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A Comparative Study on the Biology of *Macropis fulvipes* (Fabricius, 1804) and *Macropis europaea* Warncke, 1973 (Hymenoptera: Apoidea: Melittidae)

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Seasonal and daily activity of *Macropis fulvipes* (Fabricius, 1804) and *M. europaea* Warncke, 1973 are given. Their environmental preferences, foraging distances and host plants are presented. Life cycles and nest architecture are described.

Key words: Hymenoptera, Apoidea, *Macropis fulvipes*, *Macropis europaea*, biology.

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The present paper describes and compares the biology of two Central European melittids belonging to the genus *Macropis* Klug – *M. fulvipes* (Fabricius, 1804) and *M. europaea* Warncke, 1973. Moreover, it summarizes all other information about the biology of these species from earlier papers (BOUWMAN 1920; MALYSHEV 1929; PHIPPS 1948; POPOV 1958; ROZEN & MCGINLEY 1974; RUSZKOWSKI *et al*. 1988; VOGEL 1986; WESTRICH 1990).

The genus *Macropis* is divided into three subgenera – *Paramacropis*, *Sinomacropis* and *Macropis* s. str. Both *M. europaea* and *M. fulvipes* belong to the last subgenus (MICHENER 2000). These species inhabit mesic regions from the northern part of southern Europe throughout Kazakhstan and southern Siberia to Northwest Mongolia. Moreover, *M. fulvipes* (its subspecies *amurensis* Popov) also occurs in the Russian Far East (Khabarovsk Kray and Primorski Kray).

Both *M. europaea* and *M. fulvipes* have a unique biology, different from members of other genera inhabiting Europe. Females of these species prepare specific larval food (provision) for their offspring. It consists of pollen and floral oils instead of nectar. For this reason females of these species have special morphological adaptations for collection and transportation of the oils. These are short and dense, specialized hairs on ventral surfaces of all mediotarsi, and broad hind tibiae and basitarsi with short and dense, very plumose scopal hairs.

Material and Methods

The study was carried out from the first half of June until the first half of September 2003 in Ojców National Park. Observations on the biology of *M. europaea* were made in an aggregation of four nests, while the biology of *M. fulvipes* was observed in an aggregation of seven nests.

Four nests of *M. europaea* and three nests of *M. fulvipes* were excavated. The content of excavated larval cells (three eggs, four larvae, one provision of *M. fulvipes*, and four eggs, two larvae of *M. europaea*) was transferred to the laboratory. Mature larvae were excavated from cocoons and preserved in Carnoy's fixative. In order to determinate the pollen mass which is collected and transported during one foraging trip, returning females with pollen loads (ten females of each species) were collected and weighed. Pollen loads were removed from their hind legs and then the females were reweighed.

Floral preferences and distances of foraging trips were investigated by observation of all blooming plants around the nests. Additionally the author's data from faunistic researches in southern Poland, and all available data about visited plants from labels of specimens deposited in various collections were used.

Results

N e s t i n g s i t e. Nests of both species were situated near the border of the forest in clayey soil and consisted of small aggregations. Entrances to these nests were surrounded by small (sometimes almost invisible) tumuli and were hidden by rather high vegetation, consisting mainly of grasses, St-John's-wort (*Hypericum perforatum* L.), various perennials (Apiaceae) and seedlings. Nests of *M. fulvipes* were located in a low bank, while those of *M. europaea* were on horizontal ground.

Information from the literature confirms that females of both species prefer rather solid ground for nests, however *M. europaea* may dig nests in more rotten (MALYSHEV 1929) or sandy ground (PHIPPS 1948). In other parts of southern Poland the author found nests of *M. fulvipes* also in rather sandy soils.

During the time of investigation, nests of both species were penetrated by females of *Epeloides coecutiens* Giraud.

S e a s o n a l a n d d a i l y a c t i v i t y. Both *M. europaea* and *M. fulvipes* belong to the summer species, and have only one generation a year. They are clearly protandrous. Males of both species emerge even 10-12 days before females. During the investigation period, males of *M. fulvipes* appeared during the end of the first half of June (12th June) and flew till the first half of August (8th August), while females of the species emerged at the end of the second half of June (25th June) and disappeared at the end of August (24th August). Males of *M. europaea* appeared at the end of June (23rd June) and disappeared at the end of August (27th August), whereas females emerged at the beginning of July (7th July) and flew till the end of August (31st August). Data from literature (WESTRICH 1990) and from labels of studied specimens indicate that females of *M. europaea* may also fly in the first half of September (probably when summer is late). The peak of activity of *M. fulvipes* occurred in the first and second ten days of July, while the peak activity of *M. europaea* was during the second half of July and the first week of August.

Females of both species began foraging after 7.30 in the morning when the air temperature exceeded 18°C, whereas males began flying at 8 am. Both species finished their activity at half past seven in the evening, when air temperature fell to 22°C. During the day females visited a single flower of yellow loosestrife from 4 to 7 seconds.

Females of both species prepare unusual provision for their larvae. It consists of pollen and oils from flowers of yellow loosestrife (*Lysimachia* L. – Primulaceae). Similarly, the females of North American species – *Macropis nuda* (Provancher) also prepare such larval food (ROZEN & JACOBSON 1980; CANE *et al*. 1983). Female behaviour of the last species on flowers of *Lysimachia* was described in detail by CANE *et al*. (1983). Females of *M. fulvipes* and *M. europaea* commomnly gathered pollen and oils keeping their hind legs above their abdomen (Fig. 5). CANE *et al*. (1983) described the characteristic posture as defense from males. In fact, during the investigations, "kicking females" were observed. They rejected pouncing males using their hind legs. During provisional trips females mixed pollen and oils of *Lysimachia*. They carried the load mainly on hind tibiae and basitarsi in the form of very large, moist, yellowish masses surrounding the segments. Usually a little part of the load was transported also on the abdominal sternites, hind femora and middle tibiae. Females of *M. fulvipes* returning from provisional trips brought to their nests a load of 0.010-0.014 g, while those of *M. europaea* 0.009-0.012 g. The females prepare provisions from the loads. Females of both species form provisions as elongated loafs, then lay eggs on top of the proximal part of the provision (Fig. 6). Provisions of *M. fulvipes* were 5.5-6.5 mm long, 3.5-4 mm high and 4-4.5 mm wide, while those of *M. europaea* were 5.5-6 mm long, 3.5-4 mm high and 4-4.5 mm wide. These provisions weighed 0.061-0.068 g and 0.056-0.064 g, respectively. Some of the results are confirmed by data from the literature (MALYSHEV 1929; PHIPPS 1948; VOGEL 1986).

N e s t a r c h i t e c t u r e. Both species usually nest in banks or on sloping ground, but sometimes females of *M. europaea* dig burrows on flat ground. The entrances of these nests are surrounded by low tumuli. When nests are located on a gentle slope or on flat ground their tumuli are regular (Fig. 1), whereas nests in banks have asymmetric tumuli. Nests of both species are very shallow and similar in structure, though there are small differences.

The main shaft at first goes 3-4 cm slantingly or vertically downward (depending on ground inclination) and then runs 6-8 cm horizontally. Corridors of burrows inside banks run almost exclusively horizontally. In cross section the tunnels are almost circular. The main tunnel of nests of *M. europaea* is 5-5.5 mm in diameter, while in *M. fulvipes* it is 5.5-6 mm. Nests of both species have two or three short (1-2 cm) lateral tunnels in the distal part of the main shaft. Usually lateral tunnels of *M. fulvipes* have two horizontal or slightly inclined cells in a linear arrangement (Fig. 2), while nests of *M. europaea* have single cells at the end (Fig. 3).

The excavated nests of *M. fulvipes* comprised 1-4 larval cells, while those of *M. europaea* only 1-2. Undoubtedly a fully developed nest of the last species may consist of more larval cells, because MALYSHEV (1929) described a nest with three

Fig. 1. *Macropis europaea* Warncke, nest entrance with tumulus.

Fig. 5. Female of *Macropis europaea* on yellow loosestrife in defensive posture.

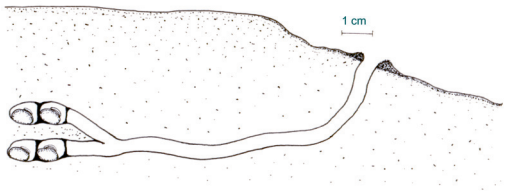

Fig. 2. Vertical section through the nest of *Macropis fulvipes*.

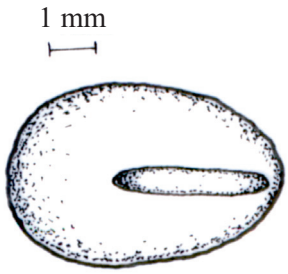

Fig. 6. Provision with an egg of *Macropis fulvipes*.

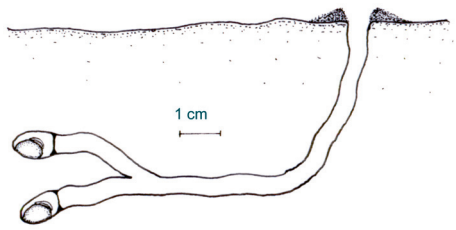

Fig. 3. Vertical section through the nest of *Macropis europaea*.

Fig. 7. Cocoon of *Macropis fulvipes* in lateral view.

Fig. 4. Section through the larval cell of *Macropis fulvipes*.

Fig. 8. Postdefecating larva of *Macropis fulvipes* in frontal view.

cells, and PHIPPS (1948) with four. WESTRICH (1990) in his book concerning the wild bees of Baden-Württembergs informs that nests of *M. europaea* may have even eight larval cells.

M. europaea and *M. fulvipes* have quite uniform larval cells. The excavated cells were ellipsoidal and slightly flattened at the bottom, and were lined inside by floral oils of yellow loosestrife (*Lysimachia* L. – Primulaceae). The lining was bluish-green and a little rough (Fig. 4). Larval cells of *M. europaea* were 8-9.5 mm long and 5.5-6 mm in diameter, while those of *M. fulvipes* were 8.5-10 mm long and 6-6.5 in diameter. In nests of both species the cells were situated 3.5-4 cm under the surface of the ground, but VOGEL (1986) reports larval cells of *M. fulvipes* only 2.5 cm under the surface.

F l o r a l p r e f e r e n c e s a n d f o r a g i n g d i s t a n c e. Flowers of yellow loosestrife (*Lysimachia* L.) are the only source of larval food (pollen and oils) for both species. During investigations females of *M. fulvipes* visited flowers of *Lysimachia vulgaris* L. and *L. nummularia* L., while those of *M. europaea* only flowers of *Lysimachia vulgaris* L. Moreover, data from the literature states also *L. nummularia* L. and *L. punctata* L. as food plants for both species (POPOV 1958, WESTRICH 1990).

At present it is known that flowers of *Lysimachia* L. do not secrete nectar, therefore adults must visit other flowers for their own energy needs. The observed individuals of *M. fulvipes* gathered nectar from flowers of chickweeds (*Stellaria graminea* L. and *S. media* (L.) Vill.), flowers of *Cerastium holosteoides* Fr. em. Hyl. and *Myosoton aquaticum* (L.) Moench, *Epilobium hirsutum* L., hedge woundwort (*Stachys sylvatica* L.) and flowers of wild thyme (*Thymus pulegioides* L.), while those of *M. europaea* drank nectar from flowers of *Lycopus europaeus* L. and various species of thistle (*Cirsium* L.). Both species also visited flowers of various species of cranesbill (*Geranium* L.) and bramble (*Rubus* L.), flowers of spiked loosestrife (*Lythrum salicaria* L.) and various umbellifers (Apiaceae).

There are many more plants that these species visit, RUSZKOWSKI *et al*. (1988) gives 10 food plants for *M. fulvipes* and 17 for *M. europaea*, while POPOV (1958) presents a list of 24 species of plants visited by *M. fulvipes* and 33 by *M. europaea*.

Nests of both species were situated from 1 to 15 m away from blooming *Lysimachia*, therefore the distance of foraging trips did not exceed 25 m. Nectaring food plants were rather scattered and some of them grew over 30 m away from the nests, so females flew from 5 to 35 m for the nectar.

D e v e l o p m e n t. Eggs of both species were strongly curved, translucent white and shiny. The eggs of *M. fulvipes* were 3.8-4.1 mm long and 0.7-0.9 mm wide, while those of *M. europaea* were 3.6-3.8 mm long and 0.7-0.8 mm wide. In both cases larvae hatched after 3-4 days. Larvae of *M. fulvipes* consumed their provision by 14-16 days, while those of *M. europaea* by 13-15 days. After consuming all larval food, larvae spin cocoons (Fig. 7). During cocoon spinning larvae defecate, and their feces are located between the outer and inner layer of the cocoons (ROZEN & JACOBSON 1980).

Mature larvae of *M. europaea* were 14-15 mm long, while those of *M. fulvipes* were 15-16 mm long (Fig. 8). Cocoons of both species fill the entire larval cells, and possess a macropyle (aperture for exchange of oxygen and carbon dioxide) in the inner layer of the proximal end (ROZEN & JACOBSON 1980). The morphology of mature larvae of *M. fulvipes* resembles that of *M. europaea*. The latter was described in detail by ROZEN & MCGINLEY (1974). Mature larvae of *M. fulvipes*, similar to that of *M. europaea,* have a well developed and projecting forward labium with large palpi. The head of the larva also has well developed maxillae with large palpi, and strongly projected salivary lips (Figs. 9-10). Mandibles of the larva do not have toothed projections on their apical concavities, and the tenth abdominal segment is somewhat elongated in its ventral part.

Unfortunately pupae could not be raised, but MALYSHEV (1929) states that larvae of *M. fulvipes*

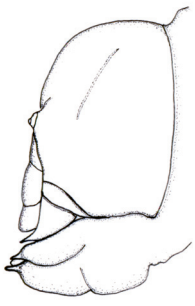

Fig. 9. Head of mature larva of *Macropis fulvipes* in lateral view.

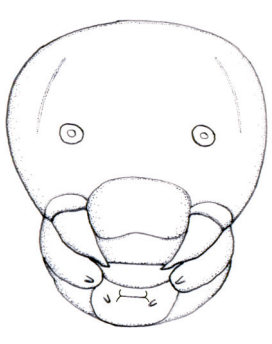

Fig. 10. Head of mature larva of *Macropis fulvipes* in frontal view.

become pupae in the second half of May. A detailed description of *M. europaea* pupae is given in ROZEN & MCGINLEY (1974). They write that the pupa of this species is very similar to the pupa of *Melitta leporina*, and differs from the pupa of the last species by the presence of tubercles on the vertex and absence of genal and metanotal spines.

Male activity and mating behaviour. During investigations males of both species patrolled blooming *Lysimachia* in search of mates. The males flew mainly around yellow loosestrife, but sometimes rested on their leaves or flowers. From time to time they flew to other flowers and gathered nectar. Males penetrating flowers of *Lysimachia* were observed a few times (presumably they ate pollen). Males pounced directly upon females (with or without pollen loads). They also attacked other males or bees. The males mated with females mainly on flowers of *Lysimachia*, but sometimes also on other food plants. Males of both species spent the night singly on flowers. Sleeping males were found mainly on flowers of various species of *Geranium* L.

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