dobużek, ad. Łaszczów, Gródek, ad. Hrubieszów, Gruszka Duża, Hatczysko-Podhucie, ad. Tomaszów Lubelski, Hrubieszów, Izbica, Jarosławiec (Zarzecze), Józefów, ad. Biłgoraj, Komarów, ad. Tomaszów Lubelski, Koniuchy, Krasnobród, Łuszków, ad. Zosin, Nowosiółki, ad. Hrubieszów, Pielaki, ad. Wojsławice, Płusy, ad. Tarnogród, Romanów, ad. Krasnystaw, Sahryn, ad. Hrubieszow, Sąsiadka, Soból, ad. Sakryń, Stryjów, ad.Krasnystaw, Strzyżów, ad. Hrubieszów, Tarnawatka, Tarnogóra, ad. Izbica, Teratyn, ad Hrubieszów, Tomaszów Lubelski, Tomaszówka, Wolica Śniatycka, ad Tomaszów Lubelski, Zwierzyniec, Żółkiewka, Łaszczów Nadolce, ad. Tomaszów, Matcze, Wożuczyn, ad. Tomaszów Lubelski.

District Zielona Góra: Borowe (Burau), ad Iłowa, Darnawa, ad. Świebodzin, Górzyn (Gohren), ad. Lubsko, Klenica, ad. Zielona Góra, Lubinicko, ad Świebodzin, Ługów (Luga), Nowe Miasteczko, ad. Nowa Sól, Torzym (Sternberg), Zielona Góra (Grünberg), Żary.

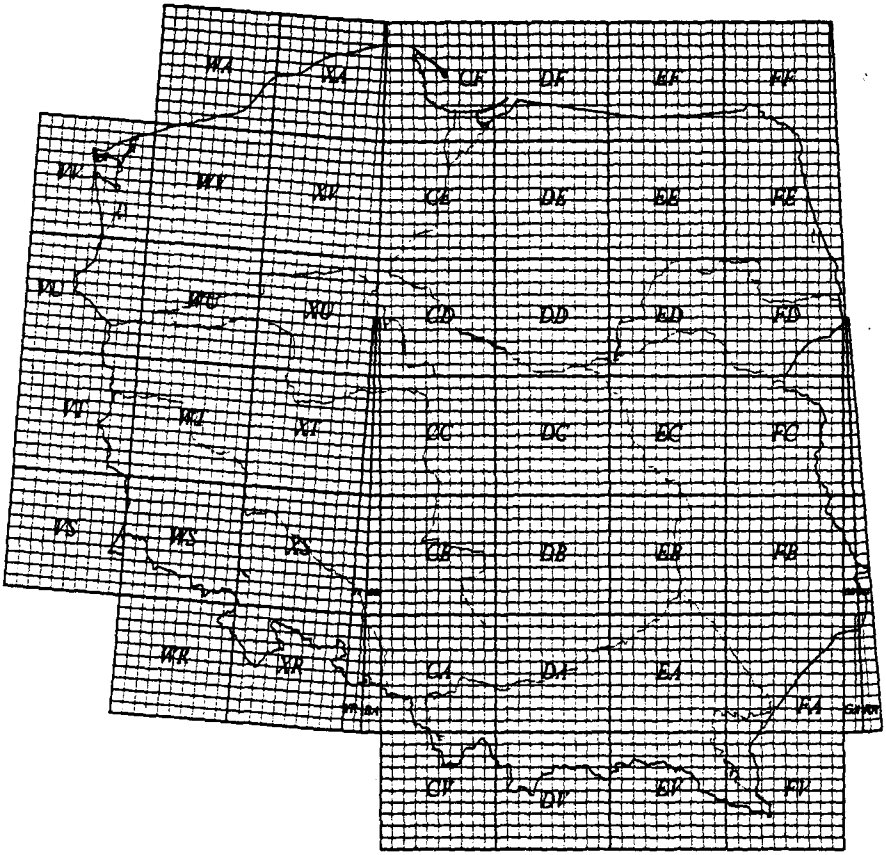

Fig. 105. Grid of UTM system on Polish territory.

Fig. 106. All localities in Poland where examined halictids were collected.

Composition of the halictid fauna of Poland

Deleted species. According to BANASZAK (1991: 33-40; the list reprinted also by DYLEWSKA, 1997: 65-67), Polish fauna includes 80 species of non-parasitic Halictidae (i.e. excluding *Sphecodes*). In this list four species were indicated for Poland evidently (for certain!) on the reason of wrong identifications; they must be excluded from the list:

Halictus scabiosae (ROSSI) and *Lasioglossum laterale* (BRULLÉ) were recorded only by the botanist ANASIEWICZ (1973: 12; 1975a: 133; 1975b: 150). The both species are narrowly Mediterranean and can not occur in Poland. The first species was correctly excluded by PAWLIKOWSKI (1992: 4) from the list of Polish halictids.

Halictus tetrazonius KLUG occurs in the south of the west Palaearctic region. The nearest habitat of the species to Poland is south-eastern Austria (Austrian "Pannonicum"; EBMER, 1988b: 560). In old publications, some other species of subgenus *Monilapis*, usually *H. compressus* (WALCKENAER) = *H. eurygnathus* (BLÜTHGEN) and *H. simplex* (BLÜTHGEN), often were named as '*H. tetrazonius*'.

Evylaeus smeathmanellus (KIRBY) is an Atlantic and west-Mediterranean species. The easternmost locality where it was recorded for certain is south-western Germany (the lower Main; EBMER, 1988b: 560). In some publications, the other green *Evylaeus* species, *E. nitidulus* (FABRICIUS), was indicated as "*Halictus smeathmanellus*", i.e. auctorum nec KIRBY, 1802; see the synonymy of *E. nitidulus* (FABRICIUS) in Chapter IV. This species was correctly excluded by PAWLIKOWSKI (1992: 4) from the list of Polish halictids.

The occurrence in Poland remains questionable for the following four species *Lasioglossum breviventre* (SCHENCK), *L. pallens* (BRULLÉ), *Evylaeus puncticollis* (MORAWITZ) and *E. pygmaeus* (SCHENCK). These species were earlier recorded from Poland by some non-taxonomists, their records were not confirmed by our examination. However, it cannot be excepted that these species will be found in Poland; so they are included to the keys and the annotation list in Chapter IV. Also seven other species, which can occur in Poland, are added to the present book: *Seladonia seladonia* (FABRICIUS), *S. smaragdula* (VACHAL), *S. kessleri* (BRAMSON), *Lasioglossum alinense* (COCKERELL), *Evylaeus marginatus* (BRULLÉ), *E. podolicus* (NOSKIEWICZ) and *E. lissonotus* (NOSKIEWICZ).

Added species. In results of our study, three species are recorded from Poland for the first time: *Seladonia gavarnica* (PÉREZ), 2 ♀ (WAR); *Evylaeus marginellus* (SCHENCK), 3 ♀ (WRO); *E. obscuratus* (MORAWITZ), 3 ♂ (WAR, WRO). To the fauna of Poland, also the following three species are added that were omitted by BANASZAK (1991: 33-40) and DYLEWSKA (1997: 65-67):

Nomiapis diversipes (LATREILLE) was recorded from Kraków by MORAWITZ (1876: 259). KUNTZE & NOSKIEWICZ (1938: 362) called this record in question, referring to more southern geographical range of the species. However, much later and independently *N. diversipes* was recorded by WARNCKE (1976b: 110) from 'Polen: Krakau' as a new record. We have found no representatives of this species caught in Poland in the collections studied, but we have no reasons for rejecting the information by WARNCKE and consider that this rare species sporadically occurs in the southern part of the country.

Seladonia leucahenea (EBMER) was recorded by some authors under the name "*Halictus fasciatus*" (i.e. auctorum nec NYLANDER, 1848; see the synonymy of *S.*

leucahenea (EBMER) in Chapter IV), but was omitted by BANASZAK (1991). This species was correctly included by PAWLIKOWSKI (1992: 4) into the list of Polish halictids; its occurrence in Poland is corroborated by new materials.

Evylaeus clypearis (SCHENCK) was recorded from Kraków by STRAND (1909: 5) in his paper containing a list of the bees identified by J. ALFKEN in the collection of the 'Museum für Naturkunde in Berlin'. Referring to STRAND, NOSKIEWICZ (1924: 178) has mentioned that this locality is a single one for *E. clypearis* in Poland. Later BLÜTHGEN (1935: 120) has confirmed the STRAND's record. We have found no representatives of this species caught in Poland in the collections studied, but we have no reasons for rejecting the information above and consider that this rare species sporadically occurs in the southern part of the country.

Also the occurrence in Poland of the following rare species is corroborated by new materials: *Dufourea halictula* (NYLANDER), *Rophites algirus* (PÉREZ), *R. hartmanni* FRIESE, *Nomiapis femoralis* (PALLAS), *Seladonia semitecta* (MORAWITZ), *Lasioglossum prasinum* (SMITH), *Evylaeus brevicornis* (SCHENCK), *E. convexiusculus* (SCHENCK), *E. cupromicans* (PÉREZ), *E. glabriusculus* (MORAWITZ), *E. euboeensis* (STRAND), *E. intermedius* (SCHENCK), *E. limbellus* (MORAWITZ), *E. minutulus* (SCHENCK), *E. nigripes* (LEPELETIER), *E. quadrisignatus* (SCHENCK) (this species was recorded for Poland only by PAWLIKOWSKI, 1992: 4), *E. semilucens* (ALFKEN), *E. setulellus* (STRAND), *E. setulosus* (STRAND), and *E. tarsatus* (SCHENCK), *E. tricinctus* (SCHENCK).

General composition. In results of our study of Polish materials and an analysis of published information, it can be considered that (a) Polish fauna of non-parasitic halictids includes for certain 81 species of 10 genera; of them *Seladonia confusa* (SMITH) is represented by two subspecies, (b) besides species above, 12 species really can also found in Poland, mostly in its south-eastern part:

Subfamily Rophitinae: *Dufourea* (4 species and 1 species in question), *Rhophitoides* (1), *Rophites* (3), *Systropha* (2);

Subfamily Nomiinae: *Nomiapis* (2);

Subfamily Halictinae: *Nomioides* (1), *Ceylalictus* (1 species in question), *Halictus* (6), *Seladonia* (6 and 3 in question), *Lasioglossum* (13 and 3 in question), *Evylaeus* (43 and 5 in question).

Thus, till now 81 species of non-parasitic halictids (or 102 species including *Sphecodes*) certanly inhabit Poland (Table 3). The Polish fauna of the Halictidae represents about 30% of the European and 10% of the Palaearctic halictid fauna.

Table 3. Numbers of species of the European genera of the Halictidae in the Palaearctic, European and Polish faunas

Genus	Distribution	Number of species in faunas		
		Palae-arctic	Europe	Poland
Dufourea	Mostly Holarctic	70	17	4
Rhophitoides	Steppous, western Palaearctic	4	2	1
Rophites	Palaearctic	17	8	3
Systropha	Eastern Hemisphere except for Australia	7	2	2
Nomiapis	Western Palaearctic	8	5	2
Nomioides	Warm zones of Africa, Europe and Asia	45(1)	2	1
Ceylalictus	Warm zones of the Western Hemisphere	5	1	-
Thrincohalictus	Western Mediterranean	1	1	-
Halictus	Holarctic, but mostly Palaearctic	98	46	6
Seladonia	Nearly cosmopolitan, absent in Australia	43	12	6
Vestitohalictus	Mediterranean basin and deserts of Asia	42	10	-
Lasioglossum	Nearly cosmopolitan, absent in Australia	115	39	13
Lucasiellus	Western Mediterranean	2	2	-
Evylaeus	Nearly cosmopolitan, absent in Australia	~400	121	43
Sphecodes	Nearly cosmopolitan, absent in S. America	~100	35	21
In total		~1000(2)	303	102

Annotations for Table 3:

(1) From PESENKO (1983), with addition of 12 restored names and four new species (PESENKO, in preparation);

(2) All Palaearctic species of the Halictidae including the genera which do not occur in Europe.

An analysis of the halictid fauna of Poland

Geographical variation of species density. In the analysis of the species richness, the division of Poland into physiographic regions adopted by zoogeographists was used. The maps below present the data on the number of halictids species in each physiographic region (Fig. 107), and the number of individuals caught in them (Fig. 108). It should be noted that the above data are witness to unequal level of our knowledge of the fauna in different parts of Poland can be seen.. Among those best investigated one should name the Krakowsko-Wieluńska Upland, and Małopolska Upland, the Mazurian Lakeland and the Wielkopolsko-Kujawska Lowland, from where relatively large samples of the Halictidae in the collections analysed come. Unfortunately, the south-east regions are comparatively under-studied, where one might hope for finding out many additional species. Being separate regions unevenly investigated, this impedes an analysis of species richness. The largest number of species is found in relatively well studied Małopolska Upland (63 species). It may be supposed that the Lubelska Upland, the Roztocze, and the Sandomierska Lowland, which adjoin it from the south-east, are likely to have a fauna richer than the scarce currently available faunistic data indicate. Also the Wielkopolska-Kujawy Lowland, Lower Silesia, and the Krakowsko-Wieluńska Upland relatively are rich in species. Special attention is attracted by the high species richness of the Halictidae in the Lower Silesia, where, despite relatively small number of samples studied, 56 halictid species is established. This is indicative of enrichment of this country's bee fauna from the southern direction, through the Morawska Gate and river valleys.

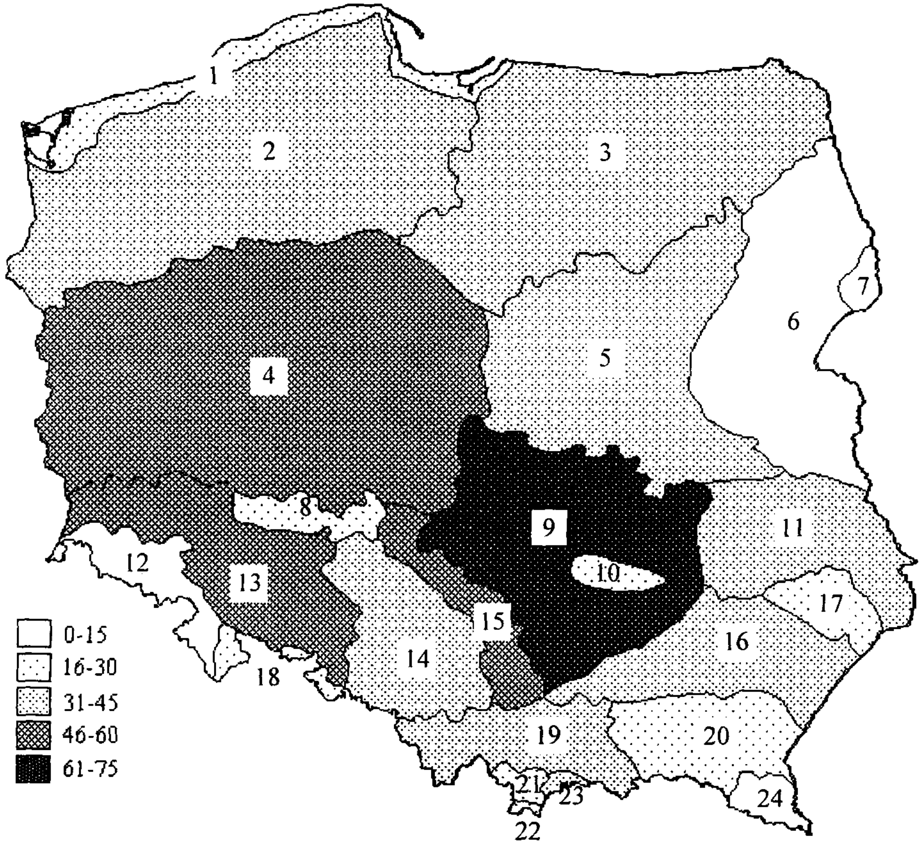

Fig. 107. Species density of halictids in Poland.
1 – Coast of Baltic Sea, 2 – Pomerania, 3 – Masurian Lakeland, 4 – Wielkopolsko-Kujawska Lowland, 5 – Masovian Lowland, 6 – Podlasie, 7 – Białowieska Primeval Forest, 8 – Trzebnickie Hills, 9 – Małopolska Upland, 10 – Świętokrzyskie Mts., 11 – Lubelska Upland, 12 – West Sudeten Mts, 13 – Lower Silesia, 14 – Upper Silesia, 15 – Częstochowsko-Wieluńska Upland, 16 – Sandomierska Lowland, 17 – Roztocze, 18 – East Sudeten Mts., 19 – West Beskid Mts., 20 – East Beskid Mts., 21 – Nowotarska Basin, 22 – Tatra Mts., 23 – Pieniny Mts., 24 – Bieszczady Mts.

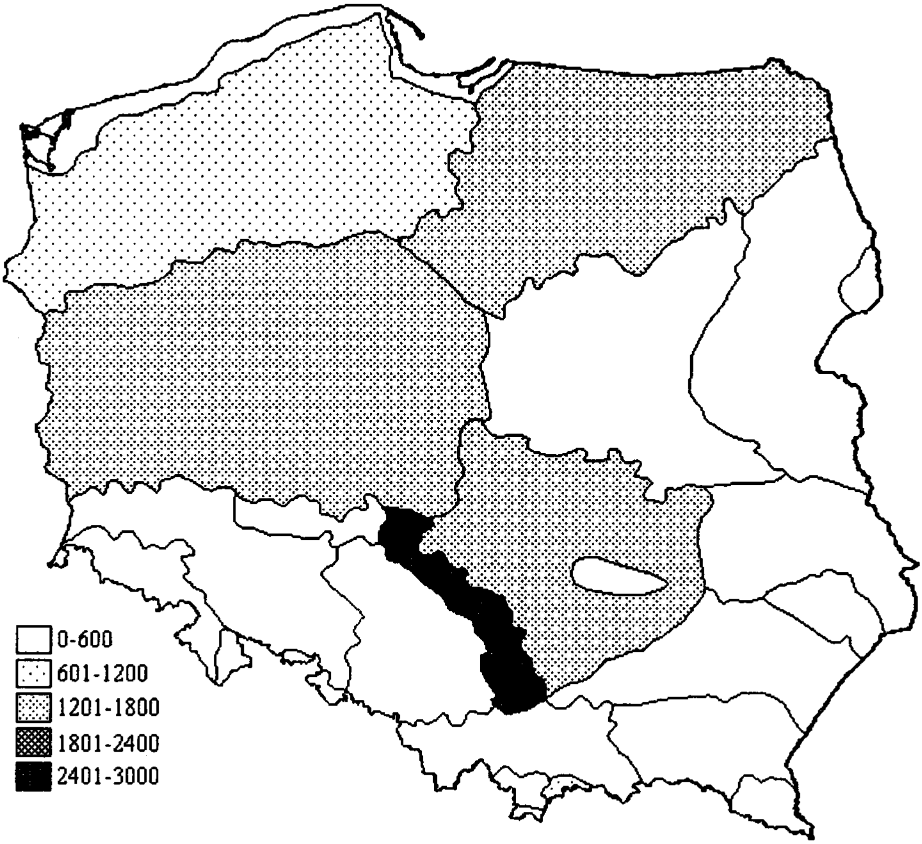

Fig. 108. Individual density of halictids in Poland (the number of specimens in the collections examined).

Distributional grouping of Polish halictids. Main zoogeographic and landscape groups in the Polish fauna of non-parasitic halictids are as follows.

Holarctic, eurybiontic, widespread in Europe: *Seladonia confusa*, *Lasioglossum leucozonium*, *L. zonulum*;

Holarctic, mostly boreal and nemoral, widespread in Europe, in the south mostly in highlands: *Halictus rubicundus*, *Evylaeus rufitarsis*;

Transpalaearctic, west Palaearctic, or Eurasian, eurybiontic, widespread in Europe: *Dufourea minuta*, *Rophites quinquespinosus*, *Systropha curvicornis*, *Halictus compressus*, *H. maculatus*, *H. quadricinctus*, *Seladonia leucahenea*, *S. subaurata*, *S. tumulorum*, *Lasioglossum costulatum*, *L. quadrinotatum*, *L. sexnotatum*, *L. xanthopus*, *Evylaeus albipes*, *E. brevicornis*, *E. calceatus*, *E. fulvicornis*, *E. laticeps*, *E. lucidulus*, *E. minutissimus*, *E. nigripes*, *E. nitidiusculus*, *E. parvulus*, *E. pauxillus*, *E. punctatissimus*, *E. quadrinotatulus*, *E. semilucens*, *E. sexstrigatus*, *E. villosulus*;

Transpalaearctic, boreal and nemoral, widespread in Europe, in the south mostly in highlands: *Dufourea dentiventris*, *D. inermis*, *Lasioglossum sexmaculatum*, *Evylaeus aeratus*, *E. fratellus*, *E. laevis*, *E. leucopus*;

Transpalaearctic, boreal, in Europe mostly in the north: *Lasioglossum sexnotatulum*;

West Palaearctic or Eurasian, mostly steppous, in Central Europe sporadic: *Rhophitoides canus*, *Rophites algirus*, *Nomiapis diversipes*, *N. femoralis*, *Nomioides minutissimus*, *Halictus simplex*, *Seladonia gavarnica*, *Evylaeus clypearis*, *E. glabriusculus*, *E. interruptus*, *E. limbellus*, *E. linearis*, *E. malachurus*, *E. obscuratus*, *E. politus*, *E. quadrisignatus*;

Euro-Mediterranean, eurybiontic, widespread in Europe: *Halictus sexcinctus*, *Lasioglossum laevigatum*, *L. lativentre*, *L. majus*, *L. subfasciatum*, *Evylaeus convexiusculus*, *E. euboeensis*, *E. intermedius*, *E. morio*;

Euro-Mediterranean, Euro-Pontic, or European, mostly steppous, in Central Europe sporadic: *Rophites hartmanni*, *Systropha planidens*, *Evylaeus marginellus*, *E. minutulus*, *E. setulellus*, *E. setulosus*, *E. tricinctus*;

Eastern European and Asian, mostly nemoral and steppous: *Seladonia semitecta*, *Evylaeus tarsatus*;

European, boreal and nemoral, in the south mostly in highlands: *Dufourea halictula*;

European, montane: *Evylaeus bavaricus*, *E. cupromicans*;

Eastern European, eurybiontic: *Evylaeus nitidulus*;

Western European and Mediterranean, eurybiontic: *Lasioglossum prasinum*.

Records from Poland are extreme localities of geographical ranges of the following species: the northernmost for *Rophites hartmanni*, *Nomiapis femoralis*, *Nomioides minutissimus*, *Seladonia gavarnica*, *Evylaeus euboeensis*, *E. glabriusculus*, *E. limbellus*, *E. marginellus*, *E. obscuratus*, *E. setulellus*, *E. setulosus*, and *E. tricinctus*; the easternmost for *Lasioglossum prasinum*.

Comparison of the Polish fauna with faunas of neighbouring countries. Of seven countries adjacent to Poland, we have taken for comparative analysis of faunas only four: Germany, Slovakia, Lithuania, and Ukraine. Belarus, Latvia and Czechia are not included in the present comparison because there are only very scanty data on halictine fauna of these countries. Main sources on halictine faunas of five compared countries (including Poland) are as follows (the symbols used in Table 5 are given in brackets):

Poland (Pl): BANASZAK (1991), PAWLIKOWSKI (1992), DYLEWSKA (1997) and original data based on a study of all main collections in Polish institutions;

Germany (De): SCHWARZ et al. (1996);

Slovakia (Sk): BELÁKOVÁ (1970, 1972, 1980), BELÁKOVÁ & DORN (1971), BELÁKOVÁ & KORENKOVÁ (1979), BELÁKOVÁ & OKÁLI (1993);

Lithuania (Lt): MONŠEVICIUS (1995);

Ukraine (except for species which were recorded only from Crimea; Ua): NOSKIEWICZ (1922, 1936), OSYTCHNJUK (1959a, 1960, 1961a, 1961b, 1963, 1964, 1966) and original data (mostly material of the Zoological Institute in St. Petersburg, identified by the Yu. A. PESENKO.

In total, 133 species were recorded at least from one of five these countries. Of them, 42 species were recorded from all five compared countries: *Dufourea dentiventris*, *D. halictula*, *D. inermis*, *D. minuta*, *Rophites quinquespinosus*, *Rhophitoides canus*, *Systropha curvicornis*, *Halictus compressus*, *H. maculatus*, *H. quadricinctus*, *H. rubicundus*, *H. sexcinctus*, *H. simplex*, *Seladonia confusa*, *S. leucahenea*, *S. semitecta*, *S. subaurata*, *S. tumulorum*, *Lasioglossum costulatum*, *L. laevigatum*, *L. lativentre*, *L. leucozonium*, *L. quadrinotatum*, *L. sexnotatum*, *L. xanthopus*, *L. zonulum*, *Evylaeus aeratus*, *E. albipes*, *E. brevicornis*, *E. calceatus*, *E. fratellus*, *E. fulvicornis*, *E. laevis*, *E. leucopus*, *E. linearis*, *E. minutissimus*, *E minutulus*, *E. morio*, *E. nitidiusculus*, *E. pauxillus*, *E. quadrinotatulus*, and *E. villosulus*.

Rather because of incompleteness of faunistic data, *Halictus carinthiacus* and *Lasioglossum sexmaculatum* were not recorded from Ukraine and 23 species from Slovakia: *Seladonia gavarnica*, *Lasioglossum albocinctum*, *L. majus*, *L. pallens*, *L. prasinum*, *Evylaeus corvinus*, *E. euboeensis*, *E. glabriusculus*, *E. griseolus*, *E. intermedius*, *E. laticeps*, *E. limbellus*, *E. lucidilus*, *E. parvulus*, *E. pauperatus*, *E. punctatissimus*, *E. puncticollis*, *E. rufitarsis*, *E. semilucens*, *E. setulellus*, *E. setulosus*, *E. sexstrigatus*, and *E. tarsatus*. 11 species of them rather inhabit all compared countries: *Lasioglossum prasinum*, *L. sexmaculatum*, *Evylaeus intermedius*, *E. laticeps*, *E. lucidilus*, *E. parvulus*, *E. punctatissimus*, *E. rufitarsis*, *E. semilucens*, *E. sexstrigatus*, and *E. tarsatus*. Therefore, these 11 species as well 42 species, really recorded from all five compared countries (see the list above), are excluded from further analysis.

80 species really inhabit only one or some of five compared countries. The conditional zoogeographical composition of them is as follows:

(1) The Alpine species (occurring only in Germany of five compared countries): *Dufourea alpina*, *D. paradoxa*, *Evylaeus alpigenus*;

(2) The northern species (in relation to Slovakia and Ukraine; occurring only in three other countries): *Lasioglossum sexnotatulum*;

(3) The south-western species (in relation to all countries except for Germany or Germany and Slovakia): *Halictus langobardicus*, *Vestitohalictus microcardia*, *Lasioglossum breviventre*, *Evylaeus angusticeps*, *Evylaeus lissonotus*, *E. smeathmanellus*, *E. subfulvicornis*, *E. subhirtus*;

Table 4. Occurrence of non-parasitic halictids in Poland and four neighbouring countries (except for 42 species inhabiting all these countries).

Species	Countries					Species	Countries				
	Pl	De	Sk	Lt	Ua		Pl	De	Sk	Lt	Ua
Dufourea alpina		+				*E. clypearis*	+	+	+		+
D. coeruleocephala					+	*E. convexiusculus*	+	+	+		+
D. paradoxa		+				*E. corvinus*		+			+
Rophites algirus	+	+	+		+	*E. crassepunctatus*					+
R. hartmanni	+				+	*E. cupromicans*	+	+			
Systropha planidens	+	+	+		+	*E. damascenus*					+
Nomiapis diversipes	+	+	+		+	*E. duckei*					+
N. femoralis	+	+	+		+	*E. elegans*					+
N. ruficornis					+	*E. euboeensis*	+	+	+		+
Nomioides minutissimus	+	+	+		+	*E. glabriusculus*	+	+	+		+
Ceylalictus variegatus		+?	+		+	*E. griseolus*		+			+
Halictus asperulus			+		+	*E. intermedius*	+	+		+	+
H. brunnescens		+	+		+	*E. interruptus*	+	+	+		+
H. carinthiacus			+			*E. laticeps*	+	+		+	+
H. cochlearitarsis					+	*E. limbellus*	+	+			+
H. langobargicus		+	+?			*E. lissonotus*		+			
H. luganicus					+	*E. lucidilus*	+	+		+	+
H. patellatus			+?		+	*E. malachurus*	+	+	+		+
H. resurgens					+	*E. marginatus*		+	+		+
H. sajoi		+	+		+	*E. marginellus*	+	+			+
H. scabiosae		+	+		+	*E. mesosclerus*					+
H. tetrazonianellus					+	*E. nigripes*	+	+	+		+
Seladonia gavarnica	+	+			+	*E. nitidulus*	+	+	+	+	+
Seladonia kessleri			+		+	*E. obscuratus*	+		+		+
Seladonia seladonia			+		+	*E. parvulus*	+	+		+	+
Seladonia smaragdula		+	+		+	*E. pauperatus*		+			+
Vestitohalictus tectus			+		+	*E. podolicus*					+
V. pseudomucoreus					+	*E. politus*	+	+	+		+
V. pulvereus					+	*E. punctatissimus*	+	+		+	+
V. microcardia		+	+			*E. puncticollis*		+			+
Lasioglossum alinense				+		*E. pygmaeus*		+	+		+
L. albocinctum		+			+	*E. quadrisignatus*	+	+			
L. breviventre		+				*E. rufitarsis*	+	+		+	+
L. discum			+		+	*E. semilucens*	+	+		+	+
L. majus	+	+			+	*E. setulellus*	+				+
L. pallens		+			+	*E. setulosus*	+	+			+
L. prasinum	+	+		+	+	*E. sexstrigatus*	+	+		+	+
L. sexmaculatum	+	+	+	+		*E. smeathmanellus*		+			
L. sexnotatulum	+	+		+		*E. sphecodimorphus*					+
L. subfasciatum	+	+	+		+	*E. subfulvicornis*		+			
Evylaeus alpigenus		+				*E. subhirtus*		+			
E. anellus					+	*E. tarsatus*	+	+		+	+
E. angusticeps		+				*E. trichopygus*			+		+
E. bavaricus	+	+				*E. tricinctus*	+	+	+		+
E. bluethgeni		+	+		+	*E. truncaticollis*					+
E. buccalis		+	+		+	In total	39	62	37	14	73

(4) The western species (in relation to all countries except for Germany and Poland): *Evylaeus bavaricus*, *E. cupromicans*, *E. quadrisignatus*;

(5) The eastern (in relation to Germany and Poland) and northern species (in relation to Slovakia and Ukraine): *Lasioglossum alinense*;

(6) The eastern (in relation to Germany or Germany and Slovakia) and southern species (in relation to Lithuania): *Rophites hartmanni*, *Evylaeus obscuratus*, *E. setulellus*;

(7) The southern species (in relation to Lithuania): *Rophites algirus*, *R. hartmanni*, *Systropha planidens*, *Nomiapis diversipes*, *N. femoralis*, *Nomioides minutissimus*, *Seladonia gavarnica*, *L. majus*, *Evylaeus clypearis*, *E. convexiusculus*, *E. interruptus*, *E. limbellus*, *E. malachurus*, *E. nigripes*, *E. politus*, *E. puncticollis*, *E. pygmaeus*, *E. setulosus*, *E. tricinctus*;

(8) The southern species (in relation to Poland and Lithuania): *Ceylalictus variegatus*, *Halictus brunnescens*, *H. sajoi*, *H. scabiosae*, *Seladonia smaragdula*, *Lasioglossum albocinctum*, *L. discum*, *L. pallens*, *Evylaeus bluethgeni*, *E. buccalis*, *E. corvinus*, *E. griseolus*, *E. marginatus*, *E. pauperatus*, *E. puncticollis*, *E. pygmaeus*;

(9) The south-eastern species (in relation to all countries except for Slovakia or Slovakia and Ukraine): *Halictus asperulus*, *H. carinthiacus*, *H. patellatus*, *Seladonia kessleri*, *S. seladonia*, *V. tectus*, *E. trichopygus*,

(10) The southern or south-eastern species (in relation to all countries except for Ukraine): *Dufourea coeruleocephala*, *Nomia ruficornis*, *H. cochlearitarsis*, *H. luganicus*, *H. resurgens*, *H. tetrazonianellus*, *Vestitohalictus pseudomucoreus*, *V. pulvereus*, *Evylaeus anellus*, *E. crassepunctatus*, *E. damascenus*, *E. duckei*, *E. elegans*, *E. mesosclerus*, *E. podolicus*, *E. sphecodimorphus*, *E. truncaticollis*.

Ecology of Polish halictids

Relative abundance. According to the logarithmic scale of relative abundance proposed by PESENKO (1972, 1982), Polish non-parasitic halictids can be divided into the following conditional classes on the basis of the number of specimens that are available in the collections studied (Table 2):

(1) very rare species (1-7 specimens), 22 species: *Rophites algirus* (6), *Nomiapis diversipes* (two specimens known only from literatural data), *N. femoralis* (2), *Seladonia gavarnica* (2), *S. semitecta* (1), *Lasioglossum prasinum* (5), *L. sexmaculatum* (2), *L. sexnotatulum* (4), *Evylaeus clypearis* (a single specimen known only from literatural data), *E. convexiusculus* (3), *E. cupromicans* (7), *E. euboeensis* (4), *E. glabriusculus* (4), *E. limbellus* (2), *E. marginellus* (3), *E. minutulus* (5), *E. obscuratus* (4), *E. politus* (7), *E. quadrisignatus* (1), *E. setulellus* (2), *E. setulosus* (1), *E. tricinctus* (2);

(2) relatively rare and uncommon species (8-40), 15 species: *Dufourea halictula* (14), *D. inermis* (11), *Rophites hartmanni* (29), *Systropha curvicornis* (26), *S. planidens* (12), *Nomioides minutissimus* (12), *Lasioglossum costulatum* (28), *Evylaeus bavaricus* (24), *E. brevicornis* (38), *E. intermedius* (9), *E. interruptus* (28), *E. laevis* (28), *E. nigripes* (32), *E. semilucens* (14), *E. tarsatus* (12);

(3) relatively common species (species of the middle abundance; 41-250), 30 species: *Dufourea dentiventris* (91), *D. minuta* (120), *Rhophitoides canus* (160), *Rophites quinquespinosus* (65), *Halictus compressus* (53, males), *H. quadricinctus* (151), *H. simplex* (98, males), *Seladonia confusa* (172), *S. leucahenea* (61), *S. subaurata* (100), *Lasioglossum laevigatum* (69), *L. lativentre* (49), *L. majus* (49), *L. quadrinotatum* (103), *L. subfasciatum* (82), *L. xanthopus* (76), *L. zonulum* (138), *Evylaeus aeratus* (47), *E. leucopus* (120), *E. linearis* (72), *E. lucidulus* (52), *E. malachurus* (81), *E. minutissimus* (68), *E. nitidulus* (124), *E. parvulus* (151), *E. pauxillus* (199), *E. punctatissimus* (70), *E. quadrinotatulus* (124), *E. rufitarsis* (76), *E. sexstrigatus* (152);

(4) common species (251-1800), 13 species; *Seladonia tumulorum* (759), *Halictus maculatus* (427), *H. rubicundus* (348), *H. sexcinctus* (251), *Lasioglossum leucozonium* (551), *L. sexnotatum* (449), *Evylaeus albipes* (461), *E. fratellus* (304), *E. fulvicornis* (554), *E. laticeps* (256), *E. morio* (928), *E. nitidiusculus* (345), *E. villosulus* (268);

(5) very common or mass species (over 1800 specimens), one species: *Evylaeus calceatus* (2488).

Biotopic preferences. The data available has made it possible to divide biotopes where halictids were caught into the following four types (1) forests and forestations (coniferous forests, and deciduous forests); (2) ecotones of these ecosystems; (3) treeless (open) habitats, which include natural and semi-natural xerothermic sward, as well as open dunes, antropogenic meadows and pastures, cultivated fields, roadsides and balks, fallows and barrens; (4) country and city habitats (gardens and orchards, cemeteries, ruins, lawns, ruderal habitats).

Saliently halictids were caught in greatest number in open habitats (66.8% observations), in particular on xerothermic sward (32.2%), dry meadows (14.4%), roadsides and balks (12.8%). Another habitat preferred by halictids were forests (28.0%). It should be noted that far more numerous halictids were caught in coniferous forests (20.7%) than in deciduous ones (7.3%). The results obtained conform to the quantitative researches of bees in different ecosystems of Poland, which has established that in grassy habitats bees, including Halictidae, are on the average 3-5 times more abundant than in forest ecosystems (BANASZAK, 1983; CIERZNIAK, 1994a; BANASZAK & CIERZNIAK, 1994a).

In the halictid fauna of Poland eurybiontic species dominate (43 species; see Section 'Distributional grouping of Polish halictids' above). These species were equally caught in forest habitats and open ones, although they were definitely more numerous in the latter ones, in particular in grassy habitats and their antropogenic transformations, such as roadsides, balks, and barrens. These species prefer, in the first place, swards on slopes, dry meadows and roadsides, where they find places fit for nesting in dry and mostly sandy soil, as well as rich food resources presented by numerous flower plants providing nectar and pollen.

Among those habitats most rich from the viewpoint of species richness one must mention xerothermic sward and roadsides, balks, dry meadows and pastures, where 59 species are established. These habitats provide places fit for nesting, yet in the first place a rich source of forage presented by numerous plant species flowering for all the vegetative season long. In forests 38 species were caught, among them 32 in coniferous forests, and 25 in deciduous ones. A greater species richness of halictids in coniferous forests as compared with the deciduous ones is explainable by better conditions for nesting - here soil is most often sandy and dry, which facilitates nesting; above that, since the forest bottom is less shaded, forage plants forming a herb layer are present here for all the vegetative season long. In generous leafy forests mostly moist soils do not favour establishment of ground nests, and the forage vegetation, although rich in species, appears only for a short period in spring, before tree leaves unfold and the forest bottom gets shaded. In other habitats, i.e. in country and cities (gardens, lawns, city parks, cemeteries, etc.), 21 species are registered. Other ecological investigations (BANASZAK, 1982a, 1985; CIERZNIAK, 1997; DATHE, 1969, 1971; DORN, 1977; SAURE, 1995) seek to demonstrate a significant variety of the halictid fauna of these habitats. The number of species established in the present investigation seems low, which might be due to paucity of the data concerning these habitats. In ecotones habitats quite high number of halictid species was found (37), which is agree with general ecological rules of high diversity of species in contact zones.

In the analysis of biotopic preferences of separate species we have taken only 27 species, for which sufficient data (over 30 records describing the habitat type) are available. These species are *Halictus maculatus*, *H. quadricinctus*, *H. rubicundus*, *H. sexcinctus*, *Seladonia confusa*, *S. subaurata*, *S. tumulorum*, *Lasioglossum leucozonium*, *L. quadrinotatum*, *L. sexnotatum*, *L. subfasciatum*, *L. zonulum*, *Evylaeus calceatus*, *E. albipes*, *E. fratellus*, *E. fulvicornis*, *E. laticeps*, *E. leucopus*, *E. linearis*, *E. lucidulus*, *E. malachurus*, *E. morio*, *E. nitidiusculus*, *E. parvulus*, *E. pauxillus*, *E. punctatissimus*, *E. quadrinotatulus*, *E. sexstrigatus*, and *E. villosulus*.

Among them, 16 species saliently prefer open habitats. Such habitats are preferred by the most abundant species of Polish fauna of the Halictidae, such as *Halictus maculatus* (90% of specimens are caught in dry and open habitats), *Seladonia tumulorum* (70%), *Lasioglossum leucozonium* (90%), *Evylaeus albipes* (80%), *E. calceatus* (80%), *E. fulvicornis* (100%), and *E. morio* (98%). As to less abundant species, grasses, roadsides, meadows etc. were preferred (in approximately 75% observations) by the following species: *Halictus quadricinctus*, *Seladonia sub-*

aurata, *Lasioglossum quadrinotatum*, *Evylaeus laticeps*, *E. malachurus*, *E. pauxillus*, *E. punctatissimus*, *E. quadrinotatulus*, and *E. villosulus*.

Only two of the species under the analyse, namely *Lasioglossum subfasciatum* and *Evylaeus fratellus*, were most often found in forest ecosystems. The former species was found in mountain forests and coniferous forests in the north of the country (95% observations), the latter in forests of different types, parks and forestations (70% observations).

The remaining species may be qualified as typically eurybiontic ones, being they found in various types of habitats and failing they to exhibit definite habitat preferences. This group is presented by *Halictus rubicundus*, *H. sexcinctus*, *Seladonia confusa*, *Lasioglossum sexnotatum*, *L. zonulum*, *Evylaeus leucopus*, *E. lucidulus*, *E. nitidiusculus*, *E. parvulus*, and *E. sexstrigatus*. It should be noted that *S. confusa* also included into this group, since it was found in different ecosystems (dunes, pine forests, roadsides, xerothermic grasses), mostly was caught in sandy biotopes.

Phenology of flight activity and seasonal dynamics of abundance. The period of flight activity of the Halictidae combined in Poland stretches throughout all of the vegetative season, i.e. since the end of March till the first decade of November (Fig. 109). All non-parasitic halictids of the Polish fauna are univoltine forms except for eusocial species. They can be subdivided into the following conditional phenological groups: (1) flying for all the seasonal long (the majority), (2) flying for late spring-early summer (*Rhophitoides canus*, mostly *Lasioglossum xanthopus*), (3) flying for mid-summer or nearly all summer long (all species of *Dufourea*, *Rophites*, *Systropha*, *Nomiapis* and *Nomioides minutissimus*)

In April the number of emerging species constantly increases till the middle of May, when the spring maximum of the number of flying species (about 45 species) is observed. Starting since the second decade of May till the second decade of July, the number of the species present remains more or less at the same level. In the second decade of July the next, summer maximum of the number of flying species (55 species) is attained, lasting it throughout September. In each decade of September a salient fall of the number of species is observed, lasting it till the first decade of November, when only a few species remain.

Considering the general flight dynamics of halictids (Fig. 109) and the phenology of flight activity of separate species (see Chapter IV), two phonological periods, the spring and summer ones, can be distinguished in the Polish fauna. The spring period begins simultaneously with the emergence of first Halictidae in the last decade of March. The first to emerge are Halictus rubicundus, Seladonia tumu*lorum, E. linearis, E. nitidiusculus, E. laticeps, E. calceatus*. Among the 51 species exhibiting greater abundance, for which the phenology of emergence is analysed, 30 species emerge in April, and 14 in May. These species continue their flight activity throughout all of the vegetative period.

The summer period begins with emergence of typically summer species belonging, in the first place, to the family Rophitinae: *Dufourea minuta, D. dentiventris, D. halictula, D. inermis, Systropha curvicornis, S. planidens, Rophites algirus, R. hartmanni, R. quinquespinosus*. These species emerge in Poland at the end of July or the beginning of August, and continue their flight activity till the middle of September. Emergence of summer species tells in general dynamics of flight activity of species as its summer maximum, which obtains till the end of September. Among the most numerous species, those finishing their flight activity in August are Rophitinae, as well as *Lasioglossum costulatum, L. laevigatum, Evylaeus linearis, E. laevis*. In September *Seladonia subaurata, Lasioglossum majus, Evylaeus laticeps, E. interruptus, E. brevicornis, E. minutissimus, E. aeratus* and *E. nitidulus* finish their flight. The remaining species can be observed in October. The latest of all, in the first decade of November, *Seladonia tumulorum* (3.X) and *Evylaeus calceatus* (1.X) were observed.

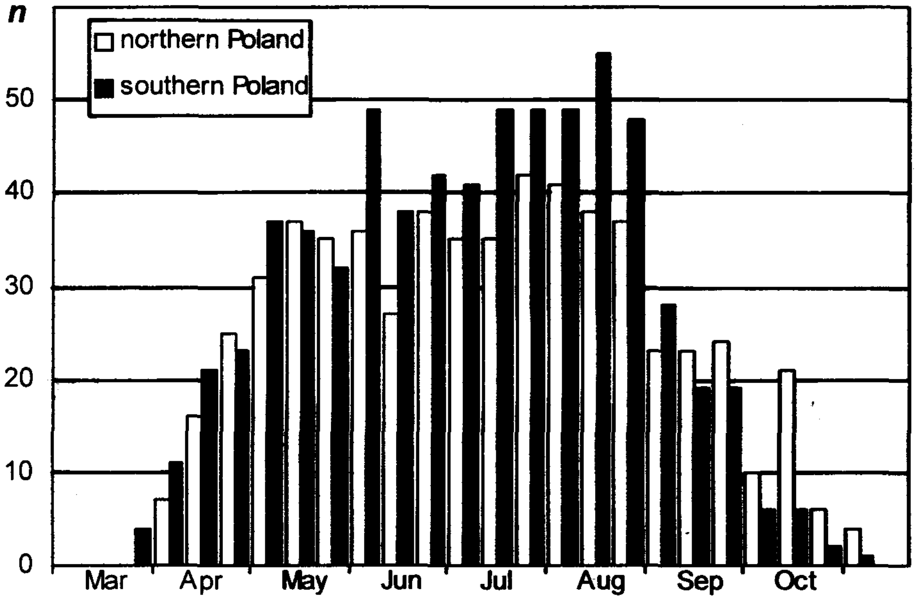

Fig. 109. The number of halictid species flying at decades in Poland.

The difference between the northern and the southern parts of Poland in the phenology of emergence of species is insignificant. In approximation, one may adopt that this difference constitutes about 10 days (the mountain regions are not taken into the analysis). This is indicated by that the spring species emerge earlier by one decade, and the spring and summer maximum is attained by one decade earlier in the south of Poland.

The general dynamics of the abundance of Halictidae in the territory of Poland exhibits two maximums. The first is observed in the first and second decades of May; the second begins in the second decade of July and lasts till the end of August (Fig. 110). The spring and summer maximums are divided by periodical fall of the number of individuals occurring since the last decade of May till the first decade of July. The differences between the northern and the southern parts of Poland in the dynamics of halictid abundance are insignificant.

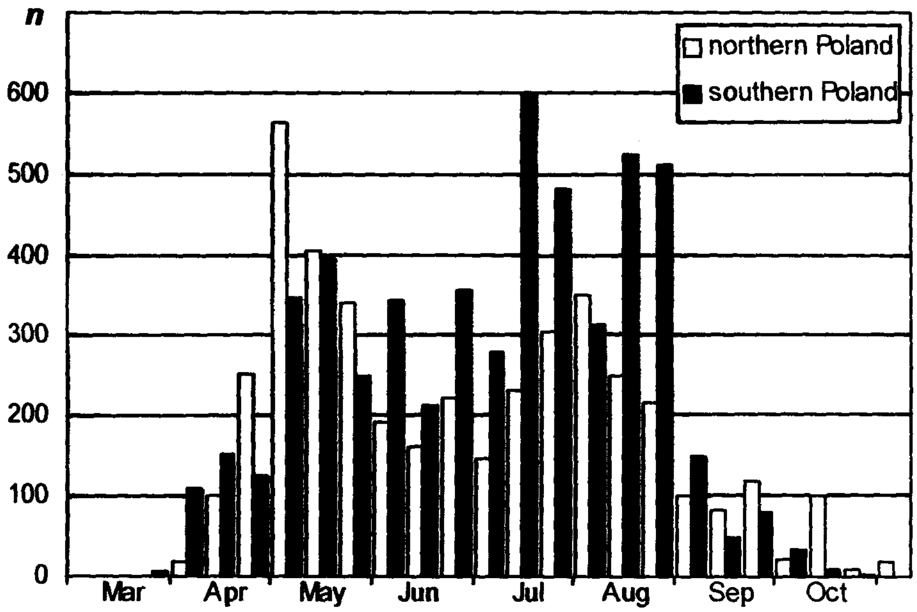

Fig. 110. The number of individuals collected at decades in Poland.

Trophic links. Most halictid species of the Polish fauna belong to polylectic forms: *Nomioides minutissimus* (inspite of that it was caught in Poland mostly on flowers of Thymus), all members of *Halictus* and *Seladonia*, the majority of *Lasioglossum* (except for *Lasioglossum costulatum*) and *Evylaeus* (except for three species of the *E. punctatissimus* group). Only 15 species (i.e. 18.5 % of non-parasitic halictids in Poland or 14.7% of all halictids including Sphecodes, which are polyleges) are certainly oligoleges of the following plants:

Fabaceae: *Nomiapis diversipes, Rhophitoides canus*;

Convolvulaceae: *Systropha curvicornis, S. planidens*;

Lamiaceae: *Rophites algirus, R. hartmanni, R. quinquespinosus, Evylaeus clypearis, E. convexiusculus, E. punctatissimus*;

Campanulaceae: *Dufourea dentiventris*, *D. halictula*, *D. inermis*, *Lasioglossum costulatum*;

Asteraceae: *Dufourea minuta*.

All oligolectic halictids of the Polish fauna are summer univoltine solitary species. The majority of them (66.7%) are very rare (4 species) or rare (6) species. Only *Rophites quinquespinosus* (65 specimens in the collections studied, see Table 2), *E. punctatissimus* (70), *Dufourea dentiventris* (91), *D. minuta* (120) and *Rhophitoides canus* (160) can be considered as relatively common forms.

A list of plants, on flowers of which the examined halictids were caught, is presented below. Numbers in brakets present: 1st - the number of halictid species, 2nd – the number of halictid specimens recorded from flowers of this plant species; also the main pollinators are given if the number of observations is higher than 30.

Ranunculaceae: Adonis vernalis (7, 20), Caltha palustris (2, 5), Ficaria verna (3, 7), Ranunculus acer (4, 9), R. repens (4, 5), R. reptans (1, 1);

Papaveraceae: Chelidonium maius (2, 2), Papaver rhoeas (2, 2);

Fumariaceae: Corydalis solida (1, 1);

Caryophyllaceae: Dianthus cartusianorum (1, 1), Jasione montana (6, 8), Melandrium album (1, 1), Stellaria holostea (2, 2), Viscaria vulgaris (1, 1);

Chenopodiaceae: Salicornia herbacea (1, 1);

Polygonaceae: Polygonum bistorta (1, 1);

Plumbaginaceae: Armeria elongata, (1, 2);

Clusiaceae: Hypericum perforatum (2, 3);

Ericaceae: Calluna vulgaris (5, 12), Vaccinium myrtillus (2, 14), V. vitis-idaea (1, 10);

Primulaceae: Lysimachia vulgaris (2, 2);

Violaceae: Viola odorata (1, 1);

Cistaceae: Helianthemum ovatum (2, 2);

Brassicaceae: Berteroa incana (10, 15), Brassica napus (12, 32, *Lasioglossum sexnotatum*), Capsella bursa-pastoris (2, 3), Cardamine pratensis (1, 2), Descurainia sophia (1, 1), Sinapis alba (3, 3), S. arvensis (6, 14);

Resedaceae: Reseda alba (1, 1), R. lutea (1, 1), R. odorata (1, 1),

Salicaceae: Salix amygdalina (1, 1), S. aurita (1, 3), S. caprea (7, 42, *Evylaeus calceatus*), S.fragilis (5, 16), S. purpurea (2, 4);

Tiliaceae: Tilia argentea (7, 35, *Evylaeus fulvicornis*);

Rosaceae: Cotoneaster lucida (2, 6), Crataegus oxyacantha (1, 1), Fragaria vesca (8, 11), F. viridis (3, 3), Geum rivale (1, 2), Potentilla anserina (4, 4), P. arenaria (1, 2), P. argentea (7, 19), P. aurea (5, 28), P. erecta (2, 9), P. recta (1, 1), P. reptans (4, 6), P. verna (7, 28), Prunus spinosa (2, 4), Rubus idaeus (3, 3);

Grossulariaceae: Ribes grossularia (1, 1), R. nigrum (1, 1);

Crassulaceae: Sedum acre (1, 1), S. album (1, 1), S. spectabile (1, 1);

Lythraceae: Lythrum salicaria (1, 1);

Onagraceae: Epilobium angustifolium (2, 16);

Aceraceae: Acer ginala (1, 3);

Geraniacaeae: Geranium arvense (1, 1), G. palustre (5, 6), G. phaeum (1, 1), G. pratense (11, 49, *Evylaeus calceatus*), G. sanguineum (8, 11), G. silvaticum (11, 41, *Evylaeus calceatus*);

Oxalidaceae: Oxalis acetosella (2, 4);

Linaceae: Linum hirsutum (1, 1), L. usitatissimum (2, 4);

Fabaceae: Coronilla varia (5, 7), Lathyrus pratensis (1, 1), Lotus corniculatus (12, 27), Medicago falcata (5, 18,), M. media (7, 28), M. sativa (14, 90, *Rhophitoides canus*), Melilotus albus (3, 6), M. officinalis (3, 4), Phaseolus vulgaris (2, 2), Trifolium arvense (1, 1), T. pratense (17, 51, *Seladonia tumulorum*), T. repens (9, 9), Vicia alba (1, 1);

Apiaceae: Aegopodium podagraria (5, 8), Anethum graveolens (5, 8), Carum carvi (8, 10), Coriandrum sativum (12, 19), Daucus carota (7, 10), Eryngium planum (2, 3);

Dipsacaceae: Knautia arvensis (20, 55, *Halictus sexcinctus*), Scabiosa canescens (1, 1), S. columbaria (1, 1), S. ochroleuca (6, 53, *Lasioglossum leucozonium*), Succisa pratensis (1, 1);

Vitaceae: Vitis vinifera (1, 1);

Convolvulaceae: Convolvulus arvensis (7, 20);

Hydrophyllaceae: Phacelia ciliata (2, 2), Ph. tanacetifolia (2, 2);

Boraginaceae: Anchusa officinalis (2, 4), Borago officinalis (1, 1), Cynoglossum officinale (3, 6), Echium vulgare (11, 15), Pulmonaria obscura (2, 2), Symphytum officinale (6, 17);

Caprifoliaceae: Symphoricarpos albus (1, 1);

Scrophulariaceae: Alectorolophus glaber (1, 1), Digitalis purpurea (1, 1), Euphrasia rostkowiana (1, 1), Melampyrum pratense (1, 1), Scrophularia nodosa (9, 33, *Lasioglossum sexnotatum*), Verbascum nigrum (1, 1), Veronica chamaedrys (14, 40, *Evylaeus calceatus*), V. longifolia (1, 1), V. officinalis (2, 2), V. sibirica (1, 1), V. spicata (4, 4), V. teucrium (4, 4);

Plantaginaceae: Plantago major (1, 1), P. media (2, 2);

Lamiaceae: Ballota nigra (10, 16), Betonica officinalis (1, 2), Galeobdolon luteum (2, 2), Glechoma hederacea (1, 1), Lamium album (3, 8), L. maculatum (3, 7), L. purpureum (5, 14), Leonurus cardiaca (2, 4), Nepeta cataria (2, 2), Origanum vulgare (12, 52, *Evylaeus calceatus*), Prunella grandiflora (1, 1), Salvia officinalis (5, 5), S. pratensis (4, 7), S. verticillata (7, 12), Stachys lanatus (1, 1), S. palustris (2, 2), S. recta (1, 1), S. silvatica (1, 2), Thymus marschallianus (1, 2), T. serpyllum (6, 7);

Campanulaceae: Campanula glomerata (3, 3), C. patula (4, 7), C. persicifolia (3, 3), C. rapunculoides (2, 2), C. rotundifolia (1, 3), C. trachelium (5, 14);

Asteraceae: Achillea millefolium (17, 38, *Evylaeus fulvicornis*), Anthemis arvensis (1, 1), A. rigescens (1, 1), A. tinctoria (10, 27), Bellis perennis (5, 6), Carduus acanthoides (6, 11), C. nutans (5, 5), Carlina vulgaris (1, 1), Centaurea cyanus (6, 16), C. jacea (12, 27), C. rhenana (15, 37, *Halictus sexcinctus*), C. scabiosa (15, 47, Evylaeus calceatus), Chrysanthemum leucanthemum (6, 16), Cichorium intybus (15, 82, *Evylaeus calceatus*), Cirsium arvense (13, 34, *Evylaeus calceatus*), C. lanceolatum (1, 1), C. oleraceum (1, 1), C. palustris (2, 2), Colendula officinalis (3, 5), Crepis biennis (3, 4), Helichrysum arenarium (3, 7), Hieracium pilosella (25, 191, *Lasioglossum leucozonium*), Hypochoeris radicata (2, 4), Leontodon autumnalis (11, 43, *Evylaeus calceatus*), L. hispidus (2, 4), Matricaria discoidea (1, 1), M. inodora (8, 10), Petasites officinalis (2, 4), Picris hieracioides (3, 6), Senecio jacobaea (21, 84, *Evylaeus calceatus*), S. vernalis (6, 10), S. vulgaris (2, 3), Sisymbrium officinale (3, 3), Solidago canadensis (4, 4), S. serotina (8, 16), S. virga-aurea (8, 22), Sonchus arvensis (4, 4), Tanacetum vulgare (16, 29), Taraxacum officinale (40, 474, *Evylaeus calceatus*, *Evylaeus fulvicornis*), Tripleurospermum inodorum (1, 1), Tussilago farfara (9, 31, *Evylaeus calceatus*);

Liliaceae: Allium cepa (11, 19), A. flavescens (3, 7), A. odorum (9, 22), A. sativum (2, 2), A. virtuosum (1, 1), Anthericum ramosum (2, 6), Asparagus officinalis (1, 2), Gagea lutea (3, 25);

Amaryllidaceae: Leucoium vernum (1, 2).

The database created on the basis of examined collections contains information on 62 halictid species visited flowers of 197 plant species belonging to 39 botanical families. The largest number of halictid species was collected on plant species belonging to Asteraceae (53), Lamiaceae (36), Scrophulariaceae (35), Fabaceae (34) and Rosaceae (31). Taraxacum officinale was the most attractive plant for analysed bees. 474 specimens of the Halictidae belonging to 40 species were recorded on flowers of this plant species. Also others plant species of Asteraceae such as Hieracium pilosella, Senecio jacobea, Centaurea rhenana, C. scabiosa were the most frequent visited by halictid bees. Among plants belonging to others botanical families, relatively large number of halictid species was registered only on flowers of Scrophularia nodosa (Scrophulariaceae).

Polylectic *Halictus sexcinctus*, *Seladonia tumulorum*, *Lasioglossum leucozonium*, *L. sexnotatum*. *Evylaeus calceatus*, and *E. fulvicornis*, being the most abundant halictid species, can rated as the main pollinators of many plants species. Of oligolectic halictids, only *Rhophitoides canus* was often recorded on flowers of Medicago. Potential pollinators of cultivated plants should be looked for just among these species. However, sufficiently numerous investigations carried out in Poland in the beginning of 1960th on plantations of different entomophilous crops have demonstrated that the role of halictids as their pollinators is relatively little. Although they visit flowers of many plants, still they do it to a less degree than other Apoidea, especially representatives of *Andrena* and *Bombus*. An exclusion may be found in *Rhophitoides canus*, which is believed to be an active pollinator of alfalfa, although it seems that the abundance of this species has been decreasing during the last years. It should be emphasised that the lists of the halictids recorded from flowers of cultivated plants are great enough, in spite of their overall low abundance of these bees. For example, among 105 bee species visited flowers of winter rape in Poland, 36 species belong to Halictidae, but representatives of Andrena are much more abundant (BANASZAK, 1982d). In contrary, halictids dominate among pollinators of lucerne on plantations in Lubelska Upland, especially *Rhophitoides canus*, *Seladonia tumulorum*, and *Evylaeus calceatus*, (ANASIEWICZ, 1975a). Even if we take the publication cited with an allowance for errors made in identification of a part of species, still the number of halictid species found remains significant: 27 species of Halictidae were recorded from flowers of red clover in the same region (ANASIEWICZ, 1976), 16 species from flowers of apple trees (ANASIEWICZ, 1972).

Chapter IV. Halictid fauna of Poland: illustrated keys, characteristics of taxa

ADAPTED KEY TO THE POLISH GENERA[1]

1. Forewings with two submarginal cells (Fig. 126) 2
- Forewings with three submarginal cells (Figs. 127-130) 4
2. 'Basal' vein (M^1) of forewings curved backward before its proximal end and forming with 'medial' vein ($M+Cu^1$) nearly a right angle (Fig. 126). Metasomal terga without hair bands, only with transverse series of hairs. Dorsal surface of propodeum as long as scutellum or longer, rounded at posterior margin. Metasomal sternum VII of male having various structures, but without distinct dorsal lobes .... 1. ***Dufourea***
- Vein M^1 of forewings nearly straight and forming with vein $M+Cu^1$ an acute angle. Terga with posterior hair bands, but sparser than those in *Halictus*. Dorsal surface of propodeum shorter than scutellum, forming a distinct angle with posterior vertical surface. Sternum VII of male with distinct slender dorsal lobes :.. 3
3. Labial palpus very long owing to greatly elongate and flattened 1st and 2nd segments, each of them at least 5 times as long as 4th segment (Fig. 116). Frons of female with modified hairs forming sharp long spines (Fig. 112) ......3. ***Rophites***
- Labial palpus usual, its 1st and 2nd segments twice as long as 4th segment or shorter (Fig. 117). Frons of female only with usual hairs, without spines .... 2. ***Rhophitoides***
4. Marginal cell of forewing broadly truncate at distal end (Fig. 129). Clypeus divided into three lobes by anterior tentorial pits lowered to lower margin of clypeus (Fig. 111). Metasomal tergum VII of male hidden by tergum VI, flattened and hairless (Fig. 133). Minute (length 3.5-5.5 mm), brightly metallic greenish or bluish forms with extensive pale markings 5
- Marginal cell of forewing sharply pointed (Fig. 128) or rounded (Figs. 127, 130-132). Clypeus entire; anterior tentorial pits spaced on level of middle or upper half of clypeus (Fig. 1). Tergum VII of male not hidden by tergum VI. Body larger, black to brownish-black or dull greenish, without or with poor pale markings on clypeus, legs or tegulae 6
5. Metasoma without metallic tints, with pale bands formed at pregragular areas of terga II and III or II-IV and appearing through hyaline posterior areas of suc-

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[1] Mainly according to EBMER (1987a: 65-73) with changes and additions.

ceeding terga. Length 3.5-4.5 mm. Mesoscutum of female without yellow spot. Metasomal sternum VIII of male with a long apical lobe (Fig. 137). Gonoforceps of male straight, flattened, without ventral projection (Fig. 138) ...... 6. ***Nomioides***

– Metasoma with metallic tints (in female only on dark coloured surface of tergum I), with pale bands at disc of terga (in male only a narrow interrupted band on terga II and III). Length 4.5-5.5 mm. Mesoscutum of female with a yellow rectangular spot before posterior margin. Sternum VIII of male without apical lobe. Gonoforceps of male curved mesad, narrowed, with a ventral projection .... 7. ***Ceylalictus***

6\. Tegula greatly enlarged, with a white spot (Fig.120). Marginal cell of forewing broadly rounded at distal end; (Fig. 128). Scutellum of male at posterolateral extremities with a sharp tooth directed backward (Fig. 120) .... 5. ***Nomiapis***

– Tegula usual, dark. Marginal cell sharply pointed or narrowly rounded at distal end (Figs. 127, 130-132). Scutellum without lateral teeth 7

7\. Metasomal terga covered with dense long dark hairs. Antennal sockets placed at lower half of face. 1st submarginal cell of forewing equal to 3rd one (Fig. 127). Five last flagellomeres of male rolled to triangular spiral (Fig.118). Metasomal sternum VII of male sclerotized, with additional structures ....4. ***Systropha***

– Pubescence of terga of other kinds. Antennal sockets placed at middle or at upper half of face). 1st submarginal cell of forewing larger than 3rd one (Figs. 130-132). Flagellum of male normal. Sternum VII of male membranous, much reduced 8

8\. Metasoma red entirely or on 3-4 first segments (except for males of some small species), shiny, very poorly pubescent, without hair or tomentose bands. Median apical process of labrum in female broad, not sharp at end, without longitudinal keel (Fig. 115). Sculpture of mesosoma very coarse. Metabasitibial plates of female absent (Fig. 125). Hind tibiae of female without scopa (Fig. 122). Fimbria of metasomal tergum V of female not divided by a longitudinal specialised area. Clypeus of male black; face below antennal sockets covered with very dense appressed simple silver-white hairs. Flagellomeres of male strongly convex at lower side, with bands of very dense and short simple hairs (Fig. 119). Metasomal sternum VII of male long (Fig. 136). Gonocoxites on outer surface longitudinally striate, dull. Gonostylus large, usually not less than one third of gonocoxite, usually divided into lobes by shallow, rounded emargination, with well developed membranous retrorse lobe (Fig. 139) .... ***Sphecodes***. (cleptoparasitic genus, not included in the book)

– Metasoma black to brownish-black or dull greenish, rarely partly red[2], usually with tomentose bands. Median apical process of labrum in female narrow, sharp or narrowly rounded at end, with a strong longitudinal keel (Figs. 113, 114). Sculpture of mesosoma usually finer. Metabasitibial plates of female well defined

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[2] Among European Halictini there are several species of the genus *Evylaeus* in which the metasoma is sometimes partly red-coloured: *E. albipes, E. calceatus, E. elegans, E. euboeensis, E. bluethgeni, E. interruptus, E. laticeps, E. malachurus, E. nigripes,* and *E. obscuratus.* Such individuals usually occur (together with dark ones) in steppes of eastern Europe.

laterally and distally by a carina (Figs. 123, 124). Hind tibiae (often also ventral side of metasoma) of female with a scopa of plumose hairs (Fig. 121). Fimbria of tergum V in female divided by a longitudinal, median, minutely pilose area. Clypeus of male usually yellow at lower part; face covered with relatively sparser, moderately plumose, white hairs. Flagellomeres of male nearly cylindrical, without hair bands (in Polish fauna except for species of *Halictus* subg. *Monilapis*). Sternum VII of male short, band-like. Gonocoxites smooth on outer surface. Gonostylus of other form, often without membranous lobe 9

9. Metasomal terga with posterior pale tomentose bands. Venation of forewing 'strong': distal transversal 'cubital' veins (*r-m* and *m-cu*) having thickness and coloration same as those of more proximal veins (Fig. 130). Gonostylus of male large, usually not less than one third of gonocoxite, often double (Fig. 11) and bifid (Figs. 252-257), always without membranous retrorse lobe 10

- Terga with anterior pale tomentose bands or lateral spots[3], sometimes without tomentum. Venation of forewing in female 'weak': at least distal transversal veins 2 *r-m* and *2 m-cu* twice or more times thinner than proximal veins (Fig. 131, 132). Gonostylus of male simple, usually less than one third of gonocoxite, usually with a membranous retrorse lobe 11

10. Body black. Gonostylus of male variable, but its main body entire, without cleft (Figs. 217-223) .... 8. ***Halictus***

- Body dull metallic greenish. Gonostylus of male double, moreover its main body bifid, divided by a deep longitudinal cleft (Figs. 252-257) ....9. ***Seladonia***

11. Transverse vein 1 *r-cu* of forewing strong (Fig. 131). Metasomal terga I-III on posterior areas dark, not translucent (except for *L. pallens* in which these areas are narrowly horny yellowish translucent; this species can be easily distinguished from the 'carina-less *Evylaeus*' by a very short head and very deeply emarginate metasomal sternum V of male). Terga II-IV with anterior pale tomentose bands or lateral spots. Metasomal terga II-IV of male usually greatly convex in disc; sternum V often emarginate posteriorly; sternum VI often with an isolated area covered with very dense and short hairs .... 10. ***Lasioglossum***

- Vein 1 *r-cu* weak (the character is expressed usually only in females; Fig. 132). Posterior areas of terga I-III usually horny yellowish translucent (if they are dark and not translucent, then terga II-IV without pale bands or with very small lateral spots; e.g., *E. interruptus*). Terga II-IV of male usually flattened or weakly convex at disc; sternum V straight at posterior margin; sternum VI uniformly inconspicuously pubescent or hairless .... 11. ***Evylaeus***

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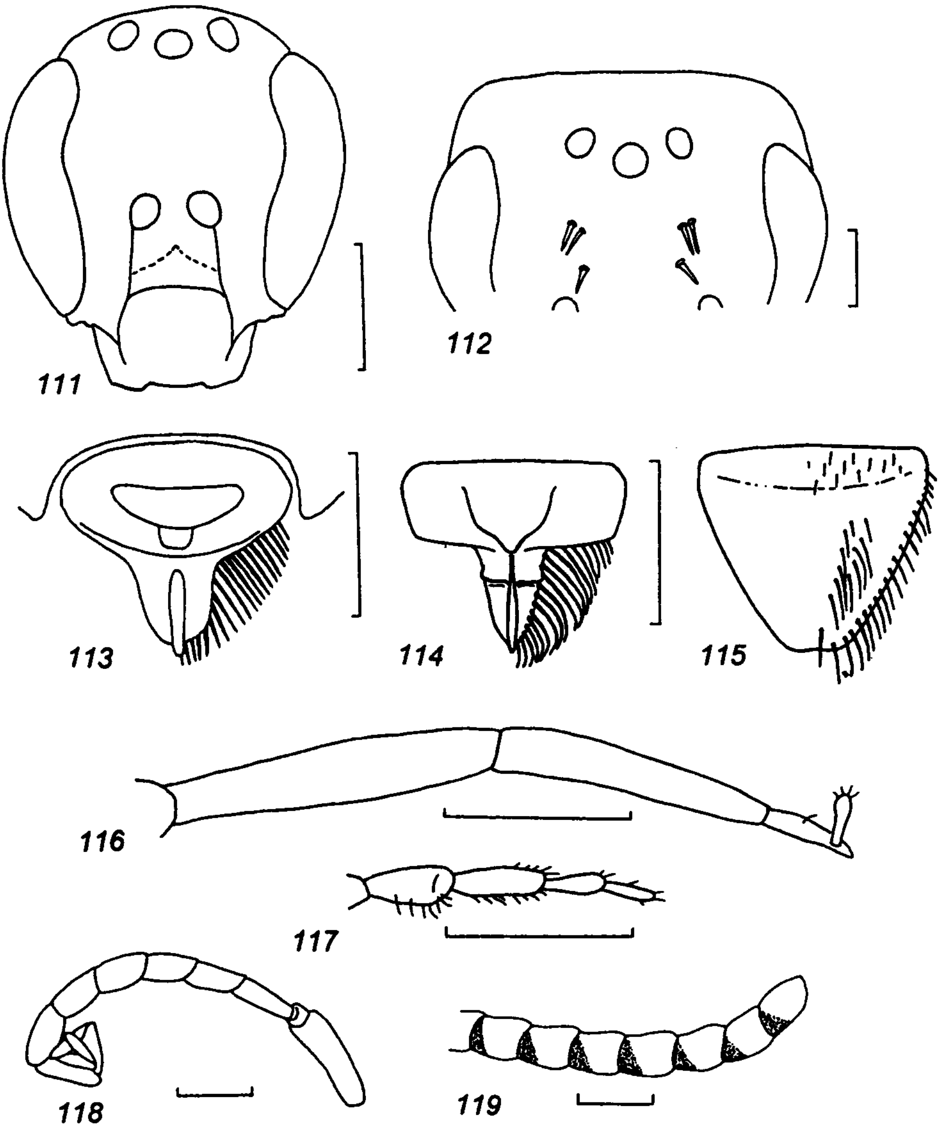
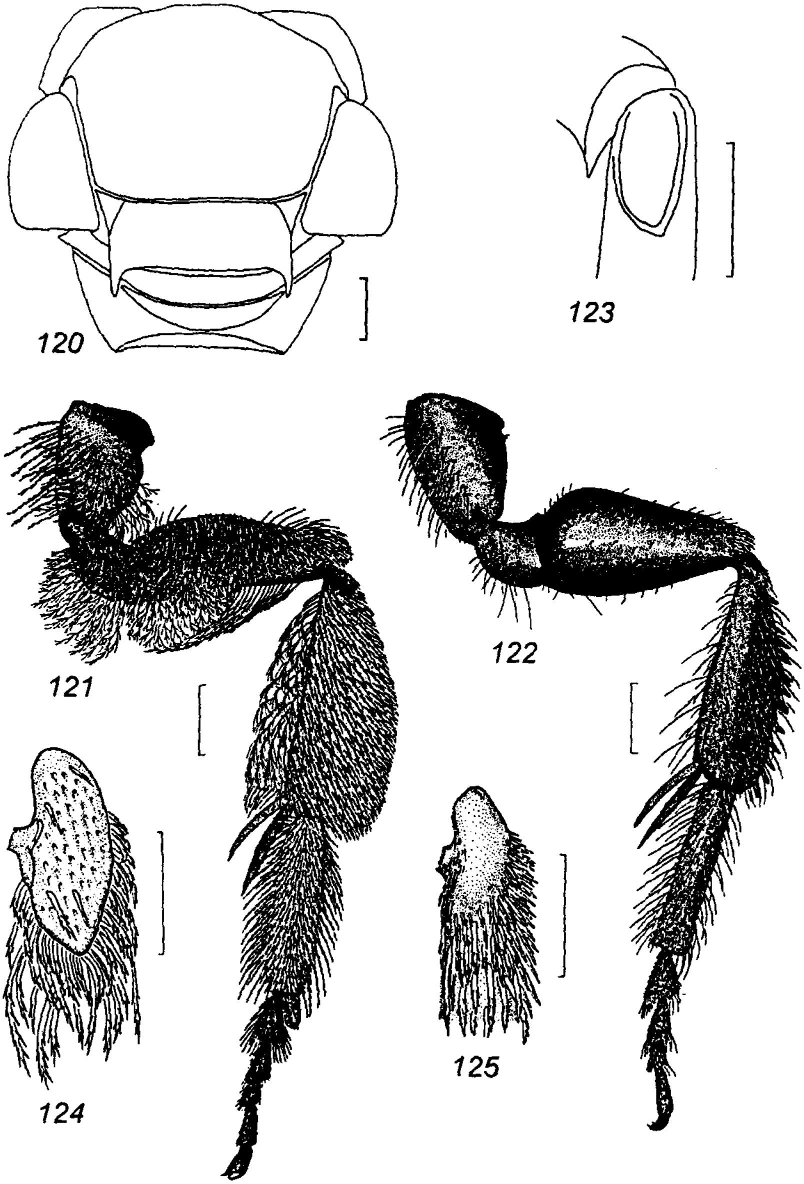
[3] In *Evylaeus marginatus* and in females of *E. sexstrigatus* and *E. setulosus*, posterior areas of metasomal terga II-IV laterally covered with not dense, white, slightly tomentose hairs forming a band-like pubescence; in females of *E. damascenus*, *E. obscuratus* and *E. tricinctus*, terga II and IV covered with a tomentum throughout.

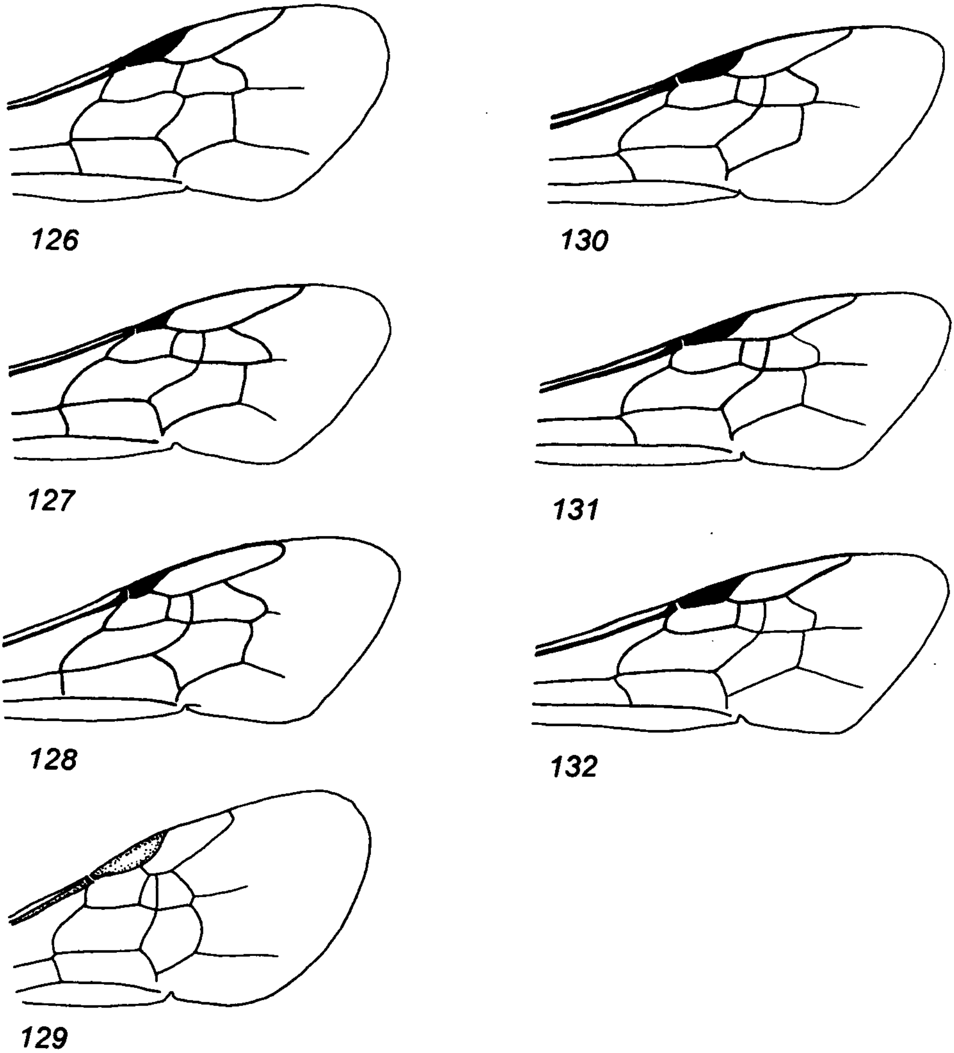


Figs. 111-119. Head and its appendages in genera of the Halictidae.

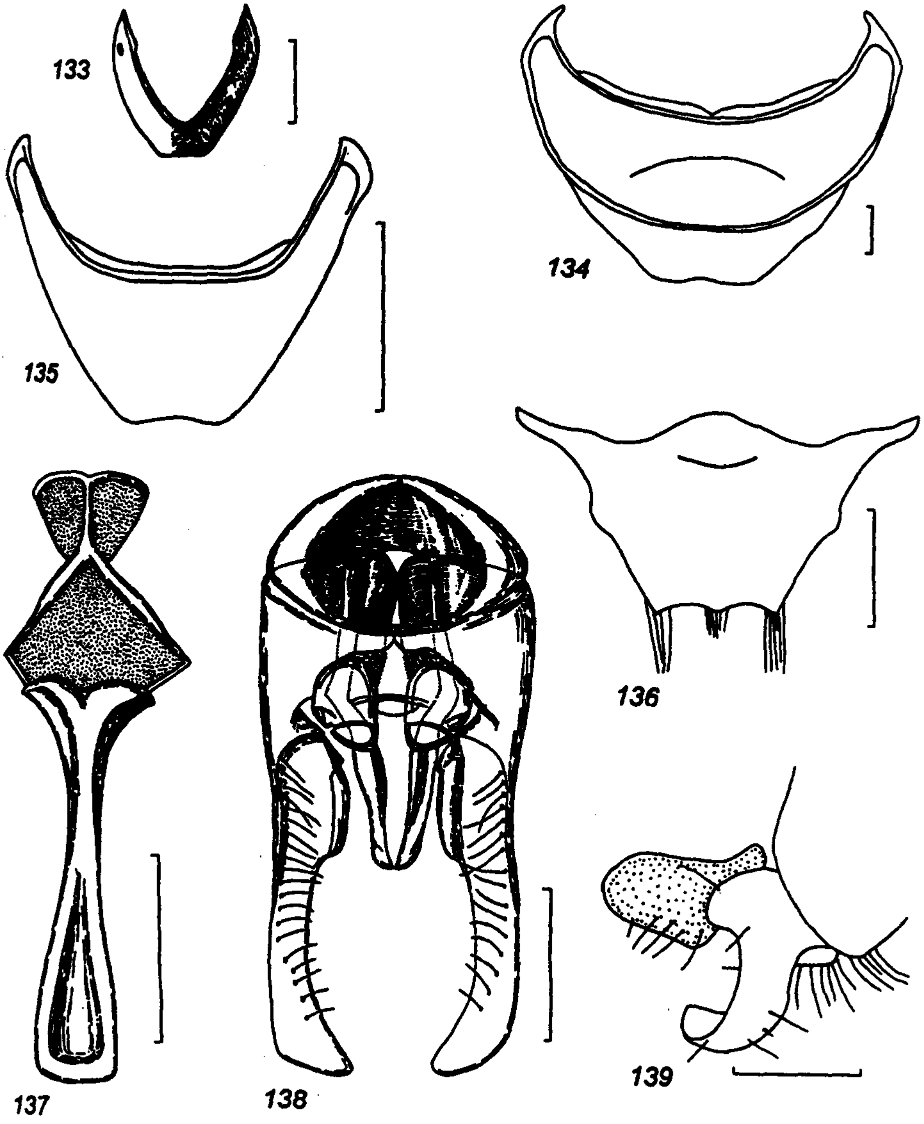
111. Female head of *Nomioides minutissimus* (from PESENKO, 1983: Fig. 9). *112.* Female frons of *Rophites hartmanni. 113.* Female labrum of *Halictus rubicundus. 114.* Female labrum of *Evylaeus malachurus* (from MICHENER, 1978a: Fig. 26). *115.* Female labrum of *Sphecodes monilicornis* (from MICHENER, 1978a: Fig. 27). *116.* Labial palpus of *Rophites quinquespinosus. 117.* Labial palpus of *Rhophitoides canus. 118.* Male antenna of *Systropha planidens. 119.* Male flagellum of *Sphecodes gibbus.* Scale lines represent 0.5 mm.



Figs. 120-125. Mesosoma and its appendages in genera of the Halictidae.
120. Male mesosoma in dorsal view of *Nomiapis diversipes*. *121.* Female hind leg of *Evylaeus malachurus* (from MICHENER, 1978a: Fig. 4). *122.* Female hind leg of *Sphecodes monilicornis* (from MICHENER, 1978a: Fig. 3). *123.* Proximal part of the female hind tibia of *Halictus rubicundus*. *124.* Proximal part of the female hind tibia of *Evylaeus malachurus* (from MICHENER, 1978a: Fig. 15). *125.* Proximal part of the female hind tibia of *Sphecodes monilicornis* (from MICHENER, 1978a: Fig. 22). Scale lines represent 0.5 mm.



Figs. 126-132. Diagrams of the forewing venation in some genera of the Halictidae. *126. Dufourea. 127. Systropha. 128. Nomiapis. 129. Nomioides. 130. Halictus. 131.* Female of *Lasioglossum. 132.* Female of *Evylaeus.*



Figs. 133-139. Metasoma of males in genera of the Halictidae.
133. Metasomal tergum VII of *Nomioides minutissimus*, dorsal view (from PESENKO, 1983: Fig. 142). *134.* Metasomal tergum VII of *Halictus rubicundus*, ventral view. *135.* Metasomal sternum VII of *Nomioides minutissimus*. *136.* Metasomal sternum VII of *Sphecodes monilicornis*. *137.* Metasomal sternum VIII of *Nomioides minutissimus* (from PESENKO, 1983: Fig. 145). *138.* Genital capsule of *Nomioides minutissimus*, ventral view (from PESENKO, 1983: Fig. 149). *139.* Gonostylus and its membranous lobe (marked by punctation) of *Sphecodes monilicornis*, lateral view. Scale lines represent 0.2 mm.

1. Genus ***Dufourea*** LEPELETIER, 1841

Almost for a century, the bees included now in the genus *Dufourea* were considered by European and American entomologists as belonging to two genera: *Dufourea* LEPELETIER, 1841, and *Halictoides* NYLANDER, 1848. (Also some species were described in the genus *Rophites* SPINOLA, 1808). The broader treatment of the genus *Dufourea* (with *Halictoides* as a subgenus) established by MICHENER (1951) is agreed by the majority of taxonomists (e.g. EBMER, 1987a; MOURE & HURD, 1987; PESENKO, 1998) and is accepted in the present monograph.

Dufourea is the Holarctic genus, also represented by several species in the north of the Oriental region: four species are described from the Himalayas (WARNCKE, 1979a) and four species from the southern China (WU, 1983b, 1990). The genus consists of about 150 currently recognised species divided into almost equal parts between North America and Eurasia. In the Palaearctic region, 70 species of *Dufourea* are known. Their subgeneric classification, worked up by WARNCKE (1979b; as several subgenera of *Rophites* s. l.) and EBMER (1984c, 1987a, 1987b, 1989, 1993b), included 13 subgenera mostly differing from each other in proportions of parts of labiomaxillary complex and structure of the male genitalia. The number of subgenera reduced to eleven by PESENKO (1998).

All species are solitary (not even subsocial). Most species are oligoleges. In the latter biological peculiarity and also in the high percent of species inhabiting mountains, *Dufourea* differs from the majority of other halictid genera.

17 species belonging to 6 subgenera inhabit Europe. A key to them was published by EBMER (1984). Four species of *Dufourea* occur in Poland. Probably also *D. paradoxa* will be found in the Polish part of the Tatra Mts.

Taxonomy: FRIESE, 1901: 33-65; COCKERELL, 1916: 61-63; BLÜTHGEN, 1930a: 772-773; POPOV, 1957: 916-924; 1958: 47-51; 1959: 225-237; MICHENER, 1965b: 321-326; EBMER, 1976b: 179-203; 1978c: 317-318; 1979: 141-143; 1984c: 313-379; 1987a: 43; 1987b: 91-93; 1989: 193-210; 1993b: 15-42; 1999: 183-228; WARNCKE, 1979a: 65-70; 1979b: 118-142; WU, 1983b: 344-347; 1990: 466-475; MOURE & HURD, 1987: 15-26; PESENKO, 1998: 670-686.

KEY TO THE POLISH SPECIES OF DUFOUREA

1. *Both sexes*: frons and mesoscutum with a deep blue tint; middle tibiae distinctly concave at outer surface; length 8-11 mm. *Female*: middle femora at distal part broadened, nearly sheet-shaped, slightly concave in anterior view). *Male:* vertex strongly stretched, nearly sharply carinate along posterior margin; middle and hind femora thickened; middle tibiae on outer surface with a sharp carina; hind tibiae at outer surface weakly concave; metasomal sternum IV with a triangular to semilunar area covered with very dense and short hairs; sternum V deeply emarginate posteriorly; sternum VI with a strong sharp posterior process curved downward. (Subgenus *Cephalictoides* COCKERELL) .... ***D. (C.) paradoxa***

- *Both sexes*: middle tibiae normal, convex at outer surface; body brownish-black to black, without metallic tint. *Female*: middle femora at distal part normal, not broadened and not concave. *Male*: vertex convex, rounded at posterior margin; legs and sterna without such structures 2

2. *Both sexes*: length 4-6 mm; 2nd segment of labial palpus as long as 3rd or 4th (Fig. 140). *Male*: metasomal sternum VI flattened (Subgenus *Dufourea* LEPE-LETIER) 3

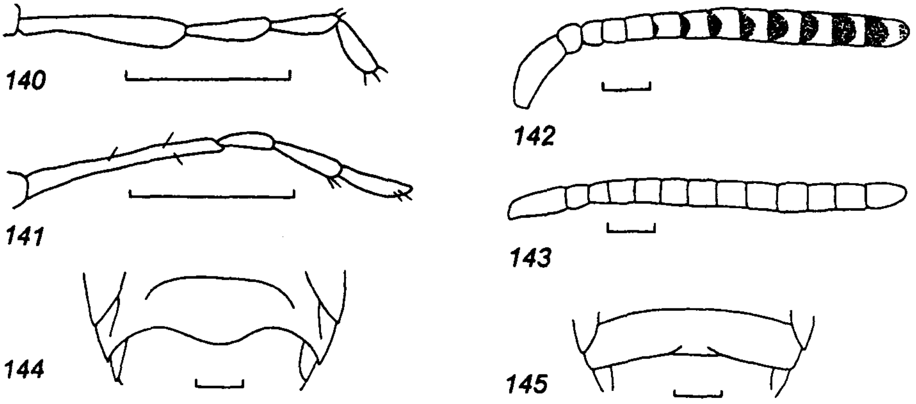
- *Both sexes*: length 6.5-9 mm; 2nd segment of labial palpus shorter than 3rd or 4th (Fig. 141). *Male*: sternum VI with distinct blister-shaped thickenings. (Subgenus *Halictoides* NYLANDER) 4

3. *Both sexes*: mesoscutum brightly shiny, with very sparse fine punctures separated by many puncture diameters; pubescence of body sparse. *Male*: 2nd flagellomere as long as wide; 4-11th flagellomeres with specialised areas covered with very dense and short hairs (Fig. 142) .... ***D. (D.) minuta***

- *Both sexes*: mesoscutum less shiny, much denser punctate, interspaces less than puncture diameters; pubescence of body denser. *Male*: 2nd flagellomere 1.2 times as long as wide (Fig. 143); flagellomeres without specialised areas, their pubescence uniform and inconspicuous .... ***D.(D.) halictula***

4. *Both sexes*: metasomal terga finely, very sparsely and irregularly punctate (1-6). *Male*: metasomal sternum V forming a large triangle projection at posterolateral extremities (Fig. 144) .... ***D. (H.) dentiventris***

- *Both sexes*: terga, especially I-III, much denser and regularly punctate (interspaces subequal to puncture diameters). *Male*: sternum V without lateral projections (Fig. 145) .... ***D. (H.) inermis***



Figs. 140-145. Structures in *Dufourea*.

140. Labial palpus of *D. minuta*. *141*. Labial palpus of *D. dentiventris*. *142*. Male antenna of *D. minuta* (from EBMER, 1984: Fig. 106). *143*. Male antenna of *D. halictula* (from EBMER, 1984c: Fig. 113). *144*. Male metasomal sternum V of *D. dentiventris*. *145*. Male metasomal sternum V of *D. inermis*. Scale lines represent 0.3 mm.

Dufourea (Dufourea) halictula (NYLANDER, 1852) (Figs. 140, 142, 146).

Synonymy: *Dufourea minuta* auctorum partim, nec LEPELETIER, 1841 (see comments for the name *D. minuta*).

Taxonomy. This species differs from other members of the subgenus in uniform (i.e. not forming specialised areas) and inconspicuous pubescence of male flagella. Morphologically constant throughout its geographical range.

Distribution. European, very sporadic, but occurring in almost all of Europe, in the south mostly in highlands.

Ecology. A univoltine species flying in mid-summer. Oligolege of Campanulaceae. Nesting unknown.

Fig. 146. Occurrence of *Dufourea halictula* in Poland.

Polish data. This relatively rare species was recorded earlier from the current territory of Poland by DITTRICH, (1903: 37; 'Schlesien: Odrau' [Silesia: Odra]), BLÜTHGEN, (1919a: 118; 'Pommern: Körlin, Stolp, Seelitz, Sellin' [Pomerania: Karlino, Słupsk, Zelice, Zielin]) and (ALFKEN (1912: 65; 'Westpreußen: Sierakowitz' [Pomerania: Sierakowice]).

Material studied (14 specimens): Olsztyn [Częstochowa district], 20.VI.1985, 1 ♀; 16.VIII.1986 1 ♀; both [on flowers of] Campanula trachelium, leg. CELARY, [KRA]. Gdynia, 8.VII.1936, leg. NOSKIEWICZ, 4 ♀ [WRO]. Bobolice [Wałbrzych district], 10.VII.1994, [on flowers of] Centaurea rhenana, leg. CELARY, 1 ♂ [KRA]. Ryczówek [Katowice district], 10.VII.1994, 1 ♀; 12.VII.1992, 1 ♀; both [on flowers of] Campanula trachelium, leg. CELARY, [KRA]. Żelazko [Katowice district], 11.VII.1992, [on flowers of] Campanula trachelium, leg. CELARY, 1 ♀ [KRA]. Mirów [Krakowska Upland], 19.VII.1992, [on flowers of] Campanula trachelium, leg. CELARY, 1 ♀ [KRA] (Fig. 146).

Dufourea (Dufourea) minuta (LEPELETIER, 1841) (Figs. 143, 147-150).

Synonymy: *Dufourea vulgaris* SCHENCK, 1861.

Comment on the name. For more than a century after its establishing, the name '*Dufourea minuta*' had no clear interpretation and was treated by most of authors as a *nomen dubium*. Later, during almost 20 years it was being considered as a senior synonym of *D. halictula* (NYLANDER, 1852). This treatment on indirect reasons (the type of *D. minuta* was considered as lost) was proposed by WARNCKE (1979b: 127) and supported by EBMER (1984c: 350) for stabilisation of the name. Only after finding of a part of LEPELETIER's collection by BAKER (1994: 1199) in the Zoological Museum of Oxford University (UK) and designation of the lectotype of *D. minuta* by him, the nomenclatural status of this name became clear. It must be considered as a senior synonym of *D. vulgaris* SCHENCK, 1861 (see: SCHWARZ et al., 1996: 89).

Taxonomy. Morphologically constant throughout its extensive geographical range. This species differs from other European species of the genus in the very shiny, nearly impunctate body.

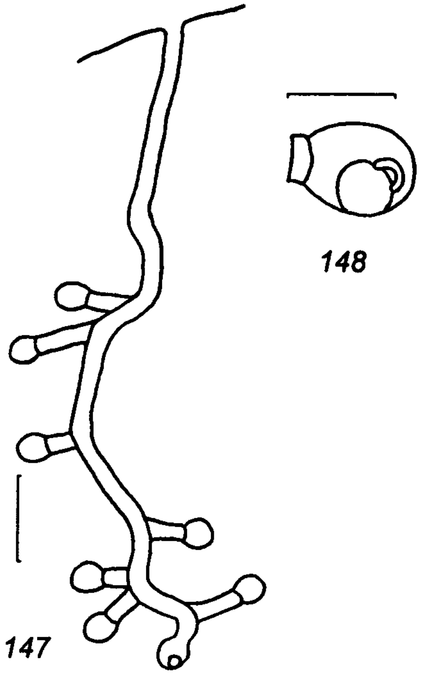
Distribution. Western Palaearctic, widespread in Europe. Recently it was recorded also from west Siberia and north-western China (PESENKO, 1998: 674).

Ecology. The commonest among European species of the genus. Univoltine, flying in the second half of summer. Oligolege of Asteraceae-Cichorioidea.

Bionomics. This species makes aggregations of nests on the slopes of shallow ravines and beams (OSITCHNJUK, 1966). The nesting of this species was studied in the region of the Middle Volga by VASILJEVA (1973), who has detected three aggregations of nests. These aggregations had a length of 8 to 15 m. The greatest density of burrows reaches 64 per 1 m^2. Young females are settled in the places of emergence, as a result nest aggregations can exist on the same places for many years. The species builds simple branched nests with laterals, which are disposed at different levels along the main burrow. The depth of nests is about 15 cm. The nest entrance (3.5 mm in diameter) conducts into the main burrow, which goes vertically downwards, periodically making small curves from 0.5 up to 1 cm long. From each short curving lateral burrows, 0.4 to 1.5 cm. long and having one cell at each end, branch off downwards (Figs. 147, 148). The cell has spherical-oval form, its length is 6 mm, diameter 4-5 mm, the diameter of cell necks 3.5 mm. The walls are dim, without any lining, and immediately absorb water droplets. Provision in cells has spherical form, 3 mm in diameter, and from bright orange to dirty-yellow colour. The pollen ball is easily scattered; if it is cut, the stratifiness is well visible, humidity inside of it is higher than outside. A bee brings provision and at once forms it in a ball, without piling it into a heap. The egg is poorly fixed, and it easily falls down from the pollen ball. On completing the feed, the larva spins a small spherical cocoon of light-brown colour.

Cleptoparasite: *Sphecodes divisus*.

References: VASILJEVA, 1973: 146-152, POPOVA & BLAGOVESCHENSKAJA, 1989: 37-42.



Figs. 147, 148. Nest and cell with egg and pollen ball of *Dufourea minuta.* (from POPOVA & BLAGOVESCHENSKAYA, 1989: Figs. 15, 16). Scale lines represent 2 cm for nest and 5 mm for cell.

Fig. 149. Occurrence of *Dufourea minuta* in Poland.

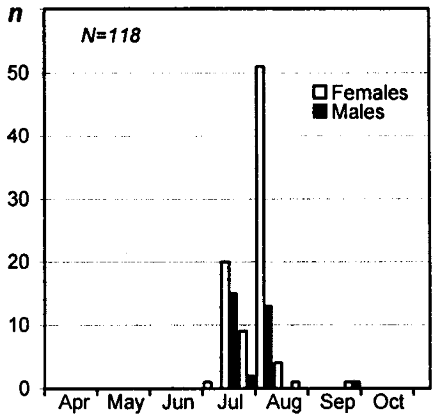


Fig. 150. Flight phenology of *Dufourea minuta* in Poland.

Polish data. An uncommon species caught in a few localities in western and southern Poland (Fig. 149). Females start flying in the first, males in the second decade of July and continue fly till the end of September (Fig. 150). Recorded from flowers of Asteraceae, mostly Leontodon and Hieracium.

Dufourea (Halictoides) dentiventris (NYLANDER, 1848) (Figs. 141, 144, 151).

Synonymy: *Dufourea dejeanii* LEPELETIER, 1841 (nomen oblitum, see SCHWARZ et al., 1996: 88); *Rophites bispinosa* EVERSMANN, 1852; *Dufourea putoniana* DOURS, 1873; *D. odontogastra* EBMER, 1978.

Taxonomy. Morphologically constant throughout its extensive geographical range. This species differs from other European species of the subgenus in the presence of large lateral teeth at metasomal sternum V of male.

Distribution. Transpalaearctic, widespread in Europe, in the south mostly in highlands.

Ecology. A univoltine species flying in the second half of summer. Oligolege of Campanulaceae, especially Campanula. Nesting unknown.

Fig. 151. Occurrence of *Dufourea dentiventris* in Poland.

Polish data. It is an uncommon species that occurs in south-western Poland, mainly in mountains (Sudeten, Karpathians), the Southern Uplands and the Silesian Lowland (Fig. 151). Females and males fly from first decade of July to second decade of August. Recorded only from flowers of Campanula: C. patula, C. trachelium.

Dufourea (Halictoides) inermis (NYLANDER, 1848) (Figs. 145, 152).

It is represented in Poland by the nominotypical subspecies.

Taxonomy. The species is morphologically constant throughout its extensive geographical range, but in northern Turkey (Erzurum) forms a separate subspecies, ssp. *pontica* (WARNCKE, 1979), differing from the typical form in the sculpture of the metapostnotum. *D. inermis* differs from the related *D. schmiedeknechtii (KOHL, 1905) inhabiting Caucasus and Asia Minor in finer* and sparser punctation of the mesoscutum and in the structure of the metasomal sternum VI of male (POPOV, 1960: 346; EBMER, 1987a: 49).

Distribution. Transpalaearctic, widespread *in* Europe, in the south mostly *in highlands. In Asia it was known from type locality* (coast *of* the Sea of

Okhotsk); recently it was recorded also from west and east Siberia and north-western China (PESENKO, 1998: 683).

Ecology. A univoltine species flying in the second half of summer. Oligolege of Campanulaceae, especially Campanula. Nesting unknown.

Fig. 152. Occurrence of *Dufourea inermis* in Poland.

Polish data. This species is relatively rare in Poland. Earlier it was recorded from the current territory of the country by DITTRICH (1909; 'West Sudeten'), TORKA (1913; Provinz Posen: Nakel' [Wielkopolska-Kujawy Lowland: Nakło n. Notecią]) and BLÜTHGEN (1919a: 118; 'Pommern: Gollnow, Stettin' [Pomerania: Goleniów, Szczecin]).

Material studied (11 specimens): Goleniów [Szczecin district], 11.VII.1896, 1 ♂ [WAR]. Sromowce Wyżne [Pieniny Mt.], 16.VII.1957, 1 ♀; 17.VII.1957, on flowers of Campanula sp., 1 ♀, 26.VIII.1957, 1 ♀, all three females leg. DYLEWSKA [KRA]. Tomaszówka [Zamość district], 17.VII.1966, on flowers of Campanula sp., 1 ♀ [PUL]. Bukowina [Tatry Mts., Nowy Sącz district], 18/19.VII.1939, leg. ZABŁOCKI, 1 ♀ [KRA]. Ojców [Kraków district], 19.VII.1963, on flowers of Campanula sp., leg. DYLEWSKA, 1 ♂ [KRA]. Kobylnica [Poznań district], 20.VII.1969, leg. BANASZAK, 1 ♂ [BAN]. Żegiestów [Nowy Sącz district], 18.VIII.1968, 1 ♀ [KRA]. Thus, the species does not show a certain geographical pattern in its occurrence in Poland (Fig. 152).

****Dufourea (Cephalictoides) paradoxa*** (MORAWITZ, 1867).

The species can be represented in Poland by the nominotypical subspecies.

Taxonomy. It sharply differs from other European species of the genus in the structure of middle and hind legs of both sexes. The species shows evident geographical variation in the form of hind tibiae of males, sculpture of the mesoscutum and coloration of pubescence.

Distribution. Nearly transpalaearctic, but in Europe and west Asia inhabiting only isolated highland areas: the Alps (ssp. *paradoxa*), the northern Pyrenees (ssp. *mesembria* EBMER, 1979), the southern Spain (Sierra Nevada, ssp. *nivalis* EBMER, 1989), the Balkans (Olymp Mt., ssp. *zolotasi* WARNCKE, 1988), Alai-Pamir Mts. (ssp. *atrocoerulea* MORAWITZ, 1876), but not occurring in the Carpathians and Caucasus. Only in southern (Altai) and eastern Siberia (Yuakutia) and Mongolia the species represented by ssp. *sibirica* PESENKO, 1998, inhabits lowlands. It can be found in the Polish part of the Tatra Mts.

Ecology. A univoltine species flying in mid-summer. Trophical links are unclear. All material from Yakutia, 26 ♀ and 2 ♂, was collected from flowers of Veronica incana (Scrophulariaceae). Nesting unknown.

2. Genus ***Rhophitoides*** SCHENCK, 1861

This is a small Palaearctic group of halictid bees. Its geographic range covers almost all the southern part of the Palaearctic region. The genus contains four species: the widespread *Rh. canus* (EVERSMANN), *Rh. epiroticus* SCHWAMMBERGER recorded from Greece, Yugoslavia, Macedonia and Turkey, *Rh. anatolicus* SCHWAMMBERGER (Central Turkey), *Rh. theryi* BENOIST (Morocco). Nesting and ecology are known only for the first species (see below).

Of the two European species, only *Rh. canus* occurs in Poland

Taxonomy : SCHWAMMBERGER, 1975: 57-63; WARNCKE, 1979b: 142-143.

Rhophitoides canus (EVERSMANN, 1852) (Figs. 13, 117, 153-157).

Synonymy: *Rhophites bifoveolatus* SICHEL, 1854; *Rhophitoides distinguendus* SCHENCK, 1861.

Taxonomy. This species does not show any distinct geographical variation. From another European species, *Rh. epiroticus* SCHWAMMBERGER, 1975, it differs in the pale antennal flagellum on lower side and details of the structure of metasomal sterna VII and VIII of males.

Distribution. Eurasian steppe species occurring from Central France in the west to Kyrgyzstan and central Mongolia in the east, in Central Europe inhabiting some warm localities (EBMER, 1988b: 685), in Asia Minor is known only in the north (Erzurum) (WARNCKE, 1979b: 142).

Ecology. It usually makes aggregations, sometimes very large. Thus, in south-eastern Ukraine on a lucerne seed field an aggregation totalling nearly 100 thousand nests was found. In some places the density of nests achieved 130 per m^2. The species prefers to settle on open places with sparse herbage. However if the nests are constructed on mowed sites, the aggregation remains in dense grass. Sometimes females dig the nests in firm soil on ground roads. A univoltine species, in Central Europe flying in mid-summer, in South Europe in the first half of summer. Oligolege of Fabaceae, the most important pollinator of lucerne.

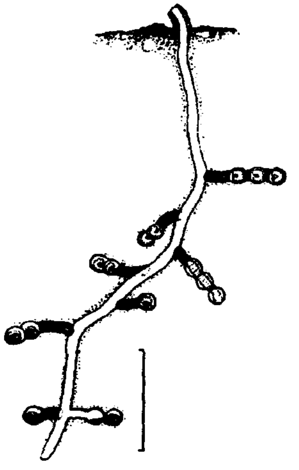
Bionomics. A solitary species. Excavated soil is put by the female around the nest entrance in a form of conic tumulus. According to observations made in Poland, the walls of the initial part of the main burrow have no adhesion, and the nest entrance is placed at the centre of the tumulus. In Ukraine the nest entrance of this species is usually located on the side of the tumulus; the initial part of the main burrow, which passes through the tumulus, has tightly rammed and slightly cemented walls. When the tumulus is washed away by rains, bent turrets 5-8 mm high remain on the ground surface (Fig. 13). If such turrets are broken, bees do not restore them. Such nest turrets are typical of chernozem sites, while on sandy soils they appear very rarely.

The main burrow (4.1-4.4 mm in diameter) in chernozem is slightly curved, almost vertical, and goes downwards to a depth of 19-26 cm. In sandy soils the main burrow is usually hard curved, and goes downwards to a depth of 20-31 cm. The lateral burrows are horizontal, 20-36 mm long; they branch off from the main one at a depth of about 20 cm (on the territory of Ukraine much shorter distance between cells and the ground surface was registered, varying it from 6 cm in chernozem to 8 cm in sandy soils; BODNARCHUK & RADCHENKO, 1985). In chernozem, at the extremity of each lateral females frequently build 2-3 cells arranged in a line, at a distance of 1.7-2.0 mm from one another (Fig. 153). In sandy soil bees usually build only one, rarely two, cells at the end of each lateral. On the territory of Poland females construct no more than 4 cells in one nest (Fig. 154). In Ukraine the average number of cells within one nest oscillates from 18 up to 25. Moreover, on completing the construction of the first nest, most females begin to build the second and then even the third, additional, nests, in which there are up to 10-13 cells.

Cells are almost spherical in form (4.6-5.5 x 5.5-6.0 mm). Their inside walls are smoothed, but not lined. In the cell the female stores a pollen ball of spherical form, having a diameter of 3-3.5 mm. It weighs 21-26 mg (23 mg on the average). On the territory of Ukraine the weight of pollen balls varies from 24 to 40 mg (on the average 31.42). On having provisioned the cell with forage and laid an egg, the bee seals the cell with a plug of small-sized pieces of soil. Egg is attached to the side of the pollen ball or to its lower part, less frequently to its top (Fig. 155).

The emerged larva crawls around the pollen ball and gnaws it around evenly, so that the ball remains spherical until the completion of the feed. It is interesting that by the end of the feed the joint mass of the pollen ball and the larva can increase due to absorption of moisture penetrating through the cell walls, which have no lining. On concluding its feed, the larva spins a thin cocoon, which very closely adjoins the cell walls and is attached to them. The cocoon has two tightly joined layers: the internal, very thin, translucent, and the external, more dense and leather-like. The head part of the cocoon is much more dense than its rest. Prepupae hibernate in cocoons.

References: Enslin, 1921: 59-65; Malyshev, 1925b: 105-107, 1936; Blagoveshchenskaja, 1955: 96-99; 1982: 31-35; Radchenko, 1982: 132-135; Bodnarchuk & Radchenko, 1985: 38-44; Wilkaniec et al., 1985: 139-151.



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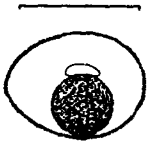

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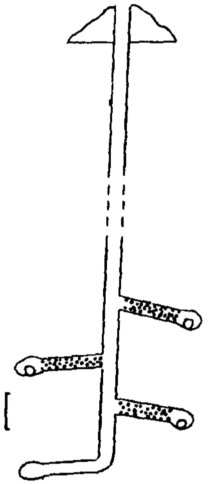


154

Figs. 153-155. Nests and cell with egg and pollen ball of *Rhophitoides canus* (from Bodnarchuk & Radchenko, 1985: Fig. 1; Wilkaniec et al., 1985: Fig. 1; Malyshev, 1925: Fig. 1). Scale lines represent 2 cm for nests and 5 mm for cell.

Fig. 156. Occurrence of *Rhophitoides canus* in Poland.

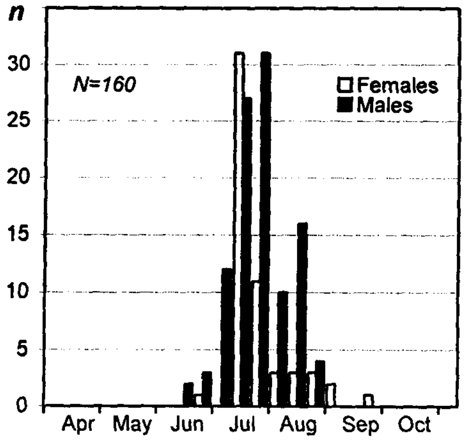


Fig. 157. Flight phenology of *Rhophitoides canus* in Poland.

Polish data. It is a relatively common species caught in southern and central Poland (Fig. 156). Mostly occurring in dry meadows, xerothermic slopes and forest margins. Nests of this species were founded also on alfalfa plantations. Females fly since the second half of June till the beginning of August; males start flying earlier, in the first decade of June (Fig. 157). Collected mainly from flowers of Fabaceae (Trifolium pratense, T. repens, Medicago sativa, M. falcata, M. media, Lotus corniculatus) and some species of other families (Knautia arvensis, Convolvulus arvensis, Symphytum officinale, Scrophularia nodosa, Ballota nigra, Plantago media, Allium cepa, Centaurea cyanus, Taraxacum officinale, Cirsium arvense, Tanacetum vulgare).

3. Genus ***Rophites*** SPINOLA, 1808

This is the Palaearctic genus, including 17 species. The highest species richness is in the Mediterranean and Pont basins. The genus is a coherent and well-isolated group of the subfamily Rophitinae, owing to the unusual structure of labial palpi and presence of spines on the frons in females.

Members of the genus are solitary univoltine summer forms nesting in soil. All ecologically known species are oligoleges of Lamiaceae.

Eight species inhabit Europe: the western Palaearctic *R. quinquespinosus* SPINOLA, Euro-Mediterranean *R. algirus* PÉREZ, Euro-Pontic *R. hartmanni* FRIESE, Pontic *R. clypealis* SCHWAMMBERGER. (recorded from Asia Minor and Crimea; EBMER & SCHWAMMBERGER, 1986: 291) and *R. leclercqi* SCHWAMMBERGER (known only from two localities in Turkey and in south-eastern Bulgaria), also *R. caucasicus* MORAWITZ (Caucasus including its European north part), *R. foveolatus* FRIESE (Greece, Turkey, Azerbaidzhan), *R. hellenicus* EBMER (Greece). Three of them, *R. quinquespinosus*, *R. algirus*, and *R. hartmanni*, occur in Poland.

Taxonomy: FRIESE, 1901: 65-79; 1902: 380-381; BLÜTHGEN, 1930a: 771-772; DUSMET, 1935: 161-163; SCHWAMMBERGER, 1971: 578-584; 1976: 225-229; EBMER, 1978a: 217-219; 1978b: 85-86; 1984a: 46-48; 1987b: 94; 1993a: 3-14; WARNCKE, 1979b: 111-155; 1980a: 37-52; 1982b: 167-169; EBMER & SCHWAMMBERGER, 1986: 271-304.

KEY TO THE POLISH SPECIES OF ROPHITES

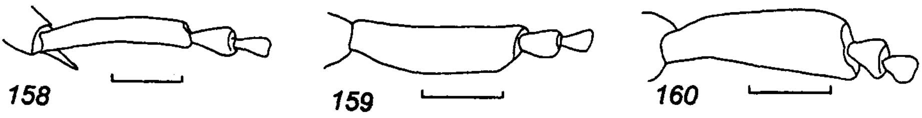
1. *Both sexes*: smaller, length 7-8.5 mm; mesoscutum and scutellum pubescent mostly with short thick hairs. *Female*: frons with 6 large spines, 3 of them above each antennal socket (Fig. 112). *Male*: hind basitarsus approximately as broad as 2nd or 3rd tarsomeres which are twice as long as wide (Fig. 158); metasomal sternum V medially with a narrow longitudinal projection not reaching posterior sternal margin and covered with short dense hairs; sternum VI at anterior third with lateral rounded inflations covered with very dense straight hairs directed

laterad; lateral teeth of sternum VI as long as pedicel or slightly shorter, spaced almost at posterior sternal margin; posterior lateral lobes of sternum VII nearly parallel-sided; gonostylus about rectangular .... ***R. hartmanni***

– *Both sexes*: larger, length 8.5-10.5 mm; mesoscutum and scutellum covered mostly with usual, long and slightly plumose hairs. *Female*: frons with many spines, often of various size. *Male*: hind basitarsus almost twice as broad as 2nd or 3rd tarsomeres, both latter ones as long as broad (Figs. 159, 160); sternum V without medial projection, flat and nearly hairless medially; sternum VI without lateral inflations, its lateral teeth twice as long as pedicel, remote from posterior sternal margin; posterior lateral lobes of sternum VII narrowed medially; gonostylus leaf-shaped 2

2\. *Female*: clypeus densely punctate throughout. *Male*: hind basitarsus nearly parallel-sided (Fig. 159); posterior lateral lobes of sternum VII with a broadly rounded inner margin before their apex; gonostylus sharply narrowed at dorsal margin .... ***R. quinquespinosus***

– *Female*: clypeus almost impunctate on lower third. *Male*: hind basitarsus broadened towards distal end; posterior lateral lobes of sternum VII with a straight inner margin before their apex (Fig. 160); gonostylus not narrowed at dorsal margin, rounded .... ***R. algirus***



Figs. 158-160. Hind basitarsus of males in *Rophites*.
158. *R. hartmanni*. 159. *R. quinquespinosus*. 160. *R. algirus*. Scale lines represent 0.5 mm.

Rophites quinquespinosus SPINOLA, 1808 (Figs. 116, 159, 161-163).

Synonymy: *Rhophites pilichi* MÓCZÁR, 1967; *Rophites moeschleri* SCHWAMMBERGER, 1971; *R. bluethgeni* BENEDEK, 1973.

Taxonomy. A rather variable species. This variation was a reason for descriptions of some redundant taxa for the last 30 years (see the synonymy above); one of which even was considered by WARNCKE (1980a: 42) as a separate subspecies, spp. *pilichi* MÓCZÁR, 1967 (=*R. bluethgeni* BENEDEK, 1973). The species is close to *R. algirus trispinosus* PÉREZ, 1903; differences between them given by WARNCKE (1980a: 39) and by EBMER & SCHWAMMBERGER (1986: 278, 280) are used by us in the key above.

Distribution. Western Palaearctic, in Europe almost throughout to southern Sweden in the north, in Asia to Kyrgyzstan and Altai.

Ecology. A univoltine summer species. Oligolege of Lamiaceae.

Bionomics. The species makes small-rarefied aggregations of nests. In front of the nest entrance there is a tumulus. The main burrow first goes downwards to a depth of 7-10 cm at an angle of 60° to the ground surface, and then it makes a small bend 3-5 cm long and falls almost vertically downwards to 5-8 cm. Thus the total length of the burrow amounts to 15-23 cm, but since at some places the burrow is gently sloping, its depth as such amounts to only 12-15 cm. In one nest the female builds 8-10 cells at the ends of short laterals (5-7 mm long), which branch from the main burrow progressively downwards at different depth (Fig. 161). Cells are spherical in form, their diameter is 8 mm. After the female has provisioned the cell and laid an egg, it closes the cell with a plug 2-3 mm thick. At the extremities of some laterals the female constructs two linearly arranged cells. Such cells are separated from each other only by the plug of the first, more distantly located, cell. The inner cell walls are thoroughly smoothed but not lined. The pollen ball is spherical in form (diameter 5 mm); the egg is curved (length 2 mm); it lays on the top of the pollen ball. The larva feeds for about 3 weeks. Then it spins a two-layer cocoon, which tightly adjoins the cell walls.

Cleptoparasite: *Biastes emarginatus*.

Reference: STÖCKHERT, 1922: 381-391.

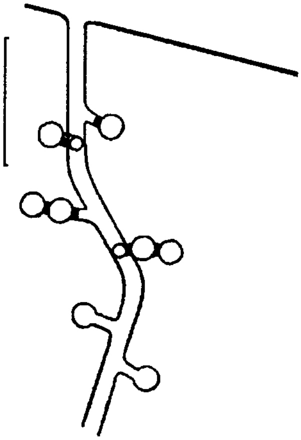


Fig. 161. Nest of *Rophites quinquespinosus* (from STOECKHERT, 1922). Scale line represents 5 cm.

Fig. 162. Occurrence of *Rophites quinquespinosus* in Poland.

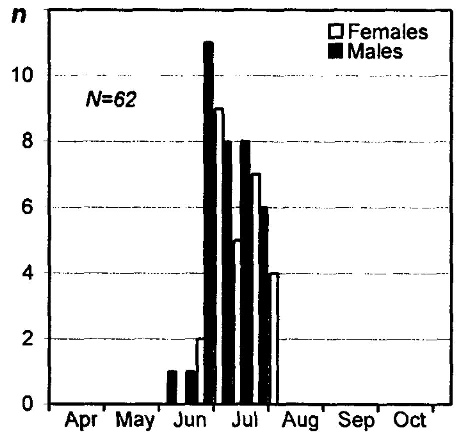


Fig. 163. Flight phenology of *Rophites quinquespinosus* in Poland.

Polish data. It is an uncommon species occurring in south and central Poland (Fig. 162). Mostly inhabiting dry meadows, glades, roadsides, xerothermic swards of forest and woodlot margins. Females and males fly in June and July (Fig. 163). Recorded mainly from flowers of Lamiaceae (Ballota nigra, Betonica officinalis, Lamium purpureum, Leonurus cardiaca, Stachys palustris, S. silvatica) and sometimes (usually males) also from Allium cepa, Centaurea jacea, C. scabiosa, Campanula sp., Echium vulgare, Geranium pratense, Knautia arvensis, Medicago sp., Scrophularia nodosa, Senecio jacobea, Potentilla sp., Taraxacum officinale.

Rophites algirus PÉREZ, 1895 (Figs. 160, 164).

The species is represented in Poland by spp. *trispinosus* PÉREZ, 1903.

Taxonomy. This is a very variable geographically species. WARNCKE (1980a: 37-52) and later EBMER & SCHWAMMBERGER (1986: 284-290) and EBMER (1988b: 687-688) have distinguished within it four subspecies (see below).

Distribution. A west Palaearctic species, represented by the following subspecies: ssp. *algirus* in North Africa and south-west Asia, spp. *trispinosus* in South and sporadically Central Europe, northern Caucasus, to Bashkiria; ssp. *graecus* WARNCKE, 1980 in southern Greece, ssp. *montanus* EBMER, 1978 in Asia Minor and Caucasus.

Ecology. A univoltine summer species. Oligolege of Lamiaceae.

Bionomics. The information on the nest structure is absent. There are only data on the structure of pollen balls and preimaginal phases, which are reported by ROZEN (1993). The food mass was spherical and had a diameter of 4.1 mm. No waterproof coating was visible, although a coating could have dissolved in the preservative (in Kahle's solution). A curved egg, 2.4 mm long and 0.6 mm in the maximum diameter, possessed a reticulated chorion, and was rounded at the front end and considerably more pointed at the back one. The embryo within it was oriented with its venter against its convex side. An intermediate-stage larva encircled the food mass, which suggested that it gripped the mass tightly while feeding on it. Intermediate-stage larvae, as well as grown larvae, have salivary lips. The protruding salivary lips and a labium divided into prementum and postmentum found in the specimen indicated that this species spins a cocoon.

Cleptoparasite: *Biastes emarginatus*.

Reference: ROZEN, 1993: 10, 15-16.

Fig. 164. Occurrence of *Rophites algirus* in Poland.

Polish data. The species was recorded from Poland (in the present borders) twice, but only on the basis of materials collected long ago: from 'Posen' [Poznań] (STÖCKHERT, 1933: 186, as '*Rhophites trispinosus*') and 'Bromberg' [Bydgoszcz] (see EBMER & SCHWAMMBERGER, 1986: 288). Our data confirm current inhabiting of the species in south-eastern Poland (Fig. 164): Dobużek [ad. Łaszczów, Zamość district], xerotermic biotope, 20.VI.1986, 5 ♀ [PUL]. Puławy [Lublin district], meadow, 20.VII.1989, 1 ♀ [PUL].

Rophites hartmanni FRIESE, 1902 (Figs. 112, 158, 165-167).

Synonymy: *Rhophites bistrispinosus* LEBEDEV, 1931.

Taxonomy. In female, this species is similar to *R. nigripes* FRIESE, 1902, occurring in Turkey and Israel; they differ in the number of spines on the frons.

Distribution. South and Central Europe to southern Germany and Austria in the west, also recorded from Israel and Turkey.

Ecology. A uncommon univoltine summer species; oligolege of Lamiaceae.

Bionomics. It makes aggregations of nests. During nest excavation the bee accumulates excavated soil on the surface, forming it into a bilaterally symmetrical tumulus at the front part of the nest entrance. Thus the nest entrance (4 mm in diameter) turns out to be placed at the side of the tumulus. The main burrow (4.5 mm in diameter) slightly slopes downwards into soil. The laterals, 7-9 mm long, are located one after another downwards along the main burrow, starting at a depth of 11 cm. Their diameter is equal to that of the main burrow. At the extremity of each branch of the burrow a female usually constructs one cell. However, at the extremities of deeply located laterals it can produce linear series consisting of 2-3 cells (Fig. 165). In our opinion, this is most probably a result of their disposition in more dense soil, or of difficulties presented by the procedure of raising excavated soil to the surface, rather than that of 'senile degeneration', as was assumed by MALYSHEV. Bees construct up to 12 cells in one nest. The larval forage has the form of a small spherical pollen loaf. Larvae develop rather fast and after completing their feed at once begin to spin a cocoon. Prepupa hibernates in the cocoon.

References: MALYSHEV, 1925b: 107-109; 1936.

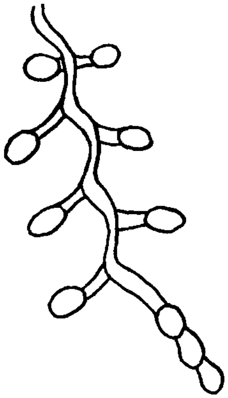


Fig. 165. Nest of *Rophites hartmanni* (from MALYSHEV, 1925b: Fig. 4).

Fig. 166. Occurrence of *Rophites hartmanni* in Poland.

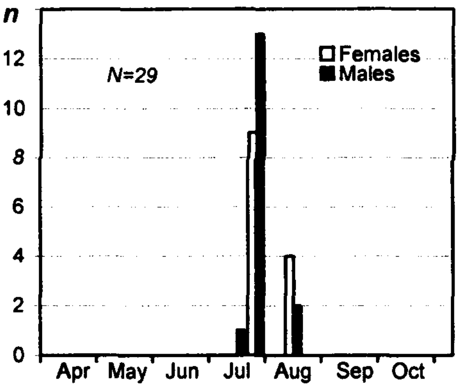


Fig. 167. Flight phenology of *Rophites hartmanni* in Poland.

Polish data. In Poland, the species was known from two localities of the country: Sandomierz vicinity (NOSKIEWICZ, 1953: 311, 1957: 160) and Przemyśl (KRYSIŃSKI, 1957: 305).

Material studied (30 specimens): Kazimierz Dolny [Lublin district], 15.VII. 1964, [on flowers of] Ballota nigra, 1 ♂ [PUL]. Jarosław [Rzeszów district], 27.VII. 1953, leg. NOSKIEWICZ, 7 ♀, 1 ♂ [WRO]. Kazimierz Dolny [Lublin district], 22.VII. 1954, leg. NOSKIEWICZ, 9 ♂ [WRO]. Same locality, 15.VII.1964, 1 ♂ [PUL]. Sandomierz [Tarnobrzeg district], 25.VII-11.VIII.1952-1959, leg. NOSKIEWICZ, 4 ♀, 3 ♂ [WRO]. Bolestrarzyce [Przemyśl district], 10.VIII.1997, leg. HUFLEJT, 2 ♀, 2 ♂ [WAR].

Thus, this is uncommon species occurring in Poland only in its south-eastern part (Fig. 166), flying since mid-July till the second decade of August (Fig. 167).

4. Genus *Systropha* ILLIGER, 1806

This is a rather small, coherent and relatively poorly studied group of the Rophitinae, inhabiting the Old World. Only western Palaearctic members of the genus are revised (references see below). In the Palaearctic region, 13 species are known: the western Palaearctic *S. curvicornis* (SCOPOLI), Euro-Pontic *S. planidens* GIRAUD, North-African *S. hirsuta* SPINOLA (= *S. pilosa* SPINOLA, *S. christae* WARNCKE; recorded also from Israel), *S. pici* PÉREZ (= *S. hirsuta* auct. nec SPINOLA) and *S. maroccana* WARNCKE, Iberian *S. grandimargo* PÉREZ, Irano-Turanian *S. ruficornis* MORAWITZ (recorded from a single locality in western Turkmenistan), *S. iranica* POPOV, *S. popovi* PONOMAREVA, S. *tadjica* WARNCKE (recorded from a single locality in southern Tadzhikistan) and *S. villosa* EBMER (recorded only from two localities in south-western Iran), also recently described from the south of Arabian

Peninsula *S. diacantha* BAKER and *S. androsthenes* BAKER. Also about ten species were described from the Afrotropical region and two species from the Oriental region (Burma and Sri Lanka).

All biologically known species of the genus are solitary univoltine summer proterandric forms nesting in soil, oligoleges of Convolvulaceae. The cleptoparasite of the European species is the anthophorine bee *Biastes brevicornis*.

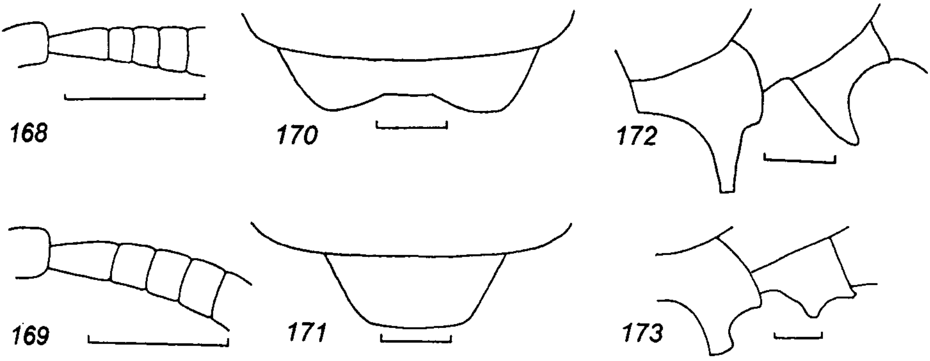
In Europe, there are two well-known species, *S. curvicornis* and *S. planidens* occurring also in Poland, and *S. grandimargo*, status of which needs confirmation.

Taxonomy: BLÜTHGEN, 1930a : 776; PONOMAREVA, 1967: 677-698; WARNCKE, 1976: 93-97; 1980b: 375-378; 1992b: 741-746; EBMER, 1978b: 86-89; 1987b: 94-95; 1994: 807-821; BAKER, 1996: 1527-1547.

KEY TO THE POLISH SPECIES OF SYSTROPHA

1. *Both sexes*: length 8-9.5 mm. *Female:* pubescence of metasomal terga I and II grey, succeeding terga brownish black; 1st flagellomere as long as 2nd and 3rd combined (Fig. 168). *Male*: each of metasomal sterna II and III with two long sharp lateral teeth (Fig. 172); metasomal tergum VII broadly emarginate posteriorly (Fig. 170) .... ***S. curvicornis***

– *Both sexes*: length 10-12.5 mm. *Female*: pubescence of all terga brownish grey; 1st flagellomere slightly shorter than 2nd and 3rd combined (Fig. 169). *Male*: sternum II with large truncated lateral teeth (Fig. 173), sternum III with small tubercles; tergum VII not emarginate posteriorly (Fig. 171) .... ***S. planidens***



Figs. 168-173. Structures in *Systropha*.
168. Female flagellomeres 1-4 of *S. curvicornis*. *169*. Female flagellomeres 1-4 of *S. planidens*. *170*. Male metasomal tergum VII of *S. curvicornis*. *171*. Male metasomal tergum VII of *S. planidens*. *172*. Male metasomal sterna II and III of *S. curvicornis*, lateral view. *173*. Male metasomal sterna II and III of *S. planidens*, lateral view. Scale lines represent 0.5 mm.

Systropha curvicornis (SCOPOLI, 1770) (Figs. 168, 170, 172, 174-176).

Synonymy: *Tenthredo convolvuli* PALLAS, 1773; *Andrena spiralis* OLIVIER, 1789; *A. labrosa* EVERSMANN, 1852.

Taxonomy. Morphologically constant throughout its extensive geographical range. Close to *S. pici* PÉREZ, 1895 (=*S. hirsuta* auct. nec SPINOLA) and *S. ruficornis* MORAWITZ, 1880 in wing venation (see the grouping by PONOMAREVA, 1967: 679), also nearly hairless metasomal sternum I and shortened teeth on sternum II of males. *S. curvicornis* differs from the two last species in smooth metasomal terga and presence of blue tint at tergum I of females, absence of an posterior median tooth at sternum VI of males.

Distribution. Western Palaearctic, from Spain to Altai and north-western China, in Europe to Poland and southern Lithuania in the north. Common in South and Central Europe, south-western and Central Asia.

Ecology. A univoltine summer species, making relatively large aggregations with a high density of nests. Oligolege of Convolvulaceae. In Central Europe, females emerge in the beginning of the second decade of June, which is correlated with the beginning of flowering of Convolvulus arvensis. Males appear by some days earlier, and besides these flowers feed on various other plants. They spend the night inside the flowers.

Bionomics. The nest has a structure similar to that of the next species. However, in contrast to *S. planidens*, which prefer clay soil, *S. curvicornis* more often builds nests in sandy one. The tumulus is bilaterally symmetrical, its diameter is up to 4 cm. On horizontal surfaces the nest entrance is placed under the tumulus in such a manner that its back part hangs over the entrance. At a distance of 1.5 cm the entrance part of the main burrow narrows down to 4.5 mm, and gently slopes downwards at an angle of 40°; the main burrow has a diameter of 5 mm and goes vertically downwards to a depth of up to 25 cm. The lateral burrows, 1.5-2.5 cm long and 4 mm in diameter, are horizontal or slightly inclined; they branch from the main one progressively downwards at every 0.5-1.0 cm, starting from a depth of 12-18 cm. At the extremity of each branch burrow one egg-shaped cell is placed (Fig. 174). The walls of cells are dim, and have no lining. The length of cells is 10 mm, the diameter in their broadest part – 8 mm. Provision has spherical form, the egg lies on its top. The inner part of the cell plug is concave, and consists of small-sized pieces of soil laid out in a spiral. On conclusion of its feed the larva spins a cocoon. Prepupae hibernate in cocoons.

References: MALYSHEV, 1925a: 21-26; GROZDANIĆ & MUĆALICA, 1966: 133-136; POPOVA, 1982: 100-105; POPOVA & BLAGOVESCHENSKAJA, 1989: 43-44.

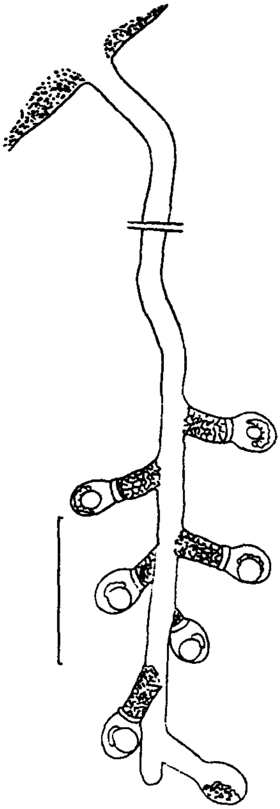


Fig. 174. Nest of *Systropha curvicornis* (from POPOVA, 1982: Fig. 1). Scale line reoresents 5 cm.

Fig. 175. Occurrence of *Systropha curvicornis* in Poland.

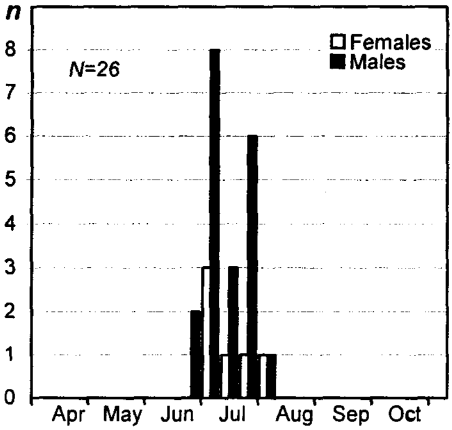


Fig. 176. Flight phenology of *Systropha curvicornis* in Poland.

Polish data. The species was recorded from Poland (in the present borders) by DITTRICH (1903: 38; 'Schlesien: Öls, Mirkau, Carlovitz' [Silesia: Oleśnica, Mirków, Wrocław-Karłowice]), ALFKEN (1912: 66; 'Pommern: Deutch Krone' [Pomerania: vicinity of Wałcz] and TORKA (1913: 128; 'Provinz Posen: Nakel, Brudzyn, Morzewo Kreise Kolmar, Talsee, Paradies' [Wielkopolska-Kujawy Lowland: Nakło, Brudzyń, Morzewo near Chodzież, Jankowo Dolne near Gniezno, Gościkowo near Miedzyrzecz]; 1933: 88; 'bei Gnesen' [vicinity of Gniezno]).

Material studied (23 specimens): Hatczysko ad. Tomaszów Lubelski, Zamość district], 28.VI.1953, 2 ♂ [WAR]. Kicin [ad. Poznań], 2.VII.1967, [on flowers of] Knautia sp., leg. Banaszak, 1 ♀, 1 ♂ [BAN]. Puławy [Lublin district], 3.VII.1987, [on flowers of] Berteroa incana, 1 ♀; 3.VII.1987, [on flowers of] Convolvulus arvensis, 6 ♂;19.VII.1973, [on flowers of] Medicago sativa, 1 ♀; 19.VII.1973, [on flowers of] Convolvulus arvensis, 2 ♂; 8.VIII.1974, [on flowers of] Trifolium pratense, 1 ♂; [all 11 specimens in PUL]. Izbica [ad. Krasnystaw, Chełm district], 10.VII.1987, [on flowers of] Convolvulus arvensis, 1 ♂ [PUL]. Augustów, 20-28.VII.19 76, leg. Kowalczyk, 1 ♀, 3 ♂ [KOW]. Barycz ['Baritch', Legnica district], 21.VII.1943, 1 ♂ [WAR]. Same locality, 27.VII.1945, 1 ♂ [WAR]. Górażdże [ad. Strzelce, Opole district], 2.VIII.1949, 1 ♀ [WAR].

Thus, this is an uncommon species sporadically occurring in the western and southern parts of the country (Fig. 175) and flying in mid-summer (Fig. 176).

Systropha planidens GIRAUD, 1861 (Figs. 118, 169, 171, 173, 177-181).

Taxonomy. This species shows distinct geographical variation, which is fixed by WARNCKE (1976: 96) who distinguished three subspecies: ssp. *planidens* GIRAUD, 1861 (Europe, except for the south-western part), ssp. *grandimargo* PÉREZ, 1903 (Spain and southern France), ssp. *anatolica* WARNCKE, 1976 (Turkey, Crime, Transcaucasus, Iran; see EBMER, 1988b: 690). The typical form differs from the two other subspecies in the longer 1st flagellomere and dark pubescence of metasoma of males. However, BAKER (1996) considered *S. grandimargo* PÉREZ as a separate species and ssp. *anatolica* WARNCKE as a synonym of *S. planidens*.

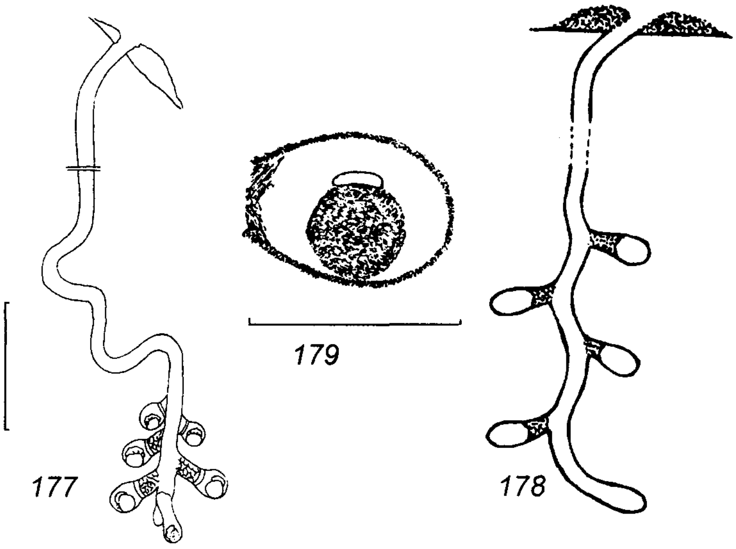
Distribution. Euro-Pontic, widely distributed in South and sporadically in Central Europe (southern Germany, Austria, southern Poland, localities see below), Asia Minor, Transcaucasus, Iran.

Ecology. Similar to that of the previous species. The nests are located on open sites well warmed by sun, usually on slopes with southern exposition, and as a rule scattered aggregations of nests are formed.

Bionomics. Near the nest entrance (diameter 5 mm) there is an eccentric or acentric tumulus. When a bee returns to the nest with a pollen load, it leaves some part of pollen in the relatively narrow nest entrance, since females hold pollen on the sides and under-surface of their metasoma. The nest has a simple branched architecture (Figs. 177, 178). The bee starts the construction of cells from the top part of the nest, so that the first cell lies the nearest to the ground surface. At first the bee digs out the sloping entrance part (1.5-2.0 cm long) of the main burrow at an angle of 40°. Then the main burrow lows steeply downwards, making several bends. The first branch burrow is concluded with a cell, which is placed at a depth of 6 to 30 cm. In different regions the total depth of the nest varies from 20 to 64 cm. Usually within the stretch of only 2.5-3.0 cm the main burrow contains up to 6-8 spirally located relatively short (7-12 mm) laterals with one cell at each end. FRIESE (1923: 190-191), on the basis of indirect data, supposed that at this species cells are arranged into linear series, but the subsequent authors have not confirmed it. The length of branch burrows fluctuates between one and several centimetres. The cell is slightly sloping (Fig. 179). It has a form of a jug with a narrow (4 mm in diameter) throat. The length of cells is 9 mm (including the throats, which have 2.5 mm of length), the breadth 6.5, thickness of walls 1.5 mm. By MALYSHEV (1936)'s data, the inner surface of cells is dim, not either polished or lined. POPOVA (1982), on the contrary, has registered polished walls and shining waterproof lining of cells. Provision is formed into rather friable pollen ball, on whose surface the egg is laid. After the complete formation of the pollen ball and oviposition the female plugs the cell and fills the branch burrow with soil. The soil for filling the cell is excavated in the course of digging the next branch burrow.

Larva has projections, which help it to hold on the food mass during the feed. In feeding the larva envelops the provision with its body. On completing the feed and excreting, the larva spins a light brown cocoon, which tightly adjoins the cell walls. The larva hibernates in the cocoon, and pupates in the spring.

References: FRIESE, 1922: 189-190; MALYSHEV, 1925b: 21-25; 1936; GROZDANIĆ & MUČALICA, 1966: 133-136; GROZDANIĆ & VASIĆ, 1968: 169-176; POPOVA, 1982: 100-105; POPOVA & BLAGOVESCHENSKAJA, 1989: 44-49.



Figs. 177-179. Nests and cell of *Systropha planidens* (from POPOVA, 1982: Fig. 2; MALYSHEV, 1936; MALYSHEV, 1925: Fig. 2). Scale lines represent 5 cm for the nest and 1 cm for the cell.

Fig. 180. Occurrence of *Systropha planidens* in Poland.

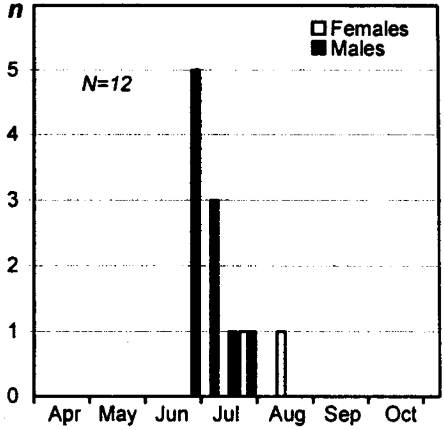


Fig. 181. Flight phenology of *Systropha planidens* in Poland.

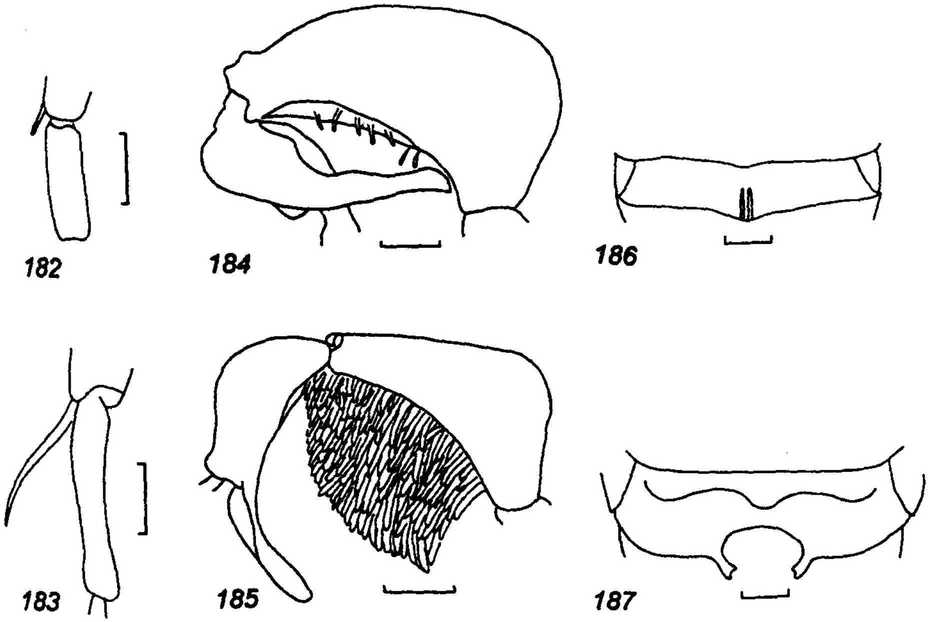
Polish data. This is a relatively rare species occurring only the southern part of the country (Fig. 180) and flying in mid-summer (Fig. 181).

Material studied (12 specimens): Krzyżanowice [ad. Pińczów, Kielce district], 26.VI.1951, leg. NOSKIEWICZ, 5 ♂ [WRO] (This locality was indicated by NOSKIEWICZ, 1953: 312). Tomaszówka [Zamość district], 1.VII.1967, on flowers of Convolvulus, 1 ♂; 3.VII.1967, on flowers of Convolvulus, 1 ♂; both ♂ leg. DYLEWSKA [KRA]. Same locality, 1.VII.1967, 1 ♂ [PUL]. Strzyżów [ad. Hrubieszów, Zamość district], 12.VII.1987, on flowers of Medicago falcata, 1 ♂ [PUL]. Gacki [ad. Busko, Kielce distr], 20.VII.1977, leg. BANASZAK, 1 ♀, 1 ♂ [BAN].

5. Genus *Nomiapis* COCKERELL, 1919

For a long time all species (over a thousand described forms) of the subfamily Nomiinae were considered as belonging to a single genus, *Nomia* LATREILLE. Only relatively recently *Nomia* s. l. was divided into several genera. *Nomiapis* was considered as a subgenus of *Nomia* (e.g., WARNCKE, 1976: 109-113; 1980b: 369-372) or *Pseudapis* W. F. KIRBY (e.g., EBMER, 1987b: 91). We accept the classification of the Nomiinae worked up by PAULY (1990: 101), who has treated *Nomiapis* as a separate genus. This genus includes eight western Palaearctic species. A key to them was published by WARNCKE (1976: 95-98; as members of *Nomia* subg. *Nomiapis*). Five species inhabit Europe, two of them are recorded from Poland. All the species of the genus are solitary and subsocial, nest in the soil, inhabit mostly arid and semiarid areas. The majority of species are oligolectic.

Taxonomy: GERSTÄCKER, 1872: 298-308; FRIESE, 1897: 45-84; BLÜTHGEN, 1930a: 768-769; WARNCKE, 1976: 109-113; 1980b: 369-372; EBMER, 1987b: 91; PAULY, 1990: 101.



Figs. 182-187. Structures of males in *Nomiapis*.
182. Tibial spur and basitarsus of the middle leg of *N. diversipes*. *183.* Tibial spur and basitarsus of the middle leg of *N. femoralis*. *184.* Hind femur of *N. diversipes*. *185.* Hind femur of *N. femoralis*. *186.* Metasomal sternum IV of *N. diversipes*. *187.* Metasomal sternum IV of *N. femoralis*. Scale lines represent 0.5 mm.

KEY TO THE POLISH SPECIES OF NOMIAPIS

1. *Both sexes*: length 8-9.5 mm; mesoscutum uniformly densely punctate nearly throughout. *Female*: legs black to brown; pubescence on inner surface of hind tibiae white. *Male*: mesotibial spur 5 times shorter than middle basitarsus (Fig. 182); hind femur moderately inflated (Fig. 184), on inner surface covered with very long and thick dense white hairs; metasomal sternum IV straight posteriorly, with two adjoined longitudinal thin bars directed backwards (Fig. 186) .... ***N. diversipes***

\- *Both sexes*: length 10-12 mm; mesoscutum at disc sparsely punctate. *Female*: legs brownish-red; pubescence on inner surface of hind tibiae goldish. *Male*: mesotibial spur 1.5 times shorter than middle basitarsus (Fig. 183); hind femur strongly inflated (Fig. 185), on inner surface covered with very sparse, moderately long, flattened hairs; sternum IV deeply roundly emarginate posteriorly, with a large flattened tooth directed posteroventrally on each side of emargination (Fig. 187) .... ***N. femoralis***

Nomiapis diversipes (LATREILLE, 1806) (Figs. 120, 182, 184, 186, 188, 189).

Synonymy: *Andrena humeralis* JURINE, 1807; *Nomia hungarica* FÖRSTER, 1853.

Taxonomy. Morphologically constant over its geographical range.

Distribution. A west Palaearctic species, mostly steppous, from Spain in the west to Kyrgyzstan (EBMER, 1988b: 679) and eastern Kazakhstan (new record based on study of the collection of the Zoological Institute in St. Petersburg) in the east. Common in South Europe, rare and sporadic in Central Europe, in the north possibly to southern Poland.

Ecology. In the temperate zone, it is a univoltine summer species making little aggregations of nests. Oligolege of Fabaceae, an important pollinator of lucerne.

Bionomics. The nesting of this species was studied by FERTON (1909) in Escaffarels (Lower Alps), by SERKOVA (1956; see Fig. 188) in southern Kazakhstan and by ROZEN (1986) in Pakistan. The nest entrances are met on packed ground surface. ROZEN found out that at least three females were associated with one nest. The main burrow of the nest (5-7 mm in diameter) descended obliquely into the earth and at the depth of 2-3 cm went down vertically to a depth of 7-8 (FERTON, 1909) to 15 cm (ROZEN, 1986). At this level it divided into a number of horizontal branches extending in various directions, abruptly turned downward and then apparently coalesced so that the branches embraced the central area, which was about 5-8 cm horizontally and 3 cm vertically. The vertical cells, one next to another, were clustered in this encapsulated area. Such a cluster consisted of at least 5-7 cells (FERTON, 1909; SERKOVA, 1956). The walls of branches were uncoated and rough, with numerous indentations created by the females' tamping the walls with their pygidial plates. In one nest described by ROZEN (1986) the main burrow also branched at a depth of about 5 cm near a single cell. All cells (Fig. 189) were vertical, with the closure end up, and spaced close to one another so that intervening distances ranged from 1.5 to 3.0 mm. Distances between cells and the descending burrows varied from 3.0 to 6.0 mm. Cell length ranged from 10.5 to 11.0 mm, increasing from the cell bottom to the outer rim of the spiral cell closure; the maximum cell diameter was 5.7 to 6.0 mm; the diameter at the closure, 3.5 to 3.8 mm. They were symmetrical about their long axes, unlike most other halictine cells, and possessed a conspicuous shiny semitransparent lining that could be peeled by sections from the wall. The lining was waterproof, and extended over the entire inner surface of the cell. The re-use of old cells from which the bees already emerged, was noted. The fecal material and exuviae, as well as some soil were at the bottom of the old cell, and a new cell bottom was plastered over the old remains. Unlike *Acunomia melanderi*, which plaster with fine soil only the top part of cell walls (Fig. 189), *N. diversipes* plastered therewith all of the walls and the cell bottom. The cell closure was a non-waterproof hard concave spiral of approximately four coils. The closure material was fused completely with the substrate, so that once plugged the entrance could not be detected. The cell neck was vertical and relatively short (4 to 5 mm long). The provisions are described by SERKOVA (1956) and ROZEN (1986) as flattened smooth spheres (the maximum diameter a little more than 5 mm and the minimum probably 4 mm). FERTON (1909) found much more liquid food in the cells. Elongated and hard curved egg (3 mm long) was placed on the top of liquid food mass or on the side of the pollen ball. Other preimaginal phases and their development remain unstudied.

A cleptoparasite of *N. diversipes* is the anthophorine bee *Pasites maculatus*. Eggs of this cleptoparasite are embedded in the cell wall so that the cell walls are flush with their flanged and obliquely flattened anterior ends (operculae) (Fig. 189). They very small in comparison with the host eggs. Besides, FERTON (1909) supposed that one of cleptoparasites of *N. diversipes* is *Epeolus variegatus*.

References: FERTON, 1909: 401-403; SERKOVA, 1956: 41-42; ROZEN, 1986: 1-8.

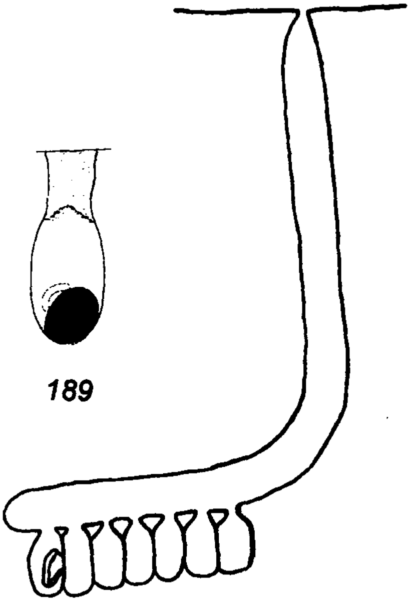


Fig. 188, 189. Nest and cell of *Nomiapis diversipes* (from Serkova, 1956: Fig. 1; ROZEN, 1986: Fig. 9; with changes).

Fig. 190. Occurrence of *Nomiapis femoralis* in Poland.

Polish data. It was recorded from Kraków by MORAWITZ (1876: 259). KUNTZE & NOSKIEWICZ (1938: 362) called this record in question, referring to more southern geographical range of the species. However, much later and independently *N. diversipes* was recorded by WARNCKE (1976b: 110) from 'Polen: Krakau' as a new record. We have found no representatives of this species caught in Poland in the collections studied, but we have no reasons for rejecting the information by WARNCKE and consider that this rare species sporadically occurs in the southern part of the country.

Nomiapis femoralis (PALLAS, 1773) (Figs. 183, 185, 187, 190).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Lasius difformis* PANZER, 1805; *Andrena brevitarsis* EVERSMANN, 1852.

Taxonomy. This species shows a distinct geographical trend in its variation. Southern populations are distinguished (see WARNCKE, 1976: 113) as a separate subspecies, spp. *valga* (GERSTAECKER, 1872). The latter differs from the typical form in the structure of metasomal sterna IV and V of males.

Distribution. A west Palaearctic species, mostly steppous, occurring from Spain to Baikal. Relatively usual in South Europe, very rare and sporadic in Central Europe, where it was recorded from southern Germany, Austria, and the Carpathians (EBMER, 1988b: 680). The localities in Poland (see below) are probably the northernmost for this species. In the southern part of its geographical range (southern Spain, Macedonia, Greece, Cyprus, Israel, Turkey, Iran, Transcaucasus, Turkmenistan and Tadzhikistan; WARNCKE, 1976: 113; 1980b: 370) the species is represented by ssp. *valga* (see above).

Ecology. In the temperate zones, it is a univoltine summer species. Nesting unknown.

Polish data. In the collections studied, we have found only two males of the species caught in Poland (Fig. 190): Gołąb [ad. Puławy, Lublin district], 28.VII.1956, leg. NOSKIEWICZ, 2 ♂ [WRO]. This locality ('Lubelska Upland: Gołąb') was published earlier by NOSKIEWICZ (1957: 158; 1959: 205) as the first record of *N. femoralis* from Poland.

6. Genus *Nomioides* SCHENCK, 1867

The genus includes about 60 species, mostly inhabiting deserts of Asia and North Africa. There are 45 currently recognised species in the Palaearctic region. All of them belong to the nominotypical subgenus, except for two unusual species. *N. socotranus* BLÜTHGEN, differing in the big body, red metasoma, strongly elongate mandibles and structure of male genitalia, is considered as belonging to the monotypic subgenus *Erythronomioides* PESENKO. Also a separate subgenus, *Paranomioides* PESENKO, was established for *N. steinbergi* PESENKO known from a single male from Iran; this subgenus differs from *Nomioides* s. str. in the shortened propodeum, shortened gonobase and greatly broadened gonostyli of the male.

All species are solitary or subsocial, polyleges, mostly inhabiting arid and semiarid biotopes.

Only two species of the genus occur in Europe; one of them, N. *minutissimus* (ROSSI), is recorded from Poland.

Taxonomy: HANDLIRSCH, 1888: 395-405; DĘBSKI, 1917: 25-50; BLÜTHGEN, 1925a: 1-100; 1933b: 114-127; 1933c: 63; 1934a: 238-283; 1934c: 493-501; 1935b: 231-237; IRELAND, 1935: 95-107; COCKERELL, 1936: 1-3; MICHENER, 1978b: 503-505; PESENKO & KERZHNER, 1981: 225-227; PESENKO, 1983: 122-177; EBMER, 1987b: 85-87; 1988b: 677-678; PAGLIANO & NOBILE, 1995: 547-561.

Nomioides (Nomioides) minutissimus (ROSSI, 1790) (Figs. 11, 129, 133, 135, 137, 138, 191-193).

The species is represented in Poland by the nominotypical subspecies.

Synonymy. (of the subspecific name): *Halictus pulchellus* GIRAUD, 1861; *Nomioides minutissima* var. *obscurata* BLÜTHGEN, 1925; *N. minutissima* var. *versicolor* BLÜTHGEN, 1925; *N. minutissima* var. *violascens* BLÜTHGEN; 1925, *N. minutissima* var. *schencki* BLÜTHGEN, 1925; *N. minutissima* var. *tristis* BLÜTHGEN, 1934; *N. minutissima* var. *fusca* BLÜTHGEN, 1934; *N. minutissima* var. *purpurascens* BLÜTHGEN, 1934.

Taxonomy. The species shows a distinct geographical variation in size, coloration and pubescence of the body. The nominotypical subspecies differs from all other subspecies of the species, distributed further south, in the larger and darker body. *N. minutissimus* can be easily distinguished from another European species, *N.* (*Nomioides*) *facilis* (SMITH, 1853), in the elongate head and details of the structure of male genitalia. Keys to them were created by PESENKO (1983: 122; among all Palaearctic species) and EBMER (1987b: 87).

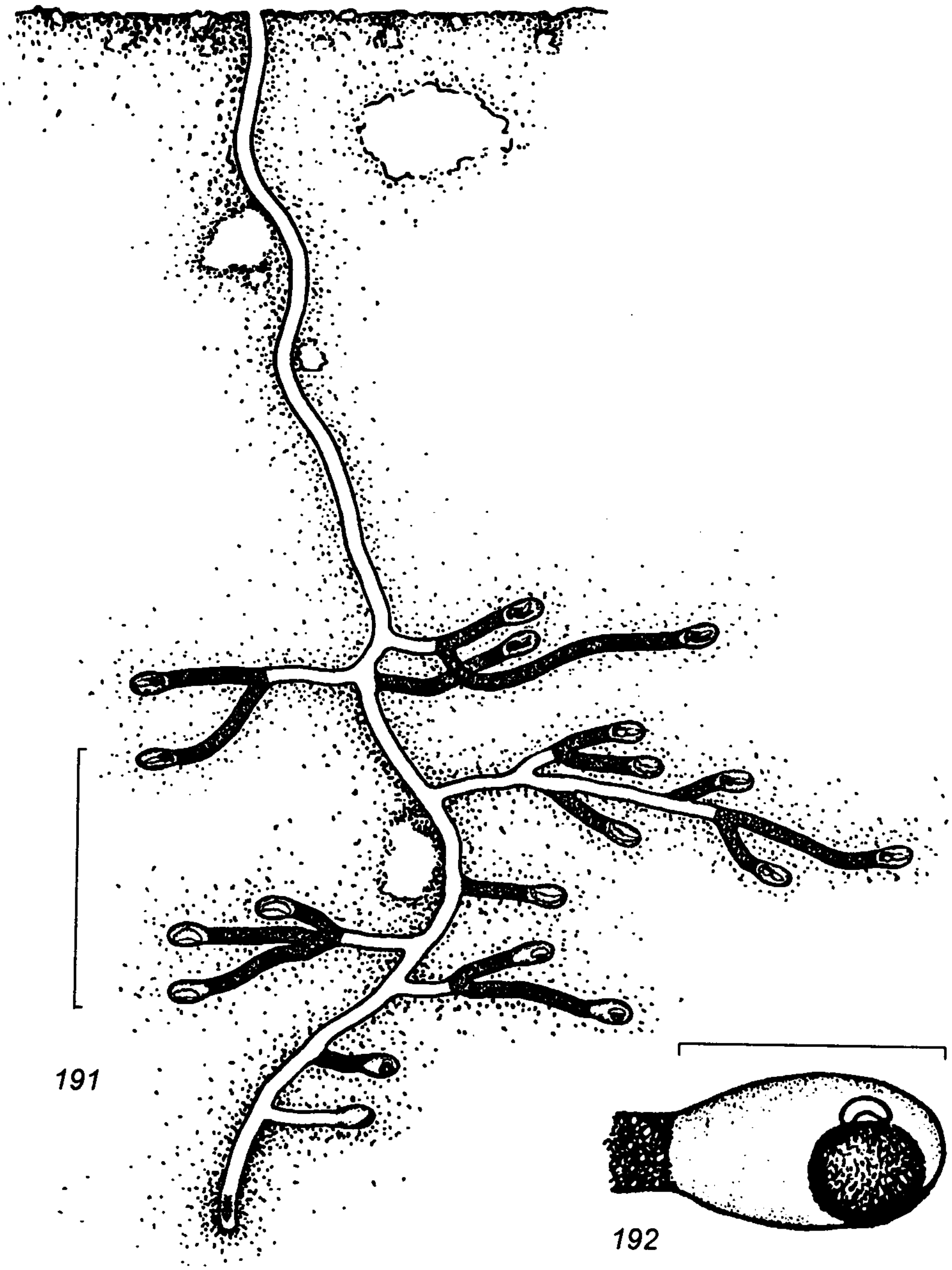
Distribution. A widely west Palaearctic species, from Canary Islands (ssp. *canariensis* BLÜTHGEN) to Mongolia, northern India and northern China. In the Atlas Mts. it is replaced by the related *N. maurus* BLÜTHGEN, in highlands of Central Asia by *N. monticola* PESENKO, 1983. The nominotypical subspecies is distributed in steppes of Eurasia, but occurs also in some warm localities in the south part of the temperate zone of Europe. The northernmost localities of *N. minutissimus* are Toruń in northern Poland ((latitude 53° N.; BANASZAK, 1979: 60) and Izhevsk in Udmurtia (latitude 56° 49' N.; SITDIKOV, 1986: 105).

Ecology. The species prefers sandy and stony areas. In the steppe zone, it is univoltine and flies for 1.0-1.5 months in mid-summer; in the Mediterranean basin and Central Asia bi- or polyvoltine and flies from April to October. Polylege, recorded as a visitor of flowers of over hundred species of plants belonging to many families. Females more often collects nectar and pollen from flowers with a small and shallow corolla. In northern parts of its range, the bee usually visits flowers of Thymus (Lamiaceae).

Bionomics. The females of this species make small aggregations of nests that are constructed in more or less hard soil. In the territory of Ukraine this species typically exhibits solitary behaviour – each female lives alone and uses a separate entrance, constructing by itself the whole of the nest (although sometimes females may use old burrows of the maternal one). Of two nests found in India, each contained several bees, which formed a communal society. The bees in these nests were all of approximately the same age, and, as BATRA (1966c) supposed, had built the nests co-operatively. The nest entrance is a circular opening, 1-2 mm in diameter, in the ground surface. A tumulus encircling the nest entrance is usually absent, because when constructed it is very small (1.5 cm in diameter, 0.75 cm high) and easily gets blown away by wind or washed away by rain. Some nests have entrances at the base of feather grass stems. When it is rainy, the bee seals the nest entrance with soil. The main burrow (whose diameter ranges from 2.0 to 3.2 mm) is vertical, unless its straightness is intervened by various soil inclusions. It extends downwards for 13 to 25 cm, and terminates in a lower blind burrow. At a depth of 5 to 18 cm, from 6 to 10 horizontal laterals (sometimes sloping downwards) extend from the main burrow to horizontal cells (Fig. 191). The laterals are between 1 and 8 cm long, 1.5 and 2 mm in diameter. The laterals are usually constructed consecutively downwards along the main burrow, and have one cell at each end. Some laterals additionally branch into 'sublaterals', each concluded by a single cell. After oviposition the laterals are filled with soil.

The cell (Fig. 192) is of ovaloid form (length 4.5 to 5.1 mm, width 2.0 to 2.7 mm), it has smoothed walls with secretory lining. In one nest the bee normally constructs 14 to 20 cells. The pollen ball has spherical form; it is 2 to 2.4 mm in diameter. The egg is laid on its top. The larva feeds relatively quickly. The total period of development from the egg to the imago is up to 30-35 days. However, young adult individuals do not emerge from the cells and hibernate therein. Cleptoparasites unknown.

References: BATRA, 1966c: 390-391; RADCHENKO, 1979: 762-765; 1980: 71-74.



Figs. 191, 192. Nest and cell of *Nomioides minutissimus* (from Radchenko, 1979). Scale lines represent 5 cm for the nest and 5 mm for the cell.

Fig. 193. Occurrence of *Nomioides minutissimus* in Poland.

Polish data. This is a rare species in Poland. It was recorded from the country (in the present borders) by DITTRICH (1884: XXXI; '*Nomioides pulchella* in Carlowitz bei Breslau' [Wrocław-Karłowice]) and BANASZAK (1979: 59-69; 'Kampinowski Park Narodowy', 'Otłoczyn pod Toruniem').

Material examined (12 specimens): Karłowice ['Carlowitz', Wrocław district], 7.VI.1885, 1 ♀; 25.VI.1882, 1 ♀; 6.VIII.1886, 1 ♂; 12.VIII.1883, 1 ♂; 12.VIII.1889, 1 ♂; 20.VIII.1881, 1 ♂; 29.VIII.1885, 1 ♂; all seven specimens leg. DITTRICH [WRO]. Same locality, 20.VIII.1882, 1 ♂ [WAR]. Otłoczyn [Toruń district], 21.VII.1975, on flowers of Thymus sp., leg. BANASZAK, 3 ♂ [BAN].

Thus, this species occurs dispersally in some sandy biotopes (Fig. 193).

7. Genus ***Ceylalictus*** STRAND, 1913

The genus includes over 15 species, mostly Palaeotropical in occurrence. It is subdivided into three subgenera distinctly differing in wing venation, coloration of the body, structure of the metanotum and propodeum, form of inner metatibial spurs of females, structure of male genitalia and pregenital sterna (see: PESENKO, 1983: 178-180): *Ceylalictus* str., *Meganomioides* PESENKO and *Atronomioides* PESENKO. The latter is the most plesiomorphous group in the tribe Nomioidini (PESENKO, in press). Six of ten currently recognised species of *Atronomioides* occur only in Madagascar (PESENKO, 1996).

Collectors' data suggest that all species are solitary (or subsocial), polyleges, mostly inhabiting arid and semiarid biotopes.

Five species of the genus are Palaearctic in occurrence. One of them, *C. variegatus* (OLIVIER), inhabits South and sporadically Central Europe, can be found also in south-eastern Poland.

Taxonomy: HANDLIRSCH, 1888: 395-405; DĘBSKI, 1917: 25-50; BLÜTHGEN, 1925a: 1-100; 1933b: 114-127; 1933c: 63; 1934a: 238-283; 1934c: 493-501; 1935b: 231-237; IRELAND, 1935: 95-107; COCKERELL, 1936: 1-3; MICHENER, 1978b: 503-505; PESENKO, 1983: 177-187; 1996: 493-516; EBMER, 1987b: 85-87; 1988b: 677-678; PESENKO & WU, 1991: 454-458; PAGLIANO & NOBILE, 1995: 547-561.

***Ceylalictus (Ceylalictus) variegatus** (OLIVIER, 1789) (Figs. 194).

Synonymy: *Andrena pulchella* JURINE, 1807; *A. flavopicta* DOURS, 1873; *Nomioides jucunda* MORAWITZ, 1873; *N. fasciatus* FRIESE, 1898; *N. fasciatus* ssp. *intermedius* ALFKEN, 1924; *N. variegata* var. *simplex* BLÜTHGEN, 1923; *N. labiatarum* COCKERELL, 1931; *N. variegata* var. *nigrita* BLÜTHGEN, 1934; *N. variegata* var. *pseudocerea* BLÜTHGEN, 1934; *N. variegata* var. *nigriventris* BLÜTHGEN, 1934.

Taxonomy. In contrast to the very variable *Nomioides minutissimus* (see above), *C. variegatus* is surprisingly uniform in all morphological characters (including coloration and pubescence) throughout its very extensive geographical range. The closest species to *C. variegatus* is *C. muiri* (COCKERELL, 1909), which inhabits subsaharan Africa and Madagascar and differs a little from *C. variegatus* in coloration of the body and details of the structure of male gonostyli.

Distribution. Widely western Palaearctic, from the Canary Islands to Mongolia and northern India. In contrast to *N. minutissimus*, it does not occur as far north. Probably, it will be found in sandy river dunes of south-eastern Poland.

Ecology. Biotopic preferences, phenology and trophic links are similar to those of *N. minutissimus* (see above).

Bionomics. The nesting of this species was studied only in India by BATRA (1966c). It has nest structure similar to that of *Nomioides minutissimus* (see above). The nests were sometimes located in loose aggregation, but usually they were scattered apart. As a rule one nest is occupied by a solitary female, rarely by two of them. The nest has radial tumuli of coarse soil, 3 cm in diameter, 1 cm high. Nest entrances are more narrowed, having average diameter of 1.4 mm, while the main burrow has a diameter of 2-3 mm. In one case presence of two entrances leading to the same nest was registered. The main burrow, having initial diameter of 1 to 2 cm, usually immediately below the entrance slants from the ground surface, and then drops vertically downward to a depth of 5 to 45 cm (on the average 28 cm). The blind burrow is frequently absent. Laterals, averaging narrower (2.0-2.5 mm in diameter) than the main burrow, ramify horizontally from the main burrow, and generally each ends by one cell, but occasionally two cells are constructed at the end of one lateral (Fig. 194). The length of laterals is 1-4 cm; they are constructed one below another. Cells are of ellipsoid form, and have the average length of 5.6 mm, and width of 2.9 mm. The necks of the cells are somewhat narrower than the laterals, having the average diameter of 1.7 mm. Pollen balls have spherical form, being of 1.5 to 2.3 mm in diameter. After oviposition bees plug the cell and fill the laterals with soil. Brood develops quickly: while the deeper cells yet contain eggs, in the upper ones pupae appear. Cleptoparasite unknown.

Reference: BATRA, 1966c: 387-390.

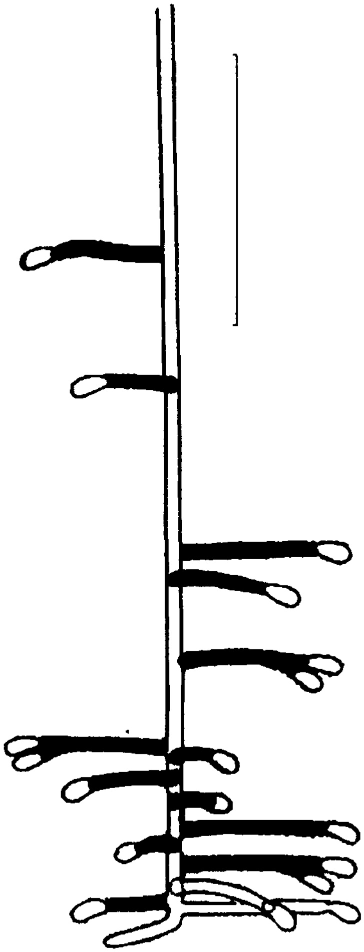


Fig. 194. Nest of *Ceylalictus variegatus* (from BATRA, 1966c: Fig. 8).
Scale line represents 5 cm.

8. Genus ***Halictus*** LATREILLE, 1804

The genus is mostly Palaearctic in occurrence and includes 98 currently recognised species. Only five species inhabit North America (including the Holarctic *H. rubicundus*) and only three species, *Halictus constrictus* SMITH, *H. latisignatus* CAMERON and *H. yunnanicus* PESENKO & WU, are Oriental in occurrence. Most species are Mediterranean and Central Asian. In the Far East of the Palaearctic region, the genus is represented only by four species: *H. quadricinctus* (FABRICIUS), *H. rubicundus* (CHRIST), *H. hedini* (BLÜTHGEN), and *H. tsingtouensis* STRAND.

In comparison with other genera of the subtribe Halictina, the genus *Halictus* includes species greatly differing in the structure of male genitalia. This genus is a paraphyletic group in relation to the widespread genus *Seladonia* (see below) and the Old World genus *Vestitohalictus* (not inhabiting Poland). Just the structure of male genitalia was taken as a basis for the subgeneric classification of the genus *Halictus* by PESENKO (1984a). According to this classification all species are divided into 12 subgenera.

Of 17 behaviourally known species of the genus, 14 species belonging to different subgenera are primitively eusocial. All species are polyleges and construct nests in soil. For nesting, the majority of them prefer warm dry areas, especially not overgrown places.

In Europe there are 43 species of 8 subgenera. Of them, only six species inhabit Poland.

Taxonomy: BLÜTHGEN, 1920: 85-86, 108; 1922b: 316-319; 1923a: 66-142; 1924b: 266; 1924c: 393-407, 483-490; 1925b: 92-95; 1926a: 673-675; 1930b: 215-221; 1934d: 5-6; 1936a: 270-313; 1937a: 103-106; 1955: 8-16; SANDHOUSE, 1941: 23-39; MITCHELL, 1960: 334-338; EBMER, 1969: 148-152, 157-168; 1974b: 186-190; 1975a: 41-71; 1976c: 213-219; 1978b: 12-23; 1980: 470-473; 1984b: 314-315; 1985a: 197-201; 1985b: 271-272; 1987b: 76-77; 1988b: 548-564; 1996b: 268; WARNCKE, 1973b: 280-282; 1975a: 107-112; 1982a: 147-164; 1984: 310-316; MICHENER, 1978b: 527, 530-534; PESENKO, 1984a: 340-357; 1984b: 446-481; 1984c: 16-32; 1984d: 33-48; 1985: 77-105; 1986b: 618-632; 1988: 126-141; PESENKO & WU, 1997: 202-206.

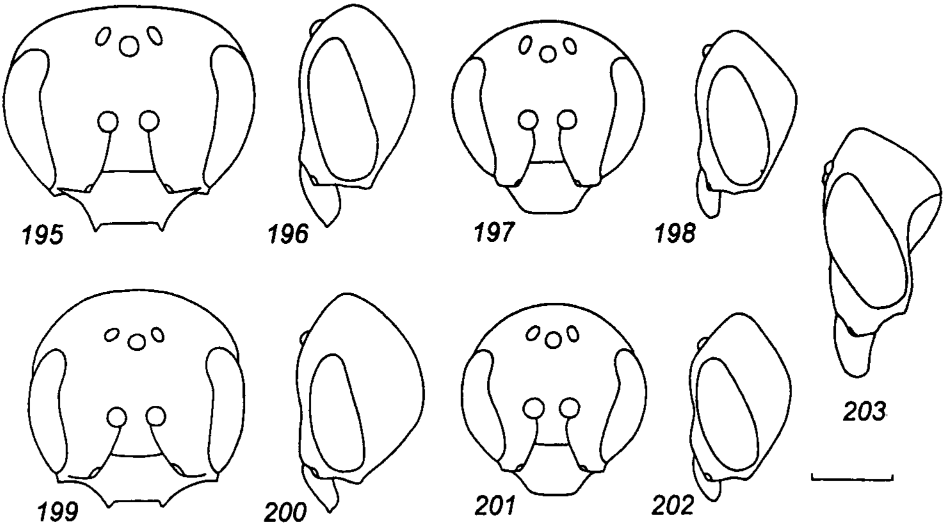
KEY TO THE POLISH SUBGENERA AND SPECIES OF HALICTUS

1. *Female*: posterior vertical surface of propodeum carinate at lateral margins. *Male*: last flagellomere hook-shaped, curved (Fig. 207); middle basitarsus along posterior margin with long erect hairs curved downward in their distal half, these hairs twice as long as width of basitarsus; metasoma very elongate, cylindrical; metasomal tergum VI with a normally developed posterior tomentose band; metasomal sternum IV broadly emarginate posteriorly, trapezoidal, its lateral margins convergent backwards, therefore narrower at posterior margin than medially (Fig. 213). Length 13-16 mm. (Subgenus *Hexataenites* PESENKO) .... ***H. (H.) sexcinctus***

– *Female*: propodeum carina-less in lateral margins. *Male*: last flagellomere normal or flattened and slightly curved; middle basitarsus shortly pubescent; metasoma not elongate, elliptic in dorsal view or broadened backward; tergum VI without band; sternum IV not narrowed backward, broadly emarginate or straight posteriorly 2

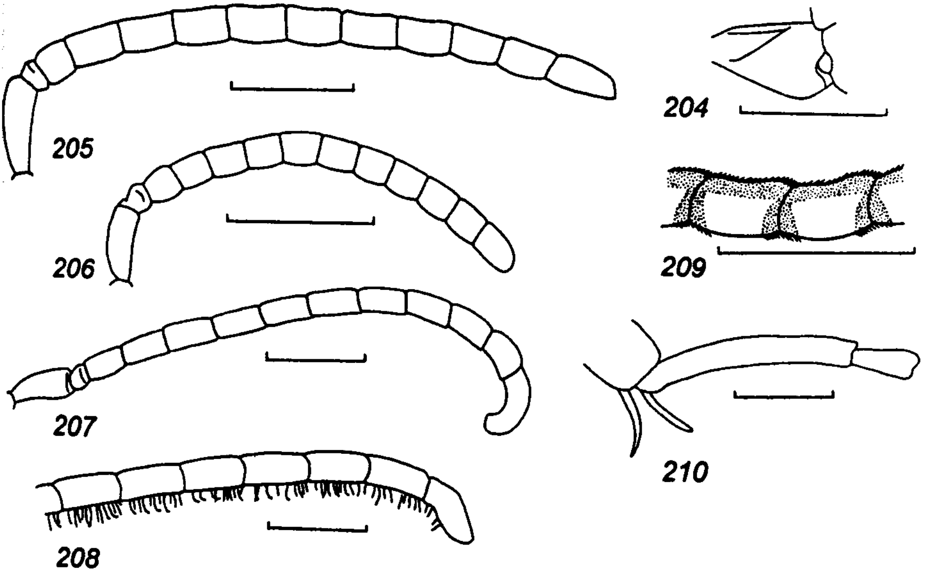
2. *Both sexes*: smaller, length 7.5-9 mm; bands of all metasomal terga broadly interrupted medially; head thick (Figs. 200, 202); posterior vertical surface and posterior part of lateral surfaces of propodeum shiny, distinctly punctate with polished interspaces equal or wider than puncture diameter. *Female*: head nearly cubical (Fig. 199); metasoma slender, with maximum width at posterior third of length; metasomal tergum I at posterior area impunctate, nearly smooth or very finely roughened, silk shiny. *Male*: antenna shorter (Fig. 206), reaching the metanotum; metasomal sterna IV and V straight posteriorly; gonostylus simple (Figs. 219, 220). (Subgenus *Tytthalictus* PESENKO) .... ***H. (T.) maculatus***

– *Both sexes*: larger, length usually more than 9 mm; at least bands of terga III and IV continuous or narrowly interrupted; head flatter, in frontal view elliptic, round or roundly triangular (except for species of subgenus *Halictus*, with a nearly cubical head); posterior vertical surface and lateral surfaces of propodeum dull, coarsely roughened, without polished interspaces, sometimes except for upper part of posterior vertical surface. *Female*: metasoma broader, longitudinally elliptic in dorsal view, with maximum width in middle; tergum I at posterior area, dull, densely punctate or roughened. *Male*: antenna longer, reaching the metasoma; sterna IV and V widely emarginate posteriorly; gonostylus composed (in subgenera *Halictus* and *Protohalictus*) or with a tassel of long hairs in middle of dorsomesal margin (in most members of the subgenus *Monilapis*) 3



Figs. 195-203. Head of females (*195, 196, 199, 200*) and males (*197, 198, 201-203*) in *Halictus*, frontal and lateral views.

195-198. H. rubicundus. 199-202. H. maculatus. 203. H. compressus. Scale line represents 1 mm.



Figs. 204-210. Appendages of the head and mesosoma of males in *Halictus*. *204*. Mandible (basal part) of *H. compressus*. *205*. Antenna of *H. rubicundus*. *206*. Antenna of *H. maculatus*. *207*. Antenna of *H. sexcinctus*. *208*. Antenna (distal half) of *H. quadricinctus*. *209*. Flagellomeres 5 and 6 of *H. compressus*. *210*. Hind basitarsus of *H. quadricinctus*. Scale lines represent 1 mm.

3. *Both sexes*: larger, length 13-16 mm; head nearly cubical. *Female*: mesoscutum coarsely, sparsely and irregularly punctate (35-55 μm / 1-4). *Male*: flagellum along lower side fringed with long hairs, its last segment flattened and slightly curved (Fig. 208); hind basitarsus curved (Fig. 210); metasoma flattened and broadened backward; metasomal sternum VI very strongly depressed medially, laterally with a brush of short and dense hairs (Fig. 211). (Subgenus *Halictus* s. str.) .... ***H. (H.) quadricinctus***

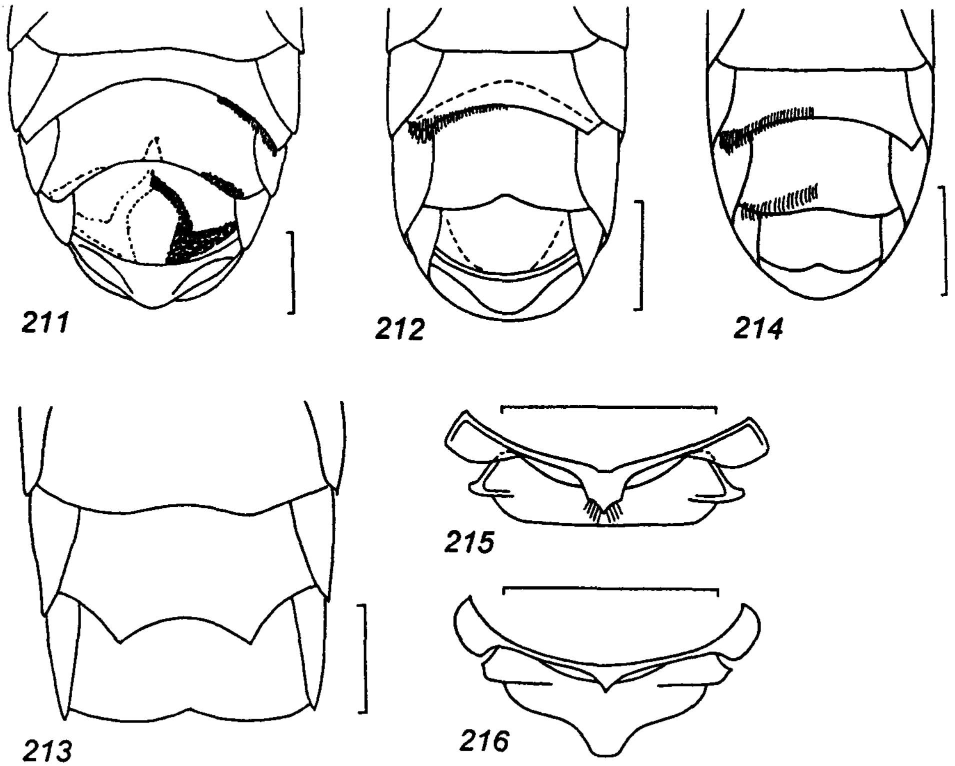
\- *Both sexes*: smaller, length 8-11 mm; head flattened, in frontal view round, roundly triangular or elliptic. *Female*: mesoscutum finely and densely punctate. *Male*: flagellum not fringed, its last segment not curved; hind basitarsus straight; metasoma not flattened, elongate elliptic in dorsal view or slightly broadened at posterior third; sternum VI flattened, without a brush (Figs. 212, 214) 4

4. *Both sexes*: head shorter, its height/width ratio about 0.8 in female (Fig. 195) and 0.85-0.95, in male (Fig. 197); metasomal terga very finely punctate (15 μm). *Female*: head flattened (Fig. 196); middle tibia in distal end, while hind tibia, middle and hind tarsi entirely golden-yellow to rusty-red. *Male*: genal area normal, convex and not emarginate (Fig. 198); flagellomeres weakly convex at lower side, without areas of specialised pubescence (Fig. 205); metasomal sternum VIII at posterior margin without a median process (Fig. 215); gonostylus double, its main body broad, on mesal surface with a branch of long and thick setae, ventral process of gonostylus short, spine-shaped (Figs. 217, 218). (Subgenus *Protohalictus* PESENKO) .... ***H. (P.) rubicundus***

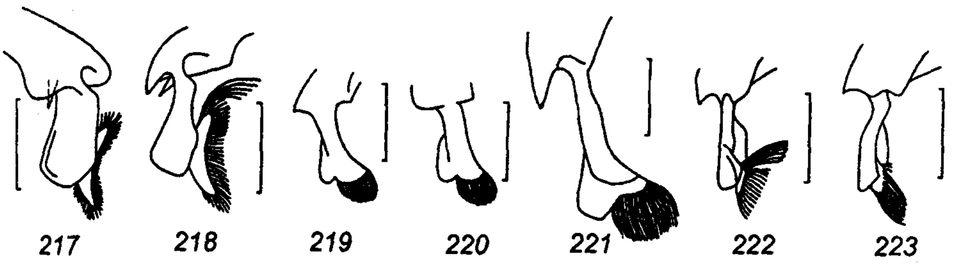
– *Both sexes*: head higher, its height/width ratio 0.95-1.0 in female and 1.1-1.2 in male; terga about twice coarser punctate. *Female*: head thickened; legs black, except for brownish medio- and distitarsi. *Male*: genal area strongly emarginate (Fig. 203); flagellomeres convex at lower side, with areas of very short and dense inclined hairs forming both proximal and distal transverse bands (Fig. 309); sternum VIII at posterior margin with a median process (Fig. 216); gonostylus simple, narrowed at proximal half. (Subgenus *Monilapis* COCKERELL) (Two species not distinguished in females) 5

5\. Male: mandibles normal, not broadened before its base; gonostylus without dorsomedial hair tassel (Fig. 223); metasomal tergum V usually without tomentum .... ***H. (M.) simplex***

– Male: mandibles broadened before their base (Fig. 204); gonostylus with a dorsomedial tassel of long hairs (Fig. 222); tergum V usually with a narrow posterior tomentose band .... ***H. (M.) compressus***



Figs. 211-216. Metasomal sterna IV and V (*211-214*), VII and VIII (*215*, *216*) of males in *Halictus*. *211*. *H. quadricinctus*. *212*, *215*. *H. rubicundus*. *213*. *H. sexcinctus*. *214*, *216 H. compressus*. Scale lines represent 1 mm.



Figs. 217-223. Gonostyli of males in *Halictus*.
217, 218. H. rubicundus (*217*, posterolateral view; *218*, posterodorsal view), *219, 220. H. maculatus. 221. H. sexcinctus. 222. H. compressus. 223. H. simplex.* Scale lines represent 0.5 mm.

Halictus (Halictus) quadricinctus (FABRICIUS, 1776) (Figs. 208, 210, 211, 224-228).

Synonymy: *Apis hortensis* GEOFFROY in FOURCROY, 1785; *Halictus quadristrigatus* LATREILLE, 1805; *H. ecaphosus* WALCKENAER, 1817.

Taxonomy. Morphologically constant throughout its extensive geographical range. Sympatric in relation to the close *H. brunnescens* (EVERSMANN, 1852) in the southern part of the Palaearctic region. The latter differs from *H. quadricinctus* in rich pubescence of female metasoma (posterior tomentose bands of the metasomal terga in female continuous and broader, tergum I on disc with lateral tomentose spots, terga II and III usually also with narrow anterior bands), pubescence of sternum VI of male (pubescent throughout) and in details of the structure of male genitalia (e.g., ventral stylar process less broadened at distal half).

Distribution. Transpalaearctic, common in temperate zones of the region from the Atlantic to the Pacific. In Sahara, this species is replaced by *H. rufipes* (FABRICIUS, 1793), whereas in deserts of Central Asia by *H. duplocinctus* VACHAL, 1902. In Europe widespread to southern Finland and St. Petersburg in the north.

Ecology. More common in steppes and dry meadows than in forests. Nesting in warm dry open areas, including parks, roadsides, etc. Univoltine in most of its extensive geographical range, in Central Europe both sexes fly mainly in midsummer. Polylege, preferring composites with big flowers (Onopordon, Carduus, Centaurea, Cirsium, etc.).

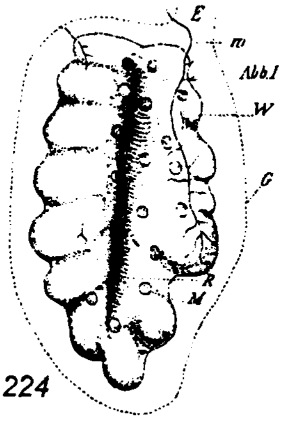
Bionomics. A solitary, possibly subsocial species. It builds nests more or less irrespective of the soil types, although preferentially settles on river bank precipices, steep slopes of ravines, and vertical quarry walls. Often aggregations with a high density of nests (usually 20 per m^2) are created; cases are recorded where at some places the nest density reached 50 per m^2. The nests are masked extremely rarely. On horizontal ground lots there is a conical tumulus around the nest entrance; its height is 3 cm, diameter 5-6 cm. The diameter of the entrance opening varies from 7 to 15 mm, which seems to correlate with the body size of the female-foundress, and in this parameter the species exhibits great variability. The main burrow is usually oval in cross-section; its diameter ranges from 7 to 19 mm. Initially the female excavates the main burrow to a depth of 20-30 cm, where it is concluded with a lower blind one. When the nests are made in vertical banks, the 'blind' burrows may bend and open to the surface below, forming a second entrance. The female starts building cells at a depth of 5-15 cm, arranging them in a dense group along one side of the burrow. Cases are registered where a female built far deeper nests, in which cell cluster formation began at a depth of 40 cm. First the uppermost cells are built, later the comb grows downwards. Synchronously with the construction of cells, the female begins to dig them around with numerous burrows, which gradually get transformed into a perfect cavity embracing the comb constructed. Such a cavity is absent in younger nests yet it is already partly existent in nests with more than 4-5 cells. Sometimes even before the cell construction the female excavates the second burrow, arch-curved downwards, which branches from the main one at a depth of 5-15 cm, and 6-10 cm farther joins it again. In result there remains one lower blind burrow at the bottom. The space between those two burrows is filled with honeycomb-arranged cells. The species makes a distinctly conical comb, since the axes of the cells are always closer to each other at the necks than at the diverged blind ends of the cells. Contrarily to many other halictines, which make a broader cell comb surrounded by a nest chamber, the comb of *H. quadricinctus* is always more high than broad, which apparently results from the side-cluster arrangement of cells along the vertical burrow. The comb is typically held by one or several lower cells that remain partly incorporated in soil. As well, the comb is supported from its sides by several soil columns, which the bee leaves intact while digging the cells around with burrows (Fig. 224). However a case is known where the columns were completely removed, so that the comb hung within the air chamber only on thin roots it was pierced with (Fig. 225). Having completed construction of one comb, the female often passes to building the next, located in the same nest at some distance below the first one. In total, from 4-5 to 20 and more cells are constructed in one comb. The largest comb described in the literature contained 69 cells. The finder, VASIĆ (1967), believes that such a gigantic comb was built by a single female, due to favourable weather conditions. In our opinion, several females, which established the nest co-operatively, are likely to take part in construction of this comb. As well combined nests are registered where several females used one common entrance and one main burrow, yet each one had its own comb. In result, such a communal nest may comprise more than 100 cells. In Central Asia (ATDAEV, 1966; KHALILOV, 1973) and in south-east of Kazakhstan (MARIKOVSKAYA, 1972) chamberless nests of *H. quadricinctus* are registered; they may have sessile cells and laterals, being each one concluded with a cell. As SITDIKOV (1987a) justly notes, these nests are undoubtedly constructed by other, related, species (in particular, *H. brunnescens*, and *H. duplocinctus*). Moreover, MARIKOVSKAYA herself supposed that such unusual nests might belong to twin species.

Cells are ovaloid in form (Fig. 226), 17-23 mm long, 9-12 mm in diameter; they are oriented more or less horizontally, only their back ends are slightly lowed. The cell neck is narrowed to 5-7.5 mm. The minimal distance between the inner walls of adjacent cells is 1 mm. In distinction from the majority of other bees, to whom a salient cyclicity of the works realised in the nest is proper (viz., a bee starts the construction of a new cell not before all the works about preparation of the previous one, oviposition, and its sealing with a cap are concluded), in *H. quadricinctus* 'line production' method is applied. First several cells are built, then all of them are filled with forage; after that the female lays eggs and seals the cells with caps. The cell cap is 3 mm thick; it consists of small soil lumps laid out in a spiral from the rims of the cell neck toward its centre; in the centre of the cap there is a small dent - the trace left by the proboscis of the bee.

Larvae are under-movable; they feed on the top of the pollen ball. Sometimes a female keeps the cells containing young larvae open, and probably controls their development. Therefore, elements of subsocial behaviour exist in this species. Within a year only one generation is reared, which emerges by the end of the summer, and which comprises females and males. After copulation females usually hibernate at the bottom of old burrows of their maternal nests.

Cleptoparasite: *Sphecodes gibbus*.

References: WALCKENAER, 1817: 1-95; EVERSMANN, 1846: 188-193; BREITENBACH, 1878: 241-243; VERHOEFF, 1891: 61-71, 1892: 711-717, 1897: 369-393; BUTTEL-REEPEN, 1903a, 1903b; SEMICHON, 1906: 295-388; FAHRINGER, 1910: 3-25; SCHOLZ, 1912b: 18-19; TORKA, 1913; ARMBRUSTER, 1916: 334; BISCHOFF, 1927: 196; HARDOUIN, 1948: 230-234; QUÉNU, 1954: 157-163; BLAGOVESCHENSKAYA, 1956: 59-63; SERKOVA, 1956: 35-56; NIKIFORUK, 1958: 24; ATDAEV, 1966: 87-89; GROZDANIĆ, 1966c: 15-18, 1971a: 59-61; VASIĆ, 1967: 181-185; OSYTCHNJUK, 1970: 28-32; MARIKOVSKAYA, 1972: 194-196; KHALILOV, 1973: 1731; RADCHENKO, 1982: 10-11; SITDIKOV, 1987a: 529-539.



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Figs. 224-226. Nests and pollen ball with egg of *Halictus quadricinctus*. (from VERHOEFF, 1897: Figs. 21-I, 69, SITDIKOV, 1987a: Fig. 12).

Fig. 227. Occurrence of *Halictus quadricinctus* in Poland.

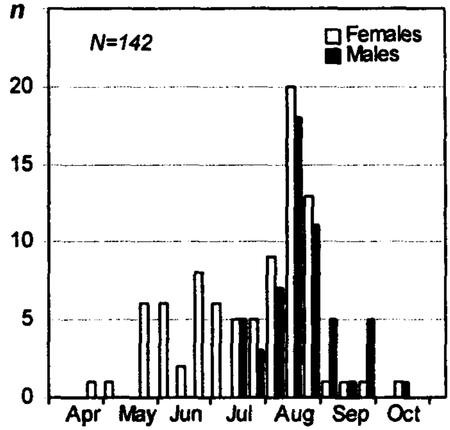

Fig. 228. Flight phenology of *Halictus quadricinctus* in Poland.

Polish data. It is a relatively common species that occurs in the whole territory of Poland (Figs. 227). It prefers open habitats such as xerothermic swards, dry meadows, roadside and uncultivated areas. Females start flying at the end of April and continue it till the second decade of October; the first males were collected later, in the second decade of July (Fig. 228). Recorded from flowers of 14 plant species of different botanical families, but preferring Centaurea jacea, C. rhenana, C. scabiosa, Knautia arvensis.

Halictus (Protohalictus) rubicundus (CHRIST, 1791) (Figs. 1-11, 113, 123, 134, 195-198, 205, 212, 215, 217, 218, 229-234).

Synonymy: *Halictus nidulans* WALCKENAER, 1817; *H. lerouxii* LEPELETIER, 1841; *H. quadrifasciatus* SMITH, 1870; *H. lerouxii* var. *ruborum* COCKERELL, 1898; *H. rubicundus* var. *nesiotis* PERKINS, 1922, nec CRAWFORD, 1918; *H. rubicundus* var. *laticinctus* BLÜTHGEN, 1923; *H. rubicundus* var. *mongolensis* BLÜTHGEN, 1936; *H. lupinelli* COCKERELL, 1939.

Taxonomy. Morphologically constant over temperate zones, only in the southern part of the Palaearctic region showing a wide variation in the coloration of legs and posterior areas of metasomal terga, width of posterior tomentose bands of terga, length of ventral process of male gonostyli (see: PESENKO, 1984b: Figs. 55-57). BLÜTHGEN (see the synonymy above) proposed names 'var. *laticinctus*' (Spain) and 'var. *mongolensis*' (northern Mongolia) for specimens with paler legs, translucent posterior areas of terga and broader tergal bands. Special analysis of the variation, based on a large material from Central Asia (where all the three forms occur), shown that (1) there are numerous hybrids between typical and paler forms and (2) there are large areas in which the typical form occurs in common with f. *laticinctus* and/or f. *mongolensis*. Therefore, the latter forms can be regarded neither as separate species, nor as subspecies of *H. rubicundus* (see Pesenko, 1984b: 466-469).

Distribution. A Holarctic species, common throughout forest zones of Eurasia and North America and mountain forests in the southern part of the Palaearctic region, sporadic in steppes. Widespread in Europe, nearly to the Polar Circle, in the south only in highlands.

Ecology. This is the most humid and commonest in forests species of *Halictus*. Females fly all the season long. Some males appear in the first (worker) brood a month after the appearance of wintered females; the proportion of males in a population increases to the end of summer. It successfully nests even in overgrown habitats. Wide polylege. Important pollinator of orchards, lucerne and some other entomophilous cultivated plants.

Bionomics. The species exhibits utmost plasticity in the manifestations of its social life. In the most part of its area it leads primitively eusocial life. Two broods are reared in colonies: the first consists of workers and a relatively high number of males (more than 20%), while the second one is reproductive. In northern and mountainous regions, where the climatic conditions permit a female to rear only one brood, reversion to a solitary mode of life is observed. In particular, in the subalpine region of the Rocky Mountains of Colorado, United States (EICKWORT et al., 1996), and in the northern part of England (POTTS & WILLMER, 1997) the species has a solitary life cycle. Formation of social or solitary mode of life depends even upon microclimatic conditions within relatively small space with insignificant macroclimatic differences and, at least, equal duration of day within the year. Thus, in the north of the Netherlands on slopes with north exposition open to frequent cold winds, only one generation develops, and the species exhibits solitary life here, whereas in the centre of the country, on the areas protected from winds and well warmed, the species rears two broods and leads eusocial life (HOGENDOORN & LEYS, 1997). BONELLI (1967), who has described briefly the nesting of *H. rubicundus* in highlands of Italy, also supposed that this species leads a solitary mode of life. However, this BONELLI's conclusion requires confirmation. As his data suggest, females of the first brood emerging in July have smaller body size than their mother. BONELLI believed that by the end of August those females increased in size, and then copulated and fell into diapause till the next year, to become foundresses of new nests. In fact, females cannot change in their body size. Therefore, BONELLI probably took the larger females emerging in the second brood for first brood females increased in size. Apart from cases of reversion to solitary life, one more striking peculiarity of this species consists in that in populations with eusocial life a part of females lead a solitary one. Thus, YANEGA (1988) has discovered that the females of the first 'worker' brood, which copulate shortly after their emergence, do not become working individuals yet fall into diapause, and in spring establish new nests. It is also noteworthy that electrophoretic studies of allozimes in *H.*

and (2) there are large areas in which the typical form occurs in common with f. *laticinctus* and/or f. *mongolensis*. Therefore, the latter forms can be regarded neither as separate species, nor as subspecies of *H. rubicundus* (see Pesenko, 1984b: 466-469).

Distribution. A Holarctic species, common throughout forest zones of Eurasia and North America and mountain forests in the southern part of the Palaearctic region, sporadic in steppes. Widespread in Europe, nearly to the Polar Circle, in the south only in highlands.

Ecology. This is the most humid and commonest in forests species of *Halictus*. Females fly all the season long. Some males appear in the first (worker) brood a month after the appearance of wintered females; the proportion of males in a population increases to the end of summer. It successfully nests even in overgrown habitats. Wide polylege. Important pollinator of orchards, lucerne and some other entomophilous cultivated plants.

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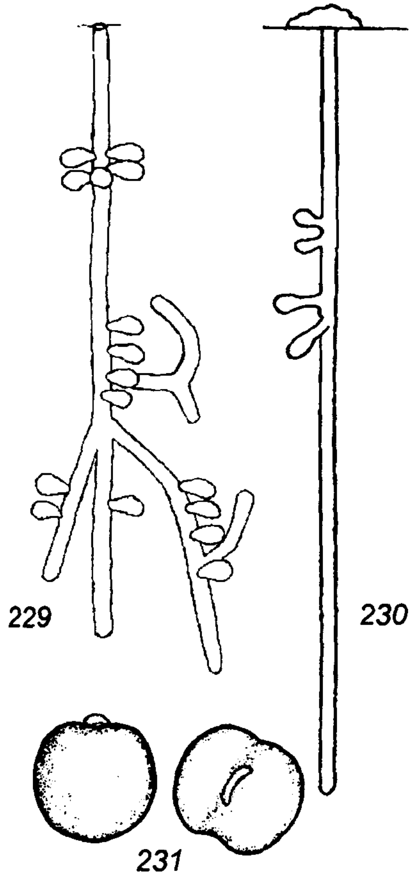
rubicundus have shown extremely high genetic variability of different populations of this species, comparable with inter-species variability in other Hymenoptera. The authors of the investigation (PACKER & OWEN, 1989) hold that this species is either unique among Hymenoptera from this viewpoint, or it indeed presents a complex of several species.

The species usually creates nest aggregations in soil, although cases of its settlement in rotten wood are recorded. Females tend to make the nest entrances well concealed. Choosing the place for a nest, females attach much importance to edaphic factors, and far less to the ground reliefe. They prefer softer soils, in which it is easier to excavate a nest. Nevertheless, aggregations with high density of nests are more frequently formed in dense soils, where the problem of maintaining the structural integrity of the nest is more easily solved. A nest is typically established by a single female, although instances of polygynous nest foundation are registered. Around the nest entrance 5-6 mm in diameter the female makes a small conical tumulus. The main burrow, 7-8 mm in diameter, goes vertically downwards to a depth of 10-20 cm. From along the main burrow, very short (5-15 mm) laterals branch off; at the extremity of each one a single cell is located (Fig. 229); their length is 16 mm, diameter 7-8 mm. In a summer nest its foundress builds 5 to 8 cells. The pollen ball is of spherical form, flattened at the poles. Besides that, there is a lenghtwise indentation on its top, into which the female lays the egg (Fig. 231). The female leaves the laterals and the cells open for the whole period of brood development. In a dense aggregation the distance between the cells of one nest and those of another never happens to be smaller than 50 mm. Having completed the establishment of the first brood, the female closes itself within the nest and waits for the emergence of its offspring, occasionally inspecting the content of the cells and sometimes flying out to feed on flowers. The summer nests containing working individuals are deeper - from 20 to 33 cm; up to 25 cells with reproductive brood are constructed therein. The main burrow of such nests may ramify into several additional burrows, possessing each one a group of cells (Fig. 230). A small part (4 to 7 %) of workers are fertilised. The female-foundress may remain alive for 12 to 14 months, while adult workers and replacement queens live for only about three weeks. In univoltine populations, where the species leads solitary mode of life, a female builds up to 16 cells in one nest. Overwintering occurs either in deepened summer nests, or in separately dug hibernation burrows, which may be located far away from the place of the emergence.

Cleptoparasites: *Sphecodes gibbus*, *S. monilicornis*, and possibly *S. rufithorax*.

References: BLACKMAN & STAGE, 1924; HICKS, 1926: 218-254; 1934: 265-271; ATWOOD, 1933: 450-451, 1934: 199-220; BOHART, 1949: 34-35; 1952: 116; MICHENER & WILLE, 1961; SAKAGAMI & MICHENER, 1962: 15-62; BONELLI, 1967: 85-96; 1972: 100; BATRA, 1968: 120-133; 1978: 547-549; KNERER, 1969b: 143-144; 1980: 512-534; MARIKOVSKAYA, 1972: 188-189; YANEGA, 1988: 4374-4377; 1989: 97-107; 1992: 231-237; PACKER & OWEN, 1989: 1049-1058; EICKWORT et al., 1996: 227-233; HOGENDOORN & LEYS, 1997: 347-352; POTTS & WILLMER, 1997: 319-328.



Figs. 229-231. Nests and pollen ball with egg of *Halictus rubicundus* (from KNERER, 1980: Fig. 17; MARIKOVSKAYA, 1972: Fig. 1; BOHART, 1952: p. 116).

Fig. 232. Occurrence of *Halictus rubicunduss* in Poland.

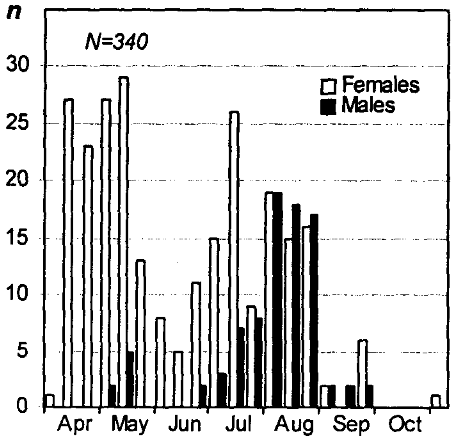


Fig. 233. Flight phenology of *Halictus rubicundus* in Poland.

Polish data. It is a common species occurring in the whole territory of Poland (Fig. 232). It inhabits different biotopes, but mainly open areas (xerothermic swards, slopes, roadsides); one third of specimens were caught in forest habitats. Females fly all the season long, since April till the beginning of November; males appear in May, in spring they are less numerous than in summer when they are numerous as well as females (Fig. 233). Recorded from flowers of 37 plant species belonging to many botanical families.

Halictus (Monilapis) compressus (WALCKENAER, 1802) (Figs. 203, 204, 209, 214, 216, 222, 235, 236).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Apis flavipes* PANZER, 1798, nec FUESSLIN, 1775, nec FABRICIUS, 1787; *Hylaeus tomentosus* HERRICH-SCHÄFFER, 1840; *H. senex* FÖRSTER, 1860; *Halictus eurygnathus* BLÜTHGEN, 1931; *H. eurygnathopsis* BLÜTHGEN, 1936; *H. veneticus* EBMER, 1969.

Comments on the name (a brief account from PESENKO, 1985: 79-80, 94). COCKERELL (1931a: 529) designated '*Hylaeus tomentosus* EVERSMANN, 1852' as type species of his new subgenus *Monilapis*. However, such a species does not exist. Really, EVERSMANN (1852: 37) only used the name *Hylaeus tomentosus* proposed by HERRICH-SCHÄFFER (1840a: 141; 1840b: 279) for replacement of the preoccupied name *Apis flavipes* PANZER, 1798 (same names established earlier independently by FUESSLIN, 1775, and FABRICIUS, 1787, for other species). Moreover, earlier for replacement of *Apis flavipes* PANZER, WALCKENAER (1802: 105) proposed the new name *Andrena compressa*.

The type of *A. flavipes* PANZER was lost long ago (PEETS, 1912: 50). While from the brief description and figure by PANZER, it can be only concluded that the species belongs to the subgenus *Monilapis* ('*H. tetrazonius* group') which includes over two dozen species. Therefore, for validation of the name *Monilapis* it was necessary to designate a neotype of *A. flavipes* PANZER. In the type locality of *A. flavipes* (Nürnberg), three species of *Monilapis* occur: *H. simplex* BLÜTHGEN, 1923, *H. eurygnathus* BLÜTHGEN, 1931, and *H. langobargicus* BLÜTHGEN, 1944. The description and figure by PANZER formally correspond to all three of them. When COCKERELL (1931a: 529) designated '*Hylaeus tomentosus* EVERSMANN, 1852' (= *H. quadricinctus* auct. nec FABRICIUS) as type species of his new subgenus *Monilapis*, he rather meant one of species with broadened mandibles of male. Such species, of the three ones above, are *H. langobargicus* and *H. eurygnathus*. The latter species is much more common than *H. langobargicus*. Therefore, as the neotype of *Apis flavipes* PANZER, 1798, the male of *H. eurygnathus* (from Regensburg, near the type locality) was designated by PESENKO (1985: 94). The designation was made for purpose of stabilisation of subgeneric and specific names. It meets all the requirements of the Code (Art. 75).

Taxonomy. The species shows the distinct geographical variation and can be easily divided into four subspecies (PESENKO, 1985: 94-95) indicated below. The European ssp. *compressus* differs from eastern subspecies in narrower bands at flagellomeres and narrower band of the metasomal tergum V of male. *H. compressus* is close to *H. langobardicus* BLÜTHGEN, 1944, which inhabits warm areas of Central Europe (distribution in details see: EBMER, 1988b: 562), but does not extend so far to the north and is absent in Poland. The latter species differs from *H. compressus* in the following characters: in female, the pubescence on the notum in fresh individuals darker and the punctation on the posterior area of the metasomal tergum I uniformly dense; in male, the proximal broadening of mandibles stronger, forming an angle of 110°, dorsomedial hair tassel of the gonostylus narrower and well differentiated.

Distribution. Common in semiarid areas of the Palaearctic region from the Atlantic to Baikal. Ssp. *compressus* occurs in south and Central Europe to Volga in the east, Caucasus and Asia Minor; ssp. *lunatus* WARNCKE inhabits north-eastern Turkey and north-western Iran; ssp. *transvolgensis* PESENKO occurs in steppes from Volga to Baikal; ssp. *gissaricus* PESENKO is represented by an isolated population in Tadzhikistan.

Ecology. Nesting in warm dry open areas. In European steppes, females fly since the end of April till late autumn, males appear mainly in the end of June. Polylege, preferring composites.

Bionomics. Phenological data suggest that the species is rather eusocial. However, BONELLI (1966) believes this species to be solitary and univoltine. It settles both on horizontal and vertical ground lots; in sandy soils small nest aggregations are created. The nest entrance, 5.0-5.5 mm in diameter, is located at concealed places in dense vegetation. The main burrow (Fig. 234) is vertical, 5-6 mm in diameter; it stretches downwards to a depth of 10-13 cm. The female first builds the whole of the depth of the main burrow, including the lower blind one, and only afterwards starts constructing cells. Cells are constructed along the main burrow progressively from down upwards (i.e. regressively). Each female prepares and provisions 3-4 to 10 brood cells arranged in a cluster. Cells are inclined down at an angle of 30° in relation to the main burrow. Cell necks immediately adjoin the main burrow. The pollen loaf has a form of a ball strongly flattened at its poles; its diameter is 6.0-6.5 mm, height 3.5-4.0 mm. After oviposition the female seals the cell with a cap. The offspring, males and females, emerges in August. Fertilised females overwinter out of their natal nests.

References: RUDOW, 1901: 385-429; BLAGOVESHCHENSKAYA, 1956: 61-62; BONELLI, 1966a: 66-75; POPOVA, 1985: 102-106.

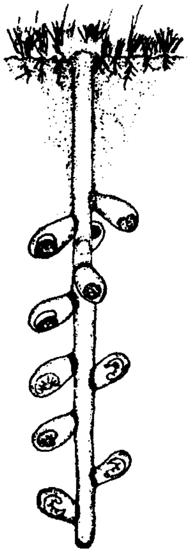


Fig. 234. Nest of *Halictus compressus* (from POPOVA, 1985: Fig. 37).

Fig. 235. Occurrence of *Halictus compressus* in Poland, based on examined males.

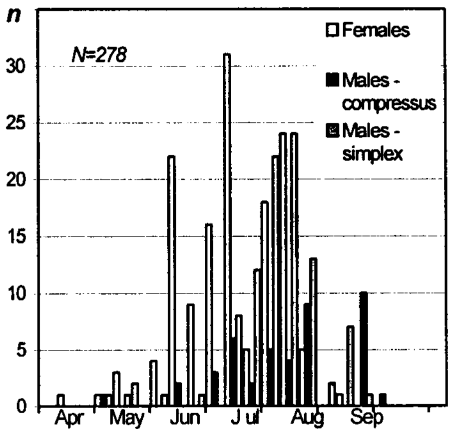


Fig. 236. Flight phenology of *Halictus compressus* and *H. simplex* in Poland. Data on females of the both species combined.

Polish data. An uncommon species collected only (males) in southern Poland (Fig. 235). Males fly since May till the beginning of October (Fig. 236). Recorded from flowers of Taraxacum officinale and Hieracium pilosella.

Halictus (Monilapis) simplex BLÜTHGEN, 1923 (Figs. 223, 237).

Synonymy: *Halictus ibex* WARNCKE, 1973; *H. marchali* sensu WARNCKE, 1982.

Taxonomy. The species occupies an isolated position within the subgenus. It shows distinct geographical variation in width of bands at male flagellomeres (Pesenko, 1985: 99). However, examined material till now is insufficient for establishing of subspecies.

Distribution. Western Palaearctic, from Spain to the Semipalatinsk province in eastern Kazakhstan. In Europe nearly throughout except for the north where it is sporadic, extending to northern Germany and central Poland.

Ecology. Biotopic preferences, phenology and trophic links similar to those of *H. compressus* (see above), but less data available.

Bionomics. Phenological data suggest that the species is rather eusocial. Only scarce data on the nesting of this species exist. Nests are established on horizontal ground lots. Over the nest entrance there is a short turret 1.5 cm high. The main burrow deepens into the ground at a moderate angle. The sessile cells located in the main burrow are only 2-3 cm distant from the ground surface. On concluding the construction of the nest, the female remains within the main burrow *and waits for the emergence of its brood.*

References: KNERER, 1980: 514; EBMER, 1988b: 558.

Fig. 237. Occurrence of *Halictus simplex* in Poland, based on collected males.

Polish data. Up to now recorded from southern, central and north-eastern Poland (Fig. 237). All examined specimens were caught in xerothermic sward covering dry slopes. Males fly in the same period as those of the previous species. Females of both species fly nearly all the season long, since Aprill till September. Caught from flowers of Campanula, Centaurea, Knautia, Mentha, Thymus.

Halictus (Tytthalictus) maculatus SMITH, 1848 (Figs. 199-202, 206, 219, 220, 238-241).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus interruptus* LEPELETIER, 1841, nec PANZER, 1798.

Taxonomy. The species has a high intrapopulation variation in size of the body and, allometrically, in relative size and thickness of the head. EBMER (1975a: 41) described a new subspecies, ssp. *priesneri*, for females from central Turkey and the Hermon Mt. in Israel, which have normal size of the body, but differ from the typical form in thinner head, slighter interrupted tomentose bands of the metasomal terga, punctation of the mesoscutum and tergum I. Later, the subspecies was found in western Iran, southern Armenia (EBMER, 1978b: 19), and north-eastern Afghanistan (EBMER, 1980: 473). PESENKO (1986b: 627) described male of this taxon and have found that in Transcaucasus (1) it is sympatric in relation to the typical form of *H. maculatus*; (2) there are no intermediate specimens between the typical form of *H. maculatus* and form *priesneri*. Therefore, the latter was considered as a separate species. However, EBMER (1988b: 557) recorded that in central Anatolia there is a wide hybridisation zone.

Distribution. Widespread in the west Palaearctic region from Spain to eastern Kazakhstan (PESENKO, 1986b: 626). In Europe nearly throughout. In moun-

Fig. 237. Occurrence of *Halictus simplex* in Poland, based on collected males.

Polish data. Up to now recorded from southern, central and north-eastern Poland (Fig. 237). All examined specimens were caught in xerothermic sward covering dry slopes. Males fly in the same period as those of the previous species. Females of both species fly nearly all the season long, since Aprill till September. Caught from flowers of Campanula, Centaurea, Knautia, Mentha, Thymus.

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Distribution. Widespread in the west Palaearctic region from Spain to eastern Kazakhstan (PESENKO, 1986b: 626). In Europe nearly throughout. In mountains of Central Asia, this species is replaced by the related H. palustris MORAWITZ, 1876.

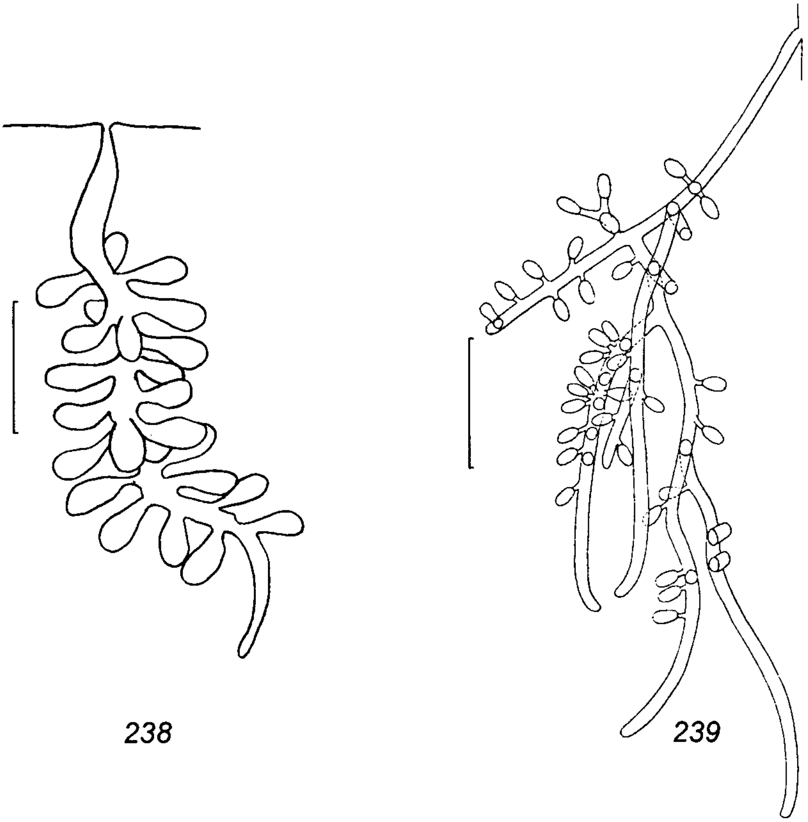
Ecology. Nesting in warm dry open areas. In European steppes, females fly since the end of April till October, males appear in the end of May. Wide polylege. Important pollinator of luzerne.

Bionomics. A primitively eusocial species. In spring, nests are usually established by solitary females, although cases were iteratively registered where nests were polygynously established by several jointly overwintered females, most probably sisters. Sometimes females partly exploit the old burrows of their maternal nest. Females either establish solitarily located nests, or form widely dissipated nest aggregations located both on plain ground and on the walls of ravines and precipices. On plain ground, the entrance is usually encircled by a small tumulus 4-6 cm in diameter. The entrance opening is narrow, 2-3 mm in diameter, which is barely more than the diameter of the head of a bee. This results in that the bees returning to the nest after foraging leave a part of pollen on the entrance walls. For the night the entrance opening is sealed with a plug of wet soil in such a manner that in case no tumulus is present the entrance opening gets absolutely undetectable on the ground surface. Sometimes the nest has a turret 6-7 mm high. At the entrance the vertical main burrow commences, making occasionally small elbow-shaped bends, after which it again drops vertically down, being concluded with a lower blind burrow. The spring monogynous nests have a depth of only 6-12 cm; 4-7 cells are constructed in them (Fig. 238). Polygynous nests are 15-22 cm deep, and usually contain 10-14 cells. The summer family nests are deeper (up to 25-35 cm); they typically branch into several additional burrows having the same diameter as the main one, and terminate with lower blind burrows (Fig. 239). In some instances the depth of spring nests reaches 25-30 cm, and after the emergence of workers they appear not to be additionally deepened. In the family nest there are 4 to 10 working individuals, which in their size fail to be significantly different from the queen, but have underdeveloped ovaries and usually do not copulate. In the summer nest a short initial stretch of the main burrow is considerably widened (to 4.5-5.5 mm), which permits two nestmates to freely pass each other, and later the burrow narrows down to 3.5-4.5 mm. The burrow walls are slightly smoothed but not lined.

Cells are of ovaloid form, their length is 10-11 mm, diameter in their broadest part 6 mm. They are built at all the sides along the main burrow and adjoin it with their necks narrowed to 2.5 mm. The long axis of a cell is usually more or less considerably inclined in relation to the ground surface, so that the neck of a cell is located higher than its back part. The total number of cells in a nest is up to 42. The cell walls are polished and lined; on their surface thin lengthwise strips remained after ramming are well visible. The provision stored in the cell has a form of a round ball 3.5 mm in diameter, very thick and quite dense. The female lays an egg on the top of the pollen ball. In summer there exists constant guarding of the family nest. Within one year two broods are reared in a nest: the first consists of workers, and the second of reproductive individuals (future foundresses). Rare males appear already in the first brood, where they constitute at the most 5%; their mass emergence occurs in the second brood, in August. The flight period of males seems to be very short. After copulation, young females hibernate in rounded chambers at the extremities of deep burrows occasionally reaching a depth of 40 cm. At the same place several females may overwinter, which in the future not rarely form a polygynous community. Cases of hibernation of males emerged in spring jointly with females are also recorded.

Cleptoparasites: *Sphecodes subovalis, S. divisus.*

References: VERHOEFF, 1891: 68-70, 1897: 393; TORKA, 1913; PERKINS, 1919: 160-161; FRIESE, 1923: 137-153; STÖCKHERT, 1923: 49-64, 217-234; NOLL, 1931: 336-338; GRANDI, 1954: 1961: 272; WU, 1960: 70-76; KNERER & PLATEAUX-QUÉNU, 1966a: 2014; 1966b: 1096-1097; 1967; BONELLI, 1965a: 33-48; 1972: 101-102; MARIKOVSKAYA, 1972: 188-192; GROZDANIĆ, 1973: 71-83; KNERER, 1969b: 141-147; 1980: 511-536.



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Figs. 238, 239. Nests of *Halictus maculatus* (from BONELLI, 1972: p. 101; WU, 1960: Fig. 4). Scale lines represent 5 cm.

Fig. 240. Occurrence of *Halictus maculatus* in Poland.

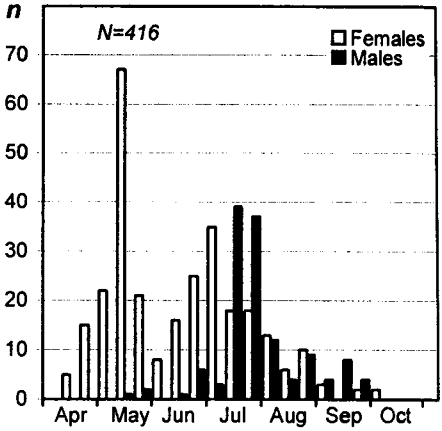


Fig. 241. Flight phenology of *Halictus maculatus* in Poland.

Polish data. A common species occurring in the whole territory of Poland (Fig. 240). Mostly inhabiting (90% of data) open and dry areas: xerothermic slopes, uncultivated areas, roadside etc. Females appear in the second decade of April and fly till the beginning of October; males start flying in the second decade of May, when they are not numerous, occur in greater numbers in July, and were observed till the end of September (Fig. 241). Recorded mainly from flowers of Asteraceae (Achillea millefolium, Anthemis sp., Bellis perennis, Carduus acanthoides, Centaurea jacea, Centaurea rhenana, Chryzanthemum leucanthemum, Cichorium intybus, Hieracium spp., Helichrysum arenarium, Matricaria inodora, Senecio jacobea, Tanacetum sp., Taraxacum officinalis), and several species belonging to other botanical families (Ballota nigra, Berteroa incana, Brassica napus, Campanula patula, Chelidonium maius, Convolvulus arvensis, Prunus spinosa, Salvia officinalis, Veronica chamaedrys).

Halictus (Hexataenites) sexcinctus (FABRICIUS, 1775) (Figs. 207, 213, 222, 242-245).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of subspecific name): *Apis ichneumonea* CHRIST, 1791; *Hylaeus arbustorum* PANZER, 1797; *Andrena rufipes* SPINOLA, 1806.

Taxonomy. Relatively morphologically constant species. Only in southwest Asia this species is represented by the separate ssp. *albohispidus* BLÜTHGEN, 1923, which differs from the typical form in the larger body, thicker head and more extensive pubescence of the metasoma. *H. sexcinctus* is close to *H. scabiosae* (ROSSI, 1790), which is Atlantic and widely western Mediterranean in occurrence, extends to warm areas of Central Europe (Belgium, Austria), but does not penetrate far to the north and is absent in Poland. The latter differs from *H. sexcinctus* in the following features: bands of metasomal terga ochre-yellow, tergum III with a broad anterior tomentose band, head of females distinctly wider than mesosoma, flagellum of male shorter and thicker, black at upper side and yellowish brown to brown at lower side, middle basitarsus of males at posterior margin with shorter hairs inclined downward.

Distribution. Widespread in Europe to Ural. In Transcaucasus, Turkey, Iran and Israel the species is represented by ssp. *albohispidus*.

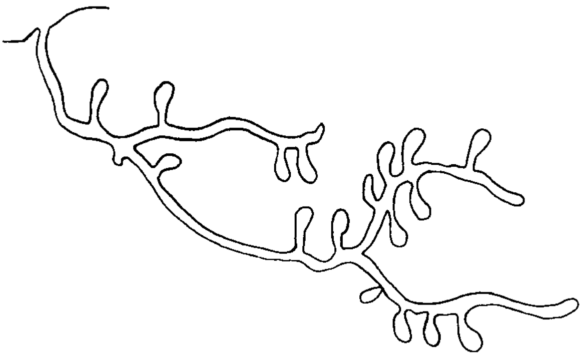
Ecology. In Central Europe, the species has one generation per year; both sexes fly from the end of May till October. Polylege, preferring composites with big flowers.

Bionomics. A solitary, possibly subsocial, species. BONELLI's (1965c) indication as to the existence of eusociality in *H. sexcinctus* contradicts the data of other authors, in particular those of VERHOEFF (1891), STÖCKHERT (1923) and KNERER (1980), who have established for this species solitary monovoltine mode of life. EICKWORT (1985: 135), considering the differences in the phenology and nest structure described, supposes that at least BONELLI and KNERER worked with different species. Females of *H. sexcinctus* prefer to build nests in steep sandy slopes, where they create large aggregations; as well, nests in clayey soil are registered. The entrance openings located in vertical cliffs have no tumulus. MALYSHEV (1936) has described the eccentric and bilateral tumulus made on flat ground. It is produced due to that the bee excavates the upper part of its main burrow obliquely. In vertical cliffs the main burrow, 9-10 mm in diameter, is hard curved; initially it goes almost horizontally into the slope, and then bends down at a right angle. In clayey soil the main burrow is less frequently bent. By LEGEWIE's (1925a) information, in sandy soil females fasten the burrow walls with a secretory substance. Short laterals branch from the main burrow; their length is 5 to 18 mm, diameter 5-7 mm; every one leads to a single cell (Fig. 242).

Cells are either horizontally oriented, or slightly inclined downwards; their length is 20 mm, diameter in their broadest part 10 mm. In the upper part of a burrow VERHOEFF (1897) observed a short blind branch, which opened at the side of the burrow opposite to the brood cells. In this branch he found the mother bee. Distinctly from sandy soils, in the clay substratum the cells are more densely concentrated (Fig. 243). As well as in *H. quadricinctus*, one female of *H. sexcinctus* can work synchronously over several cells. Having completed the cell preparation and laid eggs, the mother immures itself within the nest, and waits for the emergence of its offspring. After copulation, young females hibernate inside their maternal nests. In spring one of such females may re-use the main burrow of its maternal nest.

Cleptoparasite: *Sphecodes gibbus*.

References: FRIESE, 1891; 1923: 138-159; VERHOEFF, 1892: 711-712; 1897: 387-391; STÖCKHERT, 1923: 216-217; LEGEWIE, 1925a: 621-656; BISCHOFF, 1927: 223-224; MALYSHEV, 936; GROZDANIĆ, 1950: 171-175; BLAGOVESHCHENSKAYA, 1956: 59-64; BONELLI, 1965c: 97-122; 972: 103-104; KNERER, 1980: 511-534.



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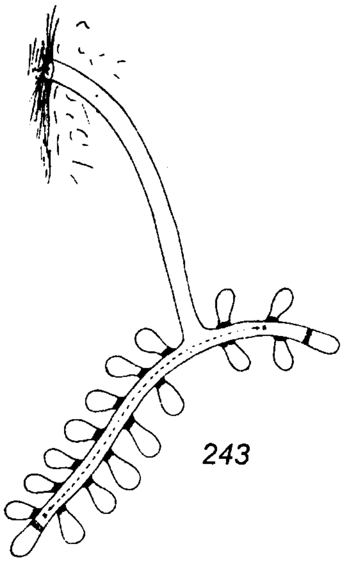

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Figs. 242, 243. Nests of *Halictus sexcinctus* (from KNERER, 1980: Fig. 21; GROZDANIĆ, 1950: Fig. 1).

Fig. 244. Occurrence of *Halictus sexcinctus* in Poland.

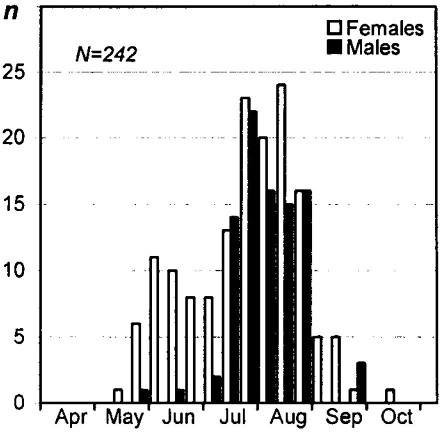

Fig. 245. Flight phenology of *Halictus sexcinctus* in Poland.

Polish data. A common species recorded from the whole territory of Poland (except for high mountains; Fig. 244). It occurs in both open areas and forests. Not showing a certain biotopic preference. Both sexes fly from the second half of May till October (Fig. 245). Collected mainly from flowers of Asteraceae (Carlina vulgaris, Centaurea jacea, C. rhenana, C. scabiosa, Cirsium sp., Echium vulgare, Hieracium spp., Hypochoeris radicata, Tanacetum vulgare, Taraxacum officinale), and sometimes other botanical families (Jasione montana, Knautia sp., Polygonum bistorta, Scabiosa columbaria, S. ochroleuca, Stachys sp., Thymus serpyllum, Trifolium arvense).

9. Genus *Seladonia* ROBERTSON, 1918

This is the most widespread genus of the subtribe Halictina. Species of *Seladonia* inhabit North and South America, Africa and Eurasia. About 100 species of this genus are described till the present time, 43 species of them inhabit the Palaearctic region (EMBER, 1988a). From *Vestitohalictus*, another Palaearctic genus with green coloration of the body, *Seladonia* differs in the poorer tomentose pubescence, simple pubescence of metasomal terga IV and V of males and structure of male genitalia. Most authors in accordance with MICHENER, (1978b: 527), consider genera *Seladonia* and *Vestitohalictus* as subgenera of the genus *Halictus* s. l. These three genera (also *Halictus* s. str.) are really more related with each other than with any other genera of the subtribe Halictina. Nevertheless, they are enough large and well morphologically isolated. Therefore, we consider *Seladonia*, as well as *Vestitohalictus* and *Halictus* s. str., as separate genera. Subgeneric classification of the genus *Seladonia* is yet not elaborated. EBMER (1988a) divided Palaearctic species of *Seladonia* into seven groups.

Females of *Seladonia* build branched nests in the soil, preferring open, warm and dry biotopes. Almost all 13 behaviourally known species of *Seladonia* are eusocial (RADCHENKO & PESENKO, 1994), possibly except for the Nearctic *S. virgatellus* (see: PACKER et al., 1989: 2876). All species are polyleges.

Of twelve European species of the genus *Seladonia*, nine species inhabit Poland. These species can be divided into five clear groups on the basis of good diagnostic characters of females: (1) the *kessleri* group (one species; head cubical); (2) the *leucahenea* group (one species; vertex strongly extended, flattened and laterally emarginate); (3) the *seladonia* group (includes also *S. subaurata*; scutum dull, very densely punctate; (4) the *smaragdula* group (includes also *S. semitecta*; small, legs with extensive yellow markings; (5) the *tumulorum* group (includes also *S. confusa* and *S. gavarnica*; not sharing any characters above). The grouping based on good diagnostic characters of males is different: (a) antenna short, metasomal sternum VI flattened (female groups 1 and 3 and also *S. smaragdula*); (b) antenna long, sternum VI with a deep median depression behind tergal gradulus (female groups 2 and 5); (c) antenna long, but sternum VI flattened (*S. semitecta*).

Taxonomy: BLÜTHGEN, 1920: 104-106, 129-131; 1921a: 288-289, 291-301; 1924c: 473-477, 535-538; 1926a: 675-687; 1929a: 77-86; 1933a: 72-80; 1935a: 111-113; 1955: 16-18; PERKINS, 1922a: 24-26; 1922b: 99-100; GAUNITZ, 1931: 224-226; RICHARDS, 1935: 170; MICHENER, 1978b: 527-529; MITCHELL, 1960: 333-334; EBMER, 1969: 152-156, 168-173; 1972b: 225-226; 1974b: 191-192; 1976c: 219-225; 1978a: 189, 190; 1979: 121-130; 1980: 481-482, 498-500; 1982: 201-205; 1984b: 316-318; 1985a: 201-203; 1987b: 77-78; 1988a: 323-375; 1988b: 565-573; 1996b: 269-271; WARNCKE, 1973b: 283-284; 1975a: 104-106; 1982a: 133-137; 1984: 305-309; DAY, 1979: 75; SAKAGAMI & EBMER, 1979: 543; PAULY & RASSEL, 1982: 137-146.

KEY TO THE POLISH SUBGENERA AND SPECIES OF SELADONIA[1]

1. *Both sexes*: head thick, nearly cubical in female, genal area in male 1.5 times as wide as eye in lateral view; vertex extending far upward from ocelli in frontal view, thick, convex; mesoscutum extending forward, with median emargination anteriorly; dorsal surface of propodeum very inclined, forming with posterior vertical surface of propodeum an angle of 165°. *Female*: clypeus with a great transverse depression before lower margin; head broader than mesosoma. *Male*: mandibles black; antenna short, reaching only the scutellum; flagellum light brown at lower side; pubescence of metasomal sterna short and sparse, nearly inconspicuous; sterna V and VI flattened; posterior margin of sternum V straight; medial lobe of main gonostylar body with many dense and relatively long hairs on distal part; ventral process of gonostylus cigar-shaped. Length 6-7.5 mm .... ***S. kessleri***

– *Both sexes*: head flattened, genal area as wide as eye in lateral view or narrower, vertex short or flattened; mesoscutum not extending forward, with straight anterior margin (except for *S. leucahenea*); dorsal surface of propodeum less inclined, forming with posterior vertical surface of propodeum an angle of 145° or even less. *Female*: clypeus without depression. *Male*: mandibles partly yellow; medial lobe of main gonostylar body hairless distally or with several short hairs; ventral process of gonostylus of other form; antenna and sterna variable. 2

2. *Both sexes*: vertex high, greatly flattened, almost sharp at posterior margin Fig. 246), slightly emarginate laterally (in male often almost imperceptibly); in frontal view of head, distance between posterior margin of vertex and lateral ocelli nearly twice wider than distance between lateral and medial ocelli; mesoscutum extending forward, with a median emargination anteriorly (Fig. 246). *Male*: antenna very long, reaching the metasoma (Fig. 250); flagellum yellow at lower side; metasomal sterna II and III with white tomentose posterior bands triangularly broadened forward medially; sternum V slightly emarginate posteriorly; sternum VI with a deep triangular depression behind sternal gradulus; medial lobe of main gonostylar body large and greatly triangularly broadened distally (Fig. 254) .... ***S. leucahenea***

– *Both sexes*: vertex short, broadly rounded at posterior margin, without lateral emargination; in frontal view of head, lateral ocelli lying immediately under upper margin of vertex or separated from the latter by a space as wide as space between lateral and median ocelli; mesoscutum not extending forward, straight at anterior margin. *Male*: sterna II and III poorly pubescent, without tomentum; medial lobe of main gonostylar body shorter, narrowed, not broadened distally; antenna and sterna V and VI variable 3

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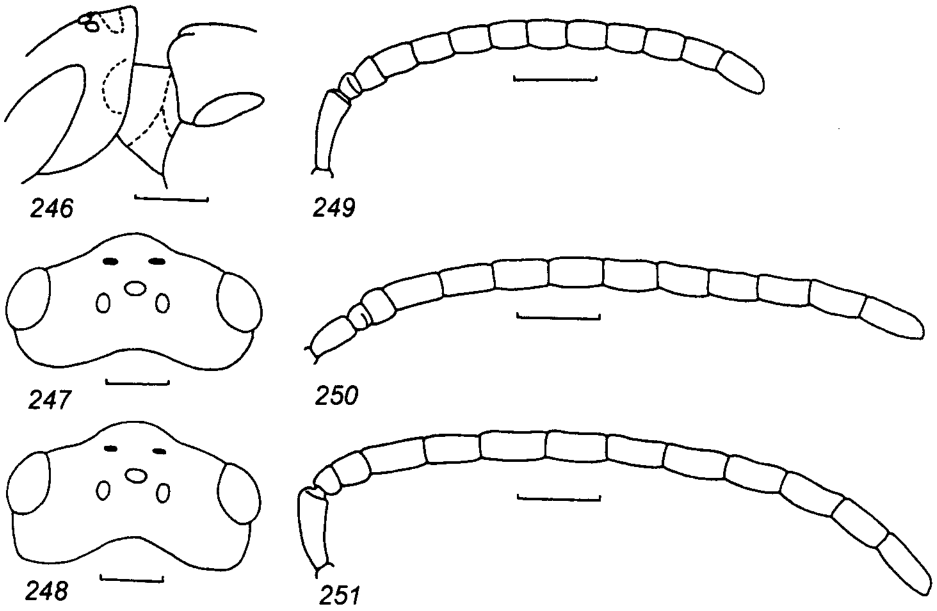
[1] The male gonostylus in *Seladonia* consists of (1) the *main body* divided by a deep cleft into the *lateral* (bigger) and *medial* (smaller) *lobes*; (2) the *ventral process*.



Figs. 246-251. Head of females and antenna of males in *Seladonia*.
246, 250. S. leucahenea (*246*, lateral view of the head with anterior part of the mesosoma, from EBMER, 1969: Fig. 17b). *247. S. confusa* (*247*, dorsal view of the head). *248, 251. S. tumulorum* (*248*, dorsal view of the head. *249. S. subaurata*. Scale lines represent 0.5 mm.

3\. *Both sexes*: propodeum shorter; its dorsal surface 0.7-0.8 times as long as scutellum. *Male*: antenna relatively short (except for *S. semitecta*), at most reaching the metapostnotum; 2nd flagellomere 1.2-1.4 times as long as wide (Fig. 249); all femora, except for their yellow distal end, brownish black with a slight green metallic tint; metasomal sternum VI flattened or with a slight longitudinal median depression 4

\- *Both sexes*: propodeum longer; its dorsal surface 0.9-1.0 times as long as scutellum. *Male*: antenna long, reaching the metasoma; 2nd flagellomere 1.7- 2 times as long as wide (Fig. 251); femora usually rusty yellow throughout or on most their surface; sternum VI with a deep triangular depression behind sternal gradulus. (Three related species in which males can be certainly identified only by the structure of genitalia) 7

4\. *Both sexes*: larger: 6.5-8 mm. *Female*: mesoscutum dull, very densely punctate, without distinct interspaces between punctures; pubescence of vertex and notum dense, plumose, bright, ochre-yellow to rusty-yellow; metasomal terga very finely and densely punctate (15 µm / 0.1-0.3 on disc of tergum I); all tibiae, middle and hind basitarsi brown, only their distal ends yellow; coloration of integument brighter, yellowish green 5

– *Both sexes*: smaller: 5.5-6 mm. *Female*: mesoscutum shiny or silk-shiny, sparser punctate (0.2-0.4 or more), with distinct interspaces; pubescence of vertex and notum sparse, less plumose, whitish; terga twice or more sparsely punctate; tibiae and metatarsi of all legs yellow, with brown spots; coloration of integument less bright, greyish-green 6

5. *Both sexes*: head shorter, with an almost not extending clypeus, transversely elliptic in frontal view in female (its height/width ratio 0.82-0.84), nearly round in male (ratio 0.95). *Female*: propodeum on areas adjoining to metapostnotum dull, very densely punctate and coarsely roughened at interspaces; metasomal terga II and III with broad anterior tomentose bands; tergum I on convex part, tergum IV throughout covered with a tomentum. *Male*: clypeus black or with a narrow yellow band along its lower margin; supraclypeal area nearly flat; posterior areas of metasomal terga not sharply separated from tergal discs; punctation of terga sparser (0.2-1.5 at disc of tergum I); main body and ventral process of gonostylus broad, medial lobe of main gonostylar body with a proximal bunch of hairs at base .... ***S. seladonia***

– *Both sexes*: head relatively higher, with normally extended clypeus, roundly triangular in frontal view, its height/width ratio 0.9-0.95 in female and 1.0 in male. *Female*: metapostnotum along lateral margins surrounded by a shiny or silk-shiny, sparsely punctate and finely roughened stripe; tergum II with a narrow anterior band, terga III and IV usually without anterior bands; tergum I on convex part with lateral tomentose spots. *Male*: clypeus with a broad yellow band; supraclypeal area convex; posterior areas of terga sharply separated from tergal discs; punctation of terga denser (0.1-0.5 at disc of tergum I); main body and ventral process of gonostylus narrowed, medial lobe of main gonostylar body without bunch of hairs (Fig. 252) .... ***S. subaurata***

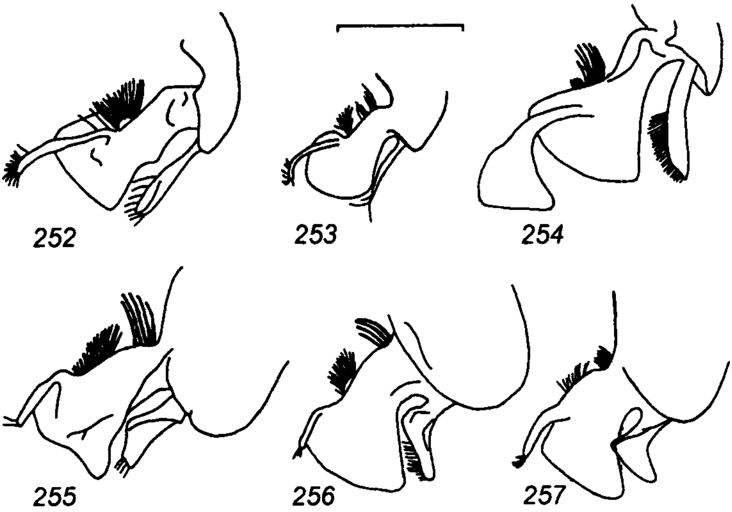
6. *Both sexes*: punctation of mesoscutum finer (15-20 µm). *Female*: clypeus weakly extending and so head slightly shorter than wide; mesoscutum silk-shiny, densely punctate (0.1-0.4); metasomal tergum IV between anterior and posterior bands usually without tomentose pubescence. *Male*: antenna relatively short, reaching the metanotum; 2nd flagellomere 1.3 times as long as wide; metasomal sternum VI flattened; main body of gonostylus nearly straight; ventral process of gonostylus thicker, rounded or truncate distally .... ***S. smaragdula***

– *Both sexes*: punctation of mesoscutum twice as coarse. *Female*: clypeus normally extending, head as high as wide; mesoscutum shiny, twice as sparse punctate; tergum IV covered with tomentose pubescence throughout. *Male*: antenna long, reaching the metasoma; 2nd flagellomere 1.8 times as long as wide; sternum VI weakly concave in middle; main body of gonostylus with a deep rectangular emargination distally; ventral process of gonostylus slender, sharply pointed (Fig. 253) .... ***S. semitecta***

7. Female 8

– Male 10

8. Genal areas convergent backward, in dorsal view of head (Fig. 247); metasomal terga brownish, with a green metallic tint; tergum I on convex part usually with large lateral spots of tomentose pubescence; tergum IV with a broad posterior tomentose band occupying all tergal posterior area and usually triangularly broadened forward medially .... ***S. confusa***



Figs. 252-257. Gonostylus (right, posterodorsal view) of males in *Seladonia*. *252. S. subaurata. 253. S. semitecta* (from EBMER, 1988a: Fig. 63). *254. S. leucahenea. 255. S. tumulorum. 256. S. confusa. 257. S. gavarnica* (from EBMER, 1988a: Fig. 73). Scale line represents 0.2 mm.

- Genal areas almost not convergent backward, nearly parallel-sided, in dorsal view of head (Fig. 248). Discs of terga distinctly green to bluish green; tergum I on convex part without tomentum; posterior band of tergum IV narrower 9

9. Head slightly shorter than wide; frons dull, finer and denser punctate (15-20 µm / 0.1-0.2); metapostnotum coarser and denser rugulose, dull; metasomal terga denser punctate (0.1-0.5 at disc of tergum I) .... ***S. tumulorum***

- Head slightly higher than wide; frons silk-shiny, 1.5 times coarser and sparser punctate; metapostnotum obscurely and sparsely rugulose, silky; terga sparser punctate (0.3-1.5 at disc of tergum I) .... ***S. gavarnica***

10. Main body of gonostylus roundly emarginate distally; ventral stylar lobe moderately and roundly broadened at distal half (Fig. 255) .... ***S. tumulorum***

- Main body of gonostylus straight distally; ventral process of gonostylus greatly triangularly broadened at distal half 11

11. In posterodorsal view of genitalia, ventral process of gonostylus directed posterolaterad and turned in profile, so not hiding the main gonostylar body in outer side (Fig. 256) .... ***S. confusa***

– In posterodorsal view of genitalia, ventral process of gonostylus directed backward and lying in same plane with main gonostylar body, so a little hiding the latter in outer side (Fig. 257) .... ***S. gavarnica***

***Seladonia seladonia** (FABRICIUS, 1794).

Synonymy: *Halictus geminatus* PÉREZ, 1903.

Distribution. Steppous western Palaearctic, occurring to Tien Shan and Altai (Teletskoye lake, new materials in the collection of the Zoological Institute in St. Petersburg) in the east, in Europe to southern Switzerland and Austria in the north. Probably it will be found in south-eastern Poland.

Ecology. Polylectic. Females fly since mid-May till late August; males appear in the second half of summer.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Seladonia subaurata (ROSSI, 1792) (Figs. 249, 250, 258-261).

The species is represented in Poland by the nominotypical subspecies.

Synonymy: *Halictus virescens* LEPELETIER, 1841; *H. gramineus* SMITH, 1849; *H. meridionalis* MORAWITZ, 1874; *H. subauratus* ssp. *syrius* BLÜTHGEN, 1933.

Taxonomy. Relatively morphologically constant throughout its wide geographical range. Only the populations inhabiting Corsica and Sardinia (ssp. *corsa* BLÜTHGEN, 1933) differ in narrower tergal bands and more bronze coloration of terga.

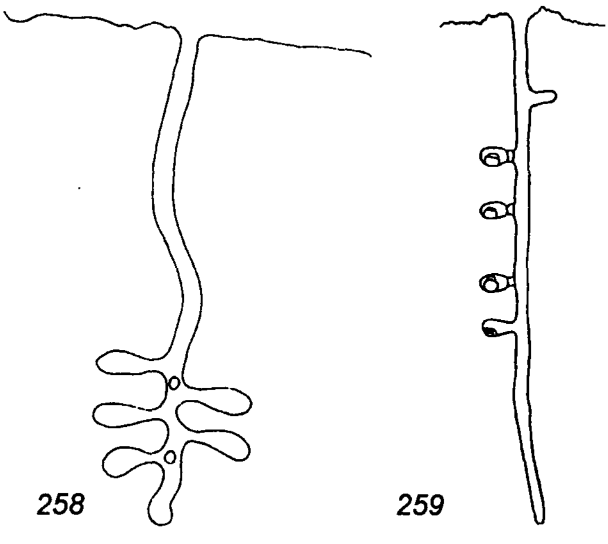
Distribution. Transpalaearctic in occurrence, mostly inhabiting zones of deciduous forests and steppes.

Ecology. Polylege, preferring composites like Tanacetum, Achillea etc. In Central Europe, females fly since May till October, males appear in the second half of summer.

Bionomics. A primitively eusocial species; it creates immense nest aggregations on slopes with sandy soil. Sometimes such aggregations exist for scores of years. As well lonely located nests may be established in clayey soil on places well warmed by sun and having rare vegetation. Nests are established by solitary females. Around the nest entrance (3 mm in diameter) the foundress constructs a small cone-like tumulus. For the night, bees close the entrance with loose soil. The main burrow, 4 mm in diameter, is usually more or less vertical, and has sessile cells; it stretches downwards to a depth of 8-14 cm, and terminates with a lower blind burrow. In separate nests at a depth of 1.5-2.0 cm construction of a lateral blind burrow 7-10 mm long and 4 mm in diameter was registered. Several varieties of the arrangement of cells in the nests of this species are known. Thus, cells may be located at one side of the main burrow (Fig. 258), at two opposite sides (Fig. 259), or at different sides, in which case they are grouped into a cluster. Usually the cells are constructed progressively downwards along the main burrow.

Cells are 8 mm long and 5 mm in diameter. The food has the form of a dry round pollen ball 3.6-3.8 mm in diameter. The cell neck is sealed with a cap comprised of soil lumps laid out in concentric circles. Knerer & Schwarz (1976) have discovered that in moist sandy soils the species makes chambers encircling cell clusters. Such a chamber probably serves for moisture control. A solitary female-foundress constructs 4-8 cells; then it closes the nest entrance and waits for the emergence of its daughters. The preimaginal development runs fast. Thus, the egg phase lasts for 3 days, and the larval feeding for 14-15 days. In the first brood workers and a small number of males are reared. After their emergence the workers deepen the main burrow to 15-20 cm, and build at this depth cells for the reproductive brood. During the workers life period there exists constant protection of the nest. Young females copulate and later overwinter out of their nests.

References: Bonelli, 1966b: 76-98; 1972: 100, 104-107; Marikovskaya, 1972: 188-190; Khalilov, 1973: 1731; Knerer & Schwarz, 1976: 445-448; Knerer, 1968: 96; 1980: 514-531.



Figs. 258, 259. Nests of *Seladonia subaurata*
(from Radchenko, unpublished; Bonelli, 1966b: Fig. 2).

Fig. 260. Occurrence of *Seladonia subaurata* in Poland.

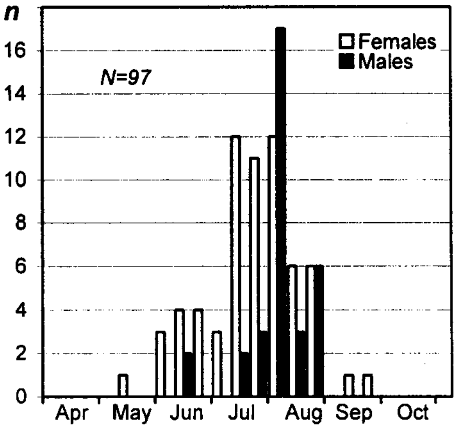


Fig. 261. Flight phenology of *Seladonia subaurata* in Poland.

Polish data. An uncommon species occurring in southern and central Poland (Fig. 260). All specimens (with labels containing habitat data) were caught in open, dry habitats such as xerothermic swards, roadsides, walls of loess ravines. Females fly since the second half of May till the end of September; males appear in the second decade of June (Fig. 261). Recorded from flowers of 18 plant species belonging to different botanical families: Allium odorum, Anthemis rigescens, A. tinctoria, Centaurea jacea, C. rhenana, Chrysanthemum leucanthemum, Helenium hybridum, Leontodon autumnalis, Lotus corniculatus, Matricaria sp., Medicago media, Ranunculus sp, Scrophularia nodosa, Stachys recta, Symphytum officinale, Tanacetum vulgare, Thymus sp., Trifolium pratense.

Seladonia smaragdula (VACHAL, 1895).

Synonymy: *Halictus barcelonicus* PÉREZ, 1903; *H. smaragdulus* f. *lupinus* BLÜTHGEN, 1923; *H. morinellus* WARNCKE, 1975; *H. buteus* WARNCKE, 1975.

Taxonomy. This species shows a high intrapopulation morphological variation, especially in the form of the head of both sexes and the male gonostylus.

Distribution. Western Palaearctic, mostly inhabiting steppes, in Europe penetrating to south-eastern Austria and Halle in Germany in the north. Probably it will be found in south-eastern Poland.

Ecology. In Central Europe, female fly all summer long, males appear in late July.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Seladonia semitecta (MORAWITZ, 1874) (Figs. 253, 262).

Taxonomy. Relatively morphologically constant throughout its extensive geographical range.

Distribution. Rare species dispersally occurring in the zones of deciduous forests and steppes of Eurasia. In Europe, it is recorded from Germany as the westernmost locality.

Ecology. Polylege. Females fly all summer long, males appear in the second half of summer.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Fig. 262. Occurrence of *Seladonia semitecta* in Poland.

Polish data. This rare species was recorded by ALFKEN (1912: 34) and BLÜTHGEN (1919a: 84; 1921a: 288) from some formerly German territories in present time mostly placed in Poland: 'Westpreußen: Kulm, Gollubien im Kreise Karthaus' [Pomerania: Chełmno, Gołubie near Kartuzy]; 'Schlesien: Öls' [Silesia: Oleśnica].

Material examined: 'Stettin' [Szczecin], 18.VII. 1920, leg. SCHROEDER, 1 ♀ [WAR] (Fig. 262).

Seladonia kessleri (BRAMSON, 1879) (Fig. 263).

The species can be represented in Poland by the nominotypical subspecies.

Synonymy: *Osmia pannonica* ZILAHI-KISS, 1915; *Halictus kessleri* ssp. *nebulosus* WARNCKE, 1975.

Taxonomy. It can be easily distinguished from two close, southern European species, *S. cephalica* (MORAWITZ, 1874) and *S. gemmea* (DOURS, 1872), in the transverse groove before the lower margin of the clypeus in females.

Distribution. Widespread in steppes of Europe and Asia Minor, in Europe occurring to Austria in the north. Probably it will be found in south-eastern Poland.

Ecology. Polylege, preferring composites like Tanacetum, Achillea etc. In Central Europe, females fly since mid-April till mid-September, males appear in August.

Bionomics. A primitively eusocial species. It forms small nest aggregations on open ground slots with dense soil. Nests are typically established by solitary female-foundresses, although cases of polygynous nest foundation by two or three sisters are recorded. The social phase lasts for two or three summer months. Workers emerge in June, in some nests only in July. There are usually 4-5 working individuals in one nest. In the case of polygynous foundation of a nest up to 9-12 workers live therein. The body size of workers varies considerably, but on the average they are smaller than their mother. There exists constant nest protection. In the flight period of workers there is a small, 4-5 mm high, turret in front of the nest entrance. The inner walls of the burrow passing through the turret are cemented. If such a turret is broken, bees do not restore it. The nest entrance is narrowed to 3 mm. The main burrow of the foundress nest goes vertically downwards to a depth of 8-12 cm, its diameter is 4-5 mm. After their emergence, workers deepen the nest to 15-20 cm, occasionally to 30 cm. In social nests the main burrow may bifurcate.

The cells of sessile type are arranged in groups in such a manner that the nest has a cluster structure (Fig. 263). Cells are of ovaloid form. Their length for workers amounts to 6-7 mm, for future foundresses 8-10 mm, although in some instances future female-foundresses emerged from smaller cells, 7 mm long. The diameter of cells is 3.3-3.5 mm. Their inner walls are smoothed and polished. The cells are arranged close to the main burrow in groups of 6-7. In total 27 to 40 cells are constructed in a summer nest. The most cells are horizontally oriented, but some of them are built inclined. The food has a form of pollen ball flattened at its poles. After oviposition the female seals the cell with a cap. After the emergence of the offspring, young males fly around the nest aggregation in search for young females. After copulation the latter ones hide for hibernation. Usually they overwinter in their maternal nest. Some of them construct by themselves a small burrow several centimetres long, at whose extremity there is a little amplification in a form of ovaloid cell, however without smoothed walls. In such a construction females hibernate. At the same time, joint hibernation of females is recorded. In one case, 85 females jointly overintered in one burrow; as well, there were in the same burrow 7 males, two of them ready dead.

References: GROZDANIĆ, 1966: 11-13; 1971: 52-54; 1973a: 41-54.

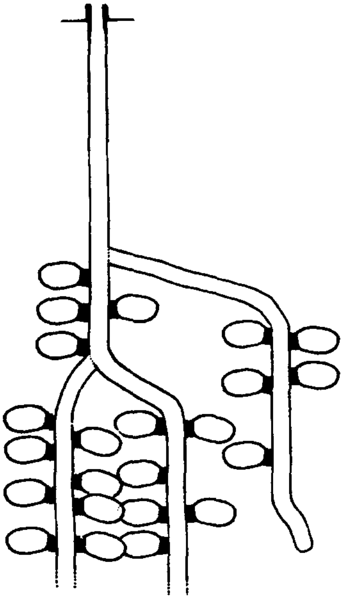


Fig. 263. Nest of *Seladonia kessleri* (RADCHENKO, unpublished).

Seladonia leucahenea (EBMER, 1972) (Figs. 246, 250, 254, 264, 265).

The species is represented in Poland by ssp. *arenosa* (EBMER, 1976).

Synonymy (of the subspecific name): *Halictus fasciatus* auctorum, nec NYLANDER, 1848, partim.

Taxonomy. The species can be well distinguished from other species of Seladonia in the shape of the vertex in both sexes and the form of the median lobe of the male gonostylus. It shows a distinct geographical variation in the shape of the head, and punctation of the body and is subdivided into a number of subspecies: the European *arenosa*, eastern Palaearctic *leucahenea* (EBMER, 1972) and *occipitalis* (EBMER, 1972) recorded from Armenia and north-eastern Turkey.

Distribution. The species is widely transpalaearctic in occurrence. The subspecies *arenosa* inhabits the temperate zone of Europe.

Ecology. Polylege, preferring composites. In Central Europe, females fly since mid-April till late September, males appear in mid-summer.

Bionomics. The level of its social development remains yet unknown, although phenological data suggest that the species is rather eusocial. Females create nest aggregations. Thus, this species was presented in the largest bee aggregation known, discovered by BLAGOVESCHENSKAYA (1963). By her estimation, in this aggregation having an area of 360 thousand m^2 there were 4.68 millions of nests of *S. leucahenea* and *Lasioglossum laevigatum*. A description of the nest of *S. leucahenea* (named as *Halictus fasciatus*) is to be found in WU's Ph.D. dissertation (1960). Around the nest entrance there is a high tumulus, whose height is 2.8 cm, diameter 7 mm. The entrance opening 4 mm in diameter is located on its top. Below the entrance opening the main burrow first gently slopes underground at a stretch of 5 cm, and then drops vertically to a depth of 16 cm, where it terminates with a lower blind burrow (Fig. 264). The diameter of the main burrow amounts to 4 mm. Starting at a depth of 6.8 cm, and down to 10 cm, 6 sessile cells are located at different sides of the main burrow. The cells are arranged progressively downwards - whereas the upper ones contain adult larvae and pupae, in the lower there are only young larvae or pollen balls being only under formation. The cells are ovaloid, 7 mm long, 5 mm in diameter; their walls are polished. The cell necks are narrowed down to a diameter of 2 mm. The pollen ball is round. Other data on the bionomics of the species are unavailable.

References: WU, 1960: 216-217; BLAGOVESCHENSKAYA, 1963: 115.

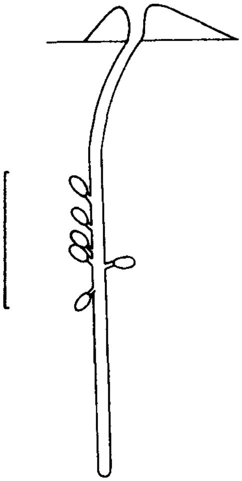


Fig. 264. Nest of *Seladonia leucahenea* (from WU, 1960: Fig. 34). Scale lines represent 5 cm.

Fig. 265. Occurrence of *Seladonia leucahenea* in Poland.

Polish data. It is an uncommon species, which does not show a certain geographical pattern in its occurrence in Poland, but not foung in highlands (Fig. 265). Mostly inhabiting dry meadows, xerothermic sward, also observed in forests. Females fly from first decade of May to third decade of September. Males are observed from August to second decade of September. Collected mainly from flowers of Asteraceae (Achillea millefolium, Helichrysum arenarium, Cirsium arvense, Leontodon autumnalis, Picris hieracioides, Taraxacum officinale), also Brassicaceae (Berteroa incana, Brassica napus, Coriandrum sativum), Geraniaceae (Geranium palustre), Fabaceae (Lotus corniculatus, Trifolium repens), and Scrophulariaceae (Veronica spicata).

Seladonia tumulorum (LINNAEUS, 1758) (Figs. 248, 251, 255, 266-269).

The species is represented in Poland by the nominotypical subspecies.

Synonymy: *Apis flavipes* FABRICIUS, 1787, nec FUESSLIN, 1775; *Halictus fasciatus* NYLANDER, 1848 (nec auctorum); *H. tumulorum* var. *deviridatus* STRAND, 1910; *H. ferripennis* COCKERELL, 1929.

Taxonomy. Relatively constant throughout almost all its extensive geographical range. Only the southern (ssp. *kirnos* EBMER, 1988 in Corsica and spp. *oros* EBMER, 1988 in Greece) and eastern populations (ssp. *higashi* SAKAGAMI et EBMER, 1979 in the Far East of the Palaearctic region) differ from the typical form in the shape of the head, punctation of the body and width of tergal bands.

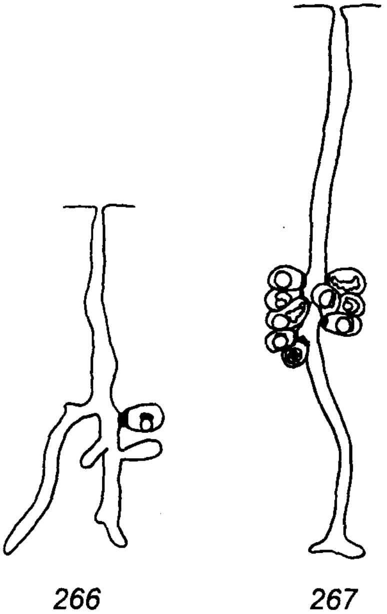
Distribution. Widespread throughout almost all zones of the Palaearctic region. The nominotypical subspecies inhabits temperate zones of the western Palaearctic region.

Ecology. Wide polylege. In Central Europe, females fly since April till late October, males appear in mid-summer.

Bionomics. A primitively eusocial species. Earlier indications of solitary mode of life of this species (e.g. SAKAGAMI & FUKUSHIMA, 1961) included into a well-known book of MICHENER (1974: 299) have proved to be erroneous. Nests are located on horizontal ground lots. The entrance opening, 2-4 mm in diameter, is placed virtually in the centre of a tumulus having a diameter of 7 mm. The main burrow is usually vertical, sometimes it initially deepens obliquely into the earth, and then straightens. Its length is 7-16 cm, diameter 3-5 mm. The blind burrow is usually simple, but occasionally ramifies (Fig. 266). In some nests a horizontal shaft (a blind burrow) branching from the lower end of the vertical main burrow is registered (Fig. 267). In a spring nest its foundress builds 6-9 cells. The cells of sessile type closely adjoin the main entrance. They have ovaloid form, a length of 7 mm, and a diameter of 5 mm. The orientation of cells is usually horizontal, but often they are slightly inclined downwards. The walls of cells are polished, while those of the burrow only slightly smoothed. The female works synchronously in several cells. The workers emerged in the first brood only slightly differ in their size from the female-foundress. As well, in the first brood a considerable number of males (approximately 30% of the first brood totality) is reared, which demonstrates that the level of social development of the given species is very low. Almost 90% of workers copulate, yet at the same time only 5% of them exhibit certain ovarian development having no mature oocytes, and no more than 4% possess well developed ovaries with mature ones. In separate individuals belonging to old female-foundresses repeated hibernation is recorded, after which they seem to resume their activity.

References: WU, 1960; SAKAGAMI & FUKUSHIMA, 1961: 118-124; SAKAGAMI & MICHENER, 1962: 18-89; EBMER, 1969: 183; SAKAGAMI & FUKUDA, 1973; SAKAGAMI & EBMER, 1979: 543-549; SAKAGAMI & OKAZAWA, 1985: 645-651; PLATEAUX-QUÉNU & PLATEAUX, 1994: 219-222.

Fig. 268. Occurrence of *Seladonia tumulorum* in Poland.



Figs. 266, 267. Nests of *Seladonia tumulorum* (from SAKAGAMI & MICHENER, 1962: Figs. 179, 180).

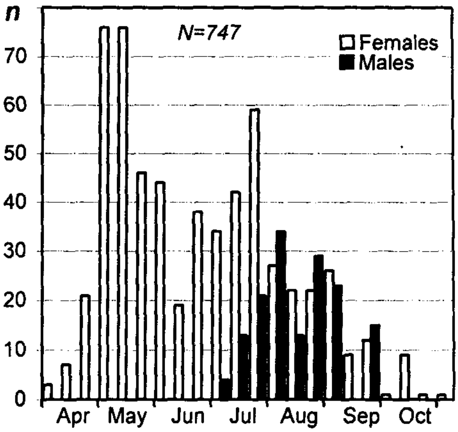


Fig. 269. Flight phenology of *Seladonia tumulorum* in Poland.

Polish data. One of the commonest species in the Polish fauna of the Halictidae, occurring in the whole country (Fig. 268). Over 70% of ecological records are from open and dry habitats such as xerothermic swards, dry meadow, secondarily uncultivated areas, roadsides. Remainder data come from some other habitats (woodlots, woodcuts, margins of forests, pine and mixed forests). Females fly all season long, since April till the first days of November; males appear in the beginning of July and fly till the end of September (Fig. 269). The species was recorded from flowers of 64 species belonging to many botanical families.

Seladonia confusa (SMITH, 1853) (Figs. 247, 256, 270-272).

Taxonomy. Basing on the study of the genetic variation between remote populations, PACKER (ROSENMEIER & PACKER, 1993: 185-200; PACKER & TAYLOR, 1997: 589) assumed that '*S. confusa*' is a complex of several different species. The species is represented in Poland by ssp. *perkinsi* (BLÜTHGEN, 1926) and ssp. *alpina* (ALFKEN, 1907) recorded by EBMER (1988b: 571) from Bukowina in the Tatra Mts. Differences between them are given in the key below:

1. *Female*: in dorsal view of head, vertex narrowly rounded (nearly angular) at posterolateral extremities; hair bands on terga ochre-yellow to cream-white (in fresh specimens). *Male*: head shorter, its height/width ratio 1.05; clypeus less protuberant; flagellum usually pale ochre .... ***S. confusa perkinsi***
- *Female*: vertex wider rounded at posterolateral extremities; hair bands on terga white. *Male*: head higher, its height/width ratio 1.1; clypeus strongly protuberant; flagellum usually dark brown to black .... ***S. confusa alpina***

Distribution. This species is Holarctic in occurrence, common in dry grasslands. The typical form and ssp. *araphanorum* (COCKERELL, 1906) inhabit North America. The subspecies *perkinsi* occurs throughout Europe except for the Alps, where ssp. *alpina* distributes, and central Spain, where ssp. *glacialis* (EBMER, 1979) occurs. Distinguishing of the separate ssp. *pelagius* (EBMER, 1996) from the Primorski Province (Far East of Russia) which is very slightly differing from ssp. *perkinsi*, is formal.

Ecology. Preferring sandy soils. Polylege. The phenology of flying is the same as that in the previous species.

Bionomics. A primitively eusocial species. The preferred habitat of the species seems to be a well-drained soil with a coverage of short grass or other low vegetation. Nests are built in soft loose soil, although establishment in denser clayey soil is recorded. The nests of this species are very difficultly found, because the entrances are always practically invisible. Most tunnels open either at the base of some plant, or else among the stems of a grass clump. In summer families the nest entrance is narrowed to 2.5 mm, and the main burrow widens to 5 mm. One female serves the function of a guard, and usually seats in the entrance stopping it up with its body; it lets other females enter receding inside. Typically the main burrow is vertically oriented, it stretches to a depth of 21 cm and terminates there with a lower blind burrow. Cells of sessile type are grouped into a cell cluster. In summer nests the main burrow may ramify into additional ones, also containing cell clusters (Fig. 270). Cells are 10 mm long, 5 mm wide; the entrance into a cell is narrowed to 2 mm. In one family nest there are up to 5 working individuals. It appears that two broods of workers are reared in the nest. The foundress dies in summer. In this species the queen is replaced by one of its daughters, often before midsummer. Most workers, except for the first brood, are fertilised. Mating takes place on open sunny spots near nesting sites, or on flowers. Reproductive females begin to hibernate soon after the middle of August. For this purpose they dig new holes in light sandy loam, partly filling the hole with loose earth.

References: ATWOOD, 1933: 452-453; DOLPHIN, 1966 quoted in MICHENER, 1974: 55, 86, 299; MARIKOVSKAYA, 1972: 191.

Fig. 271. **Occurrence of *Seladonia confusa* in Poland.**

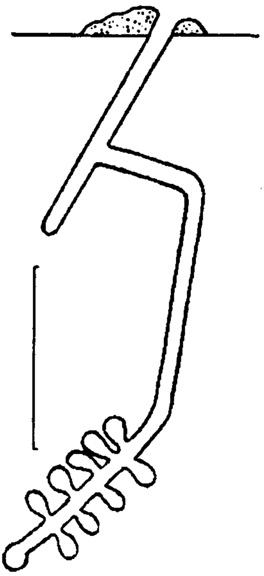


Fig. 270. Nest of *Seladonia confusa* (from MARIKOVSKAYA, 1972: Fig. 4). Scale line represents 5 cm.

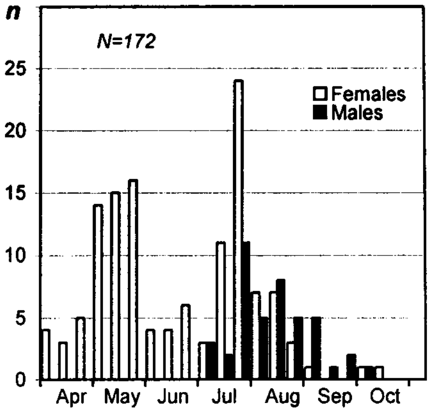


Fig. 272. Flight phenology of *Seladonia confusa* in Poland.

Polish data. A relatively common species inhabiting the whole country (Fig. 271). Occurring in pine forests, swards and other habitats situated on dune and sandy soils. Flight activity is similar to that of the previous species (Fig. 272). Collected from flowers of 22 plant species belonging to different botanical families, mainly from Calluna vulgaris, Hieracium spp., Leontodon sp., Senecio vernalis, Taraxacum officinale.

Seladonia gavarnica (PÉREZ, 1903) (FIGS. 257, 273).

The species is represented in Poland by ssp. *tatarica* (BLÜTHGEN, 1933).

Synonymy (of the subspecific name): *Halictus gavarnicus* ssp. *delphinalis* BLÜTHGEN, 1935.

Taxonomy. This species shows a high geographical variation especially in the form of the head and sculpture of the frons.

Distribution. Transpalaearctic, common in steppes. The typical form inhabits the Pyrenees. The main part of the species range is occupied by spp. *tatarica.* In southern France, intermediate forms (between ssp. *gavarnica* and *tatarica*) occur. In Europe, Austria was recorded as the northernmost locality for this species and westernmost locality for ssp. *tatarica.*

Ecology. Polylege. Females fly all summer long, males appear in midsummer.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Fig. 273. Occurrence of *Seladonia gavarnica* in Poland.

Polish data. Here this species is recorded from Poland for the first time (Fig. 273): Żędowice [ad. Strzelce Opolskie, Opole district], 8.VI.1950, leg. BIELEWICZ, 1 ♀ [WAR].

10. Genus ***Lasioglossum*** CURTIS, 1833

Members of this genus, which are known from all continents except for Australia, are especially numerous in the Holarctic region. The Palaearctic fauna consists of 117 currently recognised species, two of which, *Lasioglossum leucozonium* (SCHRANK) and *L. zonulum* (SMITH), are Holarctic. In the Palaearctic region there are three distinct centres of species richness of the genus: the Mediterranean, Central Asian and Far Eastern. The subgeneric classification of the Palaearctic species includes eight subgenera (PESENKO, 1986a; *Ctenonomia* and *Lucasiellus* are considered here, see Chapter II, as separate genera). *L. laevigatum* (KIRBY) is correctly considered by PACKER (1999) as not being a member of the subgenus *Leuchalictus* (his '*L. leucozonium* group'); it will be included in a new subgenus (PESENKO, in preparation); but in the present paper, its subgeneric position is marked as 'incertae sedis'.

All behaviourally known species are solitary forms, mostly polyleges.

A total of 39 species of 5 subgenera inhabit Europe. Out of them, 14 species are recorded from Poland. Also the following species can be found: *L. pallens* (BRULLÉ) in south-eastern Poland and *L. alinense* (COCKERELL) in north-eastern Poland.

Taxonomy: BLÜTHGEN, 1919b: 269-270; 1920: 86-90, 109-114; 1921a: 260-272; 1921b: 124-126; 1922a: 49, 50, 52, 60; 1922b: 320; 1923b: 239, 240; 1924c: 407-421, 491-501; 1925b: 87, 92, 95-103; 1926a: 496-510; 1929a: 51-58; 1931a: 325-350; 1931c: 297-298; 1934d: 7-11; 1934: 145-153; 1935: 111; 1955: 17; SANDHOUSE, 1933: 78-83; MICHENER, 1979: 193; MITCHELL, 1960: 338-347; EBMER, 1970: 19-44; 1972b: 229-237; 1974a: 125-127; 1974b: 193-197; 1975a: 71-90; 1976a: 141; 1976c: 234-238; 1978a: 192-200; 1978b: 30-45; 1978c: 309-310; 1979: 131-133; 1980: 483-184, 493-497, 500-501; 1981: 110-116; 1982: 208-211; 1985b: 277-280; 1987b: 79-80; 1988b: 579-596; 1996b: 271-278; 1997: 365-411; WARNCKE, 1973b: 284-287; 1975a: 92-95, 98-99; 1982a: 90-106, 111-116; 1984: 293-299; DAY, 1979: 75; SAKAGAMI & EBMER, 1979: 543; MCGINLEY, 1986: 1-294; PESENKO, 1986a: 113-151; 1987: 17-18.

KEY TO THE POLISH SUBGENERA AND SPECIES OF LASIOGLOSSUM

1\. *Both sexes*: posterior vertical surface of propodeum ecarinate in upper half or one third of its lateral margins where this surface roundly passes to lateral surfaces of propodeum 2

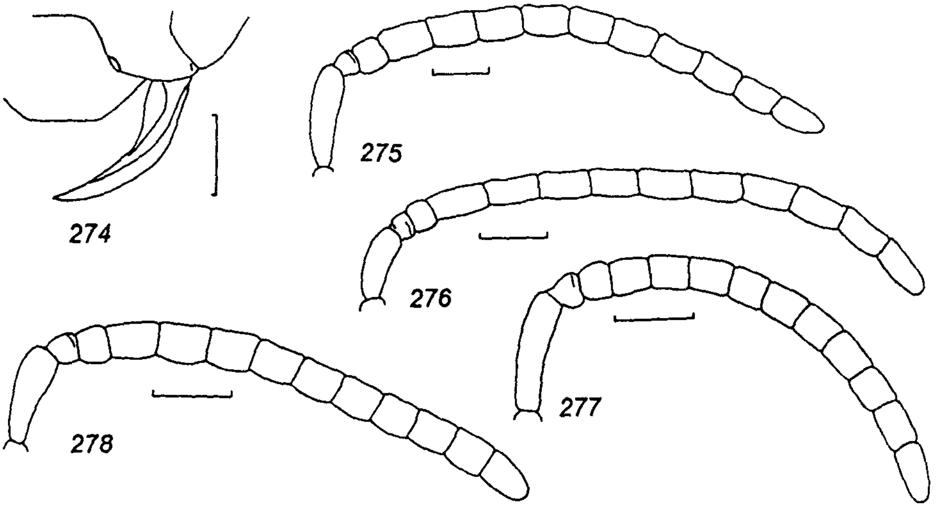
– *Both sexes*: posterior vertical surface of propodeum carinate at all lateral margins and lateral parts of upper margin 11

2\. *Both sexes*: Posterior vertical and lateral surfaces of propodeum always dull, usually rugulose or granulate, without punctures separated by distinct shiny interspaces. *Male*: gonostylus provided with a well-developed retrorse membranous lobe (Figs. 283-292). (Subgenus *Lasioglossum* s. str.) 3

– *Both sexes*: Posterior vertical surface and at least partly lateral surfaces of propodeum punctate (in male of *L. pallens* very sparsely), with pierced punctures separated by distinct, smooth, shiny interspaces. *Male*: gonostylus without a membranous lobe (Figs. 293, 294), except for *L. pallens*. (Subgenus *Pallhalictus* WARNCKE) 9

3. *Both sexes*: middle tarsi and hind tibiae and tarsi rusty-yellow to red; larger, length 11-12 mm. *Female*: head 0.8 times as wide as mesosoma, egg-shaped in frontal view, 1.1-1.15 times high as wide. *Male*: head longitudinally elliptic in frontal view, with a very high vertex; flagellomeres strongly convex at lower side, therefore flagella distinctly knotty (Fig. 275) .... ***L. (L.) xanthopus***

- *Both sexes*: legs dark (except for male of *L. subfasciatum* whose middle and hind basitarsi are whitish-yellow); smaller, length 6-10.5 mm. *Female*: head about as wide as mesosoma, triangularly roundish in frontal view, as high as wide or shorter than wide. *Male*: head roundly triangular in frontal view, with a moderately high vertex; flagellomeres not or weakly convex at lower side 4



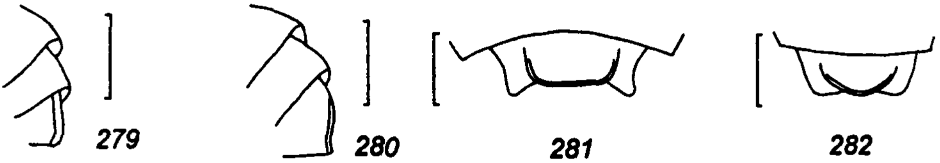
Figs.274-278. Mandible and antenna of males in *Lasioglossum*.
274, 277. L. zonulum. 275. L. xanthopus, 276. L. laevigatum. 278. L. leucozonium.
Scale lines represent 0.5 mm.

4. *Female*: metasomal terga I-III laterally, III also on posterior area and IV throughout, besides tomentose anterior bands, also covered with moderately dense, pale greyish-yellow tomentum; mesoscutum very densely punctate, mat, dully green. *Male*: metasomal tergum VII enlarged and greatly exposed (Fig. 280), orange; pygidial plate very broad, but marked only distally by a sharp carina; metasomal sternum V deeply roundly emarginate and fringed with long yellow or whitish hairs posteriorly. 8 mm .... ***L.(L.) prasinum***

– *Female*: terga only with anterior tomentose bands or spots; sculpture and coloration of mesoscutum variable. *Male*: tergum VII not enlarged and mostly hidden by tergum VI (Fig. 279), black to dark-brown; pygidial plate relatively narrow, well defined laterally and distally; sternum V straight or slightly emarginate posteriorly 5

5. ***Both sexes***: metasomal terga with a distinct grey metallic tint. ***Female***: metasomal terga I-IV dull. *Male*: metasomal sterna II-IV with long dense hairs 6

– *Both sexes*: terga black, without metallic tint. *Female*: terga I-IV shiny. *Male*: sterna II-IV with short sparse hairs 7



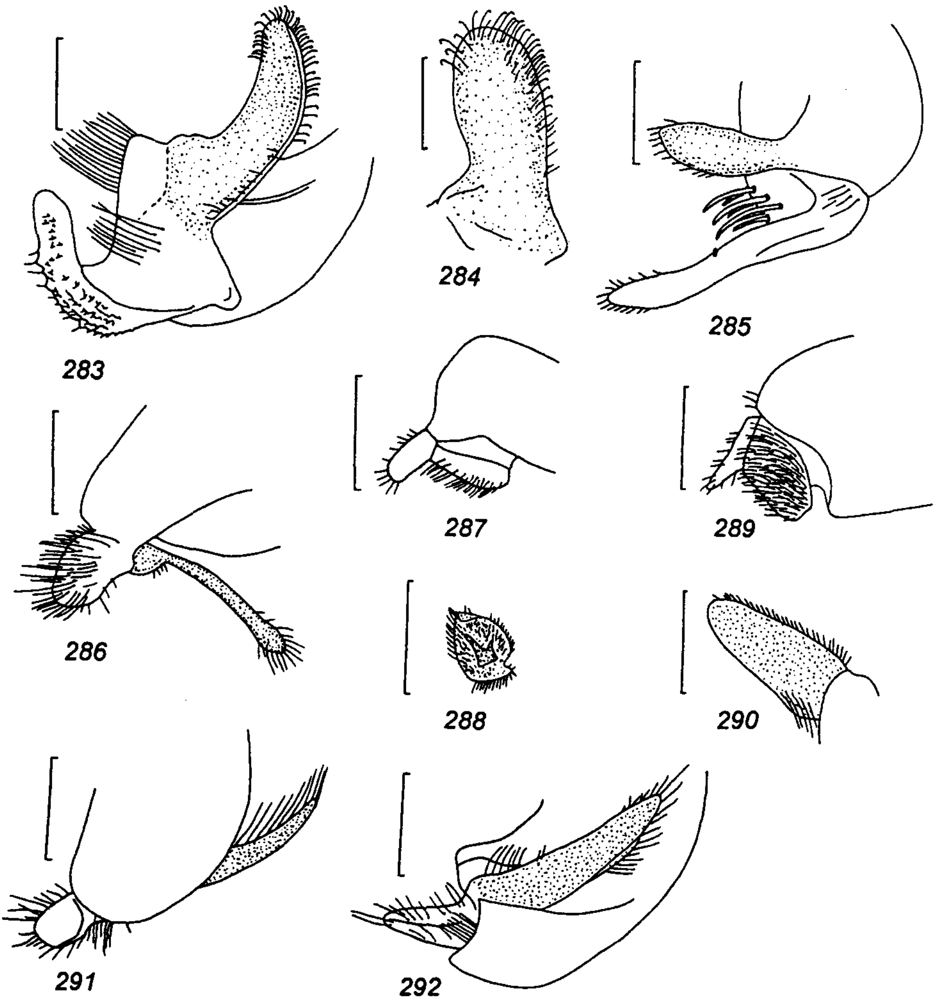
Figs. 279-282. Metasomal tergum VII of males of *Lasioglossum*.
279. L. sexnotatum (lateral view). *280. L. prasinum* (lateral view). *281. L. majus* (posterodorsal view). *282. L. zonulum* (posterodorsal view). Scale lines represent 0.5 mm.

6. *Both sexes*: smaller, length 5-8 mm; metasomal tergum I distinctly roughened between punctures on disc. *Female*: head and mesosoma blue metallic, with a short and sparse yellowish-grey pubescence; tergal tomentose bands white. *Male*: genal areas shiny, sparsely punctate, smooth on interspaces .... ***L. (L.) breviventre***

– *Both sexes*: larger, length 9-10 mm; tergum I smooth between punctures on disc. *Female*: head and mesosoma often dull greenish, with a long and dense rusty to yellowish-brown pubescence; tergal bands brownish-yellow to nearly black and shot with brown. *Male*: genal areas dull, roughened, with longitudinal, very dense and fine striae, often indistinct .... ***L. (L.) subfasciatum***

7. *Both sexes*: larger, length 9-10.5 mm; metasomal terga denser and coarser punctate. *Female*: mesoscutum black; metasomal tergum I relatively densely punctate: on disc (1-5); on posterior area (0.2-0.5), its posterior area separated from tergal disc by a depression. *Male*: genal areas on posterior surface shiny, obscurely punctate. Membranous lobe of gonocoxites long and very narrow, about 7 times as long as wide (Fig. 286) .... ***L. (L.) sexnotatum***

– *Both sexes*: smaller, length 7-8.5 mm; terga sparser and finer punctate. *Female*: mesoscutum often with a metallic tint; tergum I brightly shiny, polished, very sparsely and finely punctate on disc and impunctate on posterior area; the latter not separated from tergal disc by a depression;. *Male*: genal areas on posterior surface dull, very densely striolate. Membranous lobe of gonocoxites much shorter, of other form. (Two close species which can be identified certainly only on the basis of the structure of male genitalia) 8



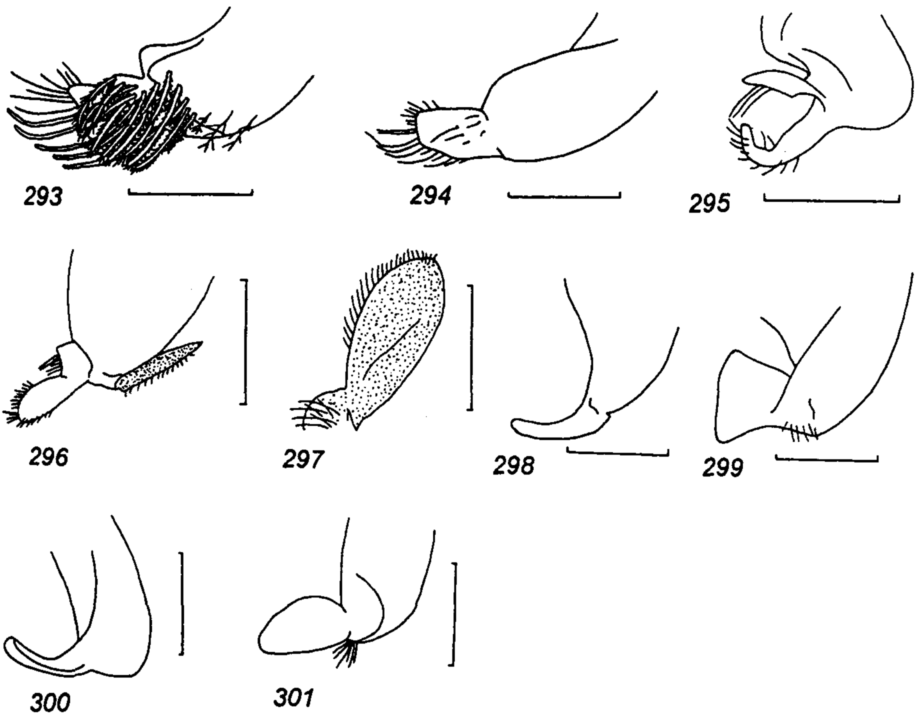
Figs. 283-292. Gonostylus of males in *Lasioglossum*
(right excepting *283*, *285*, and *292*; different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation).
283, *284*. *L. xanthopus* (*283*, ventral view, left; *284*, membranous lobe in its plane). *285*. *L. subfasciatum*, ventral view, left. *286*. *L. sexnotatum*, lateral view. *287*, *288*. *L. sexnotatulum* (*287*, posterior view; *288*, membranous lobe in its plane). *289*, *290*. *L. sexmaculatum* (*289*, posterior view; *290*, membranous lobe in its plane). *291*, *292*. *L. prasinum* (*291*, posterolateral view; *292*, ventral view, left). Scale lines represent 0.3 mm.

8\. *Female*: head slightly (about 0.95 times) shorter than wide; clypeus somewhat coarser and sparser punctate on upper part in comparison with punctation of its lower half; mesoscutum without or with a very slight metallic tint, on disc somewhat finer and uniformly punctate (20-30 μm); pubescence of vertex and mesonotum sparser and paler, yellowish-grey; pubescence of legs yellowish-grey; metasomal terga deeply black; tergum I distinctly less convex and longer, its length/width ratio 0.6-0.7; terga III and IV on discs nearly hairless. *Male*: head as high as wide to slightly shorter than wide; ocular orbits very weakly convergent underneath; membranous lobe of gonostylus 1.5 times as long as wide, irregularly triangular, with a median transverse fold, on lower surface with dense and short hairs, along mesal and posterior margins fringed with very short hairs (Fig. 288) .... ***L. (L.) sexnotatulum***

– *Female*: head about as high as wide; clypeus somewhat finer and denser punctate on upper part in comparison with punctation of its lower half; mesoscutum with slight green and reddish tints, on disc less uniformly punctate by both relatively fine and coarse punctures; pubescence of vertex and mesonotum denser and darker, brownish-yellow; pubescence of legs brownish-yellow; terga brownish-black; tergum I more convex and shorter, its length/width ratio about 0.5; terga III and IV on discs covered with not denser, yellowish dust-like pubescence. *Male*: head slightly higher than wide; ocular orbits distinctly convergent underneath; membranous lobe of gonostylus twice as long as wide, elliptic, without transverse fold, nearly hairless, only along posterior margin fringed (Fig. 290) ... . ***L. (L.) sexmaculatum***

9\. *Both sexes*: head very short, transversely elliptic in frontal view; its height/width ratio 0.8; metapostnotum strongly carinate along posterior margin, shiny, with sparse longitudinal rugulae; metasomal terga with an oily tint, therefore not very shiny, their posterior areas translucent, horny-yellow (in male narrowly). *Female*: posterior areas of terga broadened, this area of tergum I well defined anteriorly by a distinct depression across all width. *Male*: tergum I smooth, greatly narrowed to anterior end; terga flattened, their discs not convex, their posterior areas not defined anteriorly; metasomal sterna with dense, relatively short hairs; sternum V very deeply, roundly emarginate posteriorly; gonostylus with a long membranous retrorse lobe .... ***L. (P.) pallens***

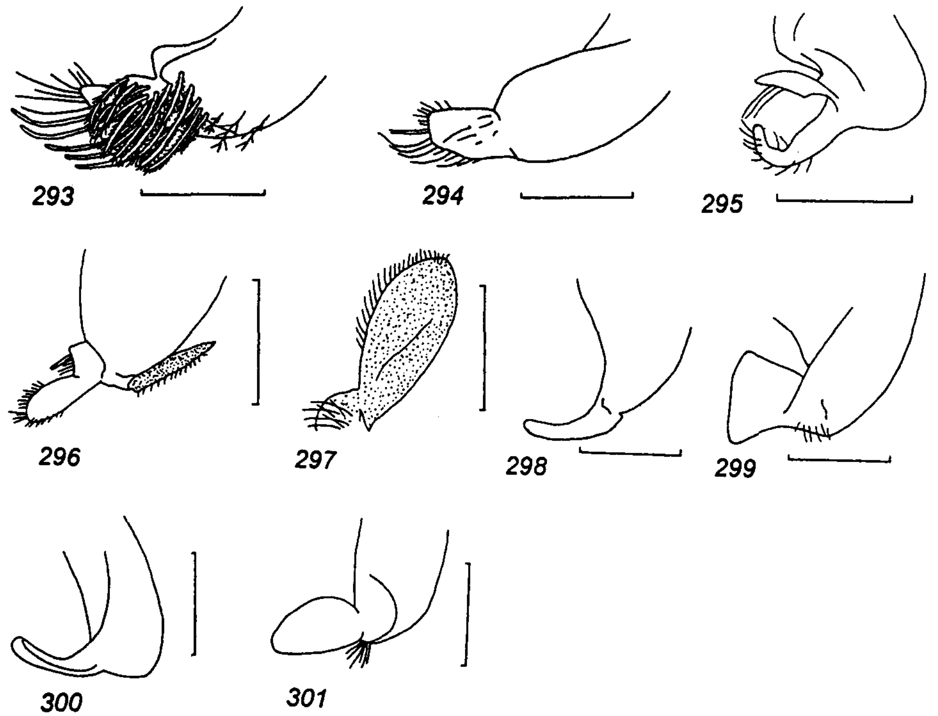
– *Both sexes*: head nearly roundish in frontal view; its height/width ratio 0.9-1.0; metapostnotum rounded at posterior margin, ecarinate, silk-dull, densely and finely longitudinally rugulose; terga black throughout, without tint, shiny; their posterior area not translucent. *Female*: posterior areas of terga narrower, this area of tergum I not defined medially. *Male*: tergum I relatively coarser and denser punctate, nearly semicircular in dorsal view; discs of terga convex, tergal posterior areas defined anteriorly by a depression; sterna with sparse hairs; sternum V slightly emarginate posteriorly; gonostylus without membranous retrorse lobe (Figs. 293, 294) 10



Figs. 293-301. Gonostylus of males in *Lasioglossum*
(right excepting *299* and *301*; different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation).
293. *L. lativentre*, dorsolateral view. *294*. *L. quadrinotatum*, dorsolateral view. *295*. *L. costulatum*, posterior view. *296*, 297. *L. laevigatum* (*296*, posterior view; *297*, membranous lobe in its plane). *298*, *299*. *L. zonulum* (*298*, posterior view; *299*, ventral view, left). *300*, *301*. *L. leucozonium* (*300*, posterior view; *301*, ventral view, left). Scale lines represent 0.3 mm.

10. *Both sexes*: head slightly shorter, its height/width ratio 0.9-0.95 in female, 0.95-0.98 in male; wing membrane nearly hyaline, slightly yellowish; stigma yellow to brownish-yellow. *Female*: metasomal tergum I denser punctate: on disc (0.5-3.0), and on posterior area (0.2-1.0); tergum IV on posterior area covered with greyish-white dense plumose appressed hairs forming a band-like pubescence. *Male*: gonocoxite nearly hairless; gonostylus only fringed at distal margin with not dense hairs (Fig. 294) .... ***L. (P.) quadrinotatum***

\- *Both sexes*: head slightly higher, its height/width ratio 0.96-0.98 in female, 1.0 in male; wing membrane slightly brownish-grey infuscated; stigma brown to brownish-yellow with dark margins. *Female*: tergum I sparser punctate: on disc (1.5-4.0), on posterior area (1-2); tergum IV on posterior area covered with a sparse pubescence. *Male*: gonocoxite at distal margin and gonostylus with very dense long thick hairs (Fig. 293) .... ***L. (P.) lativentre***



Figs. 293-301. Gonostylus of males in *Lasioglossum*
(right excepting *299* and *301*; different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation).
293. L. lativentre, dorsolateral view. *294. L. quadrinotatum*, dorsolateral view. *295. L. costulatum*, posterior view. *296*, 297. *L. laevigatum* (*296*, posterior view; *297*, membranous lobe in its plane). *298, 299. L. zonulum* (*298*, posterior view; *299*, ventral view, left). *300, 301. L. leucozonium* (*300*, posterior view; *301*, ventral view, left). Scale lines represent 0.3 mm.

10. *Both sexes*: head slightly shorter, its height/width ratio 0.9-0.95 in female, 0.95-0.98 in male; wing membrane nearly hyaline, slightly yellowish; stigma yellow to brownish-yellow. *Female*: metasomal tergum I denser punctate: on disc (0.5-3.0), and on posterior area (0.2-1.0); tergum IV on posterior area covered with greyish-white dense plumose appressed hairs forming a band-like pubescence. *Male*: gonocoxite nearly hairless; gonostylus only fringed at distal margin with not dense hairs (Fig. 294) .... ***L. (P.) quadrinotatum***

\- *Both sexes*: head slightly higher, its height/width ratio 0.96-0.98 in female, 1.0 in male; wing membrane slightly brownish-grey infuscated; stigma brown to brownish-yellow with dark margins. *Female*: tergum I sparser punctate: on disc (1.5-4.0), on posterior area (1-2); tergum IV on posterior area covered with a sparse pubescence. *Male*: gonocoxite at distal margin and gonostylus with very dense long thick hairs (Fig. 293) .... ***L. (P.) lativentre***

11. *Both sexes*: metapostnotum as long as scutellum, nearly right-angle triangular, projecting backward like a sharp transverse carina; lateral surfaces of propodeum strongly convergent backward, with very coarse longitudinal wrinkles; body, especially mesoscutum, scutellum and three first metasomal terga, with a blue metallic tint, weak in male. *Female*: mesoscutum coarsely foveolate (30-50 µm / 1-2) on disc, bottom of each fovea flat, raising backward. *Male*: gonostylus narrow, rectangular curved (Fig. 295). (Subgenus *Ebmeria* PESENKO) .... ***L. (E.) costulatum***

- *Both sexes*: metapostnotum 0.5-0.8 times as long as scutellum, widely triangular to semilunar, not extending behind posterior vertical surface of propodeum; lateral surfaces of propodeum weakly convergent backward, finer rugulose or granulate; body black, without metallic tint. *Female*: mesoscutum finely punctate on disc, with usual pierced punctures. *Male*: gonostylus broad, flattened, not curved (Figs. 296, 298-301) 12

12. *Both sexes*: pubescence of head and mesosoma very long, dense, brightly rusty-red to rusty-brown, in male often paler. *Female*: head distinctly shortened, its height/width ratio 0.8-0.9; carina that margins the posterior vertical surface of propodeum, forming a big triangle tooth at dorsolateral angles of this surface; metatibial scopa dark rusty-yellow; posterior areas of metasomal terga II-IV occupying a half of tergal length; posterior tomentose bands of terga rusty-yellow to yellowish. *Male*: clypeus black; antenna very long, reaching the metasoma; 3rd flagellomere nearly twice as long as wide Fig. 276); basi- and mediotarsi of all legs yellowish-white; metasomal sternum VI without isolated area of specialised pubescence; gonostylus provided with a large retrorse membranous lobe (Figs. 296, 297) (Subgenus incertae sedis) .... ***L. laevigatum***

– *Both sexes*: pubescence of head and thorax not so long, dense and bright; its colour brownish, yellowish, greyish or whitish. *Female*: head about as high as wide; propodeum without teeth at dorsolateral angles; metatibial scopa bicolour, greyish-white to brownish-yellow on anterior part and dark-brown along posterior margin of tibia; posterior areas of terga II-IV narrower; posterior tomentose bands of terga white. *Male*: clypeus on lower part often yellow; antenna shorter (Fig. 278); legs black (only *L. leucozonium* middle basitarsi partly and hind basitarsi are mostly yellowish-white); sternum VI provided with an isolated area of a very dense, short pubescence forming a brush; gonostylus without membranous lobe (Figs. 298-301) (Subgenus *Leuchalictus* WARNCKE) 13

13. *Both sexes*: metasomal tergum I shiny, polished between punctures; its posterior area not defined anteriorly. *Female*: dorsolateral ridges of pronotum relatively greatly extending; tergum I sparsely punctate on disc (2-7). *Male*: head thick, with convex genal areas and a high vertex, roundly square in frontal view; cly-

peus shortened; mandibles very long, sabre-shaped (Fig. 274); basitarsi of all legs always black; metasomal tergum VII with roundly triangular lateral teeth (Figs. 281, 282); brush of sternum VI longitudinally elliptic 14

– *Both sexes*: tergum I dull, roughened between punctures (sometimes nearly smooth in small males); its posterior area usually separated from tergal disc by a weak depression. *Female*: pronotal ridges slightly extending; tergum I much densely punctate on disc (1-2). *Male*: head normal, not thickened, triangularly roundish in frontal view; clypeus not shortened; mandibles normal; tergum VII without lateral teeth; coloration of middle and hind legs and form of brush of sternum VI variable 15

14. *Both sexes*: stigma yellowish-brown to brown; pubescence of vertex and notum sparser, shorter and paler, brownish-grey in female, yellowish-grey in male. *Female*: larger, length 11-13 mm; mesoscutum sparser punctate on disc (0.5-1.5); metapostnotum submat, with fine, irregular wrinkles, nearly ruguloso-reticulate; metasomal tergum I finer punctate on posterior area (15-20 µm). *Male*: head distinctly broader than mesosoma; vertex sparser punctate (1-2.5); metasomal tergum I denser punctate on disc (1.0-1.5, rarely to 2.0); teeth of tergum VII larger, exposed behind pygidial plate in dorsal view to this tergum (Fig. 281); brush of sternum VI entire; length 9.5-11 mm ....*L. (L.)* ***majus***

- *Both sexes*: stigma yellow to brownish-yellow; pubescence of vertex and notum denser, slightly longer and darker, brownish-yellow. *Female*: smaller, length 9-10 mm; mesoscutum denser punctate on disc (0.1-0.5); metapostnotum shiny, with coarser, longitudinal rugulae; tergum I coarser punctate on posterior area (20-30 µm). *Male*: head about as broad as mesosoma; vertex denser punctate; tergum I sparser punctate on disc (1-3); teeth of tergum VII smaller, usually not extending behind pygidial plate (Fig. 282); brush of sternum VI divided into three parts; length 7-9.5 mm ....*L. (L.)* ***zonulum***

15. *Both* sexes: mesoscutum coarser punctate (35-45 µm); metapostnotum 1.5 times shorter than scutellum. *Female*: metasomal tergum I covered with usual erect, moderately long, sparse hairs on convex surface; prepygidial fimbria brown to yellowish-orange. M*ale*: middle basitarsi partly and hind basitarsi mostly yellowish-white; brush of metasomal sternum VI triangular, continuous ....*L. (L.)* ***leucozonium***

- *Both* sexes: mesoscutum finer punctate (25-30 µm); metapostnotum nearly twice shorter than scutellum. *Female*: tergum I with large lateral spots of pale dense appressed hairs on convex surface; prepygidial fimbria dark-brown. M*ale*: basitarsi of all legs dark; brush of sternum VI longitudinally elliptic, divided into three parts (similar to that in *L. zonulum*) ....*L. (L.)* ***alinense***

Lasioglossum (Lasioglossum) xanthopus (KIRBY, 1802) (Figs. 275, 283, 284, 302-305).

Synonymy: *Apis emarginata* CHRIST, 1791 (nomen oblitum, see EBMER, 1974: 121); *Hylaeus derasus* IMHOFF, 1832; *Lasioglossum tricingulum* CURTIS, 1833; *Hylaeus fulvicrus* EVERSMANN, 1852; *Halictus soreli* DOURS, 1872; *H. xanthopus* spp. *lativalvis* WARNCKE, 1984.

Taxonomy. Relatively constant throughout its wide geographical range. The close *L. euxanthopus* PESENKO, 1986, described on the basis of three females from Azerbaidzhan and the western Kopetdagh Mts. (Turkmenistan), differs in the shortened head, mat mesoscutum and scutellum, coarser and sparser punctate posterior area of metasomal tergum II.

Distribution. Widely distributed in warm and temperate parts of the western Palaearctic region, to eastern Kazakhstan and western Mongolia in the east. In western Europe to southern England and Sweden in the north, in eastern Europe to Syktyvkar (62° N.).

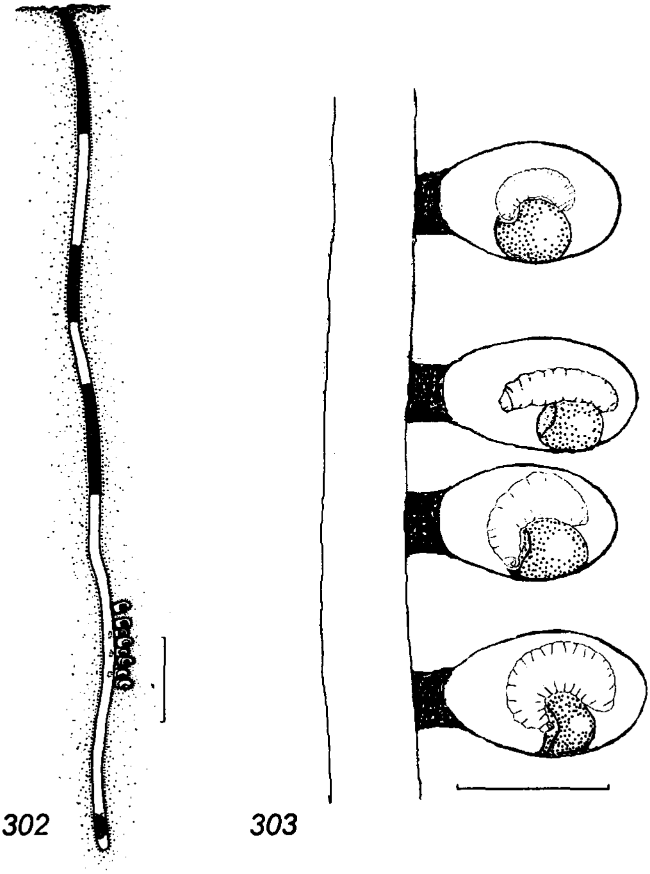
Ecology. In temperate Europe univoltine, mostly summer species. Polylege.

Bionomics. A solitary, probably subsocial species. Males are very rare, a special kind of parthenogenesis is possible. The species builds lonely located nests at places with sparse vegetation. The nest entrance sometimes has a turret, its length is 15 mm, diameter 7 mm, walls are 1.0-1.5 mm thick, and possibly strengthened by secreted material. The main burrow (Fig. 302) of nests, 6.5-7.0 mm in diameter, is slightly curved, almost vertical, and goes downwards to a depth of 44 to 49 cm, where it is finished by the lower blind burrow. The nests located in the walls of precipices have much more curved main burrow. The inner walls of the main burrow are all along smooth and rammed. On their surface the traces left by pygidial plates of bees during ramming are well visible. The cells are constructed at the bottom of the nest at a depth of 31 to 37 cm.

The cells are ellipsoid (Fig. 303), 12.5 to 18 cm in length, 6 mm in diameter, and are located horizontally and by their necks almost immediately adjoin the main burrow. They branch off from one side of the main burrow, and are disposed progressively downwards in one or two at every level, leading to them no noticeable laterals. The distance between adjacent cells is only 2-6 mm, so that they are arranged in one cluster. Each female builds only one nest with 7-8 cells. The pollen ball has spherical form, but is slightly flattened at the poles; it is 5 mm in diameter, 4 mm high. The egg lies on its top and is attached to it by its both extremities. After laying an egg the female seals the cell neck with a concavo-concave plug made of small-sized lumps of soil laid out in concentric rings. The thickness of the plug at the centre amounts to no more than 0.25-0.5 mm. The outer surface of such a plug is level with the main burrow wall, and nothing else separates the cell from the main burrow. After completing the nest construction the bee plugs the nest entrance from within, and tightly fills with soil three small sections of the main burrow. The bee remains in the lower blind burrow of the nest and, probably, monitors subsequent development of the brood, waiting for its emergence. The offspring develops very fast: larvae consume all of the provisions in two weeks, then they excrete feces, which are put in three layers at the cell bottom, and three or four days later larvae pupate. The further development of brood in the nest remains unstudied. It is not excluded that the species has primitive eusociality. Occasionally males of this species hibernate jointly with females.

Cleptoparasite: *Sphecodes spinulosus*.

References: STÖCKHERT, 1923: 53-56, 228; KNERER, 1969: 927; MARIKOVSKAYA, 1972: 189; RADCHENKO, 1989: 72-74.



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Figs. 302, 303. Nest and cell cluster of *Lasioglossum xanthopus* (from RADCHENKO, 1989: Fig. 2; RADCHENKO, unpublished). Scale lines represent 5 cm for the nest and 1 cm for cells.

Fig. 304. Occurrence of *Lasioglossum xanthopus* in Poland.

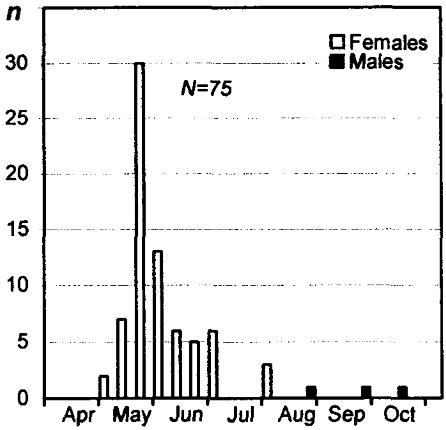


Fig. 305. Flight phenology of *Lasioglossum xanthopus* in Poland.

Polish data. An uncommon species occurring in the whole territory of Poland except for highlands (Fig. 304). Mostly inhabiting dry meadows, glades and forest margins. Females fly since May till the beginning of August; males were caught (only three specimens) since August till October (Fig. 305). Recorded from flowers of nine plant species belonging to five botanical families.

Lasioglossum (Lasioglossum) subfasciatum (IMHOFF, 1832) (Figs. 285, 306, 307).

Synonymy: *Halictus rufocinctus* NYLANDER, 1852; *Hylaeus bifasciatus* SCHENCK, 1853, nec BRULLÉ, 1832.

Taxonomy. Relatively variable in size of the body and coloration of pubescence of the mesosoma and metasomal terga. Close to *L. nomion* EBMER, 1998 described from Bhutan.

Distribution. South and Central Europe, Caucasus, Iran.

Ecology. In temperate Europe, the species is rather univoltine, but with a long flying period, since late March till October. Polylege.

Bionomics. Nesting unknown. Solitary, since male and females fly at the same time period.

Polish data. An uncommon species occurring in south-western Poland (Fig. 306). Mostly inhabiting forests and midfield afforestations (70% data). Females fly nearly all the season long, since Aprill till October; males (only six specimens) were collected since August till the first decade of September (Fig. 307). Recorded from flowers of eleven species belonging to different botanical families: Centaurea cyanus, C. rhenana, Cirsium arvense, Echium vulgare, Geranium silvaticum, Hieracium sp., Knautia arvensis, Rosa sp., Brassica napus, Taraxacum officinale, Veronica teucrium.

Fig. 306. Occurrence of *Lasioglossum subfasciatum* in Poland.

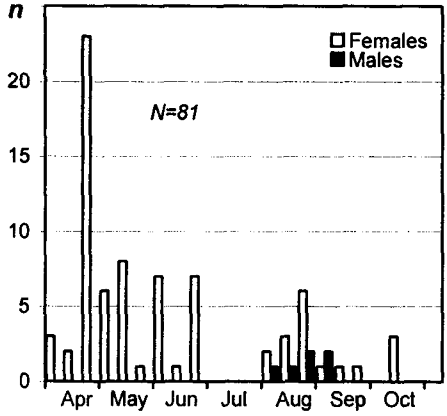


Fig. 307. Flight phenology of *Lasioglossum subfasciatum* in Poland.

Lasioglossum (Lasioglossum) sexnotatum (KIRBY, 1802) (Figs. 279, 286, 308, 309).

Synonymy. *Andrena nitida* PANZER, 1798, nec *Apis nitida* MÜLLER, 1776.

Taxonomy. Morphologically constant throughout its extensive geographical range. It occupies relatively isolated position in the subgenus.

Distribution. European and west Asian, to Mongolia in the east. In Europe to southern England, Denmark, St. Petersburg in the north.

Ecology. In the temperate part of Europe, it is a univoltine species. Both sexes are flying nearly for all the season long. Polylege.

Bionomics. Solitary (GRANDI, 1961: 272). Nesting unknown.

Fig. 308. Occurrence of *Lasioglossum sexnotatum* in Poland.

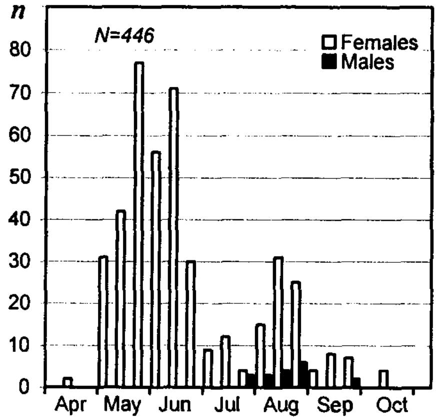


Fig. 309. Flight phenology of *Lasioglossum sexnotatum* in Poland.

Polish data. A common species occurring in the whole country (Fig. 308). It is eurybiontic, inhabiting nearly all biotopes. Females fly since April till October; males (only 19 specimens) were caught since the end of July till the end of September (Fig. 309). Recorded from flower of 68 plant species belonging to 15 botanical families.

Lasioglossum (Lasioglossum) breviventre (SCHENCK, 1853).

Synonymy: *Halictus quadrifasciatus* SCHENCK, 1875; *H. chalconotus* PÉREZ, 1895; *H. micans* STRAND, 1909.

Distribution. A rare European species, recorded from Belgium, the Netherlands, Germany, Austria, also highlands of Spain and Greece. Probably, it will be found in western Poland.

Ecology. Both sexes are flying in spring and the first half of summer.

Bionomics. Nesting unknown. Rather solitary.

Lasioglossum (Lasioglossum) sexnotatulum (NYLANDER, 1852) (Figs. 287, 288, 310).

Taxonomy. The *L. sexnotatulum* group includes almost two dozen species mostly inhabiting Central and East Asia (PESENKO, 1986a). Differences between this species and the closest *L. sexmaculatum* (see below) are given in the key above.

Distribution. Boreal Euro-Siberian, from Norway in the west to the Omsk province in the east.

Ecology. A rather univoltine summer species, with a long period of flying. Polylege.

Bionomics. Nesting unknown. Rather solitary.

Fig. 310. Occurrence of *Lasioglossum sexnotatulum* in Poland.

Polish data. Material examined (Fig. 310): 'Malitz' [Małuszów, Legnica district], 12.V.1918, 1 ♀ [WAR]. Wrocław-Psie Pole [Hundfeld], 1.VI.1903, 3 ♀, leg. DITTRICH [WRO].

Lasioglossum (Lasioglossum) sexmaculatum (SCHENCK, 1853) (Figs. 289, 290, 311).

Distribution. A very rare boreal Euro-Siberian species, sporadically occurring in Europe and Siberia, till Yakutsk, Buryatia (PESENKO, 1986a) and northern China (MORAWITZ, 1880; not 'Mongolia', comments on localities see PESENKO, 1984b: 448) in the east.

Ecology. A rather univoltine species, flying in late spring and summer.

Bionomics. Nesting unknown. Rather solitary.

Fig. 311. Occurrence of *Lasioglossum sexmaculatum* in Poland.

Polish data. This rare species was recorded from Poland (in the present borders) by BLÜTHGEN (1919a: 77; 'Westpreußen: Sellin' [Pomerania: Zelice]). It is met by us in the collections studied only once (Fig. 311): Żędowice [ad. Strzelce Opolskie, Opole district], 8.VI.1950, 2 ♀ [WAR].

Lasioglossum (Lasioglossum) prasinum (SMITH, 1848) (Figs. 280, 291, 292, 312).

Synonymy: *Halictus semipubescens* DUFOUR, 1853; *Hylaeus haemorrhoidalis* SCHENCK, 1853; *H. tomentosus* SCHENCK, 1853, nec HERRICH-SCHÄFFER, 1840; *H. albidus* SCHENCK, 1861, nec LEPELETIER, 1841; *Halictus albidulus* SCHENCK, 1874; *H. canescens* SCHENCK, 1874; *H. schencki* MORAWITZ, 1877.

Taxonomy. This species is a representative of a large group of species mostly Asian in occurrence, in which the mesoscutum is metallic greenish and the metasomal tergum I is densely punctate. However, it occupies a relatively isolated position in the group and within the subgenus on reason of differences in the structure of metasomal tergum VII and sternum V. Morphologically constant throughout its geographical range.

Distribution. An uncommon species, widely distributed in warm and temperate parts of western Europe, to Poland and Greece in the east, also recorded from Morocco.

Ecology. A rather univoltine summer species, preferring sandy biotopes.

Bionomics. Nesting unknown. Rather solitary.

Fig. 312. Occurrence of *Lasioglossum prasinum* in Poland.

Polish data. A rare species not showing a certain geographical pattern in its occurrence in the country (Fig. 312).

Material studied: 'Stettin' [Szczecin], 29.VI.1913, 1 ♀ [WAR]; 30.VIII.1909, 1 ♂ [WAR]. Bolesław [ad. Olkusz, Katowice district], 5.VII.1087, leg. CELARY, 1 ♂ [KRA]. Ogrodzieniec [Katowice district], 10.VIII.1988, on flowers of Solidago virgaurea, leg. CELARY, 1 ♀ [KRA].

Lasioglossum (Pallhalictus) quadrinotatum (KIRBY, 1802) (294, 313, 314).

Taxonomy. The *L. quadrinotatum* group (see: PESENKO, 1986a) includes five species: the western Palaearctic *L. quadrinotatum* (KIRBY, 1802) and *L. lativentre* (SCHENCK, 1853), *L. korbi* (BLÜTHGEN, 1929) inhabiting Asia Minor and Transcaucasus, the Central Asian *L. quadrinotatiforme* EBMER, 1980 and *L. tessaronotatum* EBMER, 1998 described from central China. The characters, in which

L. quadrinotatum differs from the closest *L. lativentre* (see below), are given in the key above.

Distribution. Widely distributed in the western Palaearctic region to western Kazakhstan and Uzbekistan in the east.

Ecology. In the temperate zone of Europe rather univoltine, with a long period of flying. Polylege.

Bionomics. Nesting unknown. Rather solitary.

Fig. 313. Occurrence of *Lasioglossum quadrinotatum* in Poland.

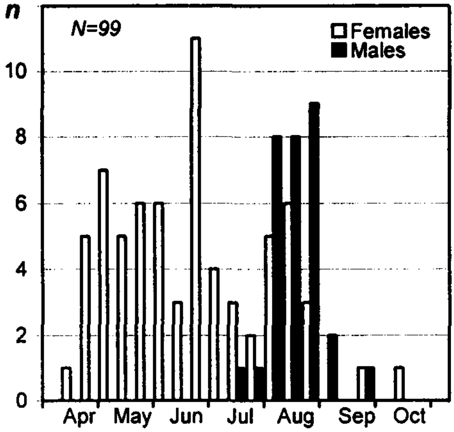


Fig. 314. Flight phenology of *Lasioglossum quadrinotatum* in Poland.

Polish data. A relatively common species occurring in whole country (Fig. 313). It prefers open and dry areas such as dry meadows, roadsides. Females fly nearly all the season long, since April till October; males were caught later, since the second decade of July till the end of September (Fig. 314). Collected from flowers of 23 species, mainly Asteraceae (Anthemis tinctoria, Centaurea jacea, Cichorium intybus, Cirsium arvense, Echium vulgare, Hieracium pilosella, Leontodon autumnalis, Matricaria inodora, Senecio sp., Tanacetum vulgare, Taraxacum officinale), and some other botanical families (Anethum sp., Carum carvi, Calluna vulgaris, Coriandrum sativum, Lotus corniculatus, Mentha sp., Linum usitatissimum, Thymus sp., Trifolium pratense, Veronica chamaedrys).

Lasioglossum (Pallhalictus) lativentre (SCHENCK, 1853) (Figs. 293, 315, 316).

Synonymy: *Hylaeus bisbistrigatus* SCHENCK, 1853; *Halictus bicinctus* SCHENCK, 1874, nec *Apis bicincta* SCHRANK, 1781; *H. decipiens* PERKINS, 1913; *H. lativentris* var. *sotschica* BLÜTHGEN, 1931.

Distribution. Widely distributed in southern and Central Europe to southern Sweden and St. Petersburg in the north, also inhabiting Asia Minor and Iran.

Ecology. In the temperate zone of Europe, it is a rather univoltine species with a long period of flying. Polylege.

Bionomics. Nesting unknown. Rather solitary.

Fig. 315. Occurrence of *Lasioglossum lativentre* in Poland.

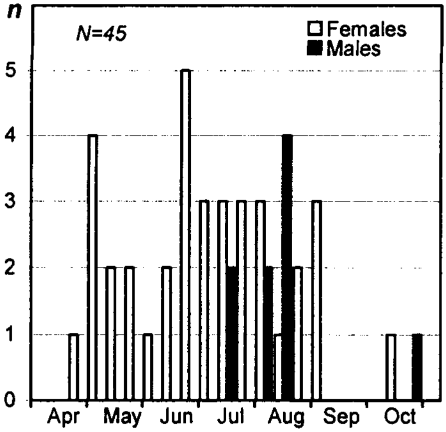


Fig. 316. Flight phenology of *Lasioglossum lativentre* in Poland.

Polish data. A relatively uncommon species occurring in the whole Poland (Fig. 315). It does not show a certain biotopic preference. Females fly since the third decade of April till October; males (only nine specimens) were caught since the second decade of July till the end of October (Fig. 316). This species was collected from flowers of ten plant species: Ballota nigra, Centaurea scabiosa, Cichorium intybus, Echium vulgare, Hieracium sp., Matricaria inodora, Potentilla argentea, Taraxacum officinale, Trifolium pratense, Veronica sp.

Lasioglossum (Pallhalictus) pallens (BRULLÉ, 1832).

The species may be represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus lineolatus* LEPELETIER, 1841, nec *Apis lineolata* SCHRANK, 1802; *H. cirrhozonius* VACHAL, 1895.

Taxonomy. This species is a representative of a large group of species mostly Mediterranean in occurrence, in which the metapostnotum is provided with the posterior carina. However, it occupies a relatively isolated position in the group and within the subgenus owing to translucent posterior areas of metasomal terga. Relatively morphologically constant throughout its geographical range. Only populations, inhabiting Cyprus (ssp. *kantarae* WARNCKE, 1982), differ from the typical form in the shorter head, slighter shagreened mesonotum and some other features.

Distribution. A widely Mediterranean and Pontic species, occurring in Morocco, south Europe, Caucasus, Asia Minor and Iran. A record from 'Mongolia' by MORAWITZ (1880) is not confirmed by materials in the Zoological Institute in St. Petersburg. In Europe to central Germany in the north. Probably, it will be found in south-eastern Poland.

Ecology. A univoltine species, flying in spring and early summer. Males can overwinter and fly together with females in spring. Polylege.

Bionomics. Solitary. Data on the nesting of this species are published only by MARIKOVSKAYA (1990: 153). In the nest she describes, found in south-east of Kazakhstan, the cell cluster was completely encircled by an air chamber. The cells are vertically oriented. Such a type of nests is not registered in other species of *Lasioglossum*. Therefore the correctness of the identification of the species, whose nest is described by MARIKOVSKAYA, needs a confirmation.

Cleptoparasite: *Sphecodes majalis*.

Lasioglossum (Ebmeria) costulatum (KRIECHBAUMER, 1873) (Figs. 295, 317, 318).

Synonymy: *Andrena campestris* EVERSMANN, 1852 (nomen oblitum, see PESENKO, 1987: 17; Opinion 1511 of ICZN); *Halictus alpestris* MORAWITZ, 1877.

Taxonomy. It differs from other species of the subgenus, the Central Asian *L. maidli* (BLÜTHGEN, 1925), *L. argaeum* (BLÜTHGEN, 1931) recorded from Asia Minor, and *L. ragusanum* (BLÜTHGEN, 1931) described from Croatia, in the rounded mesoscutum at anterior margin, small anterolateral crests of the pronotum, narrow anterior tomentose bands on metasomal terga. Morphologically constant throughout its extensive geographical range.

Distribution. Widely western Palaearctic, mostly in warm and temperate zones, from Spain and Morocco to Baikal to the east. Widespread in continental Europe except for Scandinavia and the subarctic zone of east Europe.

Ecology. A univoltine summer species. Oligolege of Campanulaceae.

Bionomics. Solitary. Nesting unknown. Only clusters of females are discovered in holes consisting of burrows 5 to 8 mm in diameter, which connect chambers having untreated walls, 1.0-1.2 cm in diameter and 1-2 cm long. No cells are found in such holes. Females were most frequently located by one in every cell, less often by two or three together; in total 10 females were unearthed. MARIKOVSKAYA (1984) supposes that the species is at the initial stage of sociality, and females join together for construction of a common nest. She also admits that that those are simply night clusters of females, which yet have no own nests.

Reference: MARIKOVSKAYA, 1984: 28.

lations, inhabiting Cyprus (ssp. *kantarae* WARNCKE, 1982), differ from the typical form in the shorter head, slighter shagreened mesonotum and some other features.

Distribution. A widely Mediterranean and Pontic species, occurring in Morocco, south Europe, Caucasus, Asia Minor and Iran. A record from 'Mongolia' by MORAWITZ (1880) is not confirmed by materials in the Zoological Institute in St. Petersburg. In Europe to central Germany in the north. Probably, it will be found in south-eastern Poland.

Ecology. A univoltine species, flying in spring and early summer. Males can overwinter and fly together with females in spring. Polylege.

Bionomics. Solitary. Data on the nesting of this species are published only by MARIKOVSKAYA (1990: 153). In the nest she describes, found in south-east of Kazakhstan, the cell cluster was completely encircled by an air chamber. The cells are vertically oriented. Such a type of nests is not registered in other species of *Lasioglossum*. Therefore the correctness of the identification of the species, whose nest is described by MARIKOVSKAYA, needs a confirmation.

Cleptoparasite: *Sphecodes majalis*.

Lasioglossum (Ebmeria) costulatum (KRIECHBAUMER, 1873) (Figs. 295, 317, 318).

Synonymy: *Andrena campestris* EVERSMANN, 1852 (nomen oblitum, see PESENKO, 1987: 17; Opinion 1511 of ICZN); *Halictus alpestris* MORAWITZ, 1877.

Taxonomy. It differs from other species of the subgenus, the Central Asian *L. maidli* (BLÜTHGEN, 1925), *L. argaeum* (BLÜTHGEN, 1931) recorded from Asia Minor, and *L. ragusanum* (BLÜTHGEN, 1931) described from Croatia, in the rounded mesoscutum at anterior margin, small anterolateral crests of the pronotum, narrow anterior tomentose bands on metasomal terga. Morphologically constant throughout its extensive geographical range.

Distribution. Widely western Palaearctic, mostly in warm and temperate zones, from Spain and Morocco to Baikal to the east. Widespread in continental Europe except for Scandinavia and the subarctic zone of east Europe.

Ecology. A univoltine summer species. Oligolege of Campanulaceae.

Bionomics. Solitary. Nesting unknown. Only clusters of females are discovered in holes consisting of burrows 5 to 8 mm in diameter, which connect chambers having untreated walls, 1.0-1.2 cm in diameter and 1-2 cm long. No cells are found in such holes. Females were most frequently located by one in every cell, less often by two or three together; in total 10 females were unearthed. MARIKOVSKAYA (1984) supposes that the species is at the initial stage of sociality, and females join together for construction of a common nest. She also admits that that those are simply night clusters of females, which yet have no own nests.

Reference: MARIKOVSKAYA, 1984: 28.

Fig. 317. Occurrence of *Lasioglossum costulatum* in Poland.

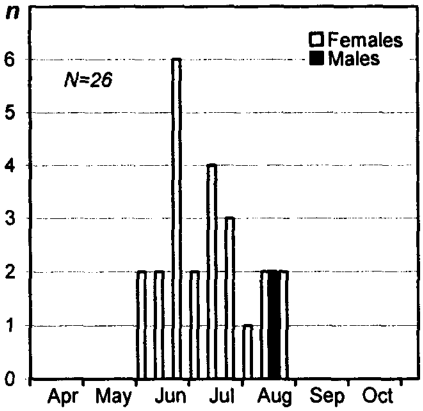


Fig. 318. Flight phenology of *Lasioglossum costulatum* in Poland.

Polish data. Material examined: Żwir [Ratajewo, Warszawa district], 5.VI.1951, 1 ♀ [WAR]. Puławy [Lublin district], 20.VI.1972, on flowers of Borago officinalis, 1 ♀; 9 and 19.VI.1972, on flowers of Jasione montana, 2 ♀; 16. VIII.1972, on flowers of Geranium pratense, 1 ♂ [all five specimens in PUL]. Gruczno [Bydgoszcz district], 20.VI.1973, leg. BANASZAK, 1 ♀ [BAN]. Płutowo [Toruń district], 22.VI.1973, leg. BANASZAK, 1 ♀ [BAN]. Górażdże [ad. Strzelce, Opole district], 29.VI-5.VIII, 12 ♀ [WAR]. Lubinicko ad Świebodzin, Zielona Góra district], 10.VIII.1972, on flowers of Centaurea jacea, 1 ♀ [PUL]. Ojców [Kraków district], 15.VIII.1971, on flowers of Stachys sp., leg. DYLEWSKA, 1 ♂ [KRA]. Dziewicza Góra [Poznań district], 24. VIII.1968, on flowers of Jasione montana, leg. BANASZAK, 2 ♀ [BAN]. This, this relatively rare species does not show a certain geographical pattern in its occurrence in the country (Fig. 317). Females fly since June till the end of August; males appear in August (Fig. 318).

Lasioglossum (Subgenus incertae sedis) ***laevigatum*** (KIRBY, 1802) (Figs. 276, 296, 297, 319, 320).

Synonymy: *Melitta lugubris* KIRBY, 1802; *Hylaeus semicinctus* FÖRSTER, 1860.

Taxonomy. It occupies an isolated position within the genus and requires the fixation as a separate subgenus (see the characteristics of the genus above). Morphologically constant throughout its geographical range.

Distribution. Widespread in Europe almost throughout and in south-western Asia.

Ecology. In the temperate zone of Europe, it is a rather univoltine species with a long period of flying, since April till September. Polylege.

Bionomics. Nesting unknown. Rather solitary.

Fig. 319. Occurrence of *Lasioglossum laevigatum* in Poland.

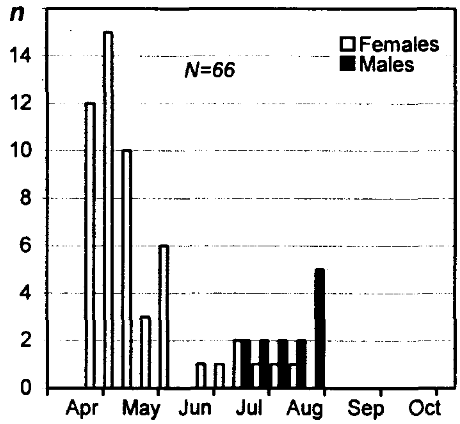


Fig. 320. Flight phenology of *Lasioglossum laevigatum* in Poland.

Polish data. An uncommon species occurring in southern and central Poland (Fig. 319). All specimens, having labels with ecological data, were caught in open areas: meadows, xerothermic swards, roadsides. Females fly since the third decade of April till the second decade of August; males fly since the second decade of July till the end of August (Fig. 320). Recorded from flowers of 19 species belonging to different botanical families: Achillea millefolium, Anthericum ramosum, Cardamine sp., Carduus nutans, Centaurea scabiosa, Fragaria vesca, Geranium phaeum, G. sanguineum, G. silvaticum, Hieracium sp., Hieracium pilosella, Lotus corniculatus, Lysimachia vulgare, Myosotis sp., Origanum vulgare, Potentilla sp., Solidago virgaurea, Tanacetum vulgare, Taraxacum officinale.

Lasioglossum (Leuchalictus) majus (NYLANDER, 1832) (Figs. 280, 321-324).

Synonymy: *Halictus lichtensteini* PÉREZ, 1903.

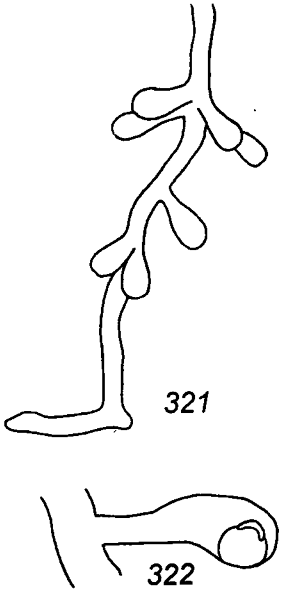
Taxonomy. Differences between this species and the closest *L. zonulum* (see below) are given in the key above. This species shows a high morphological constancy throughout its extensive geographical range.

Distribution. Widely distributed in the temperate parts of Europe, in the south mostly in highlands; also recorded from Algeria and Tunisia.

Ecology. In the temperate zone of Europe, it is a rather univoltine species with a long flying period. Polylege.

Bionomics. Solitary. The main burrow of the nest is poorly sinuous, almost vertical. Cells of sessile type are built progressively downwards. The female can gradually deepen the main burrow. The lower blind burrow at its extremity is horizontally oriented (Fig. 321). Cells are usually horizontally oriented or slightly slanting downwards. The pollen ball is ball-shaped, and strongly flattened on its top. The egg is laid on the top of the food, after that the cell gets sealed with a plug (Fig. 322).

Reference: MALYSHEV, 1936.



Figs. 321, 322. Nest and cell of *Lasioglossum majus* (from MALYSHEV, 1936: Figs. 39, 64).

Fig. 323. Occurrence of *Lasioglossum majus* in Poland.

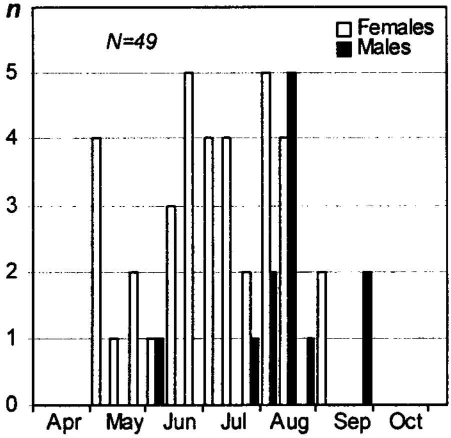


Fig. 324. Flight phenology of *Lasioglossum majus* in Poland.

Polish data. A relatively uncommon species dispersally spread in Poland (Fig. 323). It does not show a certain biotopic preference. Females fly since May till September; males (only twelve specimens) were observed since the first decade of June till the end of September (Fig. 324). Recorded from flowers of over dozen plant species belonging to different botanical families: Centaurea, Epilobium, Geranium, Hieracium, Knautia, Lonicera, Mentha, Ononis, Senecio, Stachys, Taraxacum, Thymus.

Lasioglossum (Leuchalictus) zonulum (SMITH, 1848) (Figs. 274, 277, 282, 298, 299, 325, 326).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Hylaeus trifasciatus* SCHENCK, 1853; *Halictus rhenanus* VERHOEFF, 1890; *H. recepticus* VACHAL, 1902; *H. craterus* LOVELL, 1908.

Taxonomy. This species shows a distinct geographical variation in the punctation of the metasomal tergum I. Some southern and eastern populations were described as separate subspecies: ssp. *sinistrum* (BLÜTHGEN, 1934) in Transcaucasus and Iran, ssp. *dextrum* (BLÜTHGEN, 1934) in Central Asia, spp. *euronotum* EBMER, 1998 in southern China.

Distribution. This species is Holarctic in occurrence. In the Palaearctic and northern Oriental regions, it is widely distributed in temperate and warm zones of Europe and Asia to Baikal, Buryatia and southern China in the east.

Ecology. In the temperate Europe this is a univoltine species with a long period of flying: since May till October. Wide polylege.

Bionomics. Solitary. Nests are established on open well sun-warmed lots. Around the nest entrance there is a tumulus 5 cm in diameter and 5 mm high. The entrance opening, 8 mm in diameter, is located at the centre of the tumulus. The main burrow is almost vertical. At a depth of about 20 cm it is concluded with a widened lower blind burrow. From along the main burrow, starting at a distance of 10 cm from the ground surface, laterals branch off, having each of them one cell at its extremity. The distance between laterals amounts to approximately 2 cm, their length to 1-2 cm. Cells are pear-like in form, they have narrow necks closed with caps. Cell walls are polished. The diameter of a cell in its broadest part is 9 mm, the length 12 mm. The provision of yellow pollen stored in a cell has a shape of a lump of irregular form and hard consistency. The pollen lump is tightly attached to the cell wall. The egg is fixed on the pollen ball with the both of its ends. The length of the egg is 2 mm, diameter 0.5 mm. Having completed the cell construction, the female closes itself within the nest, and waits for the emergence of its brood. After copulation young females hibernate in their mothers' nests. To this end, they deepen the main burrow of the nest as seriously as to 40-50 cm, and construct there individual hibernaculas. The foundress female hibernates together with its brood. The bees leave their nest when the winter ends, and several days later build their own nests, which are used for several seasons. Either the foundress or one of its daughters remains in the old nest, breeding a new generation, and then the cycle repeats. Thus, the female-foundress can live for two years.

References: BRITTAIN, 1933: 94; GOLUBNICHAYA & MOSKALENKO, 1991: 361-366.

Fig. 325. Occurrence of *Lasioglossum zonulum* in Poland.

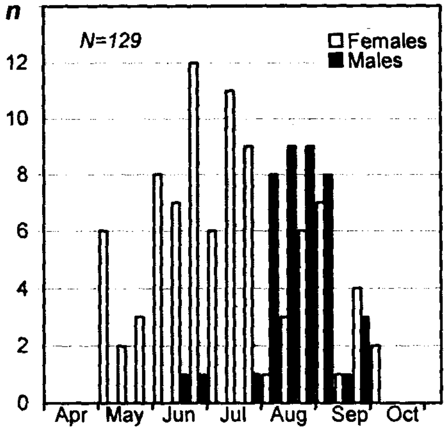


Fig. 326. Flight phenology of *Lasioglossum zonulum* in Poland.

Polish data. A relatively common species spread in the whole country (Fig. 325). Not showing a certain biotopic preference. Females fly since May till the beginning of October; males were caught since June till September (Fig. 326). Collected from flowers of 22 species belonging to different botanical families.

Lasioglossum (Leuchalictus) leucozonium (SCHRANK, 1781) (Figs. 278, 300, 301, 327-330).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Apis leucostoma* SCHRANK, 1781; *Halictus similis* SMITH, 1853; *H. bifasciatellus* SCHENCK, 1875; *H. leucozonius* var. *nigritibialis* DALLA TORRE, 1877; *H. deiphobus* BINGHAM, 1908.

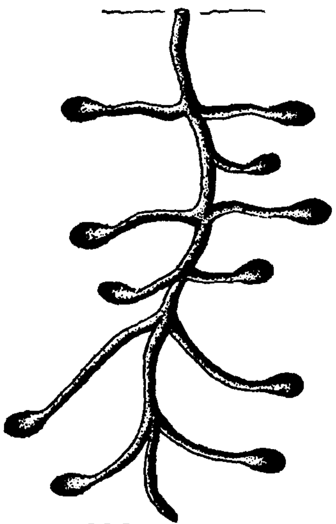
Taxonomy. Southern populations of the species differ from the typical form in the sculpture of the body and coloration of pubescence. Some of them were described as separate subspecies (see below). The typical form differs from the closest *L. tadschicum* (BLÜTHGEN, 1934), distributed in Central Asia, in the dark pubescence of the vertex and mesosoma and the narrower hair band of metasomal tergum IV, from the eastern Palaearctic *L. satschauense* (BLÜTHGEN, 1934) mostly in the denser punctation of metasomal tergum I.

Distribution. A Holarctic species. In the Palaearctic region almost throughout to the Krasnoyarsk and Irkutsk provinces in the east; in southern parts of its extensive geographical range mostly in highlands. In the Far East of Russia, northern China and Mongolia, the species is replaced with *L. satschauense*, whereas in deserts of West and Central Asia with *L. tadschicum*. Some southern geographical populations of this species are regarded as separate subspecies: ssp. *clusium* (Warncke, 1975) in Anatolia, ssp. *xylopedis* Ebmer, 1978 in Iran, ssp. *cedri* EBMER, 1976 in several localities of the Mediterranean basin, ssp. *elysium* EBMER, 1979 in mountains of north-western Spain.

Ecology. Usually univoltine, but flying all the season long. Very common, especially in drier habitats. Wide polylege, preferring composites. Important pollinator of lucerne and many other entomophilous cultivated plants.

Bionomics. Solitary. Nest aggregations are created on plain ground lots, prevalently devoid of vegetation. Often nests are built in sandy soil. Combined nests constructed by two females are registered. The female pours a small conical tumulus around the nest entrance. At night the entrance is closed. The main burrow is poorly sinuous; it stretches almost vertically downwards to a depth of 7-15 cm. Laterals are short, horizontal or more or less hardly inclined down; their length is 1-4 cm, diameter 4 mm. The nest has a typically branched structure (Figs. 327, 328). Cells are ovaloid in form, 10 mm long, 5 mm in diameter; the diameter of the cell neck is 3 mm. Having completed the provisioning of the cell and laid an egg, the female seals the cell with a cap and fills the lateral with soil. Within one nest the female builds 6 to 15 cells. After copulation young females hibernate, probably far from their maternal nests, since every year they create aggregations at new places.

References: ATWOOD, 1933: 449-451; NIELSEN, 1934: 429-430; BONELLI, 1954b: 72-78; KNERER & ATWOOD, 1966: 1338; KNERER, 1969: 925-930; GROZDANIĆ 1971a: 219-221.



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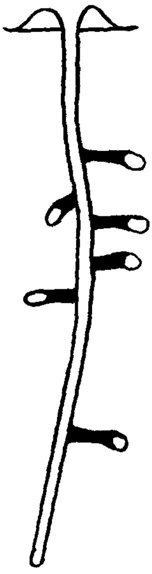

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Figs. 327, 328. Nests of *Lasioglossum leucozonium* (from BONELLI, 1954b: Fig. 1; KNERER, 1969: Fig. 1).

Fig. 329. Occurrence of *Lasioglossum leucozonium* in Poland.

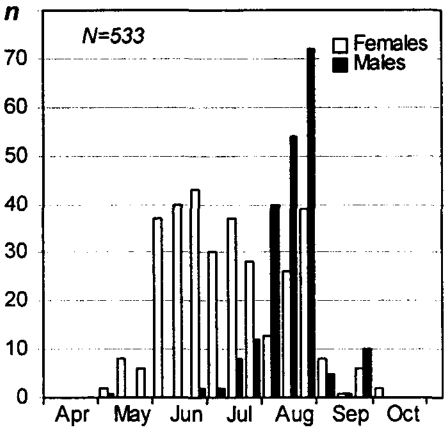

Fig. 330. Flight phenology of *Lasioglossum leucozonium* in Poland.

Polish data. A very common species occurring in the whole Poland (Fig. 329). Preferring open areas (90% records) such as meadows, xerothermic swards, roadsides, margins of fields. Both sexes fly since May till the end of September; males were caught oftenly in August (Fig. 330). The species was recorded from flowers of 50 plant species, but prefers Asteraceae (93% records).

Lasioglossum (Leuchalictus) alinense (COCKERELL, 1924).

Synonymy: *Halictus gorkiensis* BLÜTHGEN, 1931.

Taxonomy. This species differs from the closest *L. scitulum* (SMITH, 1873), inhabiting the south-eastern part of the Palaearctic region, in dull metasomal terga I and II.

Distribution. This is a very rare species, formally almost transpalaearctic in occurrence but with a great disjunction including eastern Europe and west Asia. Till now, it is known only from the Mogilev province (Belarus; type locality of *Halictus gorkiensis*), Lithuania (MONŠEVICIUS, 1995: 54), Altai (new record: Teletskoye lake; the material is in the collection of the Zoological institute in St. Petersburg), East Siberia and the Russian Far East (PESENKO, 1986a: 139). Probably, it will be found in north-eastern Poland.

Ecology and bionomics unknown.

11. Genus ***Evylaeus*** ROBERTSON, 1902

Members of this very large genus are known from all continents except for Australia. They are especially numerous in the Holarctic region. The Palaearctic fauna consists of about 400 currently recognised species. One of them, *Evylaeus rufitarsis* (ZETTERSTEDT), is Holarctic in occurrence. Many species are transpalaearctic. In the Palaearctic region there are three distinct centres of species richness of the genus: the Mediterranean, Central Asian and Far Eastern. A subgeneric classification of the genus is not yet elaborated, although some subgeneric names proposed by WARNCKE (1975a) can be used.

The genus exhibits both solitary behaviour and nearly every degree of sociality, ranging from subsocial to primitive eusocial behaviour (Michener, 1974, 1988; RADCHENKO & PESENKO, 1994; PESENKO & RADCHENKO, 1996). The members of the genus are mostly polyleges, except for species belonging to the *E. punctatissimus* group that are oligoleges of the Lamiaceae.

A total of 121 species inhabit Europe, including 44 species certainly recorded from Poland. Also the following species can be found in south-eastern Poland: *Evylaeus lissonotus* (NOSKIEWICZ), *E. marginatus* (BRULLÉ), and *E. podolicus* (NOSKIEWICZ). Distributional data for species listed below are mostly compiled from papers by EBMER cited in selected references on taxonomy.

Taxonomy. BLÜTHGEN, 1918a: 272-276; 1918b: 196-217; 1919b: 257-266; 1920: 91-103, 106-107, 114-129, 132; 1921a: 272-286, 289-291, 301-302; 1921b: 127-143; 1922a: 46-66; 1922b: 317-319; 1923a: 239-242; 1924a: 53-64, 76-95, 253-284; 1924b: 262-266; 1924c: 382-393, 422-469, 477-483, 501-533, 539-544; 1925b: 89-92, 104-124; 1926: 549-584; 1929a: 58-67; 1931a: 351-386; 1931c: 301-319; 1934b: 153-159; 1934d: 11-20; 1935a: 113-120; SANDHOUSE, 1924: 1-43; MICHENER, 1954b: 44-52; 1979: 193; MITCHELL, 1960: 348-445; EBMER, 1970: 44-82; 1971: 63-156; 1972b: 238-267; 1974b: 197-208; 1974c: 56-63; 1975a: 91-111; 1976c: 239-263; 1978a: 200-212; 1978b:45-85; 1978c: 310-317; 1979: 133-141; 1980: 475-480, 484-493, 497-504; 1981: 116-126; 1982: 211-226; 1984b: 318-324; 1985a: 203-220; 1985b: 280-291; 1986: 417-443; 1987b: 80-83; 1988b: 597-676; 1995: 525-652; 1996a: 237-246; 1996b: 278-294; 1997: 921-982; EBMER & SAKAGAMI, 1985a: 297-310; 1985b: 124-130; 1990: 535-538; WARNCKE, 1973b: 287-295; 1975a: 85-92, 95-104; 1975b: 209-211; 1982a: 68-90, 106- 110, 116-133; 1984: 278-293, 299-305; SVENSSON et al., 1977: 219-229; SAKAGAMI et al., 1982: 198-211; EBMER et al., 1994: 23-36; SAKAGAMI & TADAUCHI, 1995a: 141-176.

KEY TO THE POLISH SPECIES OF EVYLAEUS

1. Body black to brownish-black, sometimes with a slight blue metallic tint on mesoscutum (female of *E. villosulus*) or on metasoma (*E. albipes*), sometimes metasoma partly red 2
– Head, mesosoma and often metasoma dull metallic greenish, blue-greenish or bronze. (The conditional group of the 'green *Evylaeus*') 42

2. Posterior vertical surface of propodeum carinate along all lateral and upper margins, sometimes only at upper margin (in female of *E. setulellus* and *E. tricinctus*)[1]. (The conditional group of the 'carinate *Evylaeus*') 3

– Posterior vertical surface of propodeum in upper margin and at least in upper third of lateral margins without a carina, sometimes metapostnotum carinate in posterior margin, but then the carina standing vertically[2]. (Conditional group of the 'carina-less *Evylaeus*') 20

3. Metasomal terga without anterior tomentose bands, sometimes with small lateral spots; posterior areas of terga dark, black to brownish, not translucent, if terga narrowly translucent then mesepisterna finely and densely, but distinctly punctate and shiny at interspaces at least above scrobe 4

– Terga always with anterior tomentose bands or lateral spots; posterior areas of terga translucent, yellowish to whitish; mesepisterna always mat, granulate or rugulose 7

4. *Both sexes*: mesepisterna at least above scrobe distinctly punctate, usually shiny at interspaces; length 5-7 mm; posterior areas of metasomal terga narrowly translucent. *Female*: inner metatibial spurs with 2-3 relatively long thin tooth and 1-2 short (Figs. 357, 358). *Male*: antenna long, reaching the metasoma; 2nd flagellomere 1.5-1.7 times as long as wide (Fig. 394); gonostylus with a small thick drop-shaped membranous retrorse lobe (Fig. 449) 5

– *Both sexes*: mesepisterna mat, granulate or rugulose; length 6-8 mm; posterior areas of terga dark, black to brownish, not translucent. *Female*: inner metatibial spurs of other form (Figs. 354-356). *Male*: antenna short, reaching only the metanotum or shorter; 2nd flagellomere 1.2-1.3 times as long as wide (Figs. 392, 393); gonostylus without membranous lobe (Figs. 447, 448) 6

5. *Both sexes*: mesepisterna above scrobal suture finer and sparser punctate (15µm /0.2-0.6, in male slightly denser); usually somewhat larger, length 6-7 mm. *Female*: mesoscutum (1-3) and discs of metasomal terga I (2-7) and II (2-4) sparser punctate; tergum II without tomentose spots; posterior areas of terga II and IV covered with relatively long, sparse, inclined, slightly plumose, yellowish hairs. *Male*: metasomal terga flattened, posterior area of tergum III finely, but distinctly transversely striate at interspaces between punctures; metasomal sterna II-IV with long, relatively dense, erect, white hairs .... ***E. minutulus***

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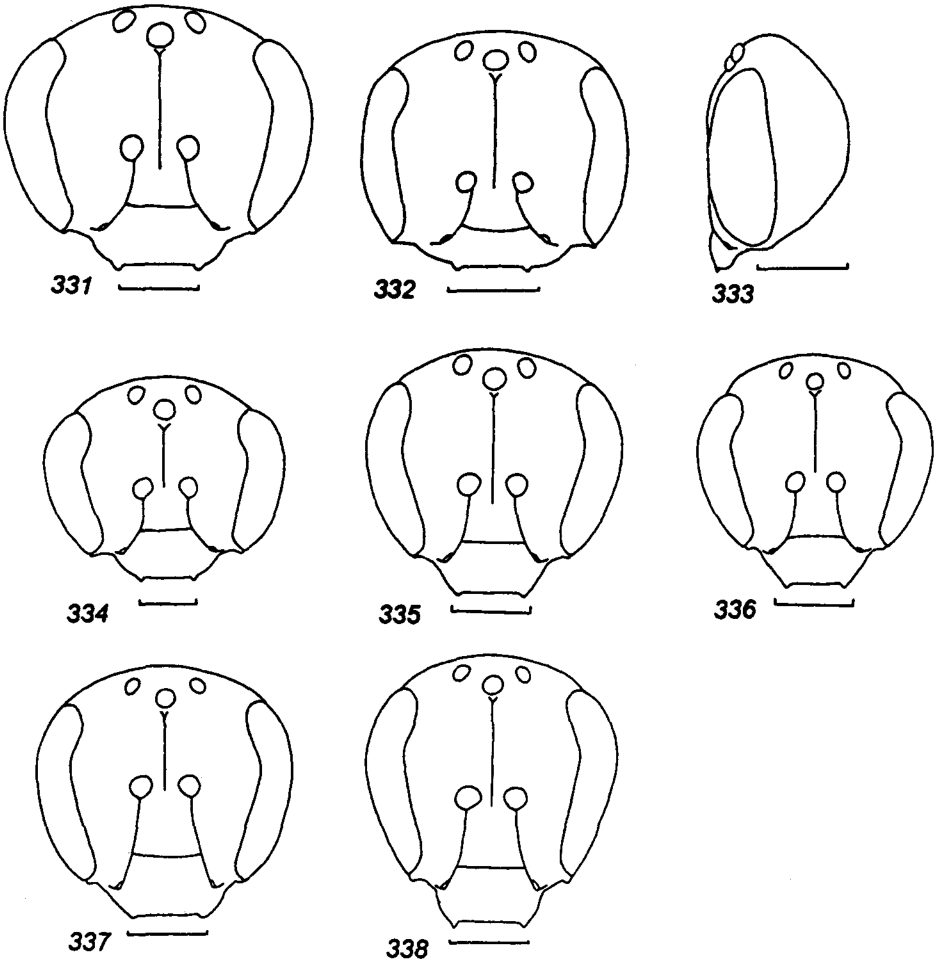
[1] In the *E. pauxillus* species-group the carina often almost indistinguishable at dorsolateral angles. In this case the species runs to Couplet 32, where it can be clearly distinguished from other species in translucent and depressed posterior areas of metasomal terga, in structure of male genitalia and other characters, see Couplet 19.

[2] In female of *E. puncticollis*, the propodeum is so coarsely rugose that its posterior surface seems carinate. In this case it runs to Couplet 4, where it can be distinguished from *E. laevis* and *E. interruptus* (same as from all other species of the true 'carinate *Evylaeus*') in very coarse and dense rugose genal areas and in some other characters, see Couplet 40.



Figs. 331-338. Head of females in *Evylaeus*, frontal and lateral views.
331. E. laticeps. 332, 333. E. politus. 334. E. quadrinotatulus. 335. E. tarsatus. 336. E. leucopus. 337. E. morio. 338. E. nitidulus. Scale lines represent 0.5 mm.

– *Both sexes*: mesepisterna above scrobal suture twice coarser and denser punctate; usually smaller, length 5-6 mm. *Female*: mesoscutum and discs of terga I and II twice denser punctate; tergum II with very small anterior lateral tomentose spots; pubescence of posterior areas of terga II and IV much denser, band-like. *Male*: terga I-III convex, their posterior areas at interspaces between punctures smooth; sterna II-IV nearly hairless .... ***E. setulosus***

6. *Both sexes*: body slender; metasomal terga polished, with very sparse and fine punctures on discs, without anterior tomentose spots (only in female the tergum II laterally sometimes with several tomentose hairs). Female: tergum II distinct-

ly convex in lateral view; inner metatibial spur finely dentate (Fig. 354). *Male*: labrum black; flagellum dark-brown on lower side; dorsal surface of propodeum as long as scutellum; metasoma flattened, distinctly broadened backward in dorsal view (Fig. 421), always black. Length 7-8 mm .... ***E. laevis***

– *Both sexes*: body robust; terga uniformly, coarsely and densely punctate (20-30 µm / 0.5-1.5); terga II and III with small anterior lateral tomentose spots. *Female*: tergum II flat in dorsal view; inner metatibial spur pectinate, with 5-6 long blunt processes (Figs. 355, 356). Male: labrum yellow; flagellum yellowish-brown on lower side; dorsal surface of propodeum 0.7 times as long as scutellum; metasoma cylindrical, elongate elliptic in dorsal view (Fig. 422); tergum I often red. Length 6-8 mm .... ***E. interruptus***

7\. *Both sexes*: metasomal terga II-IV on posterior areas covered with white dense thin appressed hairs which form narrow distinct posterior bands broadly interrupted on tergum II. *Female*: mesoscutum sparsely punctate (1-3), polished at interspaces throughout; inner metatibial spurs with four short teeth in distal half, edentate at proximal half. *Male*: head transversely elliptic in frontal view, its height/width ratio 0.8-0.85; supraclypeal area at upper part with a flattened tooth; antenna entirely black, short, reaching only the metanotum; 2nd flagellomere 1.5 times as long as wide; clypeus black; tarsi shortened, 2nd tarsomere of middle legs 1.2 times as long as wide; gonostylus relatively small, flattened, elongate rounded; membranous lobe 2.5 times as long as gonostylus, narrow, rounded at apex. Length 8-9 mm .... ***E. marginatus***

– *Both sexes*: terga II-III on posterior areas without band-like pubescence; sometimes terga III-V or IV-V covered with a not dense tomentum or dust-like pubescence nearly throughout (in females of *E. obscuratus*, *E. damascenus*, and *E. tricinctus*). *Female*: mesoscutum denser punctate, roughened at interspaces at least on anterior half; inner metatibial spurs of other form. *Male*: head round to elongate in frontal view (except for *E. laticeps*); other characters variable 8

8\. *Both sexes*: larger, length 9-11 mm (except for *E. albipes*, 7-8.5 mm); metasomal terga II-IV with broad anterior tomentose bands; terga I-III sometimes partly red. *Female*: metasomal tergum I narrower, its length/width ratio 0.75; lateral outlines of this tergum less convex (Fig. 377) (except for *E. euboeensis* in which this ratio is 0.66); inner metatibial spurs finely and densely dentate (Figs. 339, 340). *Male*: flagellum dark (dark-brown to black) on lower side; gonocoxite nearly hairless; gonostylus relatively small, flattened, elongate, rectangular rounded, poorly pubescent; without membranous retrorse lobe (Figs. 429, 430) 9

– *Both sexes*: smaller, length 5-8 mm; if body larger then tergum I very coarsely and densely punctate (*E. obscuratus*, 9-11 mm) or rugulose sculpture of metapostnotum not reaching its posterior margin (*E. malachurus*, 7-9 mm); pubescence of terga variable. *Female*: tergum I broader, its length/width ratio about 0.6; lateral outlines of this tergum more convex (Fig. 378); inner metatibial spurs variable. *Male*: flagellum usually paler (brownish-yellow to ochre-yellow) on lower side; gonostylus of other form, provided with a well developed membranous retrorse lobe, if small, flattened and without this lobe (in *E. laticeps)* then antenna very long, reaching the metasoma and head very short, transversely elliptic 12

9. *Both sexes*: metasomal tergum I on convex surface nearly impunctate, finely roughened, dull; metapostnotum granulate. *Male*: clypeus black or with a small yellow spot; labrum and mandibles black; antenna very short, reaching only the scutellum; 2nd flagellomere 1.3-1.4 times as long as wide (Fig. 388) .... ***E. nigripes***

– *Both sexes*: tergum I on convex surface polished to punctate and polished at interspaces; metapostnotum rugulose. *Male*: clypeus yellow on lower part; labrum and mandibles medially yellow (usually except for *E. calceatus*); antenna longer (Fig. 387) 10

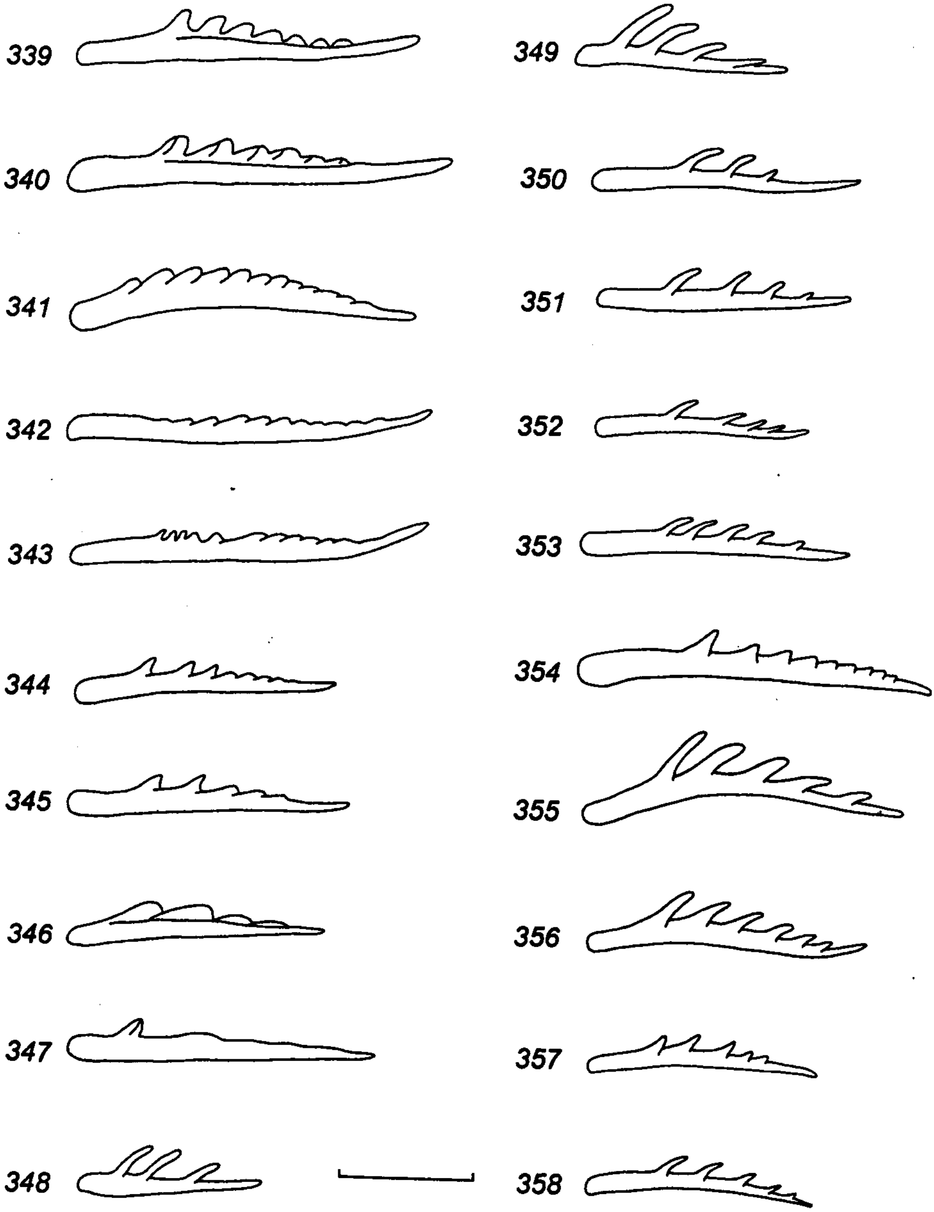
10. *Both* sexes: posterior areas of metasomal terga depressed and separated from tergal discs at all width; *Female*: clypeus coarser and sparser punctate (0.5-2.5) on upper half, polished at interspaces; tergum I uniformly and relatively densely punctate. *Male*: metasomal sternum II and subsequent ones on discs covered with relatively dense, erect, white hairs .... ***E. euboeensis***

– *Both* sexes: posterior areas of terga not separated from tergal discs. *Female*: clypeus on upper half and supraclypeal area very finely and densely punctate (0.2-0.8), roughened at interspaces, dull; tergum I impunctate or very finely, sparsely and irregularly punctate (1.5-5.0 medially). *Male*: sternum II and subsequent ones on discs covered with short hairs 11

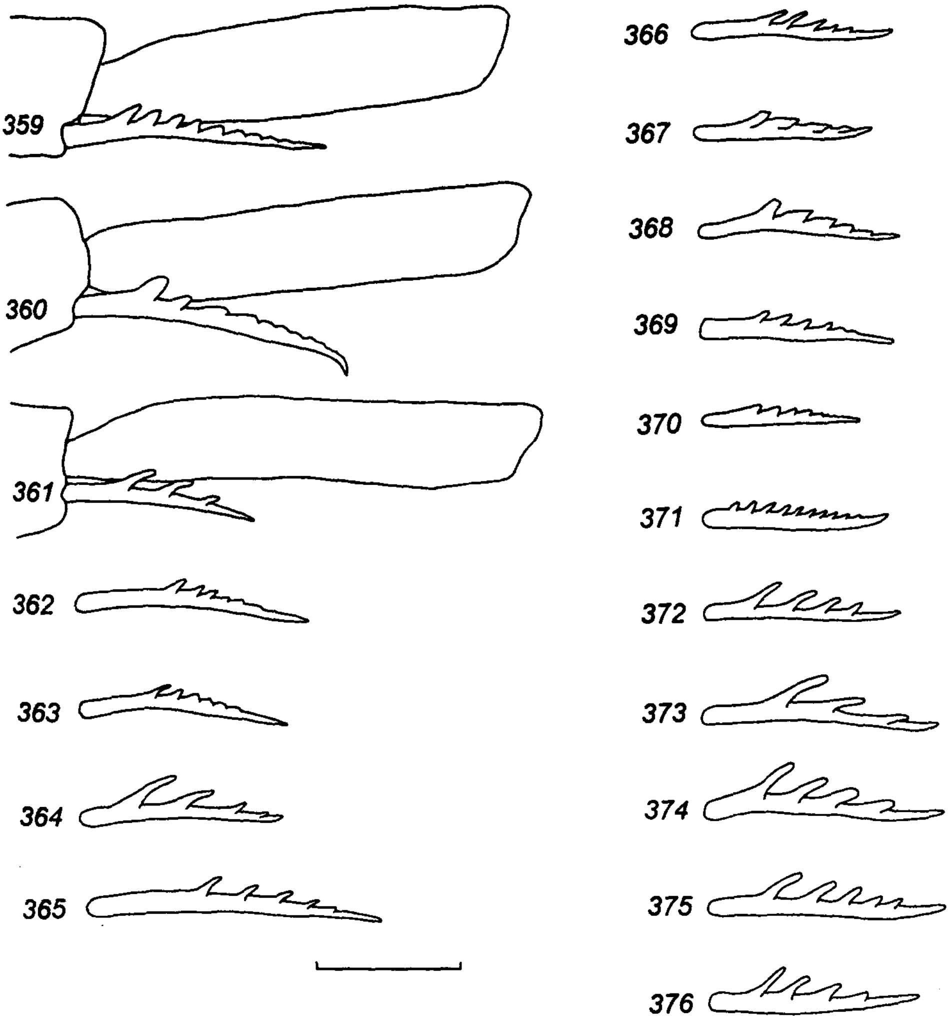
11. *Both sexes*: head shorter, as high as wide (roundish in frontal view in female; triangularly roundish in male), with shortened clypeus and slightly convex vertex; metasomal terga shiny, without blue tint; larger, length 9-10 mm. *Female*: dorsal surface of propodeum 0.8 times as long as scutellum, coarser rugulose. *Male*: labrum usually black .... ***E. calceatus***

– *Both sexes*: head higher than wide (roundly triangular in frontal view in female; elongate elliptic in male), clypeus longer, vertex more convex; terga I and II with a distinct oily-dull blue tint (slight in male); smaller, length 7.0-8.5 mm. *Female*: dorsal surface of propodeum about as long as scutellum, finer rugulose. *Male*: labrum always yellow .... ***E. albipes***

12. *Both sexes*: head transversely elliptic in frontal view; its height/width ratio 0.8-0.85 (Figs. 331, 379); mesoscutum relatively sparsely punctate, shiny at least on posterior third; metasomal tergum I relatively densely punctate; its posterior area not depressed and not separated from tergal disc at least medially; length 5-7 mm. *Female*: inner metatibial spurs nearly edentate (Fig. 347); metasoma shortened, elliptic in dorsal view. *Male*: antenna very long (Fig. 389), reaching the metasoma; metasoma very narrow, broadened backward (Fig. 420); sternum II hairless or with inconspicuous, short and sparse hairs laterally; gonocoxite nearly hairless; gonostylus relatively small, flattened, elongate, rectangular rounded, poorly pubescent; without membranous retrorse lobe (Fig. 437, 438) .... ***E. laticeps***



Figs. 339-358. Inner metatibial spur of females in *Evylaeus*.
339, 340. E. calceatus. 341. E. obscuratus. 342, 343. E. malachurus 344, 345. E. linearis. 346. E. pauxillus. 347. E. laticeps. 348. E. tricinctus. 349. E. setulellus. 350, 351. E. fulvicornis. 352, 353. E. fratellus. 354. E. laevis. 355, 356. E. interruptus. 357. E. minutulus. 358. E. setulosus. Scale line represents 0.3 mm.

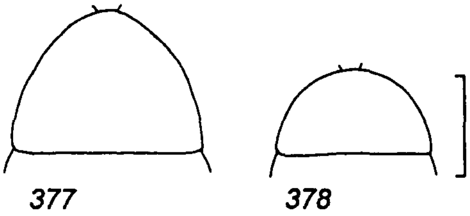


Figs. 359-376. Inner metatibial spur and metabasitarsus (*359*, *360*, and *361*) of females in *Evylaeus*. *359. E. brevicornis. 360. E. limbellus. 361-363. E. sexstrigatus. 364. E. politus. 365. E. quadrinotatulus. 366. E. minutissimus. 367. E. intermedius. 368. E. semilucens. 369. E. tarsatus. 370. E. marginellus. 371. E. quadrisignatus. 372. E. leucopus. 373. E. morio. 374. E. nitidulus. 375. E. cupromicans. 376. E. bavaricus.* Scale line represents 0.3 mm.

- *Both sexes*: head as high as wide or higher than wide (only in *E. malachurus* it is distinctly shorter than wide, in female its height/width ratio 0.9); sculpture of mesoscutum and tergum I, form of metasoma and size of body variable. *Female*: inner metatibial spurs dentate or pectinate. *Male*: length of antenna and pubescence of sternum II variable; gonostylus of other form and always provided with a well developed membranous lobe (Figs. 431-436, 439-446) 13

13. *Both sexes*: metasomal terga very coarsely punctate (25-30 µm); tergum I denser punctate (0.1-0.3), roughened at interspaces, dull; terga II and III with broad anterior tomentose bands; larger, length 9-11 mm. *Female*: inner metatibial spurs finely and densely dentate (Fig. 341); metasomal tergum IV covered throughout with sparse, short, white, tomentose hairs; metapostnotum finely rugulose, its sculpture similar to that of lateral surfaces of propodeum. *Male*: metasomal sternum II and subsequent ones on discs covered with relatively dense, erect, white hairs; gonocoxite on distal part and gonostylus over base covered with long dense hairs .... ***E. obscuratus***

– *Both sexes*: terga much finer punctate; tergum I impunctate or sparser punctate, polished at interspaces, shiny; terga II and III with interrupted anterior bands or lateral spots (except for *E. tricinctus* and *E. setulellus* in which females have well developed anterior bands); smaller, length 5-9 mm *Female*: inner metatibial spurs of other form (except for *E. malachurus* and *E. linearis*); tergum IV poorly pubescent (except for *E. tricinctus* and *E. setulellus*); metapostnotum coarser rugulose, its sculpture sharply differing from that of lateral surfaces of propodeum. *Male*: pubescence of sterna and structure of genitalia of other form (except for *E. malachurus* and *E. linearis*) 14



Figs.377, 378. Metasomal tergum I of females in *Evylaeus*, dorsal view.
377. E. calceatus. 378. E. malachurus.
Scale lines represent 1 mm.

14. *Both sexes*: mesoscutum densely punctate, very densely roughened at interspaces throughout, mat (sometimes silky-dull in female of *E. fulvicornis*); length 6-8.5 mm. *Female*: inner metatibial spurs with 2-4 thin and sharp processes (Figs. 350-353); metapostnotum sparsely and obscurely rugulose, silky; metasoma shortened, elliptic in dorsal view; metasomal tergum I nearly impunctate; its posterior area of tergum I not depressed and not separated from tergal disc at least medially. *Male*: tarsi shortened; 2nd tarsomere of hind legs 1.0-1.5 times as long as wide (Figs. 415, 416); antenna long, reaching at least the metasoma (Figs. 390, 391); pubescence of last metasomal tergum long and dense; gonostylus elongate, 2-3 times as long as wide; its membranous lobe long (Figs. 443-446) 15

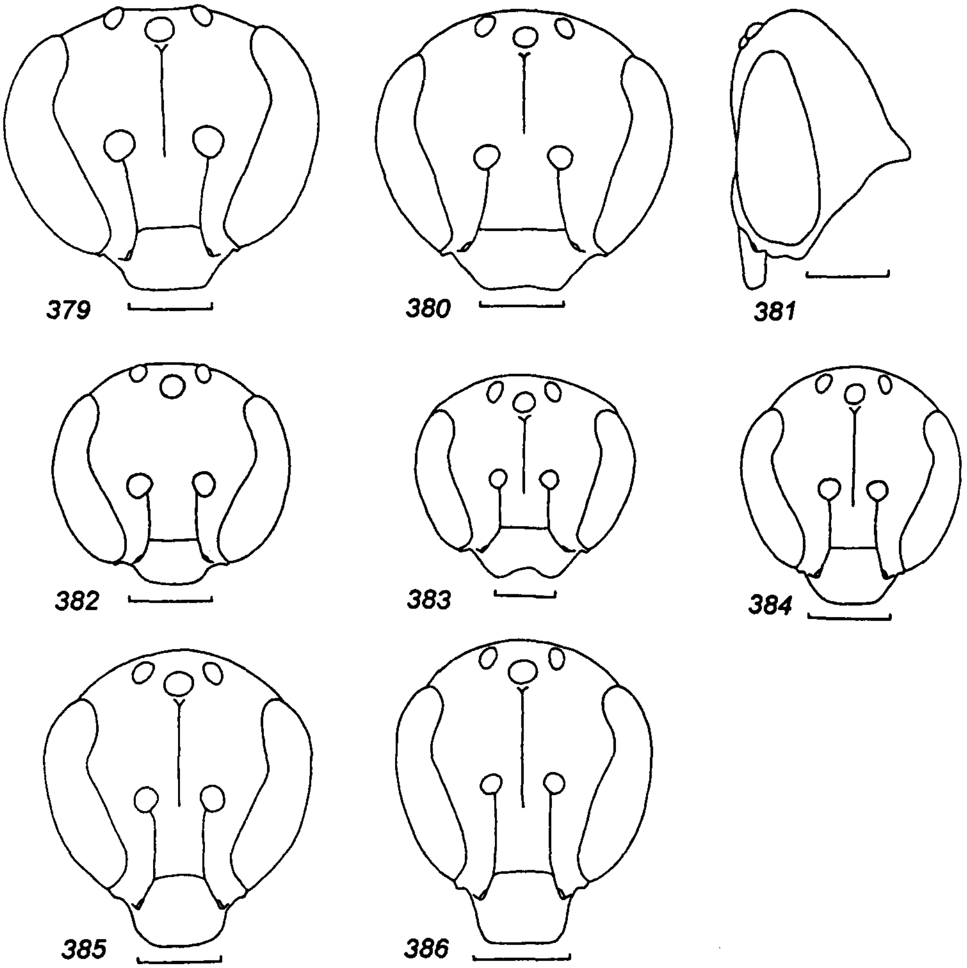
- *Both sexes*: mesoscutum sparser punctate, shiny at least on posterior third. *Female*: inner metatibial spurs of other form; form of metasoma and sculpture of tergum I variable. *Male*: tarsi normal; 2nd tarsomere of hind legs 2.0-2.5 times as long as wide (Figs, 413, 414); antenna shorter; pubescence of last terga short; gonostylus not curved; its membranous lobe variable 16

15\. *Both sexes*: head shorter, its height/width ratio 0.9-0.95; metasomal terga II and III with distinct, relatively large anterior lateral tomentose spots. *Female*: inner metatibial spurs with 2-3 long and relatively thick teeth and one short tooth (Figs. 350, 351); mesoscutum sparser and coarser punctate, sometimes obscurely roughened at interspaces and silky. *Male*: antenna shorter, reaching the end of mesosoma; flagellum thicker, its last segment about 1.5 times thicker than 1st one Fig. 390); tibiae of all legs yellow at least on proximal and distal ends. 2nd tarsomere of hind legs 1.5 times as long as wide (Fig. 415); pubescence of terga V-VII whitish, terga V and VI covered with short, sparse and inclined hairs; gonostylus directed backward in relation to gonocoxite (Figs. 443, 444) ....***E. fulvicornis***

- *Both sexes*: head slightly higher, its height/width ratio 0.97-1.05; terga II and III with small and indistinct anterior lateral tomentose spots. *Female*: inner metatibial spurs with 4-5 thin and relatively short teeth (Figs. 352, 353); mesoscutum denser and finer punctate, always densely roughened at interspaces, mat. *Male*: antenna very long, reaching the tergum II; flagellum thin; its last segment about as wide as 1st one (Fig. 391); tibiae of all legs black entirely. 2nd tarsomere of hind legs nearly as long as wide (Fig. 416); pubescence of terga V-VII black, long, dense, erect; gonostylus directed downward in relation to gonocoxite, forming with the latter a right angle (Figs. 445, 446) ....***E. fratellus***

16\. *Female*: posterior vertical surface of propodeum rounded at all its lateral margins, distinctly concave, finely granulate; metasomal tergum IV covered throughout with not dense, white tomentose hairs forming a band-like pubescence on posterior area of this tergum; inner metatibial spur coarsely pectinate, armed with 2-4 long processes rounded at apices (similar to those in *Nomioides*; Figs. 348, 349); tergum I on disc impunctate or very sparsely and irregularly punctate. *Male*: gonostylus large, axe-shaped (or like an arrow-head; Figs. 439, 441); its membranous lobe large, triangular, rolled up (Figs.440-442). Length 6-8 mm 17

- *Female*: posterior vertical surface of propodeum carinate at all its lateral margins (except for *E. pauxillus* in which the carina is often very slight), not concave, usually rugulose; tergum IV only with anterior lateral tomentose spots or without tomentum; inner metatibial spur of other form; tergum I relatively densely punctate. *Male*: gonostylus and its membranous lobe of other form 18



Figs. 379-386. Head of males in *Evylaeus*, frontal and lateral views.
379. E. laticeps. 380, 381. E. sexstrigatus. 382. E. politus. 383. E. quadrinotatulus. 384. E. leucopus. 385. E. morio. 386. E. nitidulus. Scale lines represent 0.5 mm.

17. *Female*: flagellum on lower side dark-brown; inner metatibial spurs with two long processes and one shorter process (Fig. 348); posterior areas of metasomal terga reddish-yellow to yellowish-hyaline; metasomal tergum III covered with sparse tomentose hairs behind anterior band. *Male*: head and mesosoma brownish-black, with a slight bronze tint; tibiae entirely to mostly rusty-yellow; stigma and wing veins yellowish-brown; metapostnotum coarser rugulose, margined with a sharp carina; posterior areas of metasomal terga I-III polished, impunctate, narrowly translucent, reddish-yellow; gonostylus with long bristles at both dorsal and ventral margins (Fig. 439) .... ***E. tricinctus***

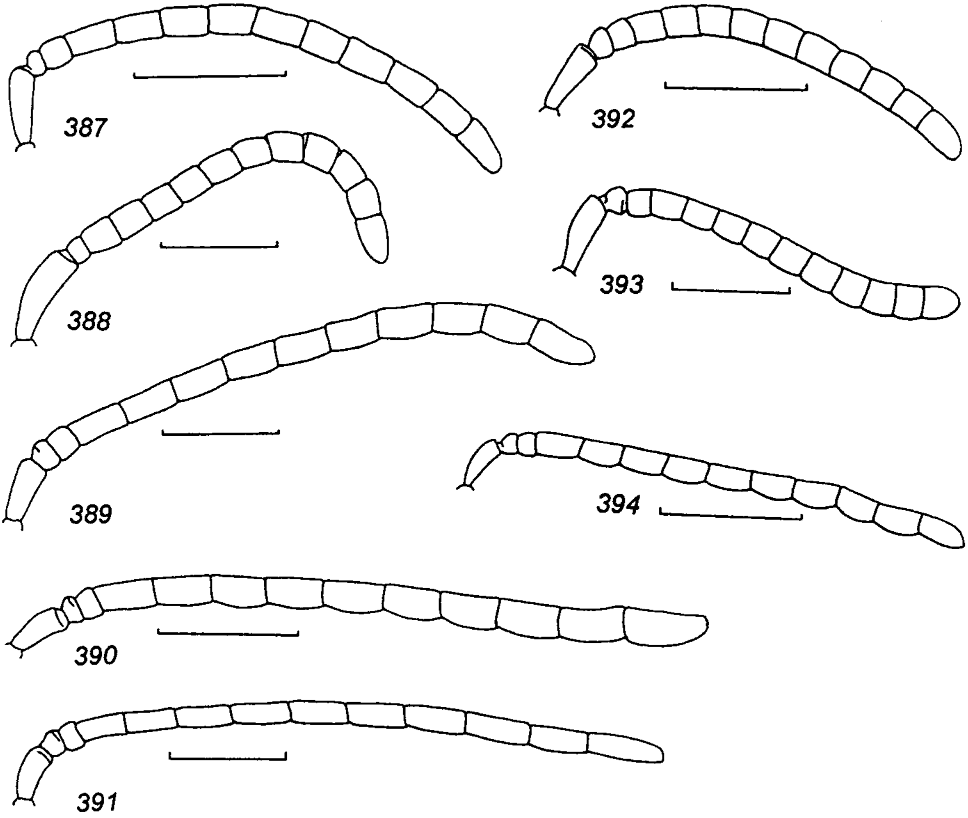
- *Female*: flagellum on lower side yellow to reddish-brown; inner metatibial spurs with three long processes and one shorter process (Fig. 349); posterior areas of terga whitish-hyaline; tergum III only with an anterior tomentose band. *Male*: head and mesosoma greyish-black, with a slight bronze tint; tibiae mostly brownish-black; stigma and wing veins light yellow; metapostnotum finer rugulose, with a slight carina at posterior margin; posterior areas of terga I-III distinctly punctate, broadly translucent, horny-yellow; gonostylus with long hairs only at dorsal margin (Fig. 440) .... ***E. setulellus***

18. *Both sexes*: larger, length 7-9 mm; head shorter than wide; metapostnotum with rugulae not reaching its posterior margin; metasomal terga II and III with large anterior lateral tomentose spots. *Female*: clypeus on upper half densely punctate, roughened at interspaces, dull; posterior areas of metasomal terga usually not depressed and not separated from tergal discs at least medially. *Male*: pubescence of metasomal sterna and structure of genitalia (Figs. 431, 431) similar to those in *E. linearis* (see Couplet 19) .... ***E. malachurus***

- *Both sexes*: smaller, length 5-7 mm; head as high as wide or higher; metapostnotum rugulose throughout; terga II and III with narrow anterior lateral tomentose spots. *Female*: clypeus on upper half sparsely punctate, smooth at interspaces, shiny; posterior areas of terga depressed and separated from tergal discs at least medially. *Male*: pubescence of metasomal sterna and structure of genitalia variable 19

19. *Both sexes*: posterior vertical surface of propodeum always sharply carinate. *Female*: inner metatibial spurs dentate with several small relatively thin, triangular teeth (Figs. 344, 345); mesoscutum coarser punctate (25-35 μm); its posterior third and scutellum polished at interspaces, shiny; metasomal tergum I on disc somewhat denser and uniformly punctate. *Male*: metasomal sternum II and subsequent ones on discs covered with relatively dense, erect, white hairs; gonocoxite on distal part and gonostylus at base covered with long dense hairs; gonostylus flattened, leaf-shaped, provided with a short roundish membranous lobe (Figs. 433, 434) .... ***E. linearis***

- *Both sexes*: lateral and upper carinae of posterior vertical surface of propodeum slight, often (especially in males) margins of the surface rounded. *Female*: inner metatibial spurs with 3-4 very broad, short, flattened, roundish processes (Fig. 346); mesoscutum finer punctate (15-25 μm); its posterior third and scutellum roughened in queens and usually polished at interspaces in workers; tergum I on disc sparser and irregularly punctate. *Male*: sternum II hairless or with inconspicuous, short and sparse hairs laterally; gonocoxite nearly hairless; gonostylus small, thick, rounded, poorly pubescent; its membranous lobe long, sharply pointed at apex (Figs. 435, 436) .... ***E. pauxillus***



Figs. 387-394. Antenna of males in *Evylaeus*.
387. E. calceatus. 388. E. nigripes. 389. E. laticeps. 390. E. fulvicornis. 391. E. fratellus. 392. E. laevis. 393. E. interruptus. 394. E. minutulus. Scale lines represent 1 mm.

20. *Both sexes*: rugulose sculpture of metapostnotum not reaching the posterior margin of dorsal propodeal surface; this surface greatly inclined and broadly roundly passing to posterior vertical surface and lateral surfaces of propodeum, so that practically not defined; if dorsal surface defined by sculpture of metapostnotum (sometimes in females of *E. brevicornis* and *E. sexstrigatus*), then either mesepisterna polished at least on lower half and posterior areas of metasomal terga entirely translucent (*E. brevicornis*), or metasomal terga II-IV provided with narrow anterior tomentose bands interrupted medially (*E. sexstrigatus*). *Male*: pubescence of metasomal sterna variable 21

– *Both sexes*: dorsal surface of propodeum horizontal to slightly inclined, forming with posterior vertical surface of propodeum a distinct angle (at least medially), and well defined either by a carina along posterior margin of metapostnotum, or by a callosity-like transverse projection at its posterior margin (e.g. in *E. vil-*

losulus), or by rugulose or granulate sculpture of metapostnotum reaching the posterior margin of dorsal surface of propodeum[3]. *Male*: sterna always pubescent with relatively long dense erect hairs 32

21. ***Both sexes***: head thick, genal areas as wide as eyes in lateral view to head or wider (Fig. 333); metasoma usually broadened backward. *Female*: head nearly square in frontal view; clypeus very shortened, 2-3 times as wide as high (Fig. 332); inner metatibial spur pectinate, with 3-4 long processes (Fig. 364). *Male*: eyes thickened downwards (Fig. 382); antenna relatively long; 2nd flagellomere 1.25-1.7 times as long as wide (Figs. 397, 398); metasomal terga II and III deeply transversely depressed at anterior part of disc; sterna nearly hairless or covered with short inclined hairs; gonostylus enlarged (in comparison with sizes of the body and genital capsule, Fig. 456); its membranous lobe wider than long (Figs. 455, 457) 22

\- *Both sexes*: head normal (except for males of *E. minutissimus* and *E. sexstrigatus* in which it is thickened); metasoma usually elongate elliptic in dorsal view, in some males nearly cylindrical. *Female*: head roundly triangular (shortened or elongate) in frontal view; clypeus normal, much higher (e.g. Figs. 334, 335); inner metatibial spur variable. *Male*: eyes not thickened downwards; antenna shorter; 2nd flagellomere about as long as wide (except for *E. tarsatus* in which it is 1.45 times as long as wide); terga II and III flattened or convex on disc, but not depressed at anterior part (except for *E. minutissimus*); sterna with long, relatively dense, erect hairs; size of gonostylus variable; membranous lobe longer than wide (Figs. 452, 454, 459, 462, 463, 466) 24

22. *Both sexes*: mesoscutum indistinctly, very finely and sparsely punctate (10-15 μm / 2-5), silky, finely roughened nearly throughout. *Female*: clypeus almost 3 times shorter than its width estimated along lower clypeal margin (Fig. 332); length of queen 5-6 mm, of worker 4-5 mm. *Male*: somewhat larger, length 4.5-5.5 mm; head round in frontal view (Fig. 382); 2nd flagellomere 1.6-1.7 times as long as wide (Fig. 397) .... ***E. politus***

\- *Both sexes*: mesoscutum coarser and denser punctate, shiny or roughened throughout or only on posterior two thirds. *Female*: clypeus twice as wide as high; length 3.5-4.5 mm. *Male*: somewhat smaller: length 4.0-4.5 mm; head elongate elliptic in frontal view; 2nd flagellomere 1.25-1.3 times as long as wide (Fig. 398) 23

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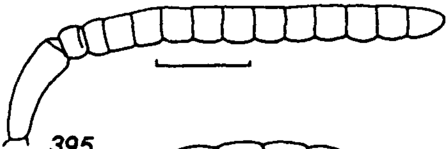
[3] The dorsal surface of the propodeum is badly defined in males of *E. convexiusculus* and *E. clypearis* and sometimes in both sexes of *E. villosulus*. In this case, each of these species runs either to Couplet 22 (both the first species), where they can be distinguished in males from species of the *E. politus* group in the short antenna and larger body (see Couplet 33), or to Couplet 25 (*E. villosulus*), where it can be distinguished from species of the *E. limbellus* group in the following characters: the mesoscutum coarser punctate, posterior areas of metasomal terga dark, the inner metatibial spurs of female not elongate and finer dentate, the head of the male shorter than wide, tarsi shortened (see Couplet 40)].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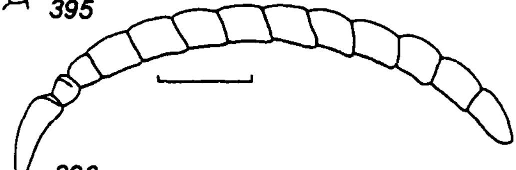
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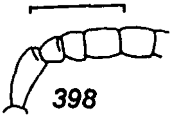
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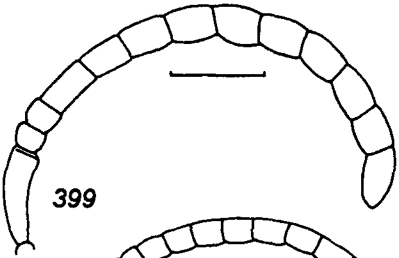
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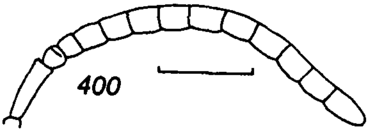
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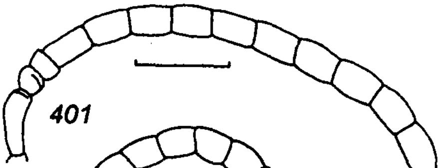
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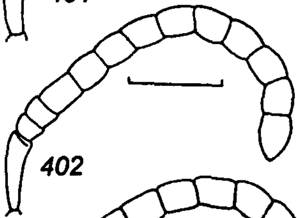
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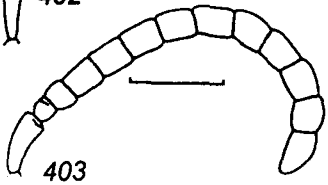
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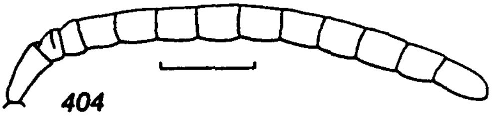
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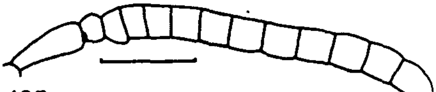
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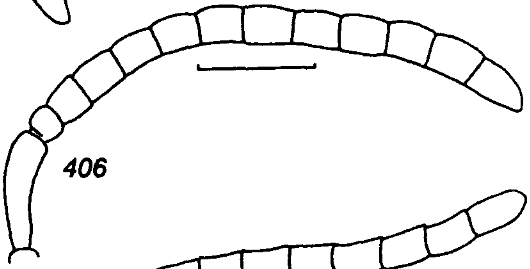
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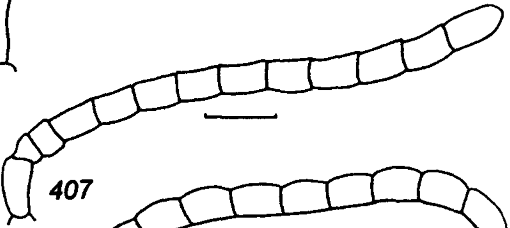
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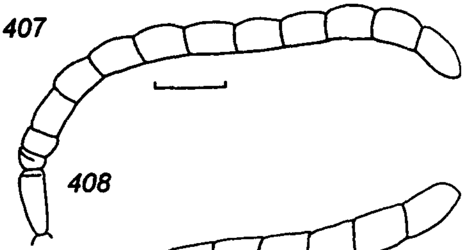
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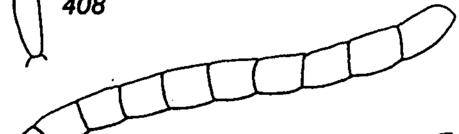
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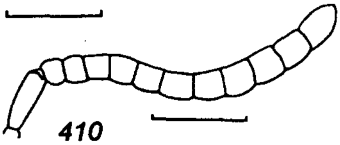
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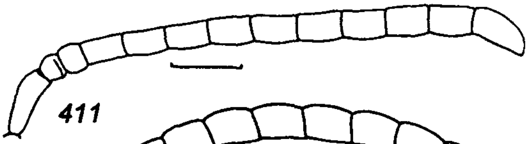
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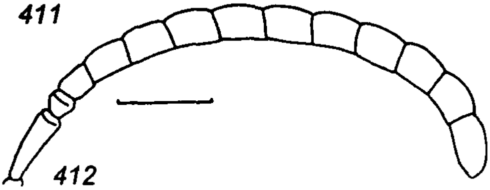

412

23. *Both sexes*: head shorter, slightly shorter than wide in female, its height/width ratio 1.15 in male. *Female*: mesoscutum denser and uniformly punctate (0.5-1.5); metasomal tergum I submat on disc, very finely and densely transversely strigulate. *Male*: 2nd tarsomere of hind legs longer than wide; metasomal terga distinctly depressed at their posterior areas; this area of tergum II sparsely punctate and transversely finely strigulate; pubescence of terga VI and VII short; gonostylus elongate and curved, poorly pubescent .... ***E. glabriusculus***

\- *Both sexes*: head higher, slightly higher than wide in female, its height/width ratio 1.2 in male. *Female*: mesoscutum sparsely and irregularly punctate (0.5-5.0); tergum I shiny on disc, polished. *Male*: 2nd tarsomere of hind legs as long as wide; terga slightly depressed at their posterior areas; this area of tergum II polished; pubescence of terga VI and VII relatively long; gonostylus broadened, nearly rectangular, covered with dense and long hairs .... ***E. trichopygus***

24. *Both sexes*: mesepisterna and posterior vertical surface of propodeum shiny, polished nearly throughout or sparsely punctate, with polished interspaces; metasomal terga with well developed anterior tomentose bands; their posterior areas entirely yellowish to whitish translucent; body somewhat larger, length 6-7 mm. *Female*: inner metatibial spur as long as two-thirds of metabasitarsus, (Figs. 359, 360). *Male*: head elongate, egg-shaped in frontal view; metasomal sterna covered with relatively long and dense hairs; gonostylus enlarged and elongate (Fig. 451); its membranous lobe broad, elliptic, slightly rolled up, only 1.5 times longer than gonostylus (Fig. 452) 25

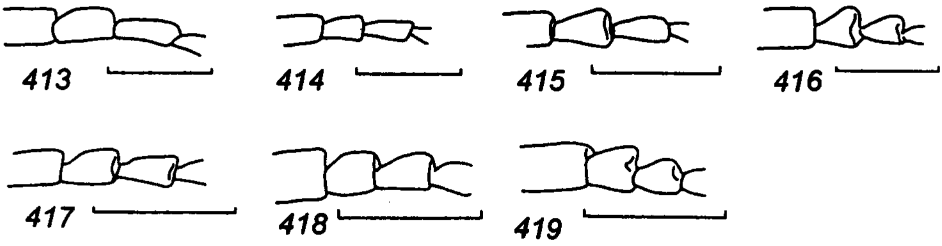
\- *Both sexes*: mesepisterna dull, roughened to densely rugulose, only on lower part sometimes shiny; posterior vertical surface of propodeum dull, finely granulate, sometimes very obscurely in males; terga without tomentum or with small lateral anterior spots; their posterior areas opaque or narrowly translucent; smaller, length usually less than 6 mm (except for *E. quadrinotatulus*). *Female*: inner metatibial spur normal, 2.5-3.0 times shorter than metabasitarsus (Fig. 361) *Male*: pubescence of sterna variable; gonostylar membranous lobe much longer in comparison with gonostylus (Figs. 459, 460, 466, 467) 26

25. *Both sexes*: wing membrane hyaline, stigma and veins light yellow; metasomal tergum I on convex part sometimes finely transversely strigulate (f. *aciculatus* BLÜTHGEN). *Female*: metasomal tergum I on disc laterally very finely and relatively densely punctate (5-8 µm / 1-2); tergum IV on disc covered with dense, tomentum-like, white pubescence; pubescence of body denser and longer. *Male*: head higher, its height/width ratio 1.15 .... ***E. brevicornis***

Figs. 395-412. Antenna of males in *Evylaeus*.

395. E. brevicornis. 396. E. sexstrigatus. 397. E. politus. 398. E. glabriusculus (proximal part). *399. E. quadrinotatulus. 400. E. minutissimus. 401. E. tarsatus. 402. E. marginellus. 403. E. quadrisignatus. 404. E. punctatissimus. 405. E. convexiusculus. 406. E. clypearis. 407. E. nitidiusculus. 408. E. rufitarsis. 409. E. villosulus. 410. E. leucopus. 411. E. morio. 412. E. nitidulus.* Scale lines represent 0.5 mm.

– *Both sexes*: wing membrane greyish infuscated, stigma and veins dark-yellow to brownish-yellow; tergum I on convex part always finely transversely strigulate, but only in female. *Female*: tergum I on disc laterally nearly impunctate; tergum IV with a white anterior tomentose band, with almost inconspicuous yellowish thin hairs on disc behind this band. *Male*: head shorter, its height/width ratio 1.05 .... ***E. limbellus***



Figs. 413-419. Hind tarsomeres 2 and 3 of males in *Evylaeus*.
413. E. malachurus. 414. E. pauxillus. 415. E. fulvicornis. 416. E. fratellus. 417. E. nitidiusculus. 418. E. rufitarsis. 419. E. villosulus. Scale lines represent 0.5 mm.

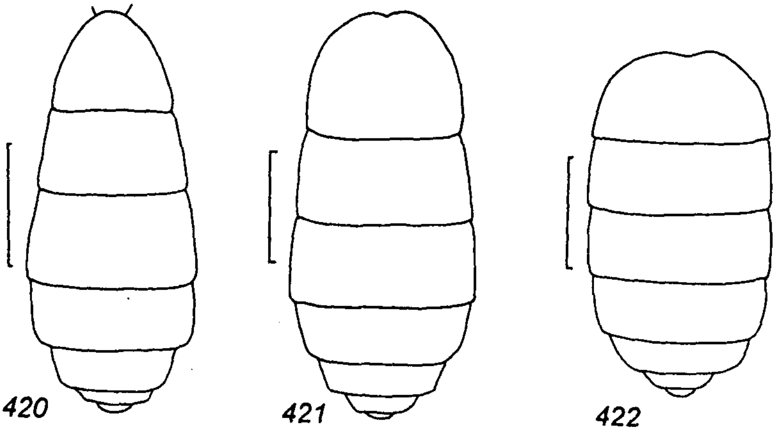
26. *Female*: metasomal terga II-IV on posterior areas with white, narrow, not dense, tomentose bands interrupted medially; terga II and III with anterior lateral tomentose spots; head shortened, its height/width ratio 0.9. *Male*: head usually greatly thickened, round in frontal view (Fig. 380); genal area with a tooth of variable size (Fig. 381); mandibles elongate, sabre-shaped; membranous lobe of gonostylus very long and narrow, about 5-7 times as long as wide (Fig. 454) .... ***E. sexstrigatus***

– *Female*: terga without posterior bands and often without anterior tomentose spots. *Male*: head not thickened, if thickened (in *E. minutissimus*) then elongate; genal area without tooth; mandibles normal; membranous lobe of gonostylus broader (Figs. 462, 463, 465) 27

27. *Both sexes*: larger, length 7.5-8.5 mm in female and 6.5-7.5 mm in male; body deep-black, posterior areas of metasomal terga not translucent; head transversely elliptic in frontal view; its height/width ratio 0.75 0.8 in female (Fig. 334) and 0.8-0.9 in male (Fig. 383); mesoscutum finely (especially in comparison with body size) and very sparsely punctate (15-20 µm / 2-7); metasomal terga with distinct anterior lateral spots of snowy-white tomentum, female with narrow dense spots nearly reaching the middle of terga II-IV, male with small spots on terga II and III. *Female*: tarsi and both ends of tibiae of all legs reddish-yellow. *Male*: clypeus black, sometimes with a small, dark-yellow spot before lower margin; labrum black; metasomal terga polished, only anterior part of tergum II with microscopically fine, very sparse punctures; gonostylus relatively small in comparison with sizes of body and genital capsule, triangular,

broadened distally, pubescent with moderately long hairs (Fig. 458); membranous lobe of gonostylus much elongate, ribbon-shaped, broadly rounded at apex, longer than gonocoxite, nearly hairless (Fig. 459) .... ***E. quadrinotatulus***

- *Both sexes*: smaller, length 4.5-6.5 mm in female and 3.5-6 mm in male; metasoma usually brownish-black, posterior areas of terga usually narrowly translucent; head higher (except for *E. tarsatus*); mesoscutum denser and usually coarser punctate; terga without tomentose pubescence, only in female sometimes terga II and III with small anterior lateral spots of sparse, dingy white tomentum. *Female*: legs dark. *Male*: clypeus on lower third and labrum yellow (except for *E. intermedius*); terga distinctly punctate (except for *E. lucidulus*); structure of gonostylus and its membranous lobe variable 28



Figs. 420-422. Metasoma of males in *Evylaeus*, dorsal view.
420. E. laticeps. 421. E. laevis. 422. E. interruptus. Scale lines represent 1 mm.

28. *Both sexes*: head distinctly shorter than wide (Fig. 335); body of middle size for this group, length of female 5.5 mm, male 5.0-5.5 mm. *Male*: antenna long, reaching the propodeum; 2nd flagellomere 1.5 times as long as wide (Fig. 401); gonostylus larger in comparison with body size, elongate elliptic in lateral view (Fig. 467); its membranous lobe small and very short, as long and wide as gonostylus, bristled with long hairs at distal end .... ***E. tarsatus***

- *Both sexes*: head as high as wide or higher. *Male*: antenna shorter; 2nd flagellomere 1.0-1.2 times as long as wide (Fig. 400); gonostylus smaller; its membranous lobe broadly elliptic, 3-5 times as long as gonostylus (Figs. 460, 462-464, 466) 29

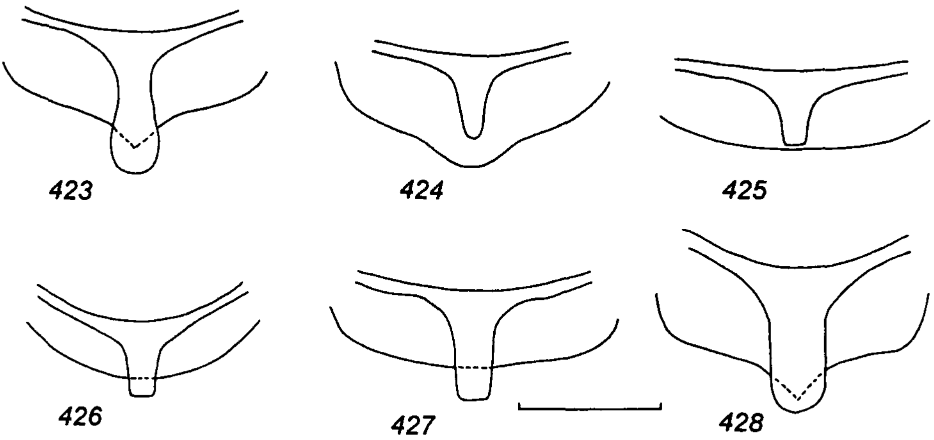
29. *Both sexes*: head elongate elliptic in frontal view, its height/width ratio 1.05-1.15; metasomal tergum II (in male also tergum III) transversely depressed at anterior part behind tergal gradulus, sharply and deeply in male; smallest species among

European Halictini (same as *E. lucidulus*, see Couplet 30), length 4.5-5.0 mm. *Female*: metasomal tergum I distinctly punctate on posterior area (8-10 µm / 1-2). *Male*: gonostylus nearly triangular in lateral view, directed backward (Fig. 460) .... ***E. minutissimus***

– *Both sexes*: head as high as wide; terga II and III flat in lateral view; size of body and form of male gonostylus variable. *Female*: tergum I impunctate on posterior area 30

30\. *Both sexes*: smaller, length of female 4.5-5.0 mm, male 4.0-4.5 mm; mesosoma narrowed, its length/width ratio 1.9; all metasomal terga impunctate, only tergum II on anterior margin with narrow strip of fine and not dense punctation. *Male*: gonostylus small, rounded in lateral view (Fig. 464) .... ***E. lucidulus***

– *Both sexes*: larger, 5.0-6.5 mm; mesosoma wider, its length/width ratio 1.8; terga richer punctate. *Male*: gonostylus larger, angular 31



Figs. 423-428. Median part of the metasomal sterna VII and VIII of males in *Evylaeus*. *423. E. punctatissimus. 424. E. convexiusculus. 425. E. nitidiusculus. 426. E. parvulus. 427. E. rufitarsis. 428. E. villosulus*. Scale line represents 0.3 mm.

31\. *Both sexes*: somewhat larger, length of female 6.0-6.5 mm, male 5-6 mm; mesoscutum slightly finer punctate. *Female*: posterior area of metasomal tergum I not depressed medially; terga II and III on anterior part finer punctate (5-8 µm), with distinct lateral tomentose spots; tergum V pubescent with dark brown hairs on each side of longitudinal specialised area; tibiae of hind legs with greyish-white pubescence on inner side. Male: clypeus, labrum, mandibles and legs entirely black; gonostylus directed backward (Fig. 463) .... ***E. intermedius***

– *Both sexes*: somewhat smaller, length of female 5.0-5.5 mm, male 4.5-5.0 mm; mesoscutum slightly coarser punctate. *Female*: posterior area of tergum I depressed along all anterior margin; terga II and III on anterior part coarser punctate (5-15 μm), with very small lateral tomentose spots; tergum V laterally longitudinal specialised area pubescent with yellowish-brown hairs; tibiae of hind legs with pale yellowish pubescence on inner side. *Male*: clypeus on lower part, usually labrum, mandibles in middle and sometimes tarsi yellow; gonostylus directed downward .... ***E. semilucens***

32. *Both sexes*: face, mesoscutum (35 to 60 μm), scutellum and especially mesepisterna very coarsely punctate; length 5-6 mm. *Female*: inner metatibial spurs finely and densely dentate, with several very small and adjoined teeth along all length of spur (Figs. 370, 371). *Male*: clypeus, labrum and hind basitarsi dark; gonostylus elongate triangular in dorsal or ventral views of genital capsule (Figs. 469, 471); its membranous lobe short, almost as long as main body of gonostylus (Figs. 468, 471) 33

– *Both sexes*: face, mesoscutum and scutellum finely (usually much finely) punctate (except for *E. puncticollis* in which the mesoscutum is coarsely punctate, 30-45 μm), mesepisterna impunctate or much finer punctate. *Female*: inner metatibial spurs pectinate or coarser dentate, with 4-7 teeth separated from each other. *Male*: clypeus on lower third and labrum yellow (except for *E. villosulus* and some individuals of *E. pygmaeus*); hind basitarsi yellow to yellowish-brown or reddish (except for *E. parvulus* in which hind basitarsi are usually dark); size and form of gonostylus variable 34

33. *Both sexes*: head 1.1-1.15 times as high as wide; mesoscutum coarser punctate (unusually coarsely, 40-60 μm in female, 25-40 μm in male); metapostnotum with very strong rare longitudinal rugae, sharply carinate at all lateral and posterior margins; posterior marginal areas of metasomal terga black. *Female*: genal area, besides punctation, with coarse longitudinal rugae; body deeply black; mesepisterna at lower part very coarsely rugoso-reticulate; metasoma shorter, more convex; terga II and III with small and indistinct anterior lateral tomentose spots; tergum IV without spots. *Male*: tarsi dark .... ***E. quadrisignatus***

– *Both sexes*: head as high as wide; mesoscutum finer punctate (25-40 μm in female, 20-30 μm in male); metapostnotum much finer rugulose, ecarinate at least laterally; posterior marginal areas of terga narrowly translucent, yellowish. *Female*: genal areas only punctate; body brownish-black; mesepisterna coarsely and not densely punctate throughout, similar to mesoscutum; metasoma slender, less convex; terga II-VI with well developed anterior lateral tomentose spots. *Male*: tarsi brownish-yellow .... ***E. marginellus***

34. *Both sexes*: head high, egg-shaped in frontal view; its height/width ratio more than 1.1 (except for female of *E. convexiusculus* in which this ratio is 1.04-1.07); metapostnotum always ecarinate; propodeum shorter, its dorsal surface 0.6-0.7 times as long as scutellum; length of body 5.5-7 mm. *Female*: clypeus, besides punctation, with longitudinal grooves; genal areas shiny, punctate. *Male*: antenna short (Figs. 404-406), at most reaching the scutellum 35

– *Both sexes*: head shorter, usually its height less than width; if head slightly higher than wide (in *E. rufitarsis*), then antenna of male long; propodeum longer; its dorsal surface 0.8-1.0 times as long as scutellum. *Female*: clypeus without longitudinal grooves. Other characters variable 37

35\. *Both sexes*: mesoscutum (20-30 µm) and mesepisterna (15-20 µm) finer punctate, roughened at interspaces, dull. *Female*: metasomal terga II and III with small, but distinct anterior lateral tomentose spots *Male*: rugulose sculpture of metapostnotum reaching the posterior margin of dorsal surface of propodeum, propodeum entirely dull; gonostylus and its membranous in Figs. 472-474 .... ***E. punctatissimus***

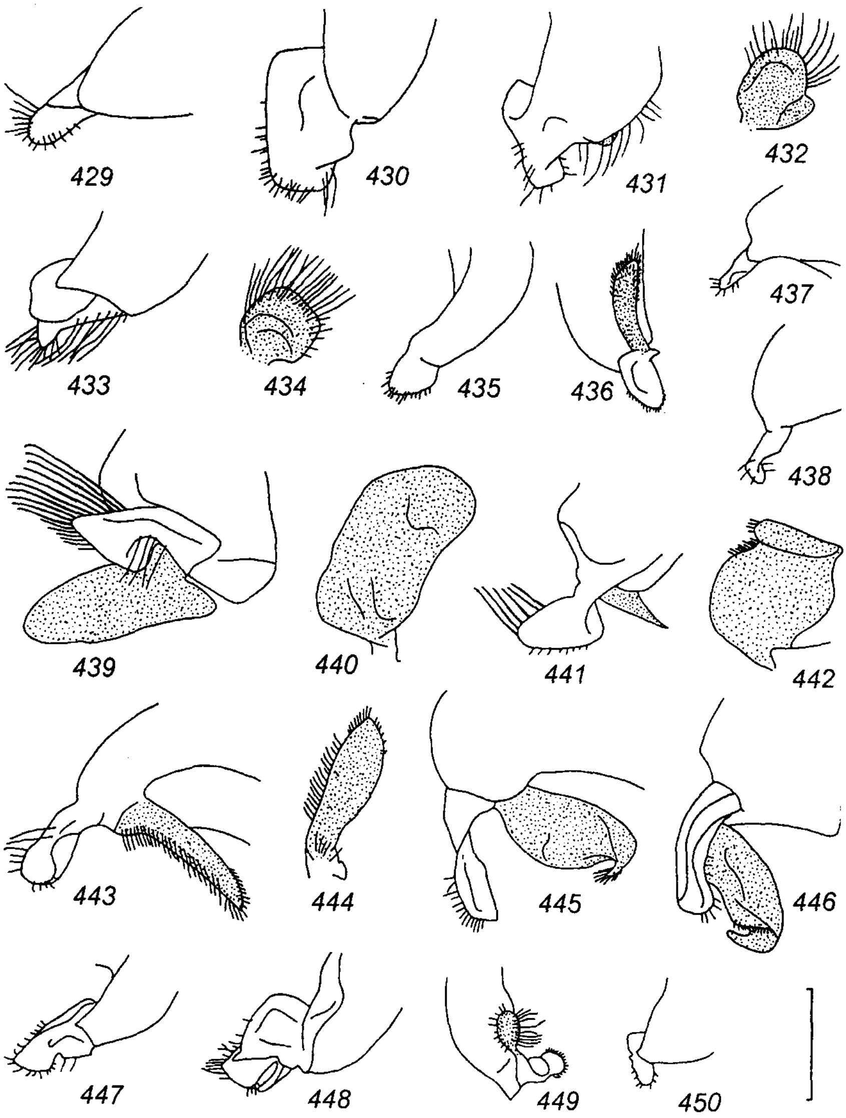
– *Both sexes*: mesoscutum (30-45 µm) and mesepisterna (25-40 µm) coarser punctate, polished at interspaces, shiny. *Female*: terga without tomentose spots *Male*: ruguloso-granulate sculpture of metapostnotum not reaching the posterior margin of dorsal surface of propodeum, posterior part of this surface at least medially and upper margin of posterior vertical surface polished, shiny........................ 36

36\. *Both sexes*: head in frontal view egg-shaped, with roundish vertex; its height/width ratio 1.05-1.1 in female and 1.15-1.25 in male. *Female*: head as broad as mesosoma. *Male*: antenna very shortened, not reaching the middle of mesoscutum; 2nd flagellomere nearly twice as broad as long (Fig. 405); metasomal tergum II flat at anterior part; gonostylus and its membranous in Figs. 475, 476 .... ***E. convexiusculus***

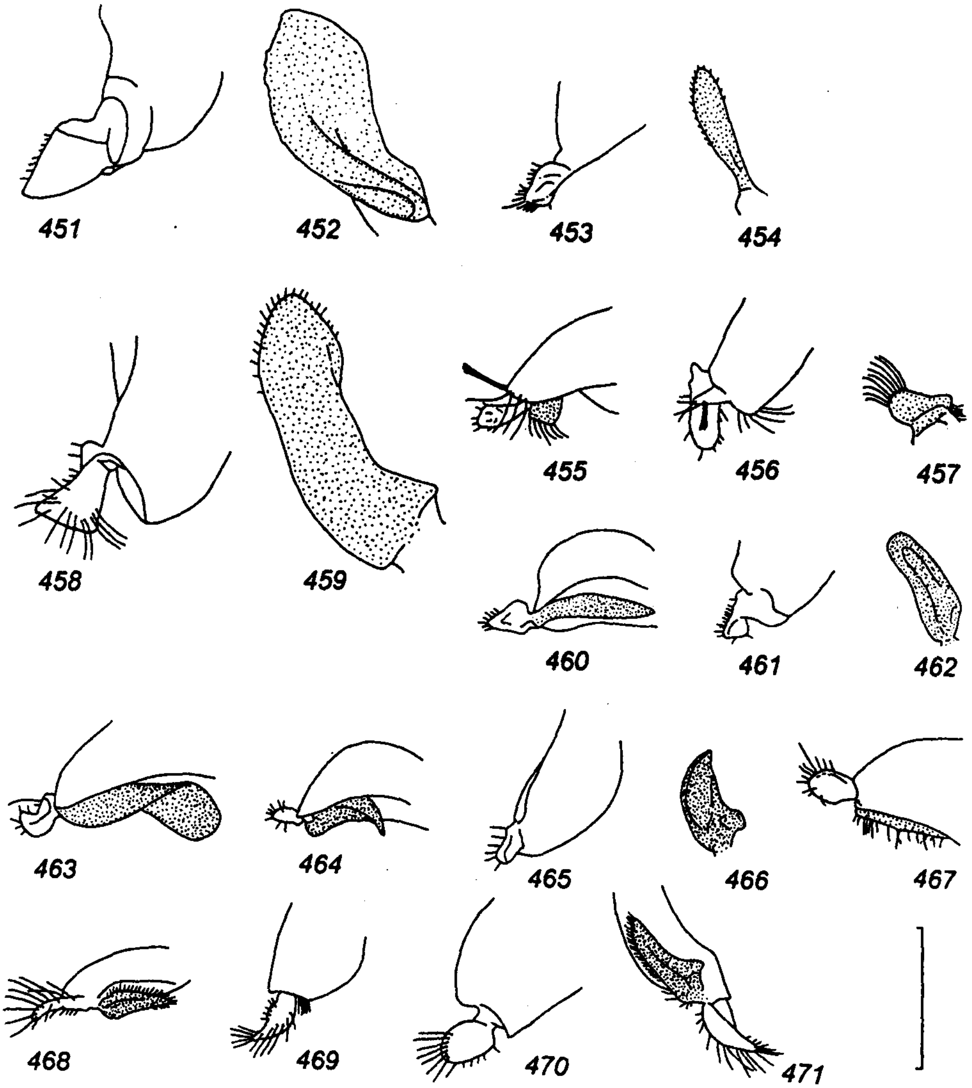
– *Both sexes*: head in frontal view strongly elongate, with vertex extending far above eyes laterally; its height/width ratio 1.35-1.5. *Female*: head narrower than mesosoma. *Male*: antennae not so short, reaching the scutellum; 2nd flagellomere slightly longer than broad (Fig. 406); tergum II transversely depressed at anterior part before tergal gradulus .... ***E. clypearis***

37\. *Both sexes*: metapostnotum finely rugulose to granulate, mat, not margined by a carina or a callosity-like transverse projection (except sometimes for a slight carina in *E. rufitarsis*). *Female*: mesoscutum finely punctate (15-25 µm), roughened at interspaces (in *E. rufitarsis* only on anterior part); mesepisterna impunctate, finely granulate and roughened, dull. *Male*: antenna long, reaching the metasoma; 2nd flagellomere at least 1.5 times as long as wide (Figs. 407, 408); clypeus yellow on lower third; metasomal sternum VIII nearly straight at posterior margin, without medial lobe (Figs. 425-427); gonostylus elongate (Figs. 477-483); its membranous lobe relatively narrow (Figs. 479, 481), except for *E. rufitarsis*, in which it is relatively broad (Fig, 484) 38

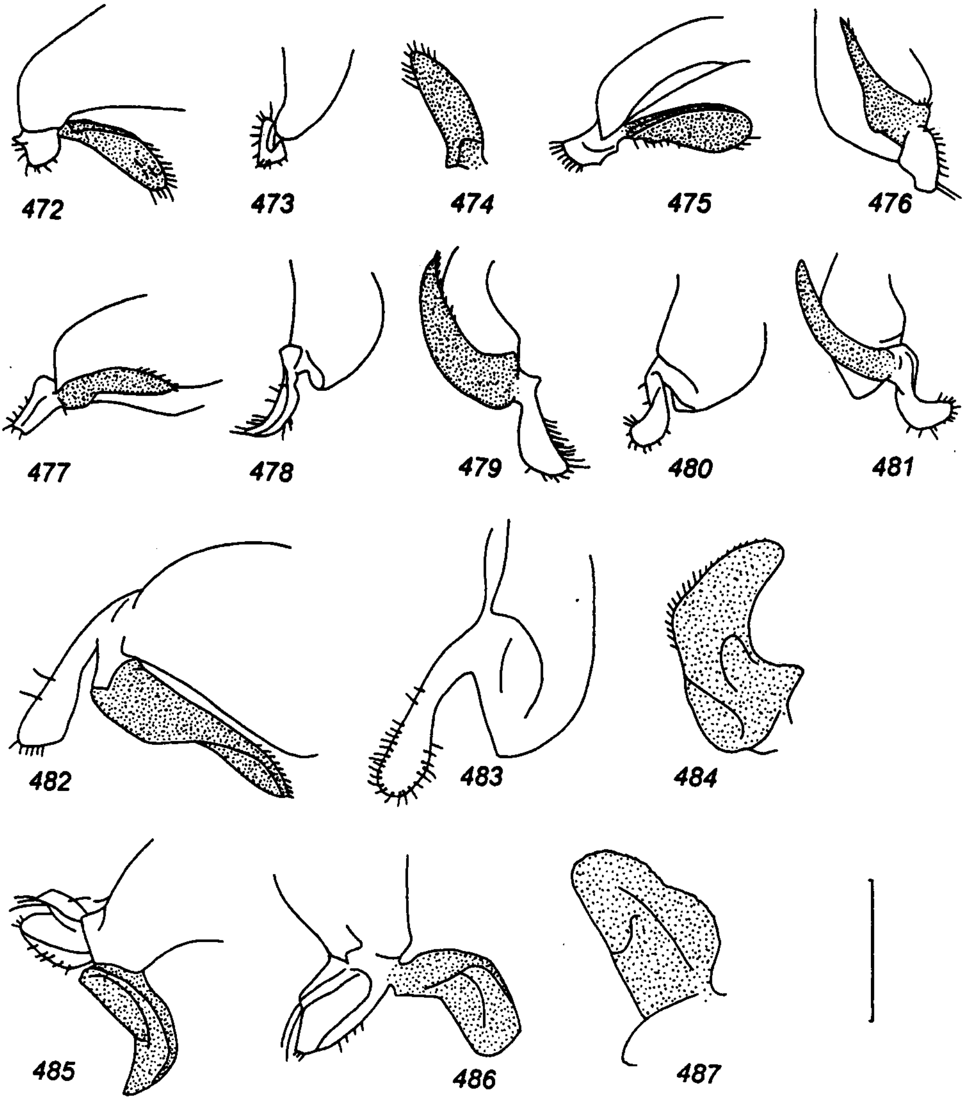
– *Both sexes*: metapostnotum coarsely longitudinally rugose, shiny, distinctly margined by a carina or a callosity-like transverse projection. *Female*: mesoscutum coarser punctate, polished at interspaces; mesepisterna punctate or coarsely ruguloso-roughened. Male: antenna short, reaching only the scutellum; 2nd flagellomere about as long as wide (Figs. 409) or shorter; sternum VIII with medial lobe at posterior margin (Fig. 428); membranous lobe of gonostylus broad (Fig. 487); coloration of clypeus and form of gonostylus variable 40



Figs. 429-450. Gonostylus of males in *Evylaeus* (right, different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation).
429, *430*. *E. calceatus* (*429*, lateral view; *430*, posterior view). *431*, *432*. *E. malachurus* (*431*, posterior view; *432*, membranous lobe in its plane). *433*, *434*. *E. linearis* (*433*, posterior view; *444*, membranous lobe in its plane). *435*, *436*. *E. pauxillus* (*435*, posterior view; *436*, ventral view, in plane of membranous lobe). *437*, *438*. *E. laticeps* (*437*, lateral view; *438*, posterior view). *439*, *440*. *E. tricinctus* (*439*, posterior view; *440*, membranous lobe in its plane). *441*, *442*. *E. setulellus* (*441*, posterior view; *440*, membranous lobe in its plane). *443*, *444*. *E. fulvicornis* (*443*, lateral view; *444*, membranous lobe in its plane). *445*, *446*. *E. fratellus* (*445*, lateral view; *446*, posterior view). *447*. *E. laevis*, posterior view. *448*. *E. interruptus*, posterior view. *449*. *E. minutulus*, ventral view. *450*. *E. setulosus*, posterior view. Scale line represents 0.3 mm.



Figs. 451-471. Gonostylus of males in *Evylaeus* (right, different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation).
451, 452. E. limbellus (*451*, posterior view; *452*, membranous lobe in its plane). *453, 454. E. sexstrigatus* (*453*, posterior view; *454*, membranous lobe in its plane). *455-457. E. politus* (*455*, lateral view; *456*, posterior view; *457*, membranous lobe in its plane). *458, 459. E. quadrinotatulus* (*458*, posterior view; *459*, membranous lobe in its plane). *460-462. E. minutissimus* (*460*, lateral view; *461*, posterior view; *462*, membranous lobe in its plane). *463. E. intermedius*, lateral view. *464-466. E. lucidulus* (*464*, lateral view; *465*, posterior view; *466*, membranous lobe in its plane). *467. E. tarsatus*, lateral view (from EBMER, 1971: Fig. 104). *468, 469. E. marginellus* (*468*, lateral view; *469*, posterodorsal view). *470, 471. E. quadrisignatus* (*470*, lateral view, *471*, ventral view, in plane of the membranous lobe). Scale line represents 0.3 mm.



Figs. 472-487. Gonostylus of males in *Evylaeus* (right, different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation). *472-474. E. **punctatissimus*** (*472*, lateral view; *473*, posterior view; *474*, membranous lobe in its plane). *475*, *476. E. **convexiusculus*** (*475*, lateral view, *476*, ventral view). *477-479. E. **nitidiusculus*** (*477*, lateral view; *478*, posterior view; *479*, ventral view, in plane of the membranous lobe). *480*, *481. E. **parvulus*** (*480*, posterior view; *481*, ventral view, in plane of the membranous lobe). *482-484. E. **rufitarsis*** (*482*, lateral view; *483*, posterior view; *484*, membranous lobe in its plane). *485-487. E. **villosulus*** (*485*, lateral view; *486*, posterolateral view; *487*, membranous lobe in its plane). Scale line represents 0.3 mm.

38. *Both sexes*: larger, length 6.3-8 mm; head slightly higher than wide; mesoscutum sparser punctate, polished at interspaces, except for anterior third or fourth; posterior vertical surface of propodeum coarser roughened, mat throughout; metasomal terga II-IV (in male usually tergum III) on posterior areas finely and obscurely, but distinctly transversely strigulate. *Female*: border between dorsal and posterior vertical surfaces of propodeum marked by a distinct angle; propodeum mat on this border. Male: flagellum darker, only a narrow strip on lower side yellowish-brown; tarsi shortened, 2nd tarsomere of hind legs nearly as long as wide (Fig. 418); gonostylus very long, directed downward in relation to gonocoxite (Fig.482, 483); stylar membranous lobe relatively broad, twice as long as wide (Fig. 484) .... ***E. rufitarsis***

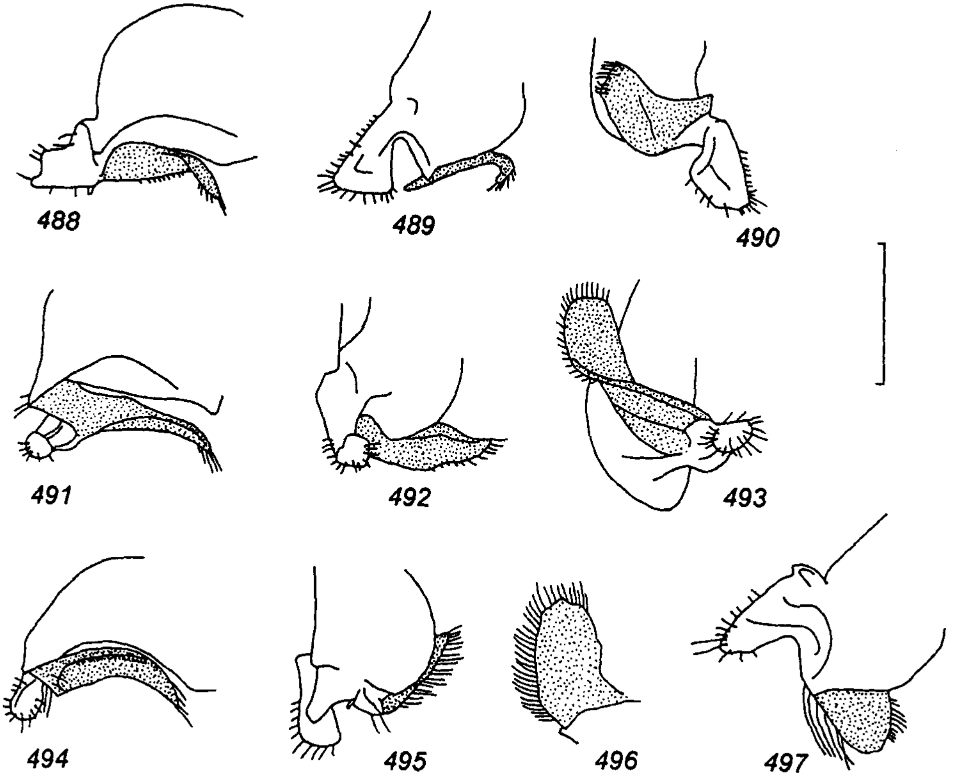
– *Both sexes*: smaller, length about 6 mm; head wider than high; mesoscutum denser punctate, finely roughened at interspaces almost throughout; posterior vertical surface of propodeum very finely roughened, silky or silk-shiny; terga on posterior areas without distinct lines. *Female*: dorsal surface of propodeum narrowly and roundly passing to its posterior vertical surface; propodeum silk-shiny on this border. *Male*: flagellum paler, ochre-yellow throughout lower half; tarsi normal, 2nd tarsomere of hind legs nearly twice as long as wide (Fig. 417); gonostylus twice shorter than that in *E. rufitarsis*, directed backward (Fig. 477-481); its membranous lobe narrower, 3-4 times as long as wide (Figs. 479, 481) 39

39. *Both sexes*: metapostnotum flat, finely ruguloso-granulate, silky. *Female*: metasomal tergum I relatively densely punctate. *Male*: metasomal sternum II medially, sterna III and IV laterally pubescent with long hairs; tarsi of all legs usually rusty-yellow; mesal outline of gonostylus in dorsal view slightly concave (Fig. 478) .... ***E. nitidiusculus***

– *Both sexes*: metapostnotum concave, coarser rugulose, mat, with a callosity-like projection at posterior margin which is finely roughened. *Female*: tergum I nearly impunctate. *Male*: metasomal sterna II-IV uniformly pubescent with shorter hairs; tarsi dark; mesal outline of gonostylus in dorsal view strongly concave (Fig. 480) .... ***E. parvulus***

40. *Both sexes*: smaller, length of body 5-6 mm; head shorter, transversely elliptic; its height/width ratio 0.9; pubescence of mesosoma poorer, white. *Female*: body robust; length/width ratio of metasoma 1.3-1.4; genal areas punctate. *Male*: antenna very short, reaching only middle of mesoscutum; mesoscutum finer, denser and uniformly punctate (15 μm / 0.3-0.8); gonostylus small, angular .... ***E. pygmaeus***

– *Both sexes*: larger, length of body 6-7 mm; head higher; about as high as wide, or slightly shorter, or slightly higher than wide; pubescence of mesosoma relatively long and dense, yellowish-brown in female (in fresh specimens). *Female*: body slender; length/width ratio of metasoma 1.6-1.7; genal areas coarsely and densely longitudinally rugulose (except for *E. villosulus*). *Male*: antenna not so short (Fig. 409), reaching the middle of scutellum; mesoscutum coarser and sparser punctate (15-30 μm / 0.4-2.0); gonostylus enlarged, roundish or elliptic (Figs. 485, 485) 41



Figs. 488-497. Gonostylus of males in *Evylaeus* (right, different views mean orientations in relation to the genital capsule; the membranous retrorse lobe of the gonostylus marked by punctation). *488-490. E. leucopus* (*488*, lateral view; *489*, posterior view; *490*, ventral view, in plane of the membranous lobe). *491-493. E. morio* (*491*, lateral view; *492*, posterior view; *493*, ventral view). *494-496. E. nitidulus* (*494*, lateral view; *495*, posterior view; *496*, membranous lobe in its plane). *497. E. bavaricus*, lateral view. Scale line represents 0.3 mm.

41\. *Both sexes*: head higher, as high as wide in female, slightly higher than wide in male; metapostnotum sharply carinate along all posterior margin; lateral and posterior vertical surfaces of propodeum coarser ruguloso-roughened. *Female*: genal area very coarsely and densely sharply transversely rugose throughout, mat; mesoscutum coarser and denser punctate (30-45 µm / 0.2-0.8 on disc), without oily tint; mesepisterna coarsely and densely punctate and rugoso-roughened throughout; metasomal tergum I impunctate; tergum II sparsely and very obscurely punctate; pubescence of tergum V at each side of longitudinal specialised area black, except for posterior end of terga. *Male*: clypeus with a yellow spot on lower part; labrum yellow; antenna entirely black; head not thick, in lateral view of head the genal area narrower than eye; mesepisterna distinctly punctate; tarsi normal, 2nd tarsomere of hind legs nearly twice as long as wide; gonostylus smaller, elongate, narrower proximally, directed backward; stylar membranous lobe, very broad, about 1.5 times as wide as long, transversely elliptic, emarginate .... ***E. puncticollis***

– *Both sexes*: head, slightly shorter than wide in both sexes; metapostnotum ecarinate; lateral and posterior vertical surfaces of propodeum finer and obscurer roughened, silky. *Female*: genal area shiny, distinctly punctate, with distinct polished interspaces, only on posterior surface with broad sparse longitudinal wrinkles which are slightly and roundly protuberant; mesoscutum finer and sparser punctate (20-30 µm / 1-3 on disc), with a slight oily tint at interspaces; mesepisterna finer and obscurely roughened, on lower part nearly polished, shiny; tergum I finely, but distinctly punctate (10 µm / 0.5-1.5); tergum II denser and distinctly punctate (10 µm / 0.3-1); pubescence of tergum V at each side of longitudinal specialised area light orange. Male: clypeus usually dark entirely; labrum brown; antenna ochre-yellow on lower side; head thick, in lateral view the genal area broader than eye; mesepisterna very obscurely punctate; tarsi shortened, 2nd tarsomere of hind legs nearly as long as wide (Fig. 419); gonostylus large, shortly elliptic, directed posterodorsad (Figs. 485, 486); stylar membranous lobe large, elongate elliptic (Fig. 486) .... ***E. villosulus***

42\. *Both sexes*: head shorter, at most as high as wide (Figs. 336, 384). *Female*: metasomal tergum I on posterior area smooth; length 5 mm. *Male*: head round in frontal view, with slightly extending clypeus (Fig. 384); antenna very short, reaching only a middle of mesoscutum; 2nd flagellomere about as long as wide (Fig. 410); metasoma shortened, elliptic in dorsal view; gonostylus strongly narrowed proximally (Fig. 489) 43

– *Both sexes*: head at least 1.05 times as high as wide (337, 338, 385, 386). *Female*: tergum I on posterior area usually distinctly finely transversely lineolate. *Male*: head egg-shaped in frontal view (Fig. 386) or elongate and roundly triangular (Fig. 385); antenna long, reaching the end of mesosoma; 2nd flagellomere 1.5-1.7 times as long as wide (Figs. 411, 412); metasoma elongate, cylindrical or broadened backward; gonostylus not narrowed proximally (Figs. 492, 495) 44

43\. *Both sexes*: mesoscutum finely punctate (15-20 µm), in female also usually sparser and irregularly punctate (0.5-2.0); posterior area of metasomal terga II-IV less depressed (in female) or not depressed (in male). *Female*: frons finer punctate (15-20 µm); posterior area of tergum I depressed only laterally; tergum II on disc sparser punctate before posterior area; terga black, usually with a bronze tint; their dusty-like pubescence poor, usually almost inconspicuous; terga II and III with small anterior lateral tomentose spots. *Male*: terga II and III slighter convex .... ***E. leucopus***

– *Both sexes*: mesoscutum coarser punctate (20-25 µm), in female also denser and uniformly punctate (0.4-1.0); posterior area of terga II-IV distinctly depressed. *Female*: frons coarser punctate (20-25 µm); posterior area of tergum I depressed at all width; tergum II on disc uniformly densely punctate; terga usually light green; their dusty-like pubescence richer; terga II and III with larger and distinct anterior lateral spots, tergum IV on anterior part often with a band-like pubescence. *Male*: terga II and III stronger convex .... ***E. aeratus***

44. *Both sexes*: metasomal terga on discs not metallic green, brown to brownish-black, with a slight bronze tint in female, black in male; smaller, length 5.0-5.8 mm. *Female*: head shorter, its height/width ratio 1.02-1.05 (Fig. 337). *Male*: head elongate, roundly triangular in frontal view, with a strongly protuberant downward and narrowed clypeus and strongly convex eyes (Fig. 385); metasomal tergum II with a sharp and deep, step-shaped transverse depression at anterior part of disc before tergal gradulus; metasomal sterna II and III over discs covered with relatively short hairs, which are 0.3-0.5 times as long as width of tibia of hind legs; membranous lobe of gonostylus elongate elliptic (Fig. 393) .... ***E. morio***

– *Both sexes*: terga dark to light or golden-green metallic; larger, length 6-7 mm. *Female*: head higher, its height/width ratio about 1.1 (Fig. 338); if head shorter (in *E. podolicus*), then posterior vertical surface of propodeum distinctly carinate at all margins, mesepisterna shiny. *Male*: head nearly longitudinal elliptic in frontal view, with a less protuberant clypeus and slightly convex eyes (Fig. 386); tergum II with a slight, gently sloping transverse depression at anterior part of disc; sterna II and III on discs covered with long hairs, which are as long as width of tibia of hind legs (except for *E. podolicus*); form of membranous lobe of gonostylus variable 45

45. *Both sexes*: body metallic light or golden-green to green; posterior areas of metasomal terga translucent entirely or partly, horny-yellowish. *Female*: mesoscutum either densely (0.3-1.0) or very sparsely (1.5-4.0) punctate, shiny at least on posterior two thirds (except for *E. nitidulus* f. *aeneidorsus*); posterior vertical surface of propodeum carinate at all lateral and upper margins; metapostnotum rugulose throughout; if its rugulae not reaching the posterior margin of dorsal surface of propodeum (in *E. lissonotus*), then mesoscutum very sparsely punctate, polished at interspaces; mesepisterna very sparsely and obscurely punctate, smooth at interspaces, shiny at least on anterior half; if mesepisterna roughened at interspaces and dull (in *E. nitidulus* f. *aeneidorsus*); then mesoscutum and metasomal terga metallic golden to golden green. *Male*: membranous lobe of gonostylus relatively elongate (Fig. 396), if short (in *E. lissonotus*) then square 46

– *Both sexes*: body dark to blackish-green metallic; posterior areas of metasomal terga dark, not translucent. *Female*: mesoscutum moderately sparsely (1-2, rarely 3) punctate, mat or silky; posterior vertical surface of propodeum usually ecarinate at dorsolateral margins; metapostnotum with rugulae not reaching the posterior margin of dorsal surface of propodeum; mesepisterna distinctly and moderately densely punctate, usually finely roughened at interspaces. *Male*: membranous lobe of gonostylus short, broad, elliptic (Fig. 397) 49

46. *Female*: mesoscutum shiny throughout, very sparsely punctate (1.5-4), polished at interspaces; metapostnotum with rugulae not reaching the posterior margin of dorsal surface of propodeum. *Male*: clypeus dark entirely; membranous lobe of gonostylus short, broad, square .... ***E. lissonotus***

– *Female*: mesoscutum relatively densely punctate (0.3-1.0 or denser); metapostnotum rugulose throughout. *Male*: clypeus with a yellow spot on lower part; membranous lobe of gonostylus relatively elongate 47

47. *Both sexes*: posterior areas of terga entirely translucent, yellowish. *Female*: head shorter, its height/width ratio 1.02-1.05; mesoscutum shiny throughout, smooth at interspaces between punctures. *Male*: discs of metasomal sterna II and III covered with relatively short hairs which are 0.3-0.5 times as long as width of tibia of hind legs; membranous lobe of gonostylus elongate triangular, sharply pointed at apex .... ***E. podolicus***

– *Both sexes*: posterior areas of terga narrowly horny translucent. *Female*: head higher, its height/width ratio about 1.1 (Fig. 338); mesoscutum dull, roughened at interspaces at least on anterior third. *Male*: discs of sterna II and III covered long hairs which are as long as width of tibia of hind legs; membranous lobe of gonostylus shorter, elliptic, broadly rounded at apes (Fig. 496) (***E. nitidulus***) 48

48. *Female*: mesepisterna shiny on anterior half, very sparsely punctate and polished at interspaces; mesoscutum sparser punctate (0.3-1.0) on disc, smooth at interspaces between punctures on posterior two thirds; metasomal terga dark green to greyish-green metallic on discs. *Male*: basitibial plates of all legs dark; tarsi black .... ***E. nitidulus*** f. **typica**

– *Female*: mesepisterna dull, roughened on all surface; mesoscutum dull, denser punctate (0.2-0.6) in disc, roughened at interspaces; mesoscutum and terga golden to golden green metallic on discs. *Male*: basitibial plates of all legs brightly yellow; tarsi paler, yellow to rusty-brown .... ***E. nitidulus*** f. ***aeneidorsus***

49. *Female*: mesoscutum denser and coarser roughened at interspaces, dull; mesepisterna nearly smooth at interspaces, shiny. *Male*: metasomal terga I-III denser punctate (0.5-2.0) on discs; membranous lobe of gonostylus larger, sharply pointed at apex .... ***E. cupromicans***

– *Female*: mesoscutum finer and obscurer roughened at interspaces, silk-shiny at least on posterior two thirds; mesepisterna distinctly roughened at interspaces, dull. *Male*: terga I-III sparser punctate (1-4) on discs; membranous lobe of gonostylus less, broadly rounded at all lateral and anterior margins (Fig. 497) .... ***E. bavaricus***

Evylaeus calceatus (SCOPOLI, 1763) (Figs. 339, 340, 377, 387, 429, 430, 498-501).

Synonymy: *Hylaeus cylindricus* FABRICIUS, 1793; *Melitta fulvocincta* KIRBY, 1802; *Melitta obovata* KIRBY, 1802; *Andrena vulpina* FABRICIUS, 1804, nec CHRIST, 1791; *Halictus terebrator* WALCKENAER, 1817; *Hylaeus rubellus* EVERSMANN, 1852, nec HALIDAY, 1836; *H. bipunctatus* SCHENCK, 1853; *Halictus* *rubens* SMITH, 1854; *H. rufiventris* GIRAUD, 1861; *H. cylindricus* var. *rhodostoma* DALLA TORRE, 1877; *H. calceatus* ssp. *ulterior* COCKERELL, 1929.

Taxonomy. A variable species. In the southern part of its range, individuals with red 3-4 first metasomal segments and a coarser rugose propodeum often occur. However, red-coloured and dark individuals so widely commonly spread in Eurasian steppes that in contrary to the opinion of EBMER (1988b: 598; 1995: 530), it is impossible to distinguish them as separate subspecies. Red-coloured individuals occur sometimes even in the southern part of the forest zone and are found in Poland. In this paper for the same reason, southern populations of *E. albipes*, *E. nigripes* and *E. euboeensis* which mostly or partly consist of red-coloured individuals, are not considered as separate subspecies.

Distribution. Transpalaearctic, almost in all natural zones. In Europe throughout, except for the subarctic zone.

Ecology. More common in dry and warm biotopes. Females fly since early spring till late autumn; percentage of males in populations increases to the end of season. Wide polylege with some preference of composites. Important pollinator of orchards, lucerne and many other entomophilous cultivated plants.

Bionomics. A primitively eusocial species. Nests are often grouped in large aggregations, which are located in plain or gently sloping soil. In severe climate conditions (e.g. in the highlands of Hokkaido; see Sakagami & Munacata, 1972), most females do not form colonies, and the species leads a solitary life. Typically the nest is built by one foundress, although cases of polygynous foundation are registered, where the largest of the individuals becomes the queen, while the rest of them serve the functions of workers. The maximal number of females jointly establishing the nest is four. The nest entrances are preferentially constructed on horizontal ground lots. The female pours a small cone-shaped tumulus around the nest entrance. For the night, and for the rainy time the nest entrance is closed with a soil plug. First the female excavates all of the length of the main burrow (usually 10-20 cm), including the lower blind one. The main burrow is almost vertical, occasionally sinuous at its lower part; its diameter is 8-9.5 mm. Later at some distance from the nest bottom the female excavates a short lateral leading to a comb-like cell cluster (Fig. 498). Such a comb is surrounded with an air chamber. After being completed, the comb is supported within the cavity only at its lower part, by one or several pillars. As the number of cells grows, the female increases the size of the chamber (Fig. 499). As well, indications are available to the effect that the species builds nests with sessile cells, or cells located at the ends of very short laterals. It is possible that the construction of nests of different types is due to different edaphic or other conditions. The foundress alone builds 4-7 cells.

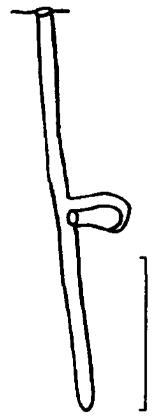
The cells form a unilateral horizontal comb, slightly divergent at its back. Its surface is smooth, and treated so that the shape of each cell is detectable from without.

The length of cells is 9-13 mm, diameter 5-6 mm; the neck is narrowed to 3-4 mm. The food is stocked in a form of a ball-shaped pollen ball 5 mm in diameter. The egg is laid on the top of the pollen ball, then the cell is closed with a cap. The female periodically opens the cell caps inspecting the development of the offspring.

The first brood consists of workers and a small number of males averaging 18%, although in more than a half of the nests investigated males were totally absent in the first brood. The body of workers is by 16% smaller than that of the female-foundress. A negative correlation is registered between the habitat temperature and the body size of workers. Thus, under high temperature the workers' body size of the first brood decreases. Under natural conditions the most of workers (85%) are fertilised, but their ovaries are under-developed. Workers are mainly occupied only in foraging. Up to four workers can simultaneously bring provisions to the same cell. BONELLI (see references below) has noted existence of a constant protection in the summer nests. However, PLATEAUX-QUÉNU, investigating this species in laboratory conditions, has specified that the nests are not protected, although the head of the queen sometimes appeared at the nest entrance when the workers were absent. In case the queen dies, its place is occupied by the oldest worker, which becomes an egg-layer. In the second brood males and future female-foundresses are reared. After copulation young reproductive females remain to overwinter in their maternal nest. Individual old queens can live for two years, overwintering together with their daughters. The indication of Dochkova with the co-authors (1984) that in Bulgaria *E. calceatus* rears four generations within one year does not seem to imply that three broods (including, presumably, two broods of workers) are reared, as all other authors (see references below), who studied this species in various zones, including those more southern, than Bulgaria, have registered only two broods in a season, from which only in the first there are workers.

Main references: WALKENAER, 1917: 1-95; FABRE, 1879: 1079-1081; 1880: 1-27; 1903: 5-27; NOLL, 1931: 332-333; MEIDELL, 1958: 1-16; VLEUGEL, 1960: 586-588; 1973: 121-127; BONELLI, 1965a: 5-54; 1968: 42-47; PLATEAUX-QUÉNU, 1963: 2247-2248; 1964: 91-96; 1973: 297-320; 1983: 41-52; 1985: 13-21; 1988: 263-270; 1992: 351-364; SAKAGAMI & MUNACATA, 1972: 411-439; PLATEAUX-QUÉNU & PLATEAUX, 1980a: 27-33; 1980b: 209-214; POURSIN & PLATEAUX-QUÉNU, 1982: 215-226; DOCHKOVA et al., 1984: 56-65; MARIKOVSKAYA, 1984: 29-30; 1990: 153-154.

Polish data. The commonest species in the Polish fauna of the Halictidae occurring in the whole country (Fig. 500). Mostly inhabiting (80% of records) dry and open habitats such as swards, dry meadows, roadsides, margins of arable fields, recorded also in dry fragments of forests, its margins and glades (20% of records). Females fly all the season long since the end of March till November; males occur in all the season long also, but are distinctly more numerous in August and September (Fig. 501). Collected from flowers of 107 species belonging to many botanical families.



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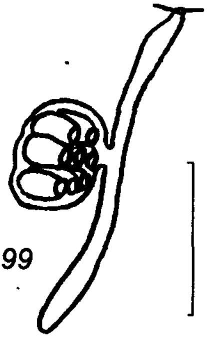


499

Figs. 498, 499. Nests of *Evylaeus calceatus* in the beginning of the construction (*498*, from PLATEAUX-QUÉNU, 1964: Fig. 4) and in the mature stage (*499*, from SAKAGAMI & MUNAKATA, 1972: Fig. 8). Scale line represents 5 cm.

Fig. 500. Occurrence of *Evylaeus calceatus* in Poland.

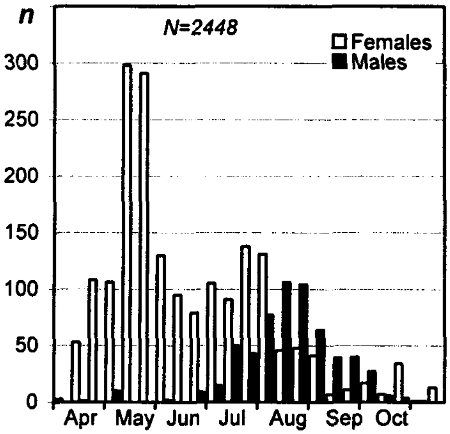


Fig. 501. Flight phenology of *Evylaeus calceatus* in Poland.

Evylaeus albipes (FABRICIUS, 1781) (Figs. 502-504).

Synonymy: *Hylaeus abdominalis* PANZER, 1798; *Halictus malachurellus* STRAND, 1909; *H. albipes* var. *alpicola* BLÜTHGEN, 1920; *H. albipes* var. *rubelloides* BLÜTHGEN, 1924.

Taxonomy. It is also a variable species in the coloration of the metasoma. EBMER (1995: 533) writes that individuals with red-coloured metasoma (f. *rubelloides*) inhabit Central Asia and considers these populations as a separate subspecies. However, the variation of this species is similar with that of *E. calceatus* (see above). In reality, red individuals widely occur also in European steppes commonly with dark ones. Hence, there is again no reason to distinguish a separate subspecies basing on coloration of the metasoma. The status of spp. *villosus* EBMER, 1995, described on the basis of three females from the Primorski Province of Russia, needs to be examined upon more extensive materials. Differences from the closest *E. calceatus* are given in the key above.

Distribution. Transpalaearctic, in Europe almost everywhere.

Ecology. Ecologically similar to *E. calceatus*, but less common. In some localities it prefers to collect pollen from flowers of Ranunculus.

Bionomics. Primitively eusocial species. In northern parts of its geographical range it can lead a solitary mode of life. Nests are built on plain ground lots. Cases are registered where a nest was established polygynously by jointly overwintered females. Around the nest entrance there exists a cone-shaped tumulus. The main burrow is vertical, 7 mm in diameter; it stretches downwards to a depth of 15-16 cm. The lower blind burrow is 5 cm long. Within one spring nest the female-foundress builds 8-9 cells. According to VERHOEFF (1897), the female constructs cells of sessile type progressively, from down up along the main burrow of the nest (Fig. 502). According to the data of Plateaux-Quénu (see references below), who reared this species in artificial conditions, the cells in the nest are formed into a comb surrounded with an air chamber, and connected to the main burrow with a short lateral burrow. The nest structure of E. albipes is very similar to that of *E. calceatus* (see above). The only difference lies in a smaller size (length, and especially width) of the cells of *E. albipes*, which is due to a smaller body size of its adults.

After oviposition the cell gets closed with a cap. The female periodically inspects the contents of the cells, and in case the forage is damaged or preimaginal phases are dead, either empties such cells, or fills them with soil. However, the female does not remove excrement from the cells, which is put by larvae at the back part of the cell. The period of development from egg to emergence lasts for one month. One brood of workers is reared; besides that, the first brood includes a great proportion of males (20 up to 50 %). In result, 67 % of workers copulate after their emergence, but in queen-right colonies all of them remain to be workers, and only in 6 % of them ovaries develop. The body size of workers is by 5 % smaller than that of their mother. Workers prepare about 50 cells, where future males and reproductive females are reared. A division of labour appears regularly among workers of this species. The family nest has no protection, but for the hottest period bees close the nest entrance with soil. Occasionally a few workers initially emerge in the second brood. They join the first brood workers and assist them in finishing the pollen provisioning of the second brood cells. In the case of premature death of the queen, its place is taken by one of its daughters. Unlike the majority of other primitively eusocial halictine species, which in such cases mostly rear only males, the brood of a replacement queen of *E. albipes* can comprise 70 % of future reproductive females. After copulation young female-foundresses build hibernacula, deepening the main burrow of their natal nest. Sometimes old queens also successfully overwinter, and establish new nests in the next spring.

Main references: SMITH, 1850: 2679; VERHOEFF, 1897: 391-392; FRIESE, 1923: 137-159; MEIDELL, 1958: 1-16; PLATEAUX-QUÉNU, 1989: 335-344; 1991: 103-110; 1992: 351-364; 1993a: 205-227; 1993b: 127-134; HEIDE, 1997: 185; PLATEAUX-QUÉNU & PACKER, 1998: 119-128.

Fig. 503. Occurrence of *Evylaeus albipes* in Poland.

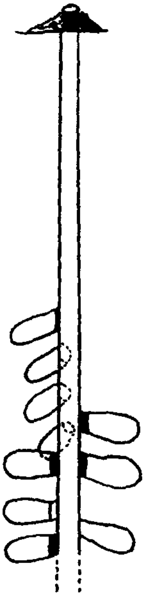


Fig. 502. Nest of *Evylaeus albipes* (from VERHOEFF, 1897: Fig. 36).

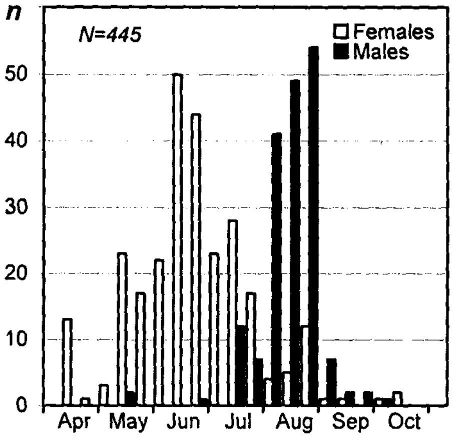


Fig. 504. Flight phenology of *Evylaeus albipes* in Poland.

Polish data. A common species occurring in the whole territory of Poland (Fig. 503). It is about five times less frequent than the previous species. Its biotopic preference and flight phenology (Fig. 504) are similar to those of *E. calceatus*.

Evylaeus nigripes (LEPELETIER, 1841) (Figs. 388, 505-508).

Synonymy: *Halictus vulpinus* NYLANDER, 1852, nec FABRICIUS, 1804; *H. nigripes* var. *nigroclypeatus* DALLA TORRE, 1877; *H. cylindricus* var. *orientalis* MAGRETTI, 1890, nec LEPELETIER, 1841; *H. nylanderi* PÉREZ, 1903; *H. pharaonis* STRAND, 1909; *H. syriacus* PÉREZ, 1911.

Taxonomy. It belongs to the *E. calceatus* species-group and is the biggest among European species of the genus. The coloration of the metasoma is variable. However, both the percentage of red-coloured individuals in a population and the degree of metasomal redness gradually increase to the south. Such a continuous geographical variation does not permit to distinguish f. *pharaonis* as a separate subspecies (contrary to EBMER, 1988b: 599, 1995: 536).

Distribution. Widely distributed in continental Europe to the Baltic See in the north, North Africa and south-western Asia to Iran in the east.

Ecology. Ecologically similar to *E. calceatus*, but much less common.

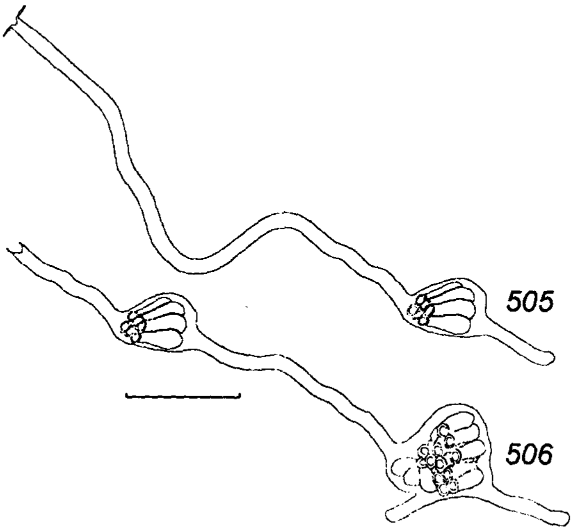
Bionomics. This species was reared in laboratory conditions by PLATEAUX-QUÉNU (1965a, 1965b). Overwintered queens establish their new burrows very late in spring at the place of their hibernation quarters. Nests usually form small aggregations on horizontal or sloping ground, and a few have been found in vertical cliffs. Polygynous nests established by two or three sisters which have hibernated together are frequently met. The species possess two distinct castes, that of queens and that of workers, although caste determination can be influenced by environmental factors. The largest bee usually remains in the nest and becomes the main egg-layer while the assistants forage pollen and nectar, and behave as summer workers. Conspicuous and constricted (4.5 mm) nest entrances were often surrounded by a large tumulus of loose soil. The main burrow was usually inclined, smooth, and about 7.0 mm in diameter. Spring nests reached a depth of nearly 20 cm and were deepened to 35-40 cm during the summer (Fig. 505). The species construct their cells in distinct clusters which are always surrounded by a cavity, which grows synchronously with the cell comb. Cells are generally constructed and provisioned before the cavity appears. Clusters extended sideways and upwards at the same time with the growth of the cavity. The distal, bulbous cell portion was lined, and the cell neck was closed with loose soil, 2 to 3 mm thick. A plug of loose soil, usually several millimetres thick, was put into the nest entrance after the daily foraging works are finished. Completed spring clusters varied considerably in size and comprised 6 to 15 cells. Nests were deepened after the emergence of the summer brood, and the spring cavity was filled with the excavated soil. A new, larger cell comb was constructed about 150 mm below the first. The cells were of the same size in the both provisioning phases, but the provisions were much more plentiful in summer. The cavity often branched off into a series of blind burrows (Fig. 506). For the period of brood's development the female seals the nest with a plug 5 cm thick.

The summer females remaining unmated behave as workers; they remain in the maternal nest, assist in the construction of a deeper and larger cell cluster, forage pollen and nectar. They never guard the nest entrance. They show some ovarian inhibition in matrifilial society but become egg-layers in queenless nests, or when establishing their own burrows. They are much shorter-lived than their mothers, require no diapause, and are unattractive for the summer males. The social level of the species is comparatively high; summer males form less than 5% of the total brood. Queens and workers are relatively distinct morphs. The physiological difference between queens and workers is often manifested in their anatomy but more often in bimodal female size distribution. Societies of this species show only a simple differentiation into egg-layers and foragers. This division is fairly clear in the summer societies where the queens lay the most of the eggs and their daughters do all the foraging. But the proportion of workers with ovarian development is high for such tiny societies, and single workers readily establish their own nests.

Cell construction and foraging rarely begin before May, and the spring provisioning phase is not concluded before June. The nests are closed with plugs up to 50 mm deep, but are opened again before the start of the summer provisioning period, when small daughters are found in the nests with their mothers. A new generation of males and large females emerges towards August or September. The mated future queens return to their natal nests and remain there in diapause until the following spring.

Cleptoparasite: *Sphecodes alternatus*.

References: PLATEAUX-QUÉNU, 1965a: 2331-2333, 1965b: 2609-2612; PLATEAUX-QUÉNU & KNERER, 1968: 31-35; KNERER & PLATEAUX-QUÉNU, 1966b: 2014-2017; KNERER & PLATEAUX-QUÉNU, 1970: 185-196; MARIKOVSKAYA, 1990: 157-158.



Figs. 505, 506. Nests of *Evylaeus nigripes*
(from KNERER &PLATEAUX-QUÉNU, 1970: Figs. 11, 12). Scale line represents 5 cm.

Fig. 507. Occurrence of *Evylaeus nigripes* in Poland.

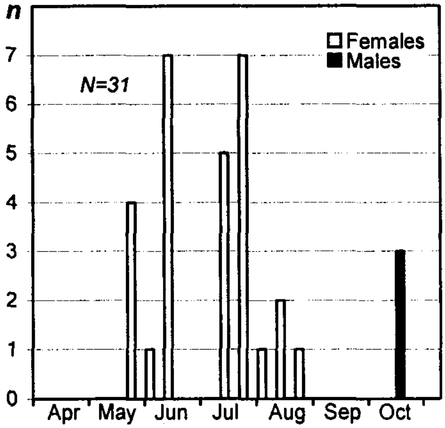


Fig. 508. Flight phenology of *Evylaeus nigripes* in Poland.

Polish data. A relatively rare species dispersally spread in southern and eastern Poland (Fig. 507). Collected in xerothermic habitats. Females fly since the end of May till August; males (only three specimens) were caught in October (Fig. 508). There are no trophic data except for alone specimen collected from flowers of Salvia pratensis.

Evylaeus euboeensis (STRAND, 1909) (Fig. 509).

Synonymy: *Halictus furnasensis* STRAND, 1909; *H. kirschbaumi* BLÜTHGEN, 1918; *H. euboeensis* var. *anatolicus* BLÜTHGEN, 1931.

Taxonomy. It belongs to the *E. calceatus* species-group. The coloration of the metasoma is variable. BLÜTHGEN (1931) described var. *anatolicus* which differs from the typical form in partly red metasoma. EBMER (1988b: 600, 1995: 538) considered it as a separate subspecies. However, from his own characteristics of the examined material (see EBMER, 1995: 538) it follows that this variation has a wide intermediate zone in European steppes.

Distribution. Widely distributed in continental Europe and North Africa, for Asia recorded only from the Middle East and Asia Minor. Mostly in steppes, but penetrating far into the forest zone. In Europe to Poland in the north.

Ecology. Prefers dry and warm habitats. Females fly for all summer long, males appear in mid-summer. Polylege.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Fig. 509. Occurrence of *Evylaeus euboeensis* in Poland.

Polish data. The species is very rare in Poland. It was recorded from the current territory of the country by BLÜTHGEN (1919a, 1920, 1924a; 'Stettin' [Szczecin], 'Bromberg' [Bydgoszcz]).

Material studied (4 specimens): Osolonia, 28.IV.1946, leg. NOSKIEWICZ, 1 ♀ [WRO]. Gołąb [ad. Puławy, Lueblin district], 28.VII.1953, leg. NOSKIEWICZ, 1 ♂ [WRO]. Skowronna [ad. Pińczów, Kielce district], 19.VIII.1954, leg. RIEDEL, 1 ♂ [WAR]. Pińczów [Kielce district], 10.IX.1953, leg. RIEDEL, 1 ♂ [WAR]. Thus, this rare species does not show a distinct pattern of its occurrence in Poland (Fig. 509).

Evylaeus obscuratus (MORAWITZ, 1875) (Figs. 341, 510).

The species is represented in Poland by ssp. *acerbus* (WARNCKE, 1975).

Taxonomy. The species is similar to *E. malachurus* (KIRBY, 1802), *E. linearis* (SCHENCK, 1869) and other species of the *E. malachurus* species-group in the structure of male genitalia (see: EBMER, 1995: 547), but sharply differs from them in the size, sculpture and pubescence of the body (see the key above). It shows a distinct geographical variation in the sculpture of the metasomal tergum I at the anterior part of which is coarser and denser in eastern populations (typical form).

Distribution. Eurasian, inhabiting mostly steppes and deserts. A locality in Poland (see below) is the northernmost.

Ecology. Prefers dry and warm habitats. Females fly for all summer long, males appear in mid-summer. Polylege, preferring composites.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Fig. 510. Occurrence of *Evylaeus obscuratus* in Poland.

Polish data. Here this species is recorded from Poland for the first time. Material studied (Fig. 510): Pieprzowe Mt. [ad. Sandomierz, Tarnobrzeg district], 12.VIII.1953, leg. NOSKIEWICZ, 1 ♂ [WRO]. Piotrkowiczki [Wrocław district], 14.VIII.1961, leg. NOSKIEWICZ, 1 ♂ [WRO]. Krzyżanowice [ad. Pińczów, Kielce district], 25.VIII.1954, leg. PISARSKI, 1 ♂ [WAR].

Evylaeus malachurus (KIRBY, 1802) (Figs. 76-83, 114, 121, 124, 342, 343, 378, 413, 431, 432, 511-517).

Synonymy: *Halictus longulus* SMITH, 1848; *Hylaeus apicalis* SCHENCK, 1853; *H. coriarius* SCHENCK, 1853; *Halictus malachuroides* STRAND, 1909; *H. malachurus* ssp. *sharificus* COCKERELL, 1937.

Taxonomy. Variable because of strong caste differentiation. Workers (f. *longulus*) are smaller and noticeably finer sculptured than queens.

Distribution. Widely distributed in Europe except for the northern part, North Africa and south-western Asia, to Iran and the western Kopet-Dag Mts. (southern Turkmenistan) in the east. Common in steppes and deserts.

Ecology. Females fly all the season long, male appear in mid-summer. Polylege, preferring flowers of composites. Important pollinator of lucerne and other crop plants in steppes of Eurasia.

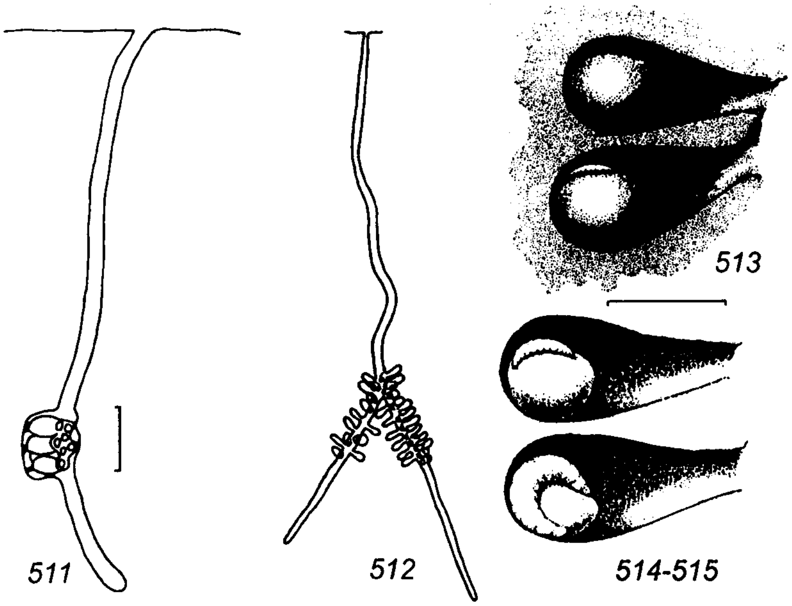
Bionomics. A primitively eusocial species. It has most high, possibly the highest level of social development among halictines. In fact, it is due to the data concerning this species that the existence of eusocial life in halictines was first established (see Chapter II). Besides that, biologically it is one of the best-studied species, since it has been repeatedly observed in Europe by numerous authors (see references below). However, descriptions differ among authors with the respect to the occurrence of the cavity around the cell cluster, the lining of the main burrow, the presence or otherwise of the cell closure etc. The species forms large aggregations with a high density of nests, usually in rammed ground, often on ground roads, which makes the nests easily detectable. Such aggregations can number many thousands of nests, and exist for many decades at the same places. The nests are established by young owerwintered females in early spring. Every spring nest is built by one female only; polygynous nest foundation is not observed, although cases of usurpation of nests by other females of a conspecific species are registered. A crater-like tumulus is made around the nest entrance. The foundress constructs the vertical main burrow, 5 mm in diameter, 20-25 cm deep, which is adjoined by sessile cells grouped into a dense cluster at a depth of 10-15 cm. The cells adjoin each other so closely that their join walls are only 1 or 2 mm thick. The cluster is usually surrounded with a chamber (Fig. 511), although some authors (LEGEWIE, ARMBRUSTER, BONELLI, APTEL; see references below) have failed to find out chambers in the spring nests of this species. The cells in the clusters are typically arranged progressively downwards, and thus the upper ones are the oldest; however, occasional deviations occur. The spring cluster usually contains 6 or 7, rarely 11 cells.

The cells are ellipsoid, and arranged horizontally; occasionally their back end is slightly lowed down. The length of the cell is 10-11 mm, the diameter in its broadest part 3-4 mm. The cell walls are polished and lined with a silky secretory substance. The bees stock forage in the form of dry pollen put to the bottom of the cell. Later the bee brings nectar, moisten the pollen with it, forms the pollen into an almost ball-shaped pollen ball (Fig. 512), and lays an egg on its top. The emerged larva is under-mobile, it feeds from the top of the food (Figs. 513, 514). According to the data of the majority of authors, the cells remain open for all the period of the larvae's feeding, being closed only after their pupation. At the same time, STÖCKHERT (1923) has indicated that the cells of this species are constantly closed.

The first brood consists entirely of workers, which are considerably (by 20 %) smaller than the queen, and all of them are not fertilised, because of absence of males. These workers prepare 20-25 cells of the size slightly greater than that of the cells built by the female-foundress. From these cells the second brood of workers emerges. The workers of the first brood gradually die off, although some of them are still alive at the time when the second brood of workers emerges. The second worker brood averages larger than the first. It constructs 60-65 cells (in one case 97 cells were found), where the reproductive brood is reared. The cells for the reproductive offspring are even larger, being 11-12 mm long and 5-6 mm in diameter. In the summer matrifilial communities chambered nests are never constructed. As the family grows, the nest gets deeper. Thus, according to the observations of LEGEWIE (1925a, 1925b), the first brood of workers develops at a depth of 10-15 cm, the second one is established at that of 40-50 cm, and the third at 60-70 cm. The workers ramify the main burrow of the nest into several additional burrows having the same diameter as the main one. These burrows are adjoined with cells (Fig. 515). In the period of the flight of workers the diameter of the main burrow increases considerably, perhaps because of the ever increasing mechanical friction with the numerous and constantly moving up and down inhabitants. The upper part of the main burrow is somewhat narrowed at a stretch of 1-2 cm; here its diameter is 2.5-3.0 mm, and its walls are smoothed, and sometimes lined with a secretory substance and coalesced. Such a narrowing of the upper part of the main burrow, observed only during the workers' flight period, simplifies for them the nest protection. There exists a division of labour among the workers. Some individuals realise the constant nest protection, and other the foraging. Besides that, the inside-nest workers inspect the cells and clean them of larval excrement. Usually workers live no longer than 3-4 weeks. Only one brood of workers is reared in the northern parts of the species' geographical range. NOLL (1931) supposed that most males of the species originate from unfertilised workers. After copulation males shortly die. The young fertilised females winter either within their maternal nest, or at the bottom of a small burrow constructed in its vicinity.

Cleptoparasite: *Sphecodes monilicornis*.

Main references: AURIVILLIUS, 1896: 67-77; LEGEWIE, 1925a: 619-684; 1925b: 246-300; ARMBRUSTER, 1923: 287-305; STÖCKHERT, 1923: 61-64; APTEL, 1931: 219-222; NOLL, 1931: 285-368; BOTT, 1937: 73-83; BONELLI, 1948: 22-42; GROZDANIĆ, 1966: 1-29; 1971a: 41-46; KNERER & QUÉNU, 1967: 455-458; GROZDANIĆ & VASIĆ, 1970: 271-303; PACKER & KNERER, 1985: 143-149; PACKER, 1991: 153-160.



Figs. 511-515. Nests and cells of *Evylaeus malachurus* (from GROZDANIĆ & VASIĆ, 1970: Fig. 1; BONELLI, 1948: Figs. 2, 3, 6). Scale lines represent 5 cm for nest and 5 mm for cells.

Fig. 516. Occurrence of *Evylaeus malachurus* in Poland.

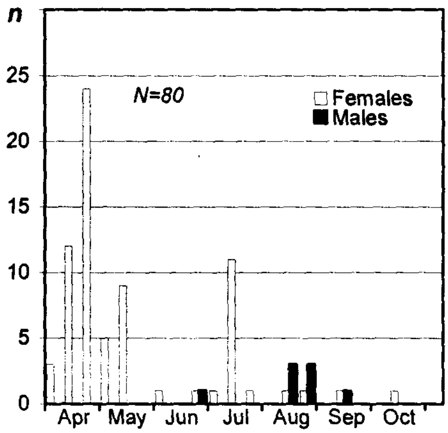


Fig. 517. Flight phenology of *Evylaeus malachurus* in Poland.

Polish data. An uncommon species occurring in southern and central Poland (Fig. 516). Recorded only from open, dry habitats such as xerothermic swards, meadows, slopes. Females fly since April till October; males (only eight specimens) were caught since June till September (Fig. 517). Collected from flowers of Centaurea scabiosa, Colendula officinalis, Hieracium sp., Leontodon autumnalis, Medicago sp., Rosa sp., Scrophularia nodosa, Senecio jacobea, Tanacetum vulgare, Taraxacum officinale, Trifolium pratense.

Evylaeus linearis (SCHENCK, 1869) (Figs. 344, 345, 433, 434, 518-521).

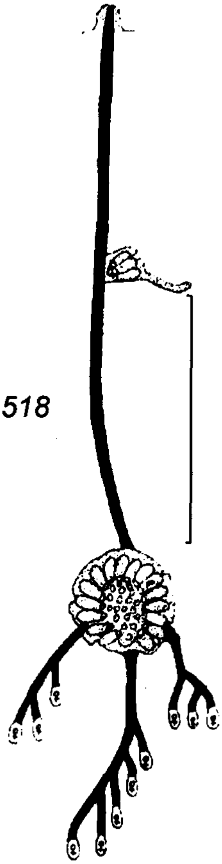
Synonymy: *Halictus longuloides* STRAND, 1909; *H. smyrnae* STRAND, 1909; *H. aeginus* STRAND, 1921; *Lasioglossum sublineare* EBMER, 1974.

Taxonomy. A variable species, finer sculptured in the southern part of its geographical range. Differences from the closest *E. malachurus* are given in the key above.

Distribution. Widely distributed in Europe, except for the north, and south-western Asia, to Iran and the western Kopet-Dag Mts. in the east.

Ecology. Females fly all the season long, male appear in mid-summer. Polylege, preferring flowers of composites.

Bionomics. Primitively eusocial species. Nests are built on open places with dense clayey soil. Often solid nest aggregations are built, sometimes adjoining nests of other species of *Evylaeus*. Nests are founded by a solitary female-foundress in early spring, although occasionally a polygynous nest foundation occurs, up to six females taking part in it. Initially the female builds 10-15 cm of the length of the vertical main burrow. A turret up to 2.5 cm high is constructed over the nest entrance. Later the female starts constructing cells at the middle of this burrow, which are grouped in one comb. The cells, 9-10 mm long, 4 mm wide, adjoin each other very tightly with their necks, whereas their back parts diverge in a fan-like fashion. The female forms a flat-top pollen ball in each cell (Fig. 519), and lays an egg on it. For the larval feeding period the cells remain open, being closed with caps only after the pupae appear. A group of cells is surrounded with an air chamber. In the nests with one foundress there is 5-7 cells. As the number of co-foundresses of a spring nest grows, the amount of offspring reared per one female drops. In total, up to 20 cells can be constructed in a spring polygynously founded nest.



518

519

Figs. 518, 519. Nest and cell of *Evylaeus linearis* (from KNERER, 1983: Figs. 10, 15). Scale lines represent 5 cm for the nest and 5 mm for the cell.

Fig. 520. Occurrence of *Evylaeus linearis* in Poland.

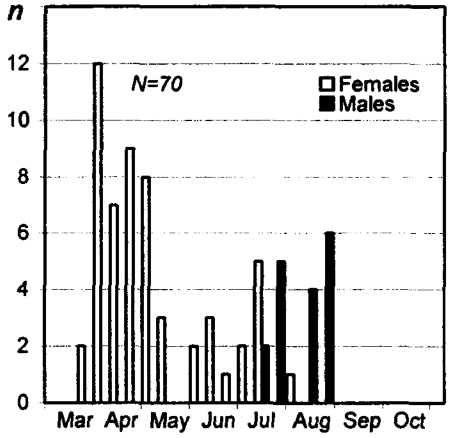


Fig. 521. Flight phenology of *Evylaeus linearis* in Poland.

Having completed the formation of the first brood, the foundress closes the nest from within by plugs a few millimetres in size, and waits for the emergence of workers. Four to eight workers emerge in a summer nest; no division of labour appears to exist between them. This way or other, nests are never protected by them, although the spring polygynous nests are effectively protected. A distinct caste dimorphism is registered, which is most salient in southern populations; thus, the body size of workers is considerably smaller (by 15-16%) than that of the queen. Males are absent in the first brood, therefore all workers are unfertilised, although 2 up to 17% of them have relatively developed ovaries. Workers fill with soil the chamber with the cells from which they emerged. Later they deepen the main burrow of the nest, and construct a new comb-like cluster comprised of 20-35 cells, which is surrounded with a chamber. There can be several lower blind burrows under such a chamber. For the second brood, workers construct larger cells, 11-13 mm long, 5 mm in diameter. The second brood consists of future female-foundresses and males. Young fertilised females hibernate within their maternal nest, in small vertical cell-like hibernaculas, building them under the summer nest chamber at the extremities of short burrows branching from the lower blind burrows (Fig. 518).

References: KNERER, 1968: 100-101; 1969b: 142-144; 1983: 177-186; GROZDANIĆ, 1969: 15-16; 1971a: 59; PLATEAUX-QUÉNU, 1993a: 205-227.

Polish data. An uncommon species dispersally spread mainly in southern Poland (Fig. 520). It inhabits dry swards, xerothermic slopes of hills, and loess ravines. Females fly all the season long, male appear in mid-summer (Fig. 521). Collected from flowers of Ballota nigra, Centaurea cyana, Chryzanthemum leucanthemum, Crepis sp., Origanum sp., Potentilla argentea, Ranunculus sp., Senecio jacobea, Solidago serotina, Taraxacum officinale, Thymus sp., Tilia argentea.

Evylaeus pauxillus (SCHENCK, 1853) (Figs. 346, 414, 435, 436, 522-524).

Synonymy: *Hylaeus similis* SCHENCK, 1853, nec FABRICIUS, 1793; *H. immarginatus* SCHENCK, 1853; *H flavicornis* SCHENCK, 1853; *H. immarginatus* var. *fuscitarsis* SCHENCK, 1853; *Halictus delicatus* PÉREZ, 1903; *H. algericolellus* STRAND, 1909.

Taxonomy. This species differs from *E. damascenus* (PÉREZ, 1910) inhabiting steppes of Europe, the Middle East and Transcaucasus, the another European representative of the *E. pauxillus* group (EBMER, 1995: 582), in the poorer pubescence of the body. A variable species because of strong caste differentiation. Workers have a shinier mesoscutum, are smaller and noticeably finer sculptured than queens.

Distribution. Widely distributed in Europe except for the north, western North Africa and the Middle East, to Iran and south-western Turkmenistan in the east. Common in steppes.

Ecology. Females fly all the season long, males appear in mid-summer. Polylege, preferring flowers of composites.

Fig. 522. Nest of *Evylaeus pauxillus* (from KNERER, 1969: Fig. 8).

Fig. 523. Occurrence of *Evylaeus pauxillus* in Poland.

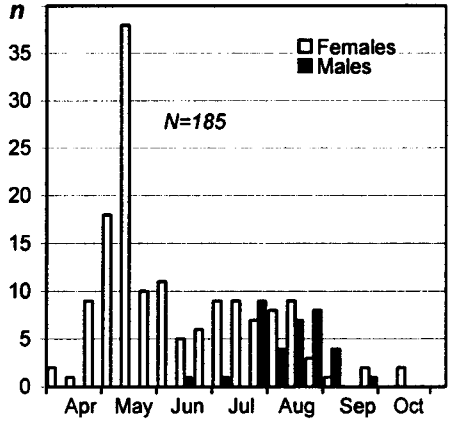


Fig. 524. Flight phenology of *Evylaeus pauxillus* in Poland.

Bionomics. Primitively eusocial species. Nest aggregations are formed in flat clayey ground. There is a turret over the entrance hole. The main burrow stretches vertically downwards. Approximately at its middle the female builds horizontally oriented sessile cells formed in a cluster. In spring nests the cells are usually arranged in a comb, which is surrounded by a chamber (Fig. 522). The order of cell construction and chamber formation is similar to that in *E. calceatus* (see above). After formation of the pollen ball and oviposition the female leaves the cells open, and periodically inspects them, removing larval feces, exuviae, dead larvae etc. Cases of polygynous nest foundation are frequently observed, where one of the females becomes the queen, and the rest of them its auxiliaries. Up to six females can work in one polygynously founded nest, building up to 25 cells, while in a monogynous nest a solitary female builds 3-6 cells. Polygynous nests are protected. Workers emerge in the first brood, which exhibit distinct morphological distinction from the queen, having, in the first place, a smaller (by 16%) body size. Males are absent, therefore all of the workers are unfertilised. A division of labour exists among workers, being some of them occupied in foraging, other in the nest protection, although occasionally nests are not protected. In summer families nest chambers are not constructed; the main burrow may ramify into several additional ones, at whose sides cells are constructed. There is one brood of workers followed with some interval by a brood containing young gynes, along with males. Young fertilised females hibernate jointly in their maternal nest, which premises formation of spring polygynous communities.

Cleptoparasites: *Sphecodes crassus, S. ferruginatus.*

Reference: STÖCKHERT, 1923: 218-221; NOLL, 1931: 355; GRANDI, 1954; KNERER & PLATEAUX-QUÉNU, 1966: 1759-1761; 1967a: 455-458; 1967b: 651-653; 1967c: 1096-1099.

Polish data. A relatively common species occurring in the whole Poland (Fig. 523). Mostly inhabiting dry meadows, swards, forest margins, roadsides. Females fly since April till the second decade of October; males appear in the second decade of June and were recorded till the end of September (Fig. 524). Recorded from flowers of 28 species belonging to many botanical families.

Evylaeus laticeps (SCHENCK, 1869) (Figs. 331, 347, 379, 389, 420, 437, 438, 525-527).

The species is represented in Poland by the nominotypical subspecies.

Synonymy: *Hylaeus affinis* SCHENCK, 1853, nec SMITH, 1853; *H. nigricornis* SCHENCK, 1853, nec SAY, 1837; *Halictus mendax* ALFKEN, 1912.

Taxonomy. The species differs from the close *E. mediterraneus* (BLÜTHGEN, 1926), an other European species of the *E. laticeps* group, only in the shape of the inner outline of male gonocoxites in dorsal view. This species shows a distinct geographical variation in the sculpture of the body. Populations inhabiting the south-eastern part of the species range (Cyprus, Asia Minor, Israel, Iran, southern Turkmenistan) are considered as belonging to a separate subspecies, ssp. *hellenicus* (BLÜTHGEN, 1937), which is characterised by the denser and coarser punctation of the metasomal tergum I. In Greece and Transcaucasus intermediate individuals occur.

Distribution. Widely distributed in Europe except for the north and south-western Asia, to Iran and southern Turkmenistan in the east. Common in steppes.

Ecology. Females fly all the season long, males appear in mid-summer. Polylege, preferring flowers of composites.

Bionomics. Primitively eusocial species, forming small nest aggregations. Nests are prevailingly established monogynously. Nest entrances are made in ground cracks on the places with dispersal vegetation. As well, nesting in joints in old stone walls is registered. The brood cells for both the spring and summer broods are grouped in a cluster surrounded by a cavity. The clusters are located in immediate proximity to the main burrow of the nest, and supported by several broad earthen pillars (Fig. 525). As the cluster size grows, the female increases the size of the chamber. In spring the cells are located at a depth of 6-10 cm. In total, 5-6 cells are built, on the average, in a spring nest, although nests have been found, which contained up to 11 cells. Unlike in the most cluster-building *Evylaeus* species, in this one the cells are not always oriented in the same direction; the compass direction varies by as much as 90° among them, and their declination from the horizontal amounts to 5° to 45°. The cell walls are thicker than those of such species as *E. malachurus* and *L. linearis* (see above), and in result appear more amorphous. After oviposition the cell is closed with a cap.

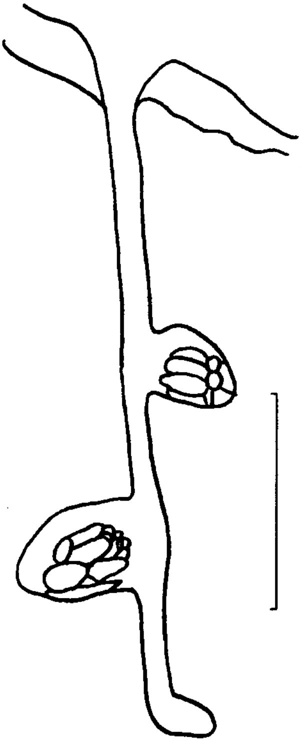


Fig. 525. Nest of *Evylaeus laticeps* (from PACKER, 1983: Fig. 1). Scale line represents 5 cm.

Fig. 526. Occurrence of *Evylaeus laticeps* in Poland.

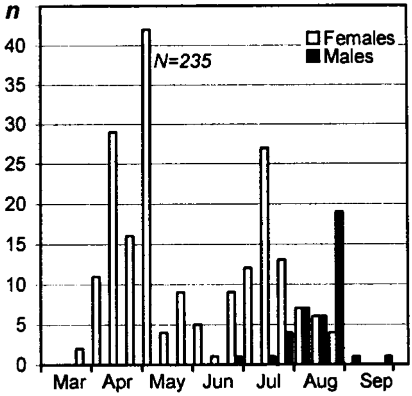


Fig. 527. Flight phenology of *Evylaeus laticeps* in Poland.

The first brood consists of workers and a relatively large number of males, which constitute 23.8% of its totality. There exists a considerable caste size overlap. The queens have a body size averaging by 4.5% more than that of workers. In 53% of workers ovaries are more or less developed, but in distinction from queens only in individual workers the ovaries contain mature oocytes, and no more than 18% of workers are fertilised. It remains yet unclear whether a division of labour among workers, and a constant nest protection exist. The summer family nests contain 12 cells, on the average (maximum 18), and their cell clusters are typically built deeper than in the spring nests. In separate nests the spring and summer cell groups are located at the same depth. Reproductive offspring is reared in the second brood.

Cleptoparasite: *Sphecodes ferruginatus.*

References: NEVINSON, 1904: 13-14; PACKER, 1983: 367-375

Polish data. A common species occurrring in the whole territory of Poland. (Fig. 526). Caught only in open habitats such as swards, meadows and roadsides. Females fly all since the third decade of March till the end of August; males appear in the end of June and continue flying till the end of September (Fig 527). It was recorded from flowers of 25 plant species belonging to many botanical families.

***Evylaeus marginatus** (BRULLÉ, 1832) (Figs. 528, 529) .

Synonymy: *Halictus fasciatellus* SCHENCK, 1869; *H. gribodoi* KRIECHBAUMER, 1873; *H. riparius* MORAWITZ, 1873; *H. vulgaris* MORAWITZ, 1876; *H. kervilleanus* PÉREZ, 1910.

Taxonomy. In morphological and behavioural aspects, the species occupies an isolated position among the 'carinate *Evylaeus*'. A surprisingly morphologically constant species throughout its extensive geographical range. Also caste differentiation is absent. However, the northern Indian populations so strongly differ genetically from European populations that they are considered as belonging to a separate (unnamed) sibling species (BLANCHELOT & PACKER, 1992; PACKER & TAYLOR, 1997).

Distribution. A south Eurasian species, distributed to Tian-Shan in the east, mostly inhabiting steppes and deserts, also recorded from Morocco (Ifrane). In Europe to south-western Germany and northern Austria. It can be found in south-eastern Poland.

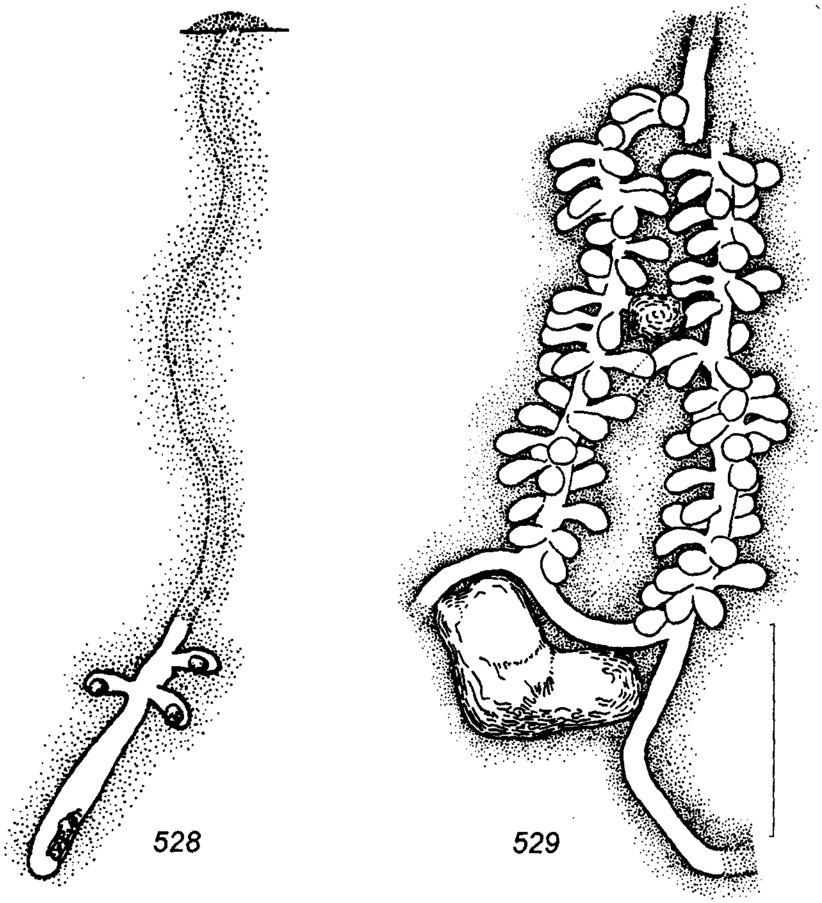
Ecology. Females fly all the season long; males appear in the end of summer. Widely polylege, preferring flowers of composites. Important pollinator of lucerne and other crop plants in the steppes of Eurasia.

Bionomics. A primitively eusocial species, having an unique perennial cycle of the existence of colonies. It forms the largest colonies among all of the halictine bees. Nest aggregations are created on ground lots with dense soil, often on ground roads. The nest is founded by a solitary female. The indications available

(GROZDANIĆ, 1966: 5-11) as to joint nest foundation by 2 or 3 females of *E. marginatus* appear to be questionable, as far as this author did neither mark individuals, nor carried out their morpho-biological examination. It is possible that he failed to distinguish between a young eusocial second year colony, in which only one or two workers can live with the queen, which do not differ from the queen outwardly, and a polygynously founded nest. A conical tumulus is made around the nest entrance, which later frequently gets turned into a turret (Figs. 63-65). The entrance is not guarded. The height of the turret depends on the nest oldness, reaching sometimes 5-6 cm. A new nest consists of a nearly vertical burrow extending to 35 to 45 cm deep. The upper part of the main burrow is narrowed to 3.5-4.0 mm; further the main burrow widens to 5-6 mm. The cells immediately adjoin the main burrow with their necks (Fig. 528).

Initially the female-foundress excavates all of the cells, then lines and provisions them; only after that it starts laying eggs, having previously closed the nest entrance with soil. In total, 2 to 6 cells are prepared. The pollen ball is of a spherical form, flattened at its poles. The egg lies on its top. After oviposition the cell remains open. During the whole of the period of the offspring's development the female-foundress remains inside of the closed nest. Occasionally it inspects the development of the offspring and removes excrement from the cells. Larval development is unusually slow for a halictine, taking the evolution from egg to adult about two months. Workers emerge in autumn, but they do not fly out from the nest and remain with their mother for hibernation, i.e. till the next spring. Workers live long enough (12 to 15 months), but their active period, when they build and provision cells, lasts no more than 1.0-1.5 months. In family nests workers construct additional burrows of the same diameter as the main one. New cells are built along these burrows (Fig. 529). After all the cells are formed, the nest is closed again from within till the next spring, and such a cycle is repeated several times. The bees do not forage during the period of larval development but remain in the closed nest, being occupied with inspection of the cells. The females not only inspect the brood but also remove larval feces, exuviae, dead larvae, and the like.

A family can exist for 5 or 6 years, which amounts to the life length of one queen; one brood is reared every year. Thus, in the second year of the nest's existence workers prepare 6-17 cells; in the third 15-39; in the fourth 50-130; in the fifth 199-411; in the sixth 590-897 cells. Throughout all these years the queen takes no part in constructing and foraging cells, but is occupied only with laying eggs. In the last years of the existence of the colony, because of a great number of cells prepared by workers, the queen fails to lay eggs immediately after the formation of the pollen balls. After all the cells are prepared and the nest entrance is closed, the queen can still lay eggs for more than one month. Unlike the queens of all other halictines, those of *E. marginatus* have unusually developed ovaries, where 10 to 30 full-sized eggs can be formed simultaneously. Thus, each of the six ovarioles contains several full-sized eggs in sequence. In other halictine species, only one egg is formed in ovaries at a time, and in one of ovarioles only.



Figs. 528, 529. Nests of *Evylaeus marginatus*
(from PLATEAUX-QUÉNU, 1960b: Fig. 10c, 10e). Scale line represents 5 cm.

For all the years of its existence, only females emerge from the nest, and all of them become workers, although they do not differ from the queen in their body size. The castes are distinctly differentiated in behaviour and physiology. Workers usually have slender ovaries, and all of them are not fertilised, since in the fall, in the males' flight period they are inside of closed nests. In PLATEAUX-QUÉNU's experiments a three-years nest with emerged females was discovered, which normally should become workers, but after copulation they started to construct new nests in spring, like normal queens. Therefore, in this species the caste differentiation is determined only by whether or not a given individual has copulated. Inside the nest there exists a division of labour: some individuals forage, and other do the inside-nest works. BONELLI assumed that young individuals work inside the nest, while the older ones are mostly occupied with foraging. Probably, he took the inside-nest workers, usually less worn as compared with foragers, to be younger. In the last year of the family's existence the queen dies, and males and future foundresses emerge in the nest. In autumn such a nest is opened, and males fly away in search of other open nests, inside of which they copulate with young females. Males are usually more numerous than females, and the most of males are produced from the eggs laid by workers. Unlike in the first years, in the last one a part of workers exhibit ovarian development. Fertilised females remain in their nest throughout the winter.

References: FRIESE, 1891; QUÉNU, 1955: 1512-1514; 1957a: 1416-1418; 1957b: 1548-1550; 1958a: 1102-1104; 1958b: 1294-1296; PLATEAUX-QUÉNU, 1960a: 325-446; 1960b: 4465-4466, 1962: 41-51; GROZDANIĆ, 1956: 321-329; 1966: 5-11; 1971a: 46-52; KNERER & PLATEAUX-QUÉNU, 1966c: 1622-1625; VASIĆ, 1966: 103-118; BONELLI, 1969: 68-78; MICHENER, 1974: 295-298.

Evylaeus tricinctus (SCHENCK, 1874) (348, 439, 440, 530).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus delmasi* PÉREZ, 1903.

Taxonomy. A variable species. Asian populations are considered as belonging to a separate subspecies, ssp. *muganicus* (EBMER, 1972). It differs from the typical form in the coarser punctation of the mesoscutum of both sexes, higher head, coarser punctation of the frons and sparser pubescence of the metasomal tergum IV of females and not so sharp an outer angle of the male gonostylus. Differences from *E. setulellus* (STRAND, 1909), other species of the *E. tricinctus* group (EBMER, 1995: 592), are given in the key above.

Fig. 530. Occurrence of *Evylaeus tricinctus* in Poland.

Distribution. A rare, mostly steppous species, occurring in south and sporadically in Central Europe to middle Germany and southern Poland in the north, in the Middle East to Iran in the east.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Polish data. Earlier, the species was recorded from two localities of Poland: Krzyżanowice near Kielce and the Pieprzowe Mts. near Sandomierz (NOSKIEWICZ 1953: 307-308). In the collections studied we have found only the following specimens of this species caught in Poland (Fig. 530): Dąbrowa Tarnowska [Tarnów district], VII. 1908, leg. ŁOZIŃSKI, 2 ♂ [KRA].

Evylaeus setulellus (STRAND, 1909) (Figs. 349, 441, 442, 531).

Synonymy: *Halictus foveolatus* BLÜTHGEN, 1924.

Distribution. A rare, mostly steppous species, occurring in south and sporadically in Central Europe to north-western France, Austria and southern Poland in the north, and in the Middle East to Iran in the east.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Fig. 531. Occurrence of *Evylaeus setulellus* in Poland.

Polish data. Material studied (Fig. 531): Pieprzowe Mts. [ad. Sandomierz, Tarnobrzeg district], 12.VI.1953, 1 ♀; 12.VIII.1953, 1 ♀, both leg. NOSKIEWICZ [WRO]. Rather the material above was indicated by (NOSKIEWICZ, 1953: 307) as caught in 'Sandomierz Lowland: Sandomierz'.

Evylaeus fulvicornis (KIRBY, 1802) (Figs. 350, 351, 390, 415, 443, 444, 523, 533).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Hylaeus laeviusulus* SCHENCK, 1853; *H. albitarsis* SCHENCK, 1853; *H. bismaculatus* SCHENCK, 1853; *Halictus opacifrons* PÉREZ, 1911.

Taxonomy. It belongs to the *E. fratellus* species-group (SVENSSON et al., 1977; EBMER, 1995: 572). Differences from *E. fratellus* (PÉREZ, 1903) are given in the key above. This species shows a small geographical variation in the structure of the gonostylus, 2nd tarsomere of hind legs and sometimes in the coloration of the clypeus of males. Southern and eastern populations are considered as separate subspecies: ssp. *antelicus* (WARNCKE, 1975) in north-eastern Turkey and Iran, ssp. *melanocornis* (EBMER, 1988) in the eastern part of the Palaearctic region, ssp. *koshunocharis* (STRAND, 1914) in Taiwan.

Distribution. Transpalaearctic, occurring throughout in almost all natural zones. The typical subspecies is widely distributed in Europe to 64° N. and in Asia to Altai in the east.

Ecology. In Central Europe, females fly all the season long, males appear in June. Polylege.

Bionomics. Solitary species. The absence of eusociality may be secondary, i.e. a result of a reversion from a social mode of life caused by some factors or other, as it is observed, for example, in E. calceatus in northern mountainous regions (see above). Nests with chambers has no lateroid; cells are closed with caps. The nest is established by a solitary female. More detailed data on the nest structure are unavailable.

References: PACKER & KNERER, 1985: 144; PACKER, 1991: 153-159.

Fig. 532. Occurrence of *Evylaeus fulvicornis* in Poland.

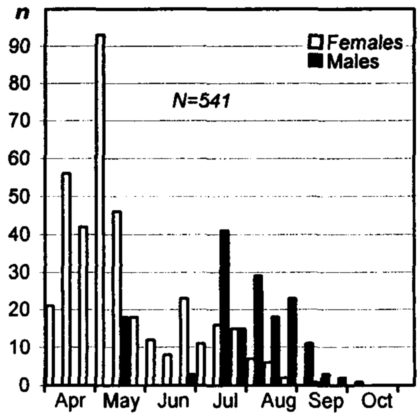


Fig. 533. Flight phenology of *Evylaeus fulvicornis* in Poland.

Polish data. A very common species in Poland. It is spread in all regions of the country (Fig. 532). All specimens were caught in dry and open areas such as xerothermic swards, dry meadows, arable fields. Females fly since April till September; males were collected since the second decade of May till the first decade of October (Fig. 533). Recorded from flowers of 64 species belonging to many botanical families.

Evylaeus fratellus (PÉREZ, 1903) (Figs. 352, 353, 391, 416, 445, 446, 534-537).

The species is represented in Poland by the nominotypical subspecies.

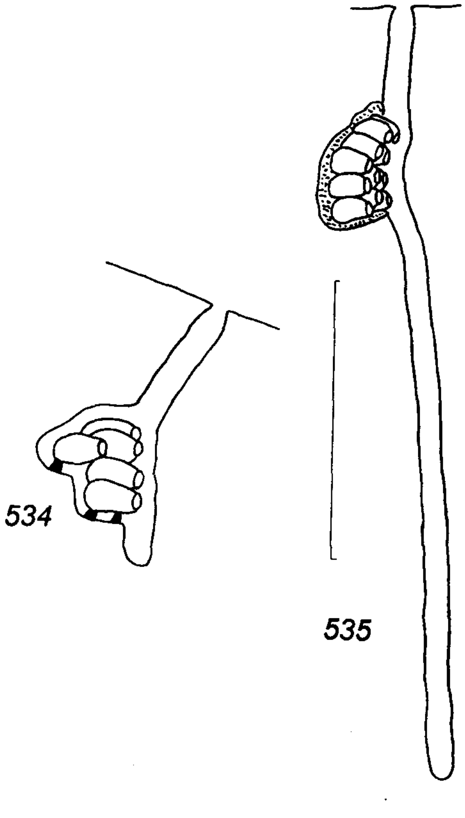
Synonymy (of the subspecific name): *Halictus subfasciatus* NYLANDER, 1848, nec IMHOFF, 1832; *H. freygessneri* ALFKEN, 1904, *H. norvegicus* STRAND, 1910; *H. niger* auctorum partim, nec VIERECK, 1903.

Taxonomy. This species is relatively constant morphologically over its extensive geographical range. Only in the Russian Far East and Korea it forms a separate subspecies, ssp. *betulae* (EBMER, 1978). The latter differs from the nominotypical subspecies by the shorter male gonostylus, narrower head and more distinctly punctate metasomal tergum I of the female. The species differs from the close *E. subfulvicornis* (BLÜTHGEN, 1934), represented in Europe by ssp. *austriacus* (EBMER, 1974) but not occurring in Poland, in the following features: the head of the female slightly higher, male gonostylus much longer, narrowed medially, its membranous lobe hairless, hook-shaped at its distal part.

Distribution. Eurasian, in Europe throughout to 69° N. in Finland, montane in south Europe.

Ecology. Flies for all the season long. Univoltine. In HEIDE's (1992) opinion, the univoltine life cycle has developed in this species from the primitively eusocial one, with two broods reared yearly. Polylege.

Bionomics. Primitively eusocial with a delayed eusociality; however, in Central and North Europe most females have a solitary life cycle. Females remain fertile for all the season long. The species is characterised by a long duration of the life of females, which overwinter twice, and can establish nests for two consecutive years. Occasionally a joint foundation of a nest by the old mother and one of its daughters occurs, thus an eusocial matrifilial community is formed. In result, the so-called delayed eusociality can be observed in *E. fratellus*, similarly to what is noted for some species of *Ceratina* (SAKAGAMI & MAETA, 1985; 1987). Also noted is a polygynous nest foundation by two females, but it remains unclear, whether they are sisters or the mother and the daughter. Alone old females retain the ability to bring up a brood in the second year of their life. Small nest aggregations are created on ground lots with rare vegetation. In spring some females can re-use the main burrow of their maternal nest, constructing there their own cells. Around the nest entrance (3.5-4.5 mm in diameter) there is a small conical tumulus. For the period of oviposition, construction of the next cell, and for the night the female plugs the nest entrance from within. The main burrow is vertical, it stretches down to a depth of 5-7 up to 17-20 cm. The cells are grouped into a cluster, which is surrounded with an air chamber (Figs. 534, 535). The cluster is held within the chamber by pillars. The walls of the main burrow and nest chambers are not polished, and have no secretory lining.



Figs. 534, 535. Nests of *Evylaeus fratellus* (from HEIDE, 1992: Figs. 7c, 7e). Scale line represents 5 cm.

Fig. 536. Occurrence of *Evylaeus fratellus* in Poland.

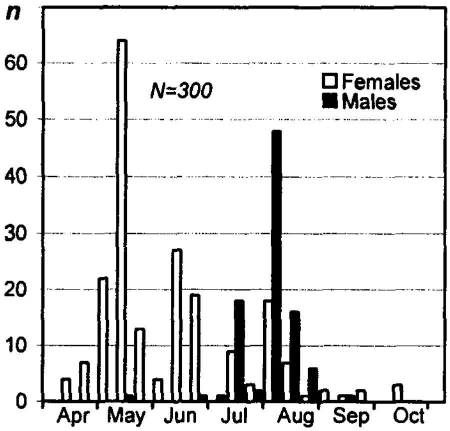


Fig. 537. Flight phenology of *Evylaeus fratellus* in Poland.

The cells are ovaloid in form, bilaterally symmetrical, more flat at their lower part. Their length is 9-11 mm, maximal diameter 5.0-5.5 mm, the diameter of necks 4 mm. The inner walls are polished and lined up with a lustrous secretory material. First the uppermost cells are constructed, and later the comb grows downwards. In order to fill one cell with forage, the female makes 9-11 pollen trips and 1-2 (rarely 3) extra trips for nectar collection. Daily the bee flies out at most 10 times, 4.5 times on the average. Thus, the provisioning of one cell usually takes 2 days. The pollen ball has a spherical form, it is slightly flattened at its poles; its diameter is 3.5-4.0 mm, height 3.0-3.3 mm. The dry weight of the pollen ball amounts to 34-36 mg. Overall, the female constructs 6-7, occasionally 9 cells. In polygynous nests there are 11-12 cells, in one instance a nest was registered, which contained a comb of 17 cells. In polygynous nests with two females one of them is occupied with foraging, while the other serves the functions of a guard. The forager bees have underdeveloped ovaries, whereas those of the guards are well developed and have mature oocytes. Within one year, one brood is reared in the nest, comprising it both females and males. Even in most warm years rearing of the second brood was not registered. A part of young females leave their maternal nest before hibernation, and a part remain therein. Those females leaving their natal nest hibernate not far from their emergence place.

Cleptoparasite: *Sphecodes hyalinatus.*

References: MEIDELL, 1958: 12; HEIDE, 1992: 171-188; FIELD, 1996: 167-182.

Polish data. This species is common in northern Poland and highlands, sporadically occurs in the southern uplands. Most (70%) examined specimens were caught in highlands, mainly in the Tatra Mts. and 27% in north-eastern Poland (Fig. 536). In the Tatra Mts. most specimens were collected in the upper montane forest zone (1200-1550 m) and the lower montane zone (900-1200 m). Almost all records indicate that the species prefers forest habitats in both mountains and lowland (pine and mixed forest). Females fly nearly all the season long, since April till October; males were recorded since May till September, in August they are most numerous (Fig. 537). Flight phenology of this species is similar in both mountains and north-eastern Poland. Collected from flowers of 18 species: Bellis perennis, Campanula sp., Chamaenerion sp., Crocus scepusiensis, Gagea lutea, Hieracium sp., Hieracium pilosella, Leontodon sp., Potentilla argentea, P. aurea, P. erecta, Ranunculus sp., Salix aurita, Taraxacum officinale, Tussilago farfara, Vaccinium myrtillus, Vaccinium vitisidea, Veronica sp.

Evylaeus laevis (KIRBY, 1802) (Figs. 354, 392, 421, 447, 538, 539).

Synonymy: *Hylaeus convexus* SCHENCK, 1853; *Halictus nigriventris* ARNOLD, 1894; *H. kriegeri* ALFKEN, 1897.

Taxonomy. The species is similar to species of the *E. calceatus* group in the structure of male genitalia, but sharply differs from them by the dark posterior areas of metasomal terga, also in the sculpture and pubescence of the body (see the key above). The species occupies an isolated position among the 'carinate *Evylaeus*'.

Distribution. Eurasian to Altai in the east, not common, mostly in woodlands, montane in south Europe.

Ecology. Univoltine (KRIEGER, 1894; NOLL, 1931: 342).
Bionomics. Rather solitary. Nesting unknown.

Fig. 538. Occurrence of *Evylaeus laevis* in Poland.

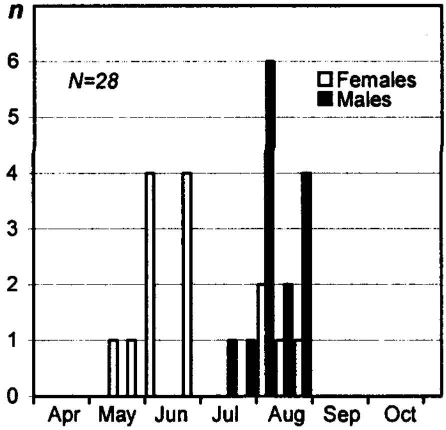


Fig. 539. Flight phenology of *Evylaeus laevis* in Poland.

Polish data. A relatively rare species sporadically occurring in southern and western Poland (Fig. 538). Females fly since May till the end of August; males were caught in July and August (Fig. 539). Recorded from flowers of 10 plant species, mostly composites.

Evylaeus interruptus (PANZER, 1798) (Figs. 355, 356, 393, 422, 448, 540, 541).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Apis basimacula* SCHRANK, 1802; *Hylaeus geminus* ERICHSON, 1835; *H. quadrimaculatus* SCHENCK, 1853.

Taxonomy. The species is similar to species of the *E. calceatus* group in the structure of male genitalia, but sharply differs from them by the strongly convex metasoma, dark posterior areas of metasomal terga, also in the sculpture and pubescence of the body (see the key above). The species, together with the close *E. anellus* (VACHAL, 1905) and *E. limbelloides* (BLÜTHGEN, 1931) occurring in south-eastern Europe and the Middle East, occupies an isolated position among the 'carinate *Evylaeus*'.

Distribution. A west Palaearctic, mostly steppous species, in Central Europe occurring locally to northern Germany and Poland to the north. South-eastern Europe to Armenia is inhabited by ssp. trispinosus (Alfken, 1907) slightly differing from the typical form mostly by the more robust body.

Ecology. In Central Europe the species prefers dry and warm habitats. Females fly all summer long, males appear in mid-summer. Polylege.

Bionomics. A primitively eusocial species. Nests are established both in clayey and sandy soil. Cases of polygynous nest foundation are registered. Nests are built on horizontal ground lots. There is a turret 2-3 cm high over the nest entrance. The female camouflages the nest opening by curving the above-soil structure toward the soil surface rather than the sky. In spring the depth of the nest is no more than 15 cm. The female builds a comb-like cluster usually consisting of 5-6 cells, which is surrounded with an air chamber. After oviposition cells seem to remain open for the most of time. Thus, in the nests investigated by GROZDANIĆ & MUČALICA (1968) the most of cells were open, which contained preimaginal phases at the early stage of development. Workers and a small number of males emerge in the first brood. In summer, during the social phase, the nest gets deepened to 30 cm. Workers also construct comb-like cell clusters, where future reproductive individuals are reared. Young fertilised females hibernate in their maternal nest, which premises the future rise of a polygynous community.

References: TORKA, 1913; KNERER & PLATEAUX-QUÉNU, 1966: 2014; GROZDANIĆ & MUČALICA, 1968: 9P-10P.

Fig. 540. Occurrence of *Evylaeus interruptus* in Poland.

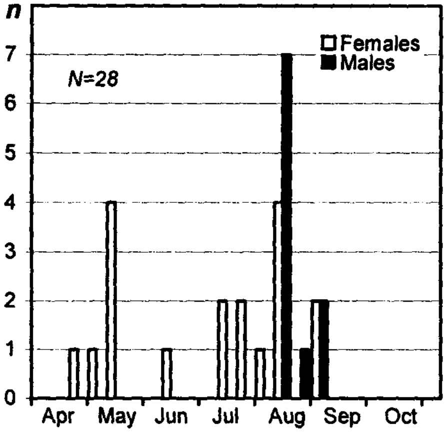


Fig. 541. Flight phenology of *Evylaeus interruptus* in Poland.

Polish data. A relatively uncommon species occurring in the whole territory of Poland (Fig. 540). Females fly since the second decade of May to the first decade of September; males in August and September (Fig. 541).

Material studied: Płutowo [Toruń district], 30.IV.1972, on flowers of Potentilla sp., leg. BANASZAK, 1 ♀ [BAN]. Krzyżanowice [ad. Pińczów, Kielce district], 8-18.V.1953, 4 ♀; 9.VIII.1953, 1 ♀, 6 ♂; 15.VIII.1954, 2 ♀; 25.VIII.1953, 1 ♂; 6.IX.1953, 2 ♀, 2 ♂ [all 18 specimens in WAR]. Sandomierz [Tarnobrzeg district], 13.V.1950, 1 ♀ [WAR]. Same locality, 25.VII.1953, on flowers of Nigella sp., 2

♀; 12.VIII.1952, 1 ♀; all three females leg. NOSKIEWICZ [WRO]. Pieprzowe Mt. [ad. Sandomierz, [Tarnobrzeg district], 12.VIII.1953, leg. NOSKIEWICZ, 1 ♂ [WRO]. Górażdże [ad. Strzelce, Opole district], 13.VII.1949, 2.VIII.1949, leg. NIESIOŁOWSKI, 2 ♀ [WAR]. Kazimierz Dolny [Lublin district], 14.VII.1962, leg. NOSKIEWICZ, 1 ♀ [WRO].

Evylaeus minutulus (SCHENCK, 1853) (Figs. 357, 394, 449, 542).

Synonymy: *Hylaeus ambiguus* SCHENCK, 1861; *Halictus semipunctulatus* SCHENCK, 1869.

Taxonomy. The species is similar to *E. setulosus* (STRAND, 1909), another European species of the *E. minutulus* group. Differences between them are given in the key above.

Distribution. A not common European species, mostly steppous, sporadically occurring in Central Europe.

Bionomics. Nesting unknown. A rather solitary species.

Fig. 542. Occurrence of *Evylaeus minutulus* in Poland.

Polish data. Earlier this rare for Poland species was recorded from 'Silesia: Seiffenau' [West Sudeten: Podgórnik] (DITTRICH (1903: 29), 'Ostpreußen: Mehlsack' [Masurian Lakeland: Pieniężno] (ALFKEN, 1909: 126), 'Westpreußen: Althausen' [Pomerania: Starogród], 'Schlesien: Breslau, Schebitz, Wartha' [Silesia: Wrocław, Szewce, Bardo] (ALFKEN, 1912: 31.

Material studied (Fig. 542): 'Breslau' [Wrocław], 18.V.1896, leg. DITTRICH, 1 ♀ [WRO]. 'Carlowitz' [Karłowice, Wrocław district], 8.VIII.1909, leg. DITTRICH, 1 ♀ [WRO]. Łódz, 26.VI.1986, leg. KOWALCZYK, 2 ♀ [KOW].

Evylaeus setulosus (STRAND, 1909) (Figs. 358, 450, 543).

Synonymy: *Halictus zius* STRAND, 1909; *H. oblongatulus* BLÜTHGEN, 1918.

Distribution. A not common Eurasian species, mostly steppous, to south-eastern Poland in the north.

Bionomics. Nesting unknown. A rather solitary species.

Fig. 543. Occurrence of *Evylaeus setulosus* in Poland.

Polish data. Material studied (Fig. 543): Kicin, ad. Poznań, 19.VI. 1976, leg. BANASZAK, 1 ♀ [BAN]. This locality was recorded for the species earlier by BANASZAK (1976a: 251-255).

Evylaeus brevicornis (SCHENCK, 1863) (Figs. 359, 395, 544, 545).

Synonymy: *Halictus lucidicollis* PÉREZ, 1895; *H. analis* PÉREZ, 1903; *H. brevicornis* ssp. *aciculatus* BLÜTHGEN, 1930; *H. optimellus* COCKERELL, 1938.

Taxonomy. Together with the European *E. laevidorsus* (BLÜTHGEN, 1923) and *E. limbellus* (MORAWITZ, 1876) and some other species, this species forms the *E. brevicornis* group (EBMER, 1976: 402) which differs from other groups of the 'carina-less *Evylaeus*' in polished mesepisterna, translucent posterior areas of metasomal terga, big male gonostylus and some other characters. Differences from the close *E. limbellus* are given in the key above. The species shows a distinct variation in the sculpture of the metasomal tergum I (this tergum transversely striate in f. *aciculatus* BLÜTHGEN, 1930), which has not geographical correlation.

Distribution. Western Palaearctic, to Afghanistan in the east; widespread in Europe to southern Sweden in the north.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

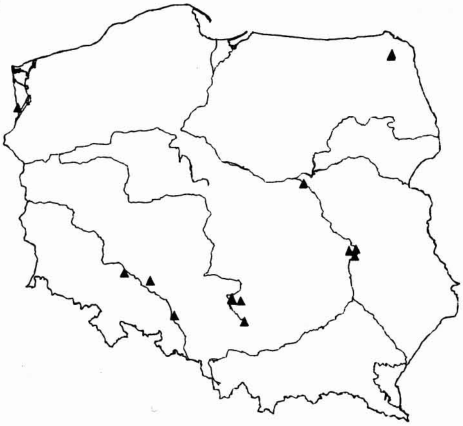


Fig. 544. Occurrence of *Evylaeus brevicornis* in Poland.

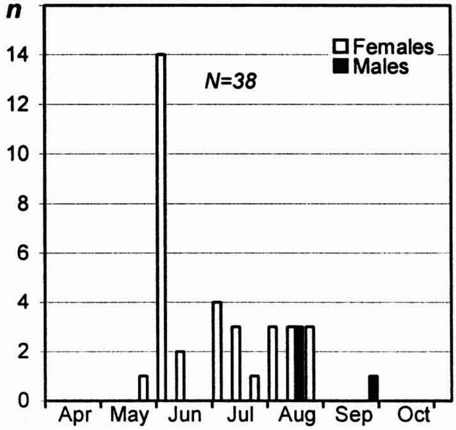


Fig. 545. Flight phenology of *Evylaeus brevicornis* in Poland.

Polish data. A relatively rare species sporadically occurring in the whole Poland (Fig. 544). Not showing a certain biotopic preference. Females fly since the last decade of May till the end of August; males were observed in August and September (Fig. 545). It was collected from flowers of 10 plant species, mostly composites (95% of records).

Evylaeus limbellus (MORAWITZ, 1876) (Figs. 360, 451, 452, 546).

Synonymy: *Halictus gibbulus* PÉREZ, 1903; *H. ventralis* PÉREZ, 1903; *H. combinatus* BLÜTHGEN, 1921; *H. limbellus* var. *dongaricus* BLÜTHGEN, 1934; *H. rufocinctulus* COCKERELL, 1937; *H. frigescens* COCKERELL, 1938.

Taxonomy. In contrary to the opinion of BLÜTHGEN (1931: 210), WARNCKE (1973: 290) and earlier EBMER (1972: 625) which accepted *H. ventralis* PÉREZ, 1903 as a junior synonym of *Halictus limbellus* MORAWITZ, 1876, later EBMER (1974: 137; 1975: 276; 1978: 67; 1981: 125; 1988: 651-653) considers *E. limbellus* as consisting of two separate subspecies: the western ssp. *ventralis* occurring to Austria (Oberösterreich, Kärten and Tyrol) in the east and the eastern ssp. *limbellus* occurring also to Austria (Burgerland, Wien, Niederösterreich) but in the west of geographical range of the latter subspecies. Although EBMER (1988: 652) has given a long list of morphological differences between these subspecies, among them there are no distinct ones.

Distribution. The species is uncommon, western Palaearctic in occurrence, to northern China in the east. Localities in Poland are northernmost.

Bionomics. According to the photos by MADER (1999: pls. 7, 8, 41-43), the species forms large nest aggregations at vertical hill walls of thick sandy material. The nest structure and level of social development are unknown.

Fig. 546. Occurrence of *Evylaeus limbellus* in Poland.

Polish data. Material studied (Figs. 546): Kazimierz Dolny [Lublin district], VI.1932, leg. NOSKIEWICZ, 1 ♀ [WRO]. Other records of this rare for Poland species (DROGOSZEWSKI, 1932; MINKIEWICZ 1935; KOSIOR.& J. FIJAŁ, 1992) need confirmation.

Evylaeus sexstrigatus (SCHENCK, 1869) (Figs. 361-363, 380, 381, 396, 453, 454, 547, 548).

Synonymy: *Halictus sabulosus* WARNCKE, 1986.

Taxonomy. This species sharply differs from other 'carina-less *Evylaeus*' inhabiting Europe in the presence of posterior tomentose bands of metasomal terga in females and the presence of a tooth (of variable size) at genal areas in males. In Europe, it is a single representative of a big group, all other species of which inhabit the south-east Palaearctic and north Oriental regions (SAKAGAMI & EBMER, 1996: 899-916).

Distribution. Transpalaearctic; in Europe to Belgium in the west, to Lithuania in the north.

Bionomics. A rather primitively eusocial species (GROZDANIĆ, 1966: 2; VASIĆ, 1966: 103). Nesting unknown.

Fig. 547. Occurrence of *Evylaeus sexstrigatus* in Poland.

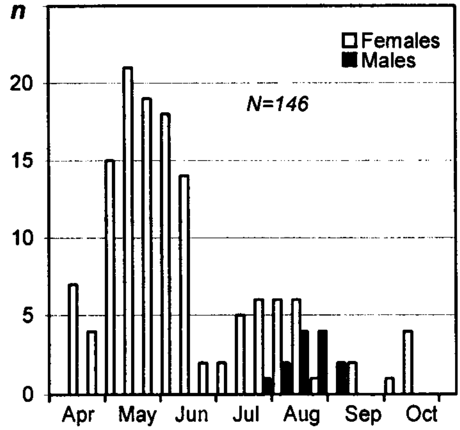


Fig. 548. Flight phenology of *Evylaeus sexstrigatus* in Poland.

Polish data. A relatively common species occurring in the whole Poland (Fig. 547). It inhabits different biotopes, not showing a certain preference. Females fly since the second decade of April till the second decade of October; males are recorded since the last decade of July till the second decade of September (Fig. 548). Collected from flowers of 28 plant species belonging to many botanical families.

Additional note. WARNCKE (1986: 126) established his new species *Halictus sabulosus* basing on some materials from Germany, northern Italy and Austria. However, he gave too short description containing few distinct morphological differences from the close *E. sexstrigatus*. EBMER (1988b: 659) synonymised *E. sabulosus* with *E. sexstrigatus* referring to weak differences between them and high morphological variation of *E. sexstrigatus* correlated with the body size. Recently HERRMANN & DOCZKAL (1999) found several new distinct characters well distinguishing *E. sabulosus* from *E. sexstrigatus* and shown that *E. sabulosus* is really a separate species:

1. *Both sexes*: 'hypoepimeral areas' (mesepisterna above scrobal suture) mat, rugulose, indistinctly punctate; mesoscutum shagreened, mat, flatter and denser punctate (0.5-1.5) (The differences in the sculpture of the mesosoma become slightly apparent in males). *Female*: inner metatibial spurs provided with short teeth (Figs. 362, 363); frons punctate with distinct interspaces; head distinctly wider than high. *Male*: metasomal tergum II sharply depressed at anterior part, before tergal gradulus; tergum I very slightly sparsely punctate and only at anterior half of lateral inflations, with sparse hairs on lower parts (laterotergites); pale coloration of clypeus, mandibles, and labrum yellowish-white; clypeus convex at lower part; tooth of genal areas mostly small, if it is long, than as wide as flagellum; pubescence of metasomal sternum II sparse and shorter .... ***E. sexstrigatus***

\- *Both sexes*: hypoepimeral areas distinctly punctate with smooth interspaces; mesoscutum deeply and sparser punctate (1-2) with mostly shiny interspaces. *Female*: inner metatibial spurs provided with long teeth (Fig. 361); frons very densely, honeycomb-like punctate; head hardly wider than high. *Male*: tergum II flat at anterior part; tergum I strongly and densely (2-5) punctate, with richer pubescence on lower parts; pale coloration of clypeus, mandibles, and labrum with reddish tint; clypeus flattened at lower part; tooth of genal areas small in small individuals, but always wider than flagellum in big individuals; pubescence of metasomal sternum II denser and longer .... *E. sabulosus*

The main texts on the taxonomy and distribution of *E. sexstrigatus* above were written in the late 1998. In the present work we did not set ourselves the task of making a taxonomic revision of the genus *Evylaeus*. Nevertheless, we noticed unusual bimodal variation of the Polish *E. sexstrigatus* s. l. in the sculpture of the mesosoma and structure of female inner metatibial spurs (cf. Fig. 361 and Figs. 362, 363). Therefore, we are sure that both *E. sexstrigatus* and *E. sabulosus* inhabit Poland. However, the important paper by HERRMANN & DOCZKAL (1999) concerning the taxonomic status of *E. sabulosus* appeared when we finished studying the Polish halictids in main collections (see Table 2 in Chapter III) and were preparing the manuscript of this book for press. For this reason, we have not labelled *E. sabulosus* in the Polish collections and, hense, could not include it to the annotated list as a separate species. Also *E. sabulosus* is not taken into account in our analyses of the Polish fauna of the Halictidae in Chapter III.

Evylaeus politus (SCHENCK, 1853) (Figs. 332, 333, 364, 382, 397, 455-457, 549-551).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Hylaeus nanulus* Schenck, 1853.

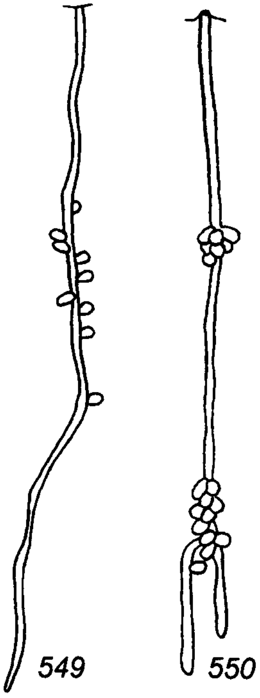
Taxonomy. This species is a member of the *E. politus* group. In the European fauna, the latter consists of seven species, including *E. glabriusculus* (MORAWITZ, 1872) and *E. trichopygus* (BLÜTHGEN, 1923) (see below). It is a variable species because of strong caste differentiation: workers are smaller (less than 5 mm) and noticeably finer sculptured than queens (length more than 5 mm).

Distribution. The species is transpalaearctic in occurrence. EBMER (1988: 666-667) distinguishes three subspecies differing mostly by the punctation of the frons: ssp. *politus* inhabiting Europe to 53° N., ssp. *atomarius* (MORAWITZ, 1876) occurring in Egypt and warm areas of western Asia, and ssp. *pekingensis* (BLÜTHGEN, 1925) occurring from northern China to Japan.

Bionomics. A primitively eusocial species. Nests are established monogynously. The nest entrance, 1-1.5 mm in diameter, may be placed both on horizontal ground and on a vertical precipice bank. Over the entrance hole there often is a turret 2 cm high, which is restored by bees if damaged. The main burrow, 2.2-2.5 mm in diameter, goes down into the soil perpendicularly to its surface. The lower part of the main burrow occasionally ramifies into two burrows. Sessile type cells are either grouped in clusters, or scattered along the main burrow (Figs. 549, 550). The female excavates and lines the cells in the night, in order to already forage them in the daytime. In a bad weather it sometimes prepares two cells at once for foraging. The length of a cell is 6.5 mm, diameter 2.5-3.0 mm. After the provisioning and oviposition the cell is closed with a cap.

The first brood consists of 5-6 workers. Males are almost absent in it, therefore workers are very rarely fertilised. The castes exhibit a distinct morphological differentiation, only an insignificant size overlap among the largest workers and the smallest queens is observed in the populations. Besides that, the most of workers have under-developed ovaries, and only 9% of them have mature oocytes. As well, a salient division of labour exists in the social phase. Workers prepare cells for the second brood, which consists entirely of reproductive offspring.

References: QUÉNU, 1954: 157-163; KNERER, 1968: 105-106; 1981: 1-10.



Figs. 549, 550. Nests of *Evylaeus politus* (from KNERER, 1981: Figs. 10, 11).

Fig. 551. Occurrence of *Evylaeus politus* in Poland.

Polish data. A relatively uncommon species in Poland. Earlier it was recorded from two dozens of localities in different parts of the country (in the present borders) (ALFKEN, 1909: 13; 1912: 32; TORKA, 1913: 118; DITTRICH, 1903: 28; NOSKIEWICZ, 1920a: 156, 1953: 309, and some others).

Material studied (Fig. 551): Kazimierz Dolny [Lublin district], 4.VI.1952, leg. RIEDEL, 2 ♀ [WAR]. Puławy [Lublin district], 18.VII.1964, 1 ♀ [PUL]. Kraków, 11.VII.1921, leg. ŁOZIŃSKI, 2 ♀ [KRA]. Soból [ad. Sahryń, Zamość district], 8.VIII. 1974, 1 ♀ [PUL]. Pieprzowe Mt. [ad. Sandomierz, Tarnobrzeg district], 18.IX.1952, leg. NOSKIEWICZ, 1 ♂ [WRO].

Evylaeus glabriusculus (MORAWITZ, 1872) (Figs. 398, 552, 553).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus leucopygus* PÉREZ, 1903; *H. truncatus* ALFKEN, 1905; *H. granulosus* ALFKEN, 1906.

Taxonomy. Similar to *E. trichopygus* (BLÜTHGEN, 1923) (see below). Differences between these species are given in the key above.

Distribution. This is an uncommon western Palaearctic, mostly steppose species. The nominotypical subspecies distributes in Europe, to Poland in the north. Another subspecies, spp. *ultraparvus* (COCKERELL, 1938) differing by the sparser punctation of the face (see: EBMER, 1985: 290), occurs in North Africa.

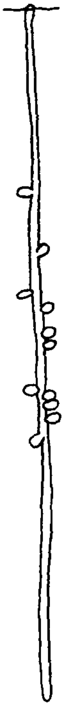


Fig. 552. Nest of *Evylaeus glabriusculus* (from KNERER, 1981: Fig. 15).

Fig. 553. Occurrence of *Evylaeus glabriusculus* in Poland.

Bionomics. A primitively eusocial species. The most of nests are established polygynously by sisters. The role of the queen is played in such nests by the largest individual. In a polygynous community the queen is occupied not only with egg-laying yet also with protection of the nest. The nest entrance is narrowed, its diameter is 1.0-1.5 mm; usually it is placed on horizontal ground lots. The main burrow, 2 mm in diameter, stretches vertically downwards. An unusual order of the nest construction is typical for the species. Initially the female prepares cavities for all or for the majority of future cells. Thus, in spring up to eight empty newly excavated cells may be found in a nest. However, the female polishes and lines up only one cell at a time, provisioning it and laying an egg. After sealing this cell with a cap, the female starts lining it up, and then provisioning the next cell etc. Females construct sessile cells, which lie close to the main burrow of the nest. The length of the cell is 5-6 mm, diameter 2.5-3.0 mm. Unlike in *E. politus* (see above), in *E. glabriusculus* cells are built almost all along the main burrow (Fig. 552). Neither comb-like cell clusters, nor nest chambers are constructed. Monogynous nests contain 6-7 cells. Four females may work simultaneously in a polygynous nest, building up to 22 cells.

One brood of workers is reared in a nest. Only individual males occur in the first brood, so that workers are not fertilised. Morphological caste differences are indistinct, but a salient division of labour exists in the social phase. Thus, a part of workers serve the functions of guards, being positioned in the entrance hole. The nest has a turret up to 2 cm high, which is restored by workers if damaged. In the flight period of workers, a large number of half-ready (not yet polished and lined up) cells exists in the nest. In summer the nest depth amounts to 30 cm, occasionally 40 cm. Reproductive offspring is reared in the second brood. After copulation young females hibernate in their mother's nest.

References: GRANDI, 1937; KNERER, 1969: 927; 1981: 1-10.

Polish data. In all the collections examined, we have found only the four following specimens of the species caught in Poland (Fig. 553): Pieprzowe Mt. [ad. Sandomierz, Tarnobrzeg district], 18.V.1952, leg. NOSKIEWICZ, 1 ♀; 2.VI.1952, leg. SZYMCZAKOWSKI, 2 ♀; 2.VII.1952, leg. NOSKIEWICZ, 1 ♀ [all in WRO]. This locality was already recorded earlier by NOSKIEWICZ (1959a: 203).

****Evylaeus trichopygus*** (BLÜTHGEN, 1923).

Distribution. A rare species inhabiting south-eastern Europe, Asia Minor and Transcaucasus, also sporadically occurring in Central Europe; the northernmost locality is eastern Austria. It can be found in the south-eastern part of Poland.

Bionomics. A primitively eusocial species. It forms dense aggregations with 50-60 nests per 1 m^2. The species settles in clayey and sandy soils with sparse vegetation. The cases are registered where the nest was founded polygynously by two or three females, existing a division of labour among them. In polygynous nests one of the females serves the functions of the guard. As well, protection is detected in the summer matrifilial nests. The nest structure and details of the social structure are unknown.

References: GROZDANIĆ, 1966c: 18-19; 1969: 14.

Evylaeus quadrinotatulus (SCHENCK, 1861) (Figs. 334, 365, 383, 399, 458, 459, 554-556).

Synonymy: *Halictus pallipes* MORAWITZ, 1865; *H. megacephalus* SCHENCK, 1869; *H. sexsignatus* SCHENCK, 1869.

Taxonomy. Together with eastern Palaearctic *E. amurensis* (VACHAL, 1902) and *E. sakagamii* (EBMER, 1978), this species forms a separate group of the 'carina-less *Evylaeus*' which differs from the close *E. minutissimus* species-group (see below) in the larger body, poorer pubescence of metasomal terga on discs and some other characters. Morphologically constant throughout its extensive geographical range.

Distribution. Western Palaearctic, to the Transbaikal in the east and Asia Minor in the south. In Europe it occurs to southern Finland in the north.

Ecology. In the southern Europe the species flies from April till September. Polylege.

Bionomics. A solitary species. Preferentially it settles in sandy soils, creating there small nest aggregations. Nests are recorded to be occasionally built inside of the holes of Sand Martin birds, in vertical precipice walls.

The nest entrance, 3.5-4.8 mm in diameter, is often masked. The main burrows of the nests, 4.5-6.0 mm in diameter, if located in precipices, are sinuous; they go almost horizontally into the soil. Their length reaches 55 cm. At the end of the main burrow there is a blind one 12-20 mm long. Cells are built at the extremities of laterals 4.5-25 mm long and 3-4 mm in diameter, which are located along the main burrow. The first lateral starts at a distance of 9-14 cm from the nest entrance. The cells are horizontal; their back end is slightly lowed. The walls of the cells are lined not completely yet only to two thirds. Their remaining part located closer to the neck has no polish on its surface, and seemingly is not covered with special secret. The pollen loaf has a shape of an irregular form ball; its diameter is 4-5 mm, height 3 mm. After oviposition every lateral gets filled with soil.

Reference: SITDIKOV, 1987: 107-109.

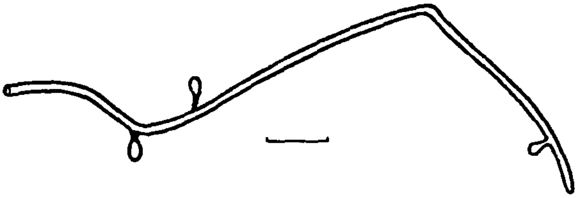


Fig. 554. Nest of *Evylaeus quadrinotatulus* (from SITDIKOV, 1987b: Fig. 1). Scale line represents 5 cm.

Fig. 555. Occurrence of *Evylaeus quadrinotatulus* in Poland.

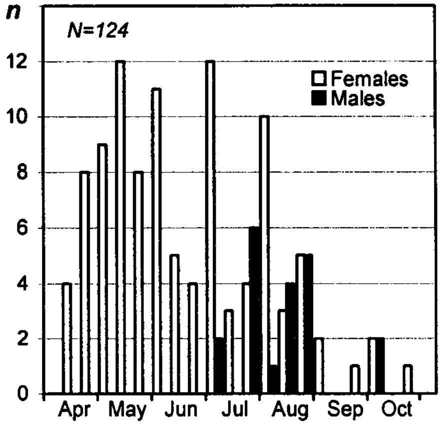


Fig. 556. Flight phenology of *Evylaeus quadrinotatulus* in Poland.

Polish data. A relatively common species occurring in all investigated districts of Poland, except for highlands (Fig. 555). Mostly inhabiting dry and open areas such as meadows, slopes, roadsides (90% of records). Females fly nearly all the season long, since April till October; males (only 20 specimens) were caught since the beginning of July and till October (Fig. 556). Recorded from flowers of 12 plant species belonging to different botanical families.

Evylaeus minutissimus (KIRBY, 1802) (Figs. 366, 400, 460-462, 557-559).

Synonymy: *Hylaeus exilis* SCHENCK, 1861; *Halictus hollandi* SAUNDERS, 1904; *H. costiferellus* STRAND, 1909; *H. kosensis* STRAND, 1909; *H. xanthosensis* STRAND, 1909; *H. arnoldi* SAUNDERS, 1910; *H. lucidellus* COCKERELL, 1937; *H. lilliput* BENOIST, 1961.

Taxonomy. This is a member of the *E. minutissimus* group of the 'carina-less *Evylaeus*', which includes about dozen small species, mostly western Palaearctic in their distribution (SAKAGAMI & TADAUCHI, 1995). Ten species occur in Europe, including four species listed below. *E. minutissimus* differs from other species of the group in the high head and the presence of transverse groove at the metasomal tergum II.

Distribution. Western Palaearctic, in Europe almost everywhere to southern Sweden and Lithuania in the north.

Bionomics. A solitary univoltine species. Nests are constructed in sandy soil. The structure and size of nests are similar to those of *E. lucidulus*. The female excavates the vertical main burrow up to 9 cm deep. Sometimes its linearity can be intervened by solid inclusions in soil, like stones, etc. Relatively long (up to 1.0-1.3 cm) laterals branch off from the sides of the main burrow, each of them leading to one horizontally oriented cell (Fig. 557). After formation of the pollen ball and oviposition the female seals the cell with a cap, and tightly fills the lateral with soil. A small number of cells (2 to 8) are built in one nest, after which the females, most probably, construct new additional nests. Only one brood consisting of reproductive individuals is reared in each nest. In our view, the fact that a small number of cells are built within one nest and additional nests are constructed in this connection, may be due to that the species settles in sandy soil. Thus, among burrowing bees a general tendency towards a sharp reduction of the number of cells built within one nest is observed, down to construction of one-celled nests if bees settle in sandy soil.

References: KNERER, 1969c: 926-929; 1981: 1-10.

Fig. 558. Occurrence of *Evylaeus minutissimus* in Poland.

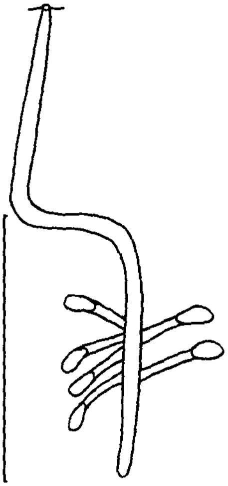


Fig. 557. Nest of *Evylaeus minutissimus* (from KNERER, 1981: Fig. 8). Scale line represents 5 cm.

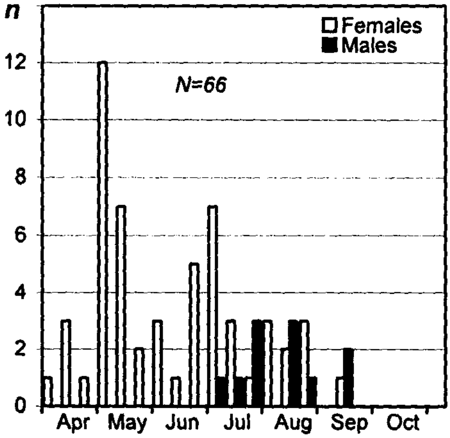


Fig. 559. Flight phenology of *Evylaeus minutissimus* in Poland.

Polish data. An uncommon species occurring dispersally in the whole country (Fig. 558). Females fly since April to the second decade of September; males (only eleven specimens) were collected since July till the second decade of September (Fig. 559). Caught from flowers of 10 plant species belonging to different botanical families.

Evylaeus intermedius (SCHENCK, 1869) (Figs. 367, 463, 560).

Synonymy: *Halictus melanoproctus* PÉREZ, 1903; *H. servulellus* STRAND, 1909.

Taxonomy. The biggest species on the *E. minutissimus* group. Similar to *E. scirpaceus* (WARNCKE, 1975) which was described from Asia Minor and possibly is a Pontic subspecies of *E. intermedius* (EBMER, 1988: 661).

Distribution. Europe and west Asia to northern Iran in the east, not common, in Europe almost everywhere to Lithuania in the north.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Fig. 560. Occurrence of *Evylaeus intermedius* in Poland.

Polish data. It is a relatively rare species in Poland. Material studied (Fig. 560): Mądralin, V.1930, leg.NOSKIEWICZ, 1 ♀ [WRO]. Szczecin [Stettin], 1.VI.1933, leg. PAUL, 1 ♀ [WAR]. Sromowce Wyżne [Pieniny Mt.], 16.VI.1961, meadow, leg. DYLEWSKA, 2 ♀ [KRA]. Goleniów [Szczecin district], 23.VI.1897, leg. LUDERWALDT, 1 ♀ [WAR]. Wrocław, Psie Pole, 4.VIII.1946, leg. NOSKIEWICZ, 1 ♂ [WRO]. Turew [ad. Kościan, Leszno district], 24.VIII.1977, on flowers of Cichorium inthybus, leg. BANASZAK, 1 ♀ [BAN]. Puszczykowo [Poznań district], 17.IX. 1978, leg. BANASZAK, 1 ♀ [BAN].

Evylaeus semilucens (ALFKEN, 1914) (Figs. 368, 561, 562).

Synonymy: *Hylaeus pygmaeus* SCHENCK, 1861, nec SCHENCK, 1853.

Taxonomy. Similar to *E. pressithorax* (EBMER, 1974) and *E. tschubuklinus* (BLÜTHGEN, 1931) recorded from Greece and Turkey.

Distribution. Eurasian, to Kyrgyzstan in the east; in Europe almost everywhere to Lithuania in the north.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Fig. 561. Occurrence of *Evylaeus semilucens* in Poland.

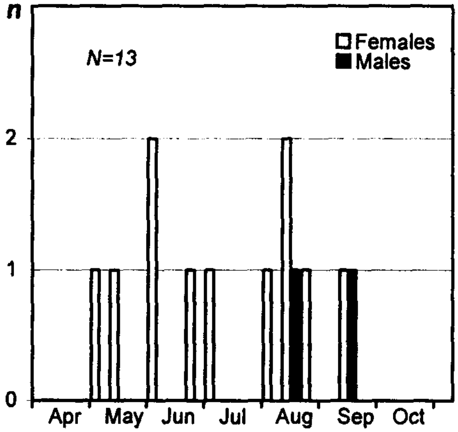


Fig. 562. Flight phenology of *Evylaeus semilucens* in Poland.

Polish data. A relatively uncommon species earlier recorded from dozen localities in Poland (BLÜTHGEN, 1919a, 1920; TORKA, 1927; MÖSCHLER, 1938). It does not show a certain pattern of its distribution in the country (Fig. 561). Females fly since May till the second decade of September; males (only two specimens) were caught in August and September (Fig. 562).

Material studied: Folusz [ad. Szubin, Bydgoszcz district], 1.V.1973, leg. BANASZAK, 1 ♀ [BAN]. Krzywe [Suwałki district], 18.V.1989, 1 ♀; 6.VII.1989, 1 ♀; both leg. KRZYSZTOFIAK [KRZ]. Wigry [Suwałki district], 3.VI.1990, leg. KRZYSZTOFIAK, 1 ♀ [KRZ]. Turew [ad. Kościan, Leszno district], 9.VI.1982, 1 ♀;14.VIII.1977, 1 ♀; 24.VIII.1977, on flowers of Cichorium intybus, 1 ♀; all three specimens leg. BANASZAK [BAN]. Chylice [ad Grodzisk Mazowiecki, Skierniewice district], 26.VI.1983, 1 ♀; 13.IX.1983, 1 ♀, both leg. BANASZAK [BAN]. Królówek, 30.VI.1992, leg. KRZYSZTOFIAK, 1 ♀ [KRZ]. Sieraków [ad. Warszawa], 11.VIII. 1968, leg. BANASZAK, 2 ♂ [BAN]. Wielkopolski National Park [Poznań district], 12.VIII.1990, leg. BANASZAK, 1 ♂ [BAN].

Evylaeus lucidulus (SCHENCK, 1861) (Figs. 464-466, 563-565).

Synonymy: *Hylaeus tenellus* SCHENCK, 1861; *Halictus gracilis* MORAWITZ, 1865; *H. unguinosus* PÉREZ, 1903; *H. chotanensis* STRAND, 1909.

Taxonomy. It is the smallest species among European Halictini (same as *E. minutissimus*). It differs from other species of the *E. minutissimus* group in the nearly impunctate metasomal terga.

Distribution. Western Palaearctic, to Mongolia in the east; in Europe almost everywhere to Sweden and middle Finland in the north.

Ecology. Monovoltine, with long period of the flight activity. Polylege.

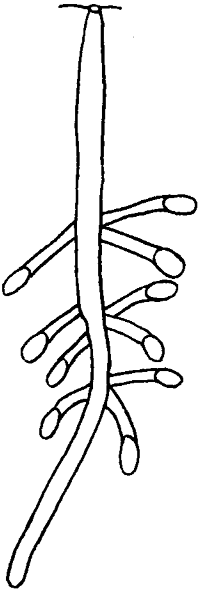


Fig. 563. Nest of *Evylaeus lucidulus* (from KNERER, 1981: Fig. 6).

Fig. 564. Occurrence of *Evylaeus lucidulus* in Poland.

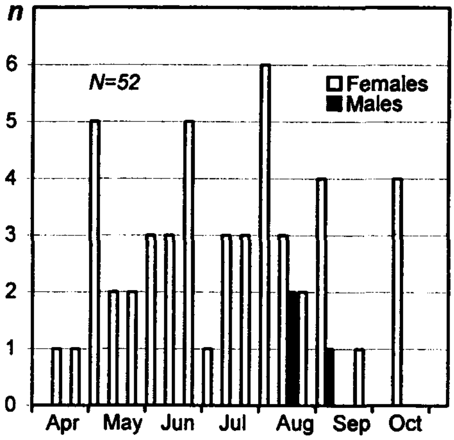


Fig. 565. Flight phenology of *Evylaeus lucidulus* in Poland.

Bionomics. A solitary species. Lonely located nests are constructed on horizontal ground lots; very unfrequently rarified aggregations are created. The nest entrance in narrowed, its diameter is 1-1.2 mm. The main burrow, 3 mm in diameter, stretches vertically downwards to a depth of 5 to 9 cm; occasionally its lower part is slightly curved. The cells are constructed by one at the ends of laterals 3 to 13 mm long that branch from the main burrow at different depth. After filling the cell with forage, oviposition and sealing the cell with a cap the female fills the lateral with soil, thus excluding a possibility of its further contact with the offspring. The female usually builds 2 up to 8, sometimes 10-11 cells within one nest (Fig. 563). KNERER (1981) supposes that females can build several nests.

References: KNERER, 1969c: 925-930; 1981: 1-10.

Polish data. An relatively uncommon species dispersally spread in central and northern Poland; not collected from the southern part of the country (Fig. 564). It inhabits different biotopes. Females fly nearly all the season long, till April till the second decade of October; males (only three specimens) were caught in August and September (Fig. 565). Collected from flowers of 9 plant species belonging to different botanical families.

Evylaeus tarsatus (SCHENCK, 1869) (Figs. 335, 369, 401, 467, 566, 567).

Synonymy: *Halictus berolinensis* STRAND, 1909.

Taxonomy. It differs from other species of the *E. minutissimus* group in the short head of both sexes, long antennae, relatively large male gonostylus and very short its membranous lobe.

Fig. 566. Occurrence of *Evylaeus tarsatus* in Poland.

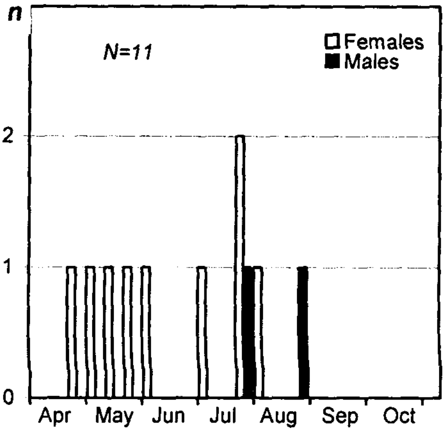


Fig. 567. Flight phenology of *Evylaeus tarsatus* in Poland.

Distribution. Sporadically occurring in east Europe from Belgium and the Netherlands in the west, to Macedonia in the south, to southern Norway and Finland in the north and in west Asia to Afghanistan.

Ecology. Uncommon species, preferring steppous and sandy areas.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Polish data. This is a relatively rare species in Poland. Earlier it was recorded from the country (in the present borders) by BLÜTHGEN (1919a: 82; 'Pommern: Körlin, Stolp' [Pomerania: Karlino near Białogard, Słupsk]) and MÖSCHLER (1938: 271; 'Ostpreußen: Rositten' [Masurian Lakeland: Rejsyty]).

Material studied: Płutowo [Toruń district], 30.IV.1972, xerotermic biotope, on flowers of Potentilla sp., 1 ♀; 5.VIII.1971, xerotermic biotope, 1 ♀, both females leg. Banaszak [BAN]. Folusz [ad. Szubin, Bydgoszcz district], 1.V.1973, xerotermic biotope, on flowers of Potentilla sp., leg. Banaszak, 1 ♀ [BAN]. Krzywe [Suwałki district], 18.V.1989, on flowers of Veronica, 1 ♀; 24.V.1989, 1 ♀;1.VI.1990, 1 ♀; all 3 ♀ leg. KRZYSZTOFIAK [KRZ]. Bliszczyce [Opole district], 8.VII.1973, leg. PISARSKI, 1 ♀ [WAR]. Rosochaty Róg [Suwałki district], 24.VII.1992, leg. KRZYSZTOFIAK, 2 ♂ [KRZ]. Bardo [Wałbrzych district], 21.VII.1949, leg. NOSKIEWICZ, 1 ♀ [WRO]. Sandomierz [Tarnobrzeg district], 26.VII.1961, leg. NOSKIEWICZ, 1 ♀ [WRO]. Pieprzowe Mts. [ad. Sandomierz, Tarnobrzeg district], 26.VIII.1953, leg. NOSKIEWICZ, 1 ♂ [WRO].

Thus, the species does not show a distinct pattern of its occurrence in Poland (Fig. 566). Females were caught since the end of April till the beginning of August; males in July and August (Fig. 567).

Evylaeus marginellus (SCHENCK, 1853) (Figs. 370, 402, 468, 469, 568).

Synonymy: *Halictus marqueti* PÉREZ, 1903.

Taxonomy. This is a member of the *E. marginellus* group which includes about two dozen species, mostly Central Asian in their distribution. The species group differs from other groups of the 'carina-less *Evylaeus*' by the sculpture of mesoscutum, scutellum and especially mesepisterna that are very coarsely punctate and polished on interspaces (the wider diagnosis of the group see: EBMER, 1997: 929-931). Six species occur in Europe, including *E. quadrisignatus* (see below). The closest species to *E. marginellus* is *E. subaenescens* (PÉREZ, 1895) inhabiting steppes of the west Palaearctic region.

Distribution. An European, mostly steppous species, sporadically occurring in Central Europe to Poland in the north.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Fig. 568. Occurrence of *Evylaeus marginellus* in Poland.

Polish data. Here this species is recorded from Poland for the first time: Sandomierz [Tarnobrzeg district], 14.VI.1957, 2 ♀; 6.VII.1954, 1 ♀, all leg. NOSKIEWICZ [WRO] (Fig. 568).

Evylaeus quadrisignatus (SCHENCK, 1853) (Figs. 371, 403, 470, 471, 569).

Synonymy: *Hylaeus rufipes* SCHENCK, 1853; *H. atratulus* SCHENCK, 1853; *Halictus pleuralis* MORAWITZ, 1872; *H. nigerrimus* SCHENCK, 1875; *H. commixtus* DALLA TORRE et FRIESE, 1895.

Taxonomy. This is other member of the *E. marginellus* group. Its differences from *E. marginellus* are given in the key above.

Fig. 569. Occurrence of *Evylaeus quadrisignatus* in Poland.

Distribution. Western Palaearctic, mostly steppous, occurring to Iran in the east; widely in south and sporadically in Central Europe to middle Germany and Poland in the north.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Polish data. This is a very rare species in Poland. Earlier it was recorded from the country by ALFKEN (1912: 29; 'Westpreußen: Seeresen' [Pomerania: Dzierżążno]).

Material studied (Fig. 569): Krzywcze [Przemyśl district], 19.VIII.1933, leg. NOSKIEWICZ, 1 ♀ [WRO].

Evylaeus punctatissimus (SCHENCK, 1853) (Figs. 404, 423, 472-474, 570, 571).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Hylaeus flavitarsis* SCHENCK, 1853; *Halictus simillimus* SCHENCK, 1869; *H. porcus* MORAWITZ, 1872; *H. grisescens* SCHENCK, 1873; *H. longiceps* SAUNDERS, 1879; *H. tinitinensis* COCKERELL, 1938.

Fig. 570. Occurrence of *Evylaeus punctatissimus* in Poland.

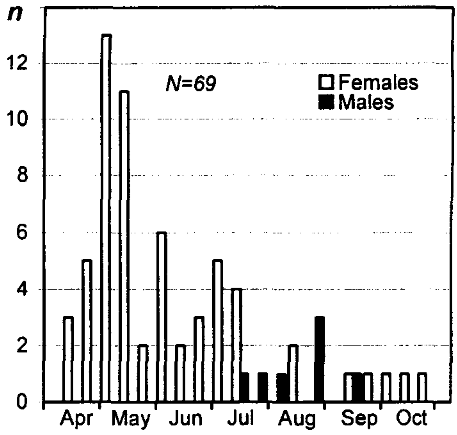


Fig. 571. Flight phenology of *Evylaeus punctatissimus* in Poland.

Taxonomy. It belongs to the *E. punctatissimus* species-group. Members of this large group differ from most other 'carina-less *Evylaeus*' in the elongate head. The group is possibly polyphyletic. So the similarity between its members can be resulted by independent adaptations for visiting of flowers of Lamiaceae (see: EBMER, 1986: 420; 1987: 82; 1997: 924). 17 species occur in Europe, including *E. clypearis* (SCHENCK, 1853) and *E. convexiusculus* (SCHENCK, 1853) (see below).

E. punctatissimus differs from the closest *E. angusticeps* (PERKINS, 1895), sporadically occurring in the southern part of the west Palaearctic region, only in the structure of male genitalia (cf. EBMER, 1971: Figs. 94 and 95; also EBMER, 1988: 671).

Distribution. Western Palaearctic, occurring to Iran in the east; in Europe almost everywhere to Finland in the north. In southern Spain and west North Africa, the species is represented by ssp. *angustifrons* (VACHAL, 1892) which differs from the nominotypical subspecies in the narrower head, finer and sparser punctate mesoscutum and some other characters of the male (see: EBMER, 1985: 290).

Ecology. Oligolege of Lamiaceae.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Polish data. An uncommon species dispersally occurring in the whole Poland (Fig. 570). It mostly inhabits open areas such as swards, meadows, forest margins. Females fly nearly all the season long, since April till October; males (only seven specimens) were caught since July till September (Fig. 571). Collected (all four records for males and females without pollen loads) from flowers of Hieracium pilosella, Medicago sp., Taraxacum officinale, and Veronica sp.

Evylaeus clypearis (SCHENCK, 1853) (Fig. 406).

Taxonomy. It distinctly differs from other species of the *E. punctatissimus* group in the shape of the head. Morphologically constant throughout its extensive geographical range.

Distribution. Western Palaearctic, mostly steppous, occurring to Iran in the east; in Europe widespread in the southern half, sporadically northerner, to middle Germany and southern Poland in the north.

Ecology. Oligolege of Lamiaceae.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Polish data. The species was recorded from Kraków by STRAND (1909: 5) in his paper containing a list of bees identified by J. ALFKEN in the collection of the 'Museum für Naturkunde in Berlin'. Referring to the paper by STRAND, NOSKIEWICZ (1924: 178) has mentioned that this locality is a single one for *E. clypearis* in Poland. Later BLÜTHGEN (1935: 120) has confirmed the STRAND's record.

Evylaeus convexiusculus (SCHENCK, 1853) (Figs. 405, 424, 475, 476, 572).

Synonymy: *Halictus appropinquans* SCHENCK, 1869; *H. puncticollis* var. *genevensis* FREY-GESSNER, 1903.

Taxonomy. It is also a member of the *E. punctatissimus* species-group. This species differs from the closest *E. samaracus* (BLÜTHGEN, 1935) distributed to the east from Hungary in the sculpture of the mesosoma.

Distribution. Widely distributed in Europe to Poland in the north and in West Asia to Iran.

Ecology. Oligolege of Lamiaceae.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Fig. 572. Occurrence of *Evylaeus convexiusculus* in Poland.

Polish data. This is a rare species in Poland. Earlier, it was recorded from the country (in the present borders) by TORKA (1913: 118; 'Provinz Posen: Nakel' [Wielkopolska-Kujawy Lowland: Nakło n. Notecią]) and BLÜTHGEN (1930: 743; 'Posen' [Poznań]).

Material studied (Fig. 572): Kraków, 30.V.1918, 1 ♀ [KRA]; Krzyżanowice [ad. Pińczów, Kielce district], 25.VIII.1954, 1 ♂ [WAR]. Sandomierz [Tarnobrzeg district], 11.VII.1954, leg. NOSKIEWICZ, 1 ♂ [WRO].

Evylaeus nitidiusculus (KIRBY, 1802) (Figs. 407, 417, 425, 477-479, 573-575).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Hylaeus rugosulus* SCHENCK, 1853; *H. pusillus* SCHENCK, 1853; *Halictus nitidulus* PÉREZ, 1903, nec FABRICIUS, 1804; *H. obsoletus* WARNCKE, 1975.

Taxonomy. This species belongs to a relatively small (nine Palaearctic species), but coherent species group, usually named as the *E. nitidiusculus* group. Members of this group differ from most other 'carina-less *Evylaeus*' in the long propodeum, finely sculptured mesosoma, long male antennae and large gonostylus (a wider diagnosis of the group see: EBMER & SAKAGAMI, 1985: 297). All the three species occurring in Europe, also *E. parvulus* (SCHENCK, 1853) and *E. rufitarsis* (ZETTERSTEDT, 1838) (see below), inhabit Poland.

Distribution. Western Palaearctic, occurring to Iran in the east; in Europe nearly everywhere to middle Finland in the north. The most part of the species geographical range is occupied by the nominotypical subspecies. Only Sardinia is inhabited by *E. nitidiusculus* ssp. *pseudocombinatus* (BLÜTHGEN, 1921) which differs in the slightly elongate head.

Ecology. Univoltine, polylectic.

Bionomics. A solitary species. It creates immense aggregations on sandy slopes, which sometimes exist for decades. Often other bee species, in particular *Seladonia subaurata*, enter into such aggregations. Nests of the species (under the name of *E. minutus*; later the material has been re-examined by EBMER; cited after SAKAGAMI et al., 1985) were described by KNERER (1969c). Nests are established on the walls of precipices. The main burrow of the nest is sinuous, it can be ramified into additional burrows; it goes downwards into soil at almost right angle to the ground surface. Cells are arranged in linear series at the extremities of short laterals, or by one at the end of each lateral (Fig. 573). Such an architecture of nests excludes the mother's contact with the developing offspring, and prevents the development of a social life.

References: KNERER, 1969c: 925-929; 1980: 518.

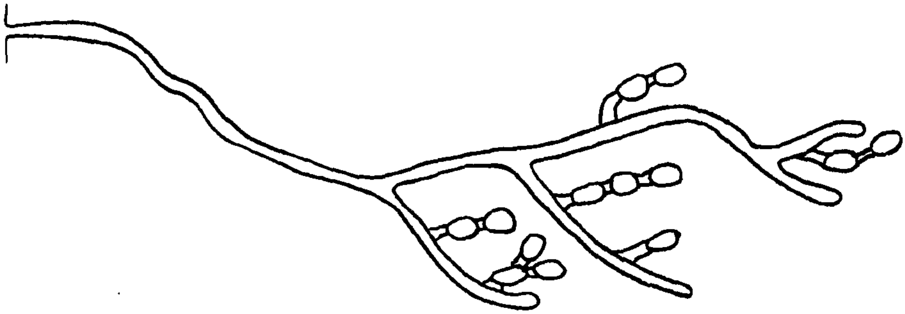


Fig. 573. Nest of *Evylaeus nitidiusculus* (from KNERER, 1969: Fig. 2).

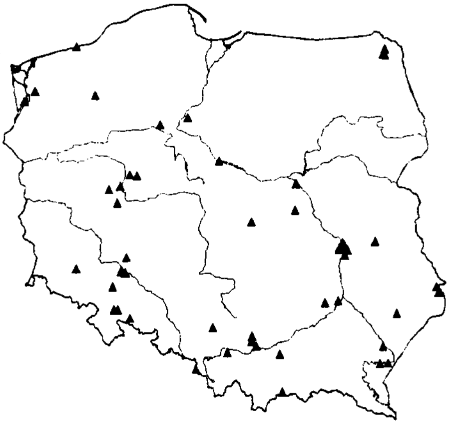


Fig. 574. Occurrence of *Evylaeus nitidiusculus* in Poland.

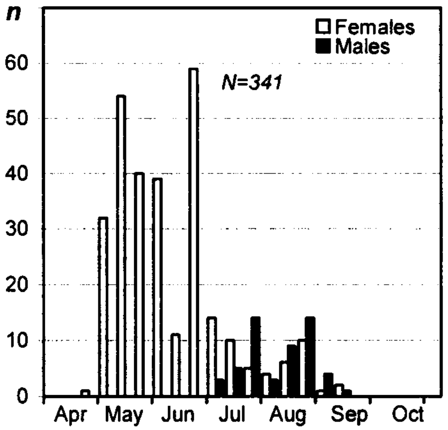


Fig. 575. Flight phenology of *Evylaeus nitidiusculus* in Poland.

Polish data. A common species occurring in the whole Poland (Fig. 574). It inhabits different biotopes not showing a certain preference. Females fly since the end of April till the second decade of September; males were caught since the beginning of July till the second decade of September (Fig. 575). Recorded from flowers of many plant species, but mostly composites (70% of records).

Evylaeus parvulus (SCHENCK, 1853) (Figs. 426, 480, 481, 576-579).

Synonymy: *Halictus striatus* SCHENCK, 1869; *H. ferrugineipes* SCHENCK, 1869; *H. minutus* auctorum nec *Hylaeus minutus* FABRICIUS, 1798.

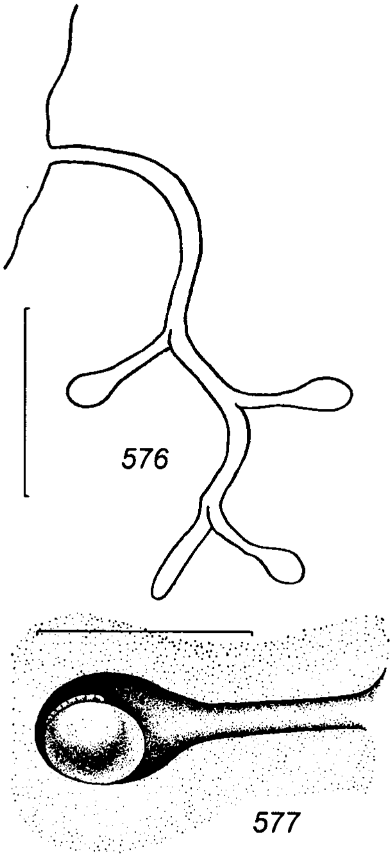
Taxonomy. This species is close to the Japanese *E. allodalus* (EBMER et SAKAGAMI, 1985). Differences between them are given in a key by EBMER & SAKAGAMI (1985: 301, 302).

Distribution. Western Palaearctic, occurring to Iran in the east. In Europe nearly everywhere to southern Sweden and Lithuania in the north.

Ecology. Univoltine, polylectic.

Bionomics. A solitary species. Nests are built in banks of precipices. The main burrow, 10-15 cm long, is vertical or slanting downwards, having a more horizontal initial section. Curved laterals 1.0-1.5 cm long branch from the main burrow (Fig. 576). Cells are horizontal, or their back end, of a length 6-7 mm and the maximum diameter 4 mm, is lowed down. The pollen ball, 3 mm in diameter, has a spherical form, its top is slightly flattened. The larva feeds from the top of the pollen ball (Fig. 577). The feeding period of the larva is 10-15 days. After the emergence and copulation each young female digs a simple horizontal burrow in a bank and hibernates there solitarily.

References: VERHOEFF, 1892: 717; BONELLI, 1954a: 18-21; GRANDI, 1961: 272; KNERER, 1969: 925-929.



Figs. 576, 577. Nest and cell of *Evylaeus parvulus* (from BONELLI, 1954: Figs. 1, 2). Scale lines represent 5 cm for the nest and 1 cm for the cell.

Fig. 578. Occurrence of *Evylaeus parvulus* in Poland.

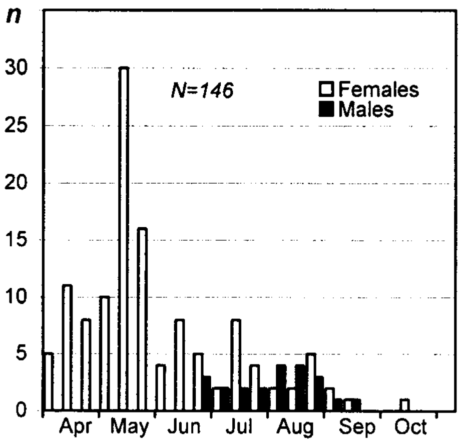


Fig. 579. Flight phenology of *Evylaeus parvulus* in Poland.

Polish data. A relatively common species occurring in southern and western Poland. Not recorded from north-eastern Poland (Fig. 578). An eurybiontic species inhabiting different biotopes, including forests as well as open areas. Females fly since April till the second decade of October; males (only 22 specimens) were caught since the end of June till the second decade of September (Fig. 579). Collected from flowers of 29 plant species belonging to many botanical families.

Evylaeus rufitarsis (ZETTERSTEDT, 1838) (Figs. 408, 418, 427, 482-484, 580, 581).

Synonymy: *Halictus parumpunctatus* SCHENCK, 1869; *H. lucidus* SCHENCK, 1869; *H. atricornis* SMITH, 1870.

Taxonomy. A relatively aberrant species of the *E. nitidiusculus* group. Morphologically constant throughout its very extensive geographical range.

Distribution. A Holarctic common species, inhabiting all temperate zones in the Palaearctic region, mostly montane in the south; in Europe to 67° N.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

Fig. 580. Occurrence of *Evylaeus rufitarsis* in Poland.

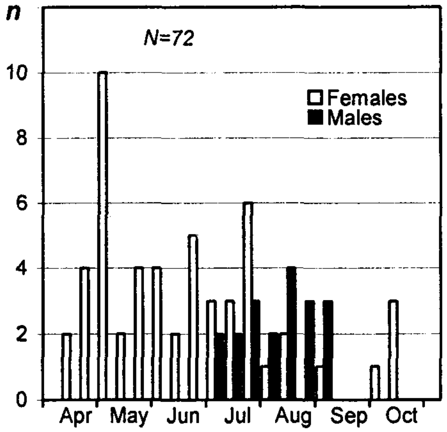


Fig. 581. Flight phenology of *Evylaeus rufitarsis* in Poland.

Polish data. An uncommon species dispersally spread in Poland (Fig. 580). It mostly inhabits forest biotopes. Females fly nearly all season long, since April till October; males (only 19 specimens) were caught since July till the beginning of September (Fig. 581). Recorded from flowers of nine plant species belonging to different botanical families.

***Evylaeus pygmaeus** (SCHENCK, 1853).

The species can be represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Hylaeus nitidus* SCHENCK, 1853, nec PANZER, 1798; *Halictus distinctus* SCHENCK, 1869.

Taxonomy. It belongs to a relatively small species-group of the 'carinaless *Evylaeus*', usually named as the *E. pauperatus* group. This species is close to the Ponto-Mediterranean *E. bluethgeni* (EBMER, 1971) (=*Halictus hirtiventris* BLÜTHGEN, 1923, nec COCKERELL, 1922).

Distribution. This species is western Palaearctic, occurring to Afghanistan in the east. The nominotypical subspecies inhabits Europe to the southern Netherlands in the north. The eastern subspecies, *E. pygmaeus* ssp. *patulus* (VACHAL, 1905), recorded from the Balkans and the Middle East, differs in the coloration of clypeus in males which is always yellow before its lower margin. Till now, the occurrence of E. pygmaeus in Poland recorded by some authors-not taxonomists, was not confirmed by our study and remains questionable. Nevertheless, this species can be found in the south-eastern part of the country.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather solitary.

****Evylaeus puncticollis*** (MORAWITZ, 1872).

Synonymy: *Halictus saundersii* DALLA TORRE et FRIESE, 1895.

Taxonomy. It is a member of a separate species group of the 'carinaless *Evylaeus*'. In the European fauna, also three other species belong to this group, among them there is *E. villosulus* (KIRBY, 1802) (see below).

Distribution. Western Palaearctic, occurring to Iran in the east; in Europe to middle Germany in the north. NOSKIEWICZ (1950b: 7) recorded *E. puncticollis* from 'Silesia' without a locality. The occurrence of it in Poland recorded also by some other authors was not confirmed by our study and remains questionable. Nevertheless, this species can be found in the south-eastern part of the country.

Ecology. A bivoltine species, at least in southern Europe (GRANDI, 1961: 272). Polylege, preferring flowers of composites.

Bionomics. The species is rather solitary. Only brief information on its nesting is available. Nests are built in clayey soil. Sometimes there is a turret over the nest entrance. The main burrow stretches vertically downwards. The cells are arranged along the sides of the main burrow, joining it with their necks. Normally the cells are grouped into a cluster. Chambers around clusters are absent.

References: STÖCKHERT, 1923: 221-222; NOLL, 1931: 338-339, 351.

Evylaeus villosulus (KIRBY, 1802) (Figs. 409, 419, 485-487, 582-584).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Melitta punctulata* KIRBY, 1802; *Halictus hirtellus* SCHENCK, 1869; *H. medinai* VACHAL, 1895; *H. pauperatellus* STRAND, 1909; *H. barkensis* BLÜTHGEN, 1930; *H. villosulus* ssp. *perlautus* COCKERELL, 1938; *H. rufotegularis* COCKERELL, 1938; *H. villiersi* BENOIST, 1941.

Taxonomy. Close to *E. puncticollis*. Main differences between them are given in the key to species above. Morphologically constant (for the exception of the 'intrapopulation' variation of the body size, see below) through its extensive range, only its far-eastern populations, ssp. *trichopsis* (STRAND, 1914), differ by the shorter head. For a long time it was known that distinctly bigger (giant) individuals of *E. villosulus* occur in some localities besides usual (normal) ones. BLÜTHGEN (1930a: 743), basing on materials from Germany, described such a giant form as '*Halictus villosulus* var.'. EBMER (1971: 106) stated that big individuals of this species had been found also in Austria and Poland (Sandomierz). Later, PLATEAUX-QUÉNU & PLATEAUX (1987, 1993) recorded the occurrence of big individuals from some French localities and stated that the size distributions of the giant and normal forms are non-overlapping. Moreover, recently PACKER et al. (1999) have shown that genetic differences between normal and giant forms are so strong that latter should be established a separate cryptic species. In the present work we did not set ourselves the task of making a taxonomic revision of the genus *Evylaeus*. Nevertheless, we noticed strong size variation of the Polish *E. villosulus*. Therefore, we are sure that both *E. villosulus* and the unnamed cryptic species inhabit Poland. However, the important paper by PACKER et al. (1999) concerning the both sibling species appeared when we finished studying the Polish halictids in main collections (see Table 2 in Chapter III) and were preparing the manuscript of this book for press. For this reason, we have not labelled the unnamed cryptic species in Polish collections separately and, hence, could not include it to the annotated list as a separate species. Also it was not taken into account in our analyses of the Polish fauna of the Halictidae in Chapter III.

Distribution. A transpalaearctic species, widespread throughout all natural zones except for the subarctic zone. Its nominotypical subspecies occurs to Mongolia in the east, in Europe everywhere to 64° N.

Ecology. Bivoltine. The most noticeable difference between *E. villosulus* and some other species of this genus, at least *E. fratellus* and *E. calceatus*, consists in that females realise provisioning more rapidly, especially when conditions get poorer.

Bionomics. A solitary species, although KNERER (1968: 109) believed it to be primitively eusocial. Nest aggregations are created. Around the nest entrance there is a small conical tumulus. The main burrow is vertical. Cells are horizontally oriented, and placed at the extremities of long lateral burrows (Fig. 582). These laterals are filled with soil immediately after the egg is laid on the pollen ball, and never get re-opened, as far as the female has no direct access to them. STÖCKHERT (1923) has noted that the species builds cells, which directly adjoin the main burrow with their necks, although other authors (see references below) have found more or less long laterals.

The sex proportion is palpably female biased in the both generations. Thus, in the summer one it constitutes 4:1, and in the autumnal 2:1, on the average. Females build nests by themselves, or use the main burrow of their maternal nest. The spring female-foundresses can remain active after the emergence of their offspring, and construct several extra cells in the old nest. Sometimes young daughters work together with their mother in the same nest. However, no co-operation in the work, or division of reproductive functions is established. Every female of such a communal nest builds its own cells, provisioning them with pollen and laying eggs in them. The nests constructed by the summer generation females are deeper than those of the spring ones. Overwintered females frequently survive long enough to forage simultaneously with their earlier emerged offspring. Cohabitation between females of the same generation occurs with a low frequency, but no division of labour results from this, being communal colonies rather formed. Young females copulate with males within the nests, or outside, on flowers.

References: STÖCKHERT, 1923: 221-222; KNERER, 1968: 109; PLATEAUX-QUÉNU & PLATEAUX, 1981; 1985: 293-302; 1986: 73-82; 1987: 259-266; 1993: 387-393; PLATEAUX-QUÉNU et al., 1989: 245-263; PLATEAUX-QUÉNU, 1993a: 205-227; FIELD, 1996: 167-168, 176-177.

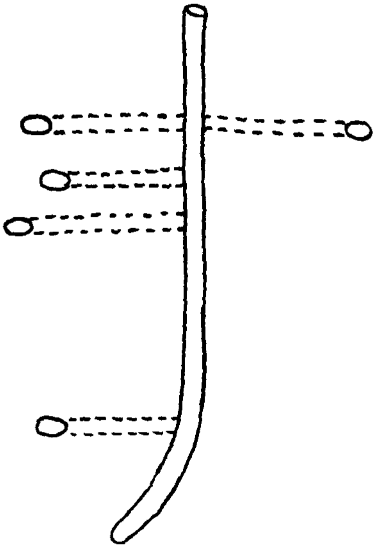


Fig. 582. Nest of *Evylaeus villosulus* (from PLATEAUX-QUÉNU, 1993a: Fig. 2).

Fig. 583. Occurrence of *Evylaeus villosulus* in Poland.

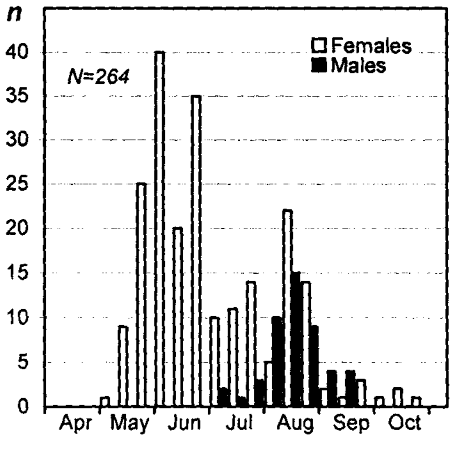


Fig. 584. Flight phenology of *Evylaeus villosulus* in Poland.

Polish data. A common species occurring in the whole territory of Poland. (Fig. 583). It prefers open and dry areas such as meadows, xerothermic swards, dunes, roadsides (95% of records). Females fly since May till the end of October, males were caught in July-September (Fig. 584). Recorded from flowers of many plant species, but mostly composites (Hieracium, Leontodon, Taraxacum; 85% records).

Evylaeus aeratus (KIRBY, 1802) (Figs. 585, 586).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus semiaeneus* BRULLÉ, 1832; *H. viridiaeneus* BLÜTHGEN, 1918.

Taxonomy. This species belongs to a relatively small coherent species-group, named as the *E. aeratus* or *E. leucopus* group. Members of this group differ from most other green *Evylaeus* by the short head, polished metasomal terga and in the structure of male gonostylus (a wider diagnosis of the group see: EBMER & SAKAGAMI, 1990: 835-838). All the two species occurring in Europe, *E. aeratus* and *E. leucopus* (see below), inhabit Poland. *E. aeratus* is a morphologically constant species through its extensive geographical range, only in Crete it forms a separate subspecies, ssp. caudatus (Warncke, 1982), which slightly differs by the sculpture of metasomal terga.

Distribution. Western Palaearctic occurring to Kyrgyzstan in the east. In Europe to southern Finland in the north, in the south in highlands.

Bionomics. A polylectic species. Nesting unknown. Phenological data suggest that the species is rather primitively eusocial.

Fig. 585. Occurrence of *Evylaeus aeratus* in Poland.

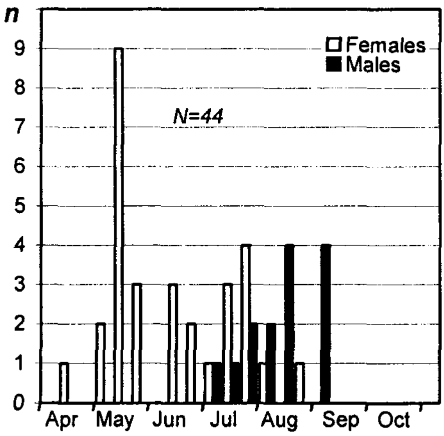


Fig. 586. Flight phenology of *Evylaeus aeratus* in Poland.

Polish data. A relatively uncommon species dispersally spread in the all regions of Poland except for the north-eastern part (Fig. 585). Recorded from open biotopes. Females were caught since April till the end of August, males since the begining of July till the begining of September (Fig. 586). Collected from flowers of Allium cepa, Daucus carota, Euphorbia sp., Coriandrum sativum, Anethum graveolens, Taraxacum officinale, Veronica chamaedrys.

Evylaeus leucopus (KIRBY, 1802) (Figs. 336, 372, 384, 410, 488-490, 587, 588).

Taxonomy. Close to *E. aeratus*. Differences between them are given in the key to species above. Morphologically constant through its extensive geographical range.

Distribution. It is an Euro-Siberian species, occurring to the Omsk province in the east. In Europe this species is boreo-montane, spread to middle Finland in the north.

Bionomics. A primitively eusocial species. Polylege. Nests are built in ground. During the summer phase small families are formed; the nest entrance is protected. The workers are not fertilised; the castes are not differentiated morphologically. The cells in the nests are closed with caps. Other data on the nest structure are unavailable.

Reference: MEIDELL, 1958: 12.

Fig. 587. Occurrence of *Evylaeus leucopus* in Poland.

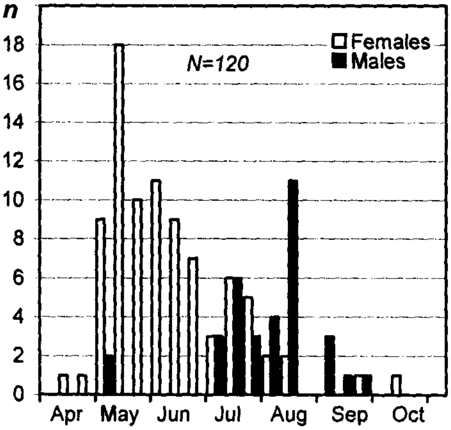


Fig. 588. Flight phenology of *Evylaeus leucopus* in Poland.

Polish data. A relatively common species dispersally spread in Poland (Fig. 587). It does no show a certain biotopic preference. Females fly nearly all the season long, since April till October; males were collected since May till September

(Fig. 588). Recorded from flowers of 26 plant species belonging to different botanical families.

Evylaeus morio (FABRICIUS, 1793) (Figs. 337, 373, 385, 411, 491-493, 589-591).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus morio* var. *basalis* DALLA TORRE, 1877, nec SMITH, 1857; *H. balticus* BLÜTHGEN, 1919.

Taxonomy. Close to *E. corsicanus* (BLÜTHGEN, 1931) recorded from Corsica and to *E. soror* (SAUNDERS, 1901) which is endemic of the Canary Islands. Morphologically constant species throughout Europe; populations in southern Spain, the Canary Islands and North Africa, ssp. cordialis (Pérez, 1903), differ in the more robust body and narrower face (EBMER, 1988: 623).

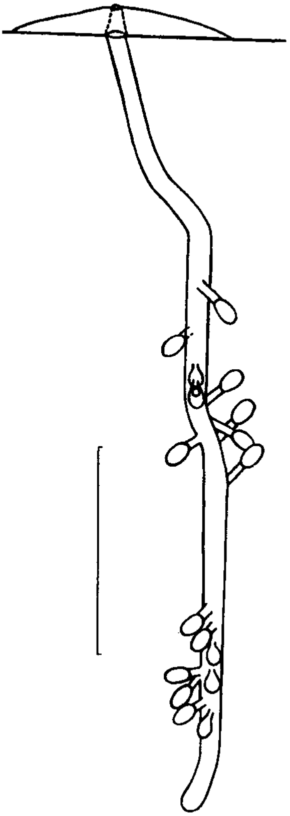


Fig. 589. Nest of *Evylaeus morio* (from WU, 1960: Fig. 30). Scale line represent 5 cm.

Fig. 590. Occurrence of *Evylaeus morio* in Poland.

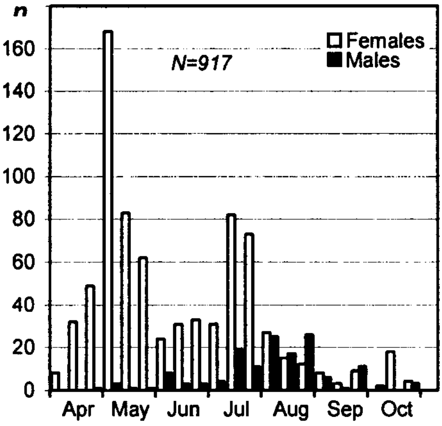


Fig. 591. Flight phenology of *Evylaeus morio* in Poland.

Distribution. This is the commonest species of the genus *Evylaeus* in Europe. Widespread in Europe to 60° N. and North Africa, throughout all natural zones.

Ecology. It is an eurybiontic polylectic species, in Central and northern Europe preferring warm areas. More common in steppes and dry meadows than in forests. Nesting in warm dry open areas, including parks, roadsides etc. The flight period is since April till September.

Bionomics. A primitively eusocial species. Nests aggregations are created on horizontal ground lots. The female pours a small cone-shaped tumulus around the nest entrance (4 mm wide). In one nest a turret over the entrance aperture was found. The main burrow of the nest, 5 mm in diameter, is vertical or slightly sinuous; it stretches down to a depth of 19-21 cm. Cells are either of sessile type, or located at the ends of very short, 2 to 10 mm, laterals, which branch from the main burrow at different depth (Fig. 589). Cells are ovaloid in form, 5-6 mm long, 4 mm in diameter; their necks are narrowed to 3 mm. The pollen ball is of a spherical form. From 10 to 18 cells are constructed in one nest. The larva feeds for 10-12 days. One brood of workers is reared. Data on the details of the social structure of nests, and the division of labour among individuals are unavailable. Young fertilised females hibernate jointly in the burrows in soil, occasionally excavating ramified burrows under stones.

References: SMITH, 1855: 2679-2680; VERHOEFF, 1892: 715-716; NOLL, 1931: 343; WU, 1960: 213-216; KNERER, 1969: 928.

Polish data. One of the commonest species in the Polish fauna of the Halictidae. It occurs in all regions of Poland (Fig. 590). The species prefers open and warm areas such as xerothermic sward, roadsides; only 2% of specimens were collected in forest biotopes. Both sexes fly all the season long; percentage of males increases in the second half of summer and in autumn (Fig. 591). Recorded from flowers of 44 plant species belonging to many botanical families.

Evylaeus nitidulus (FABRICIUS, 1804) (Figs. 338, 374, 386, 412, 494-496, 592, 593).

The species is represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus aeneidorsus* ALFKEN, 1921; *H. fudakowskii* NOSKIEWITZ, 1926; *H. continentalis* BLÜTHGEN, 1944; *H. smeathmanellus* auctorum partim, nec KIRBY, 1802.

Taxonomy. It is a member of the *E. smeathmanellus* group consisted of ten species in the European fauna including *E. podolicus* (NOSKIEWICZ, 1925) and *E. lissonotus* (NOSKIEWICZ, 1926), see below. This species is very variable in the coloration and sculpture of the body. However, this variation is mostly not geographical but intrapopulation one. Of six subspecies of *E. nitidulus* distinguished by EBMER (1988: 623-625), 'ssp. *aeneidorsus*' and 'ssp. *fudakowskii*' are not evidently geographical races. They and their intermediate forms widely occur (often far their geographical ranges recorded by EBMER) commonly with the nominotypical form (e.g. f. typica, f. *aeneidorsus* and intermediate forms widely occur in Poland) or with each other (e.g. f. *aeneidorsus*, f. *fudakowskii* and intermediate forms widely occur in the southern European part of Russia). So only the following island forms can be accepted as separate subspecies: ssp. *cretensis* (WARNCKE, 1975) inhabiting Crete, the endemic of the Balearic Islands ssp. *hammi* (SAUNDERS, 1904), ssp. *sardinius* (EBMER, 1978) recorded from Sardinia.

Distribution. East Europe to Belgium in the west, to southern Sweden and Lithuania in the north. In western Europe, this species is replaced with *E. smeathmanellus* (KIRBY, 1802).

Bionomics. Polylege. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Fig. 592. Occurrence of *Evylaeus nitidulus* in Poland.

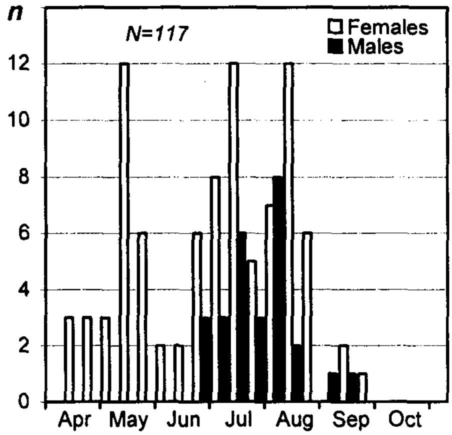


Fig. 593. Flight phenology of *Evylaeus nitidulus* in Poland.

Polish data. A relatively common species widely spread in Poland (Fig. 592). It mostly inhabits open areas. Females fly since April till September; males appear in the end of June and fly till September (Fig. 593). Recorded from flowers of 28 species belonging to many botanical families.

Evylaeus podolicus (NOSKIEWICZ, 1925).

The species can be represented in Poland by the nominotypical subspecies.

Synonymy (of the subspecific name): *Halictus smeathmanellus* ssp. *petrosus* WARNCKE, 1975; *H. smeathmanellus* ssp. *nucleolus* WARNCKE, 1982.

Taxonomy. It is close to the previous species, differences from the latter are given in the key to species above.

Distribution. A mostly steppose species inhabiting south and sporadically Central Europe, Asia Minor and the Middle East. A separate subspecies, ssp. *canus* (WARNCKE, 1982), inhabits Iran; it differs from the nominotypical subspecies by the rounder membranous gonostylar lobe. Previous records of *E. podolicus* from Poland either are based on wrong identification or in fact relate to 'Podol' in northwestern Ukraine (e.g. EBMER, 1988: 626). A single female from Poland ('Oicòw, D. Pragnika, 11.V.1968, leg. DYLEWSKA'; KRA; examined) determined by EBMER as '*Lasioglossum* (*Evylaeus*) *podolicum*' is really *Evylaeus nitidulus* f. typ. with somewhat shinier mesoscutum. Nevertheless, this species can be found in south-eastern Poland.

Bionomics. Polylege. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Evylaeus lissonotus (NOSKIEWICZ, 1926).

Taxonomy. It is close to *E. nitidulus* and *E. podolicus*. Differences from them are given in the key to species above.

Distribution. This is a rare eastern European, mostly steppose species. It can be found in south-eastern Poland.

Bionomics. Nesting unknown. Phenological data suggest that the species is rather eusocial.

Evylaeus cupromicans (PÉREZ, 1903) (Figs. 375, 594).

The species is represented in Poland by ssp. *tirolensis* (BLÜTHGEN, 1944).

Taxonomy. It is a member of the *E. alpigenus* species-group consisted of seven species in the European fauna including *E. bavaricus* (BLÜTHGEN, 1930), see below. Species of this group differs from other the European green *Evylaeus* by the following characters: the body dark to metallic blackish-green; posterior areas of metasomal terga dark, not translucent; the metapostnotum of female with rugulae not reaching its posterior margin; membranous lobe of the male gonostylus short, broad, elliptic. The species shows a distinct geographical variation in the sculpture of the body, structure of male genitalia, coloration of antennae and legs in males. The variation is underlined by the disjunctive distribution of this montane species and was fixed by distinguishing of several subspecies (see: Ebmer, 1988: 629-635).

Distribution. A mostly montane species inhabiting highlands of Europe and Asia Minor: ssp. *cupromicans* (PÉREZ, 1903) in Ireland, Scotland, the Pyrenees, highlands of south-eastern France and middle Italy, and the western Alps; ssp. *tirolensis* (BLÜTHGEN, 1944) in the eastern Alps, Tatra Mts., Carpathians; ssp. *pangaeus* (WARNCKE, 1982) in the highlands of Greece; ssp. *gevriensis* (WARNCKE, 1984) in the Sat Mts. in Turkey.

Ecology. A rare summer, univoltine species, rather polylege.

Bionomics. Nesting unknown. Scanty phenological data suggest that the species is rather solitary.

Fig. 594. Occurrence of *Evylaeus cupromicans* in Poland.

Polish data. Earlier this rare species was recorded from Poland only by NOSKIEWICZ (1920a: 156), which found it in the Tatra Mts. (Toporowa Cyrhla and Mała Łąka valley).

Material studied (Fig. 594): Krzyż ['Kreutz', Piła district], 21.V.1923, leg. NOSKIEWICZ, 2 ♀ [WRO]. Toporowa Cyrhla Mt. [Tatry Mts.], 1.VIII.1919, leg. NOSKIEWICZ, 1 ♀ det. J. ALFKEN [KRA]. Kuźnie [Nowy Sącz district], 6.VIII.1947, leg. NOSKIEWICZ, 2 ♂ [WRO].

Evylaeus bavaricus (BLÜTHGEN, 1930) (Figs. 376, 497, 595, 596).

The species is represented in Poland by the nominotypical subspecies.

Taxonomy. Differences from the close *E. cupromicans* are given in the key above.

Distribution. This uncommon montane species occurs in the Alps, Tatra Mts. (ssp. *bavaricus*) and the Balkans (ssp. *olympicus* (WARNCKE, 1982).

Ecology. It is a rare summer univoltine species, rather polylege.

Bionomics. Nesting unknown. Scanty phenological data suggest that the species is rather solitary.

Polish data. Discovered in Poland by CELARY (1986). Material studied by us (Fig. 595): Biskupice [ad. Miechów, Kielce district], 6.V.1988, on flowers of Tussilago officinalis, 1 ♀; 4.VI.1983, on flowers of Galeobdolon luteum, 1 ♀;23.VI.1983, on flowers of Potentilla anserina, 1 ♀; all three specimens leg. CELARY [KRA]. Ojców [Kraków district], 2.VI.1967, on flowers of Stellaria holostea, 1 ♀; 22.VI.1975, on flowers of Trifolium repens, 1 ♀;26.VI.1975, on flowers of Salix fragilis, 2 ♀; all four females leg. DYLEWSKA [KRA]. Same locality, 27.VIII.1987, on flowers of Achillea millefolium, 1 ♀; 28.VIII.1987, on flowers of Centaurea scabiosa, 1 ♀; both female leg. CELARY [KRA]. Przysłop Miętusi [Tatry Mts.], 8.VI.1969, leg. DYLEWSKA, 1 ♀ [KRA]. Sromowce Wyżne [Pieniny Mt.], 13.VI. 1961, 1 ♀; 9.VII.1971, 1 ♀; 15.VII.1957, 1 ♀; all three female leg. DYLEWSKA [KRA]. Olsztyn [Częstochowa district], 16.VII.1986, on flowers of Anthemis tinctoria, leg. CELARY, 1 ♀ [KRA]. Jaworzynka Valley [ad. Kużnice, Tatry Mts.], 19.VI.1970, on flowers of Potentilla aurea, 3 ♀; on flowers of Taraxacum officinale, 6 ♀; all nine females leg. DYLEWSKA [KRA].

Thus, females were observed from May till the end of August (Fig. 596); no males were caught in the territory of Poland.

Fig. 595. Occurrence of *Evylaeus bavaricus* in Poland.

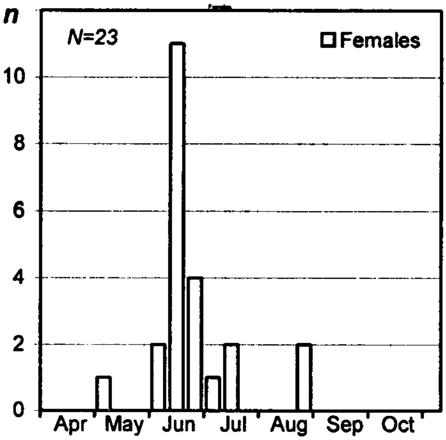


Fig. 596. Flight phenology of *Evylaeus bavaricus* in Poland.

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Index of Latin names of halictid species[1]

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[1] Explanation of used fonts: bold - valid names of species; light straight - valid names of subspecies; italic - junior synonyms or junior homonyms; in round brackets - the genus in combination with which the specific name is given in the text or the species to which the subspecies belong.

The morphology of the Halictidae is described, and some terms are discussed. A synopsis of classification this family is given. Phylogenetic relationships between its members are shown. An analytical account of bionomics of halictids is made, including different kinds of social life. On the basis of the study of the main entomological collections of institutions as well as private ones and original materials, the Polish fauna of non-parasitic halictids is established. It includes 81 species belonging to 10 genera: *Dufourea* (4 species), *Rhophitoides* (1), *Rophites* (3), *Systropha* (2), *Nomiapis* (2), *Nomioides* (1), *Halictus* (6), *Seladonia* (6), *Lasioglossum* (13), *Evylaeus* (43). All species recorded from Poland and also 14 species that may be found in Poland (rather in its south-eastern part), are characterised in this book in distributional, ecological and bionomical aspects. The distribution of halictids within the country is mapped and analysed. The zoogeographical status of the Polish halictid fauna against the background of the European and the Palaearctic faunas is described. Trophic links of halictid bees with flower plants, their biotopic preferences, abundance and phenology in Poland are presented. Original illustrated keys for identification of Polish halictids have been created. The book contains the following chapters: I. Introduction, II. General characteristics of halictid bees, III. Study on halictids in Poland, IV. Halictid fauna of Poland: illustrated keys, characteristics of taxa. The bibliography includes 824 titles. The book is illustrated by 596 figures.

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