

First record of a bee fly (Diptera: Bombyliidae) parasitic on antlions (Myrmeleontidae) in Russia

Первый случай паразитирования мух-жужжал (Diptera: Bombyliidae) на муравьиных львах (Myrmeleontidae) в России

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КЛЮЧЕВЫЕ СЛОВА: мухи-жужжала, муравьиные львы, паразиты, Дагестан, Россия.

ABSTRACT. A review of the bee flies (Diptera: Bombyliidae) parasitic on preimaginal stages of antlion (Myrmeleontidae) is given. A first case of *Micomitra stupida* (Rossi, 1790) as a parasite of an antlion, probably *Euroleon nostras* (Geoffroy in Fourcroy, 1785), in Dagestan, Russia is presented. The distribution of *M. stupida* is mapped.

РЕЗЮМЕ. Дан обзор паразитирования мух-жужжал (Diptera: Bombyliidae) на муравьиных львах (Myrmeleontidae). Описан первый случай паразитирования *Micomitra stupida* (Rossi, 1790) на муравьином льве, предположительно *Euroleon nostras* (Geoffroy in Fourcroy, 1785), в Дагестане, Россия. Распространение *Micomitra stupida* картировано.

Bee flies (Bombyliidae) are a biodiverse family with species that are parasitoids or predators as larvae and nectarivorous as adults. The family distributed globally except Antarctica with more than 4.780 described species [Evenhuis, Greathead, 2015]. The larvae of Bombyliidae are parasitoids or predators of preimaginal stages of other insects or spider's egg masses. Many species are endoparasites of bees, solitary wasps, larvae and pupae of Lepidoptera and Coleoptera, hyperparasites of Diptera and Hymenoptera developing in caterpillars. A few species are known as parasites of antlions. Bombyliidae are the only known Diptera specifically parasitic on antlions.

Smith [1934] was the first who recorded *Dipalta serpentina* Osten-Sacken, 1877 (Anthracinae, Bombyliidae) as a parasite of *Myrmeleon immaculatus* De

Geer, 1773 in North America, later Leech and MacDonald-Leech [1989] reared the same species of Bombyliidae from a pupa in the cocoon of *Myrmeleon immaculatus* in California. Steffan [1967] published a case of parasitism of Bombyliidae on antlions in the Old World. He bred four specimens of *Micomitra stupida* (Rossi, 1790) from cocoons of *Euroleon nostras* (Geoffroy in Fourcroy, 1785), *Myrmeleon inconspicuous* Rambur, 1842, *Megistopus flavicornis* (Rossi, 1790) and *Creoleon lugdunensis* (Villers, 1789) on the south of France. Du Merle [1975] published a review of the literature of host and preimaginal stages of Bombyliidae. Pantaleoni [1984] recorded rearing the bombyliid *Pterobates* sp. from pupae of *Myrmeleon inconspicuous* Rambur, 1842 in Italy. Baba et al. [1987] recorded *Villa myrmeleonostena* (Baba, 1953) as a parasitoid of an antlion in Japan. Zaitzev [1998] described a case of parasitism of *Micomitra stupida* on an undetermined antlion in Tajikistan. Adults of those Bombyliidae emerged in August. Miksch [1993] described from Greece adults and pupae of *Oestranthrax myrmecaeluri* Miksch, 1993 bred from the larva of antlion *Myrmecaelurus trigrammus* (Pallas, 1771), the first record of antlion parasitism in the genus *Oestranthrax* Bezzi, 1923. In her observations, usually the larvae of the 3^d stage, and sometimes larvae of the 2^d stage were parasitized, antlion larvae completed development after cocoon formation, and adult Bombyliidae emerged from cocoons in August. Matsuda et al. [1998] described the development of larvae of *Villa myrmeleonostena* (Baba, 1953) in the larvae and pupae of *Myrmeleon bore* (Tjeder, 1941) in Japan. They

found that larvae of *Villa* Lioy, 1864 of the first stage develop as endoparasites. Larvae of the third stage develop as ectoparasites on the pupae of antlion, which are inside of the cocoons. Marshall [2012] mentioned an unnamed species of *Anthrax* Scopoli, 1763 reared from an antlion. Uchoa and Missirian [2014] reared parasites of an undetermined species of *Paravilla* Painter, 1933 from *Myrmeleon brasiliensis* in Brazil. Evenhuis [2017] described a new species of *Chrysanthrax* (*C. pennyi*) parasitic on an undetermined species of *Myrmeleon* from Costa Rica; and Evenhuis [2018] described the new genus and species *Taiwanon phormae* from Taiwan, parasitic on the non-pit building antlion, *Dendroleon esbenpeterseni* Miller et Stange, 1999.

We recently received 5 specimens of Bombyliidae bred from cocoons of antlion, in Sarykum, Dagestan, Russia. All specimens emerged on 14.08 (year was not written), leg. G. Khabiev. G. Khabiev noted on the labels the antlion's name as *Euroleon nostras*. Unfortunately, the cocoons with larval exuviae of the antlion as well as the pupal exuviae of flies were not kept and exact determination of the antlion is impossible. Nevertheless, within the known fauna of Sarykum Dune [Ilyina et al., 2014], 7 species of antlions with propor-

tionate sizes of cocoons occur there, consequently *Euroleon nostras* (Geoffroy in Fourcroy, 1785) could be one of the potential hosts of bee flies reared from collections made in Sarykum, Dagestan. Other candidates to the host role are the pit-building antlions *Myrmeleon immanis* Walker, 1853, *M. inconspicuus* Rambur, 1842, *Myrmecaelurus trigrammus* (Pallas, 1771), and the non-pit building larvae *Distoleon tetragrammicus* (Fabricius, 1798), *Macronemurus bilineatus* Brauer, 1868 and *Creoleon plumbeus* (Olivier, 1811).

The bee flies were determined as *Micomitra stupida* (Rossi, 1790). This species is widely distributed in the Palearctic Region: Armenia, Austria, Azerbaijan, Egypt, Finland, France, Germany, Greece (incl. Naxos), Georgia, Hungary, Iran, Israel, Italy (incl. Sardinia, Sicily), Kazakhstan, Kyrgyz Republic, Libya, Poland, Portugal, Romania, Russia (vic. Sankt Petersburg, the Crimea, Orenburg Province and Dagestan), Spain, Sweden, Switzerland, Tajikistan, Turkey, Turkmenistan, Uzbekistan [Zaitzev, 1966; Evenhuis, Greathead, 2015 and data from the collection of the Zoological institute of Russian Academy of Sciences in St. Petersburg] (Map).



Map. Distribution of *Micomitra stupida* (Rossi, 1790) on data in Zaitzev [1966]; Evenhuis, Greathead [2015] and the collection of the Zoological institute of Russian Academy of Sciences.

Карта. Распространение *Micomitra stupida* (Rossi, 1790) по данным из Зайцева [1966]; Evenhuis, Greathead [2015] и коллекционным материалам Зоологического института РАН.

Conclusion

To the present day species from the genera *Micomitra* Bowden, 1964, *Oestranthrax* Bezzi, 1923, *Villa*, *Anthrax* Scopoli, 1763, *Pterobates* Bezzi, 1921, and *Taiwanon* Evenhuis, 2018 (Diptera: Bombyliidae) are known as parasites of antlions in the Old World; and *Chrysanthrax* Osten Sacken, 1886, *Dipalta* Osten-Sacken, 1877, and *Paravilla*, are ant lion parasites in the New World. All these genera belong to the subfamily Anthracinae, but to different tribes. The subfamily Anthracinae is the largest among Bombyliidae and includes nearly half of all species of the family and many of the largest and most widespread genera.

The larvae of bee flies are parasites of antlion larvae that live in pits or free in sand. We propose that, like in other cases, the 3^d stage larva of antlions are attacked by fly larva. When larva of the antlion builds the cocoon and molts to the pupal stage, the fly larva metamorphoses. In coevolution, the tendency to a primary connection of bee flies with pit-building antlions could be proposed, the flies of which are able to locate hosts by searching for sands with colonies of antlion larvae, after which the female shoots the eggs to the pits while hovering overhead. Parasitism on the non-pit building antlion larvae is not a next step in evolution, but is instead an independently derived behavior.

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References

- Baba K., Nagatomi A., Nagatomi H. & Evenhuis N.L. 1987. Redescription of *Villa myrmeleonostena* (Insecta, Diptera, Bombyliidae) a parasitoid of antlion in Japan // Zoological Science. Vol.4. P.903–911.
- Du Merle P. 1975. Les hôtes et les stades pré-imaginaux des Diptères Bombyliidae: revue bibliographique annotée // Bulletin de la Section Regionale Ouest Palearctique (Organisation Internationale de Lutte Biologique). Vol.4. P.1–289.
- Evenhuis N.L. 2017. A new species of *Chrysanthrax* Osten-Sacken (Diptera: Bombyliidae) from Costa Rica parasitic on an antlion (Neuroptera: Myrmeleontidae) // Zootaxa. Vol.4363. P.583–588.
- Evenhuis N.L. 2018. A new genus and species of *Villoestriini* Hull (Diptera: Bombyliidae) from the Oriental Region parasitic on antlions (Neuroptera: Myrmeleontidae), with a key to genera in the tribe // Bishop Museum Occasional Papers. Vol.124. P.1–10.
- Evenhuis N.L., Greathead D.J. 2015. World catalog of bee flies (Diptera: Bombyliidae). Revised September 2015. Available at: <http://hbs.bishopmuseum.org/bombcat/bombcat-revised2015.pdf>.
- Ilyina E.V., Khabiev G.N., Krivokhatsky V.A. 2013 [2014]. [Myrmeleontoid lacewings (Neuroptera: Myrmeleontidae, Ascalaphidae) of Sarykum and environs] // Trudy gosudarstvennogo prirodnogo zapovednika “Dagestanskiy”. Vol.5. P.32–36 [in Russian].
- Leech R., MacDonald-Leech J.U. 1989. *Dipalta serpentina* Osten-Sacken (Diptera: Bombyliidae) as a predator on pupae of the antlion *Myrmeleon immaculatus* De Geer (Neuroptera: Myrmeleontidae) in California // The Canadian Entomologist. Vol.121. P.727–728.
- Marshall S.A. 2012. Flies. The natural history and diversity of Diptera. Firefly books. 616 pp.
- Matsuda Ö., Ohno H., Sakamoto M. 1998. Rate of parasitism of the antlion larvae, *Myrmeleon bore* (Neuroptera: Myrmeleontidae) by the bee fly *Villa myrmeleonostena* (Diptera: Bombyliidae) // Entomological Science. Vol.1. No.3. P.321–325.
- Miksch G. 1993. *Oestranthrax myrmecaeluri* n. sp. (Diptera: Bombyliidae) aus Griechenland mit Angabe des Wirtes // Stuttgarter Beiträge zur Naturkunde. Serie A. (Biologie). Nr.493. S.7–9.
- Pantaleoni R.A. 1984. Note su alcuni parassiti (s.l.) di Neuroteri Planipenni con segnalazione del ritrovamento di Acari forestici su di un Crisopide // Bollettino dell’Istituto di Entomologia della Università degli studi di Bologna. Vol.38. P.193–203.
- Smith R.C. 1934. Notes on the Neuroptera and Mecoptera from Kansas // Journal of the Kansas Entomological Society. Vol.7. P.120–145.
- Steffan J.R. 1967. *Exoprosopa stupida* (Rossi) parasite de formilions dans l’Ancien monde (Dipt. Bombyliidae) // L’Entomologiste. Vol.23. No.3. P.78–80.
- Uchoa M.A., Missirian G.L.B. 2014. *Myrmeleon brasiliensis*’s parasitoids (Neuroptera: Myrmeleontidae) in the South Pantanal, Brazil // Florida Entomologist. Vol.97. P.313–316.
- Zaitzev V.F. 1966. [Parasitic flies of the family Bombyliidae (Diptera) in the fauna of the Transcaucasia] // A.A. Stackelberg (ed.). Opredelitelnyy po faune SSSR, izdavaemye Zoologicheskimi institutom AN SSSR. Vol.93. 375 pp. [In Russian]
- Zaitzev V.F. 1998. On the morphology of the pupae of flies of the family Bombyliidae (Diptera). III. // Entomological review. Vol.78. Nr.5. P.613–619.