Potter Wasps (Hymenoptera: Vespidae, Eumeninae) as Hosts of *Amobia* Robineau–Desvoidy, 1830 (Diptera: Sarcophagidae, Miltogramminae) in Ukraine

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Abestract: *Amobia signata* (Meigen, 1824) was reared from the nests of eumenine wasps *Symmorphus bifasciatus* (Linnaeus, 1761), *Discoelius zonalis* (Panzer, 1801), and *Amobia oculata* (Zetterstedt, 1844) from *S. bifasciatus* in Ukraine. Both species of wasps are the new hosts for those flies. *A. oculata* was firstly recorded from Poltava region. All recent published data on hymenopteran hosts and the distribution of both species of flies are processed and listed.

Keywords: Potter wasps, *Amobia*, kleptoparasites, Poltava, Ukraine.

Introduction

Potter, or mason wasps (Hymenoptera: Vespidae, Eumeninae) consist of nearly 4000 species and 205 genera of solitary or semisocial insects. The species use various available cavities (such as coleopteran burrows made in wood, old nail holes etc) for the nest construction, or they themselves build underground burrows for nesting, and aerial nests on the stems of grasses and shrubs (so called "clay jugs"). Each nest includes from one to several brood cells. Predatory larvae feed on provisions (beetle larvae, caterpillars, etc.), paralyzed and transported by their parents in advance. Imagoes of all known species usually feed on the nectar and (rarely) pollen of flowering plants (Blüthgen, 1961). The genus *Amobia* Robineau-Desvoidy, 1830 contains fifteen species distributed all over continents except Antarctica from the subpolar regions to the tropics. The species of this genus are specialized in consistently attacking the nests of Vespidae and Sphecidae (sensu lato) in general, Predatory maggots feed on the food supply of the host larvae: paralized caterpillars of different Lepidoptera, larvae of beetles (mainly Chrysomelidae and Curculionidae) and sawflies (Hymenoptera), adults Diptera and spiders in the nests of hosts, but sometimes the larvae live in the solitary bees' nests (Spofford *et al*., 1989; Verves and Khrokalo, 2006).

Discoelius zonalis nests in preexisting cavities (burrows of xylophagous beetles in old trees and dry pones). Multicellular nests (3–11 cells) are linear, consisting of a row of several consecutive cells and a plug, which closes the entering. The partitions between the cells and plug are made of a paste of reconditioned tree leaves. Prey for larvae–paralyzed caterpillars of different species of Lepidoptera: Noctuidae (many species); Crambidae: *Patania ruralis* (Scopoli, 1763); Gelechiidae: *Cheimophila salicella* Hübner, 1801, *Corcyra cephalonica* (Stainton, 1866); Tortricidae: *Eupoecilia ambiguella* (Hübner, 1796), and larvae of *Pamphilius sylvaticus* (Linnaeus, 1758) (Hymenoptera: Pamphiliidae) (Budrienė, 2003).

The nests of *S. bifasciatus* are placed in the hollow stems of plants, reed roofs, disused plant galls of *Andricus kollari* (Hartig, 1843) (Hymenoptera: Cynipidae), where the female wasp constructs a number of cells, separated from each other by walls made of clay. Prey for larvae – paralyzed larvae of different species of leaf beetles (Coleoptera: Chrysomelidae): *Linaeidea aenea* (Linnaeus, 1758), *Phratora laticollis* (Suffrian, 1851), *P. vitellinae* (Linnaeus, 1758), *P. vulgatissima* (Linnaeus, 1758), *Plagiodera versicolora* (Laicharting, 1781) (Veenendaal and Piek, 1988; Blüthgen, 1961; Malyshev, 1952). *Amobia oculata*, *A. signata*

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and other species of this genus are very similar to each other habitually and their reliable determination is possible only by peculiarities of male postabdomen. Senior authors made a lot of efforts to establish the actual determination of these species and eliminate taxonomic confusion in all available publications (see references). The present results show only verified detailed data about food composition of wasp larvae, observation administrative territories[1], etc.

Materials and Methods

The nests of the wasps *Discoelius zonalis* (Panzer, 1801) and *Symmorphus bifasciatus* (Linnaeus, 1761) were selected as objects for the study. The field studies took place at bushes and meadows in Poltava Region, Pyriatin District, Leliaky village, 50°18'N, 32°31'E. Laboratory investigations of the hymenopteran nests were performed at the Faculty of Biology, Kyiv Taras Shevchenko National University, and the determination of the flies – took place at the Institute for Evolutionary Ecology, National Academy of Sciences of Ukraine, Kyiv.

Both species are able to nest in artificial reed nests. Such nests were installed to attract the hymenopteran insects. They were bound in bunches of trimming hollow stems of cane, *Phragmites australis* (Cav.) Trin. ex Steud., 1841, elderberry or raspberry of 25 cm long and 4 to 9 mm in diameter. The nests were established during May and June on different substrates, and were collected in October for further study under laboratory conditions. The study of the nests, and their structure, and the species composition of settlers were conducted in laboratory conditions in winter. A cane stem was cut along by a stationery knife. After full opening, each nest was sketching out in the form of a full-size scheme on a separate sheet of paper. Measurements were made using calipers. The insect cocoons were removed from the scattered reed and were placed in Eppendorf's tubes, of a 2 ml volume, closed with a thick cotton swab, and were provided with the number of the nests and the cells. The Eppendorf's tubes were kept at room temperature. Adults emerged from the cocoons in late May – June. The newly-emerged imagoes were mounted on pins for further identification. Dry individuals were pre-placed in desiccators for soaking moisture.

1The faunistic data missing from the catalog (Pape, 1996) are shown in bold.

Results

Amobia oculata[2] (Zetterstedt, 1844)
Synonym: *Pachyophthalmus distortus* Allen, 1926.
Material examined: 1♂1♀, and 2 ♂, bred from two nests of *Symmorphus bifasciatus*.

Distribution

Nearctic: Canada: British Columbia (Allen, 1926), Labrador (Allen, 1926), New Brunswick (Allen, 1926), Ontario (Criddle, 1927); USA: Arizona (Pape, 1996), California (Pape, 1996), Colorado (Pape, 1996), Georgia (Allen, 1926), Kansas (Byers, 1962), Maine (Pape, 1996), Maryland (Allen, 1926), Minnesota (Allen, 1926), Missouri (Rau, 1928), New Hampshire (Allen, 1926), New York (Allen, 1926), North Carolina (Pape, 1996), Pennsylvania (Allen, 1926), Wisconsin (Medler, 1965), Wyoming (Evans, 1973).

Palaearctic: Algeria (Séguy, 1941); Belarus (Verves, 1986); Croatia (Pape, 1996); Czech Republic: Bohemia (Povolný and Verves, 1997), Moravia (Jacentkovský, 1941); Estonia (Draber-Monko, 1966); Finland (Pohjoismäki and Kahanpää, 2014); Germany (Verves, 1986); Italy: mainland (Verves, 1986); Japan: Hokkaido, Honshu, Kyushu, Tsushima Is. (Kurahashi and Kakinuma, 2015); Kazakhstan (Verves, 1984); Lithuania (Pakalniškis and Podénas, 1992); Mongolia (Rohdendorf and Verves, 1980); North Korea (Verves, 1986); Norway (Rognes, 1986); Poland (Draber-Mońko, 2007); Russia: *European part*: Leningrad (Stackelberg, 1962), Rostov (Minoranski *et al.,* 1970), Voroniezh (Khitzova, 1967), *West Siberia*: Altai (Verves and Khrokalo, 2006); *East Siberia*: Chita (Kolomietz, 1966), *Far East*: Amur (Artamonov, 1993), Khabarovsk (Verves and Khrokalo, 2006), Primorie (Khitzova, 1977); Slovakia (Čepelák, 1986);

2 Firstly recorded from the Poltava region.

Spain (Carles-Tolrá, 2002); Sweden (Verves, 1986); Turkey (Kara and Pape, 2002); Ukraine: Cherkasy (Verves, 1998), Chernigiv (Stackelberg, 1962), Dnipro (Verves, 1975, 2000), Donetzk (Minoranski *et al.,* 1970), Kyiv (Verves, 1975), Poltava[1].

Oriental: Nepal (Pape, 1996); Taiwan (Kurahashi, 1974).

Comments: The faunistic data from China on "*Amobia oculata*" sensu Fan & Pape, 1996: 138, are really on *Amobia quatei* Kurahashi, 1974 (Zhang *et al.,* 2011).

Data on hymenopterean hosts (in list)[3]

Vespidae (Eumeninae)

Ancistrocerus adiabatus (Saussure, 1853) [Evans, 1973; Krombein, 1967; Pickering, 2009, as "*Ancistrocerus adiabatus adiabatus* (Saussure)"].

A. antilope (Panzer, 1789) [Ashmead, 1894; Fateryga, 2013; Krombein, 1967, 1979; Pickering, 2009, as" *Ancistrocerus antilope antilope* (Pz.)"].

A. catskill (Saussure, 1853) [Buck *et al*., 2008; Fye, 1965; Krombein, 1967, 1989].

A . flavomarginatus (Brethes, 1906) [Yamane, 1990].

Anterhynchium flavomarginatum (Smith, 1852) [Itino, 1986, 1988, 1992, 1997]

A. micado (Kirsch, 1873) [Kurahashi, 1973 (as "*Anterhynchium flavomarginatum micado* Kirsch"; Yamane, 1990].

Eumenes fraterculus Dalla Torre, 1941 [Iwata, 1978; Yamane, 1990].

E. rubrofemoratus Giordani Soika, 1941 [Kurahashi, 1973; Yamane, 1990].

E. rubronotatus Pérez, 1905 [Yamane, 1990].

Euodynerus dantici (Rossi, 1790) [Blüthgen, 1961; Buyanjargal & Abasheev, 2015; Itino, 1988, 1992; Iwata, 1976].

E. leucomelas (Saussure, 1855) [Buck *et al.,* 2008; Fye, 1965; Krombein, 1989; Pickering, 2009; Richards, 1978].

Orancistrocerus drewseni (Saussure, 1857) [Itino, 1986, 1988, 1992,1997; Iwata, 1982].

Oreumenes decoratus (Smith, 1852) [Kurahashi, 1973, as "*Eumenes decoratus* Smith"; Yamane, 1990].

Pachodynerus nasidens (Latreille, 1812) [Rosenheim, 1990].

Pararrhynchium ornatum (Smith, 1852) [Itino, 1988, 1997].

Rhynchium fukaii Cameron, 1911 [Kurahashi, 1973, as „*Rhynchium haemorrhoidale fukaii* Cameron"; Yamane, 1990].

Stenodynerus frauenfeldi (Saussure, 1867) [Iwata, 1963, 1980; Kurahashi, 1973; Yamane, 1990].

Symmorphus albomarginatus (Saussure, 1855) [Krombein, 1967].

S. captivus (Smith, 1873) [Kurahashi, 1973].

S. crassicornis (Panzer,1798) [as „*Odynerus crassic*ornis": Draber-Mońko, 1964, 1966; Mihályi, 1979].

S. cristatus (Saussure, 1853) [Evans, 1973; Krombein, 1967; Pickering, 2009, as "*Symmorphus cristatus cristatus* (Saussure)"].

Apoidea (Sphecidae, sensu lato**)**

Ammophila sabulosa (Linnaeus, 1758) [Artamonov, 1988; Casiraghi *et al*., 2001; Field, 1992a, b; Pulawski, 2020].

Cerceris halone Banks, 1912 [Byers, 1962, 1978; Jobin and Perron, 2009; Krombein, 1958].

Ectemnius lapidarius (Panzer,1804) [Hamm and Richards, 1926; Lomholdt, 1975, 1976].

E. stirpicola (Packard, 1866) [Krombein, 1960; Srba, 2010].

Isodontia (*Murrayella*) *mexicana* (Saussure, 1867) [Medler, 1965; Pickering, 2009, as "*Sphex apicalis* Sausurre"; Pulawski, 2020].

Rhopalum clavipes (Linnaeus, 1758) [Lomholdt, 1984; Pakalniškis and Podénas, 1992].

Sceliphron destillatorium (Illiger, 1807) [Gorobchishin, 2005;___Mader, 2013; Minoranski, 1971; Minoranski *et al.,* 1970].

Trypoxylon clavatum (Say, 1837) [Krombein, 1967; Pickering, 2009; Srba, 2010].

T. figulus (Linnaeus, 1758) [Pakalniškis and Podénas, 1992].

T. frigidum Smith, 1856 [Evans, 1973, as "*Trypoxylon aldrichi* Sandhouse, 1940"; Krombein, 1967, as "*Trypoxylon aldrichi* Sandhouse, 1940"; Medler, 1967; Pickering, 2009, as "*Trypoxylon frigidum frigidum* Smith"; Srba, 2010].

T. lactitarse Saussure, 1867 [Krombein, 1967; Medler, 1967; Pickering, 2009].

T. obsonator Smith, 1873 [Kurahashi, 1973; Srba, 2010].

3. Author(s) and year of publication are shown in square brackets.

T. petiolatum Smith, 1858 [Kurahashi, 1973].
T. politum Say, 1837 [Allen, 1926; Downing, 1996; Pickering, 2009; Rau, 1928; Srba, 2010].
T. regium Gussakovskij, 1932 [Srba, 2010].
T.striatum (Provancher, 1888) [Srba, 2010].

Amobia signata (Meigen, 1824)
Material examined: 2♂2♀, and 1♂3♀, bred from two nests of *Symmorphus bifasciatus*; 1♂ bred from nest of *Discoelius zonalis*.

Distribution

Palaearctic: Algeria (Verves, 1986); Armenia (Verves, 1980); Austria (Verves, 1986); Azerbaijan (Verves, 1980); Belgium (Verves, 1986); Bulgaria (Verves, 1986); Canary Is. (Becker, 1908); China: Beijing (Zhang *et al.,* 2011), Shaanxi (Fan and Pape, 1996), Sichuan (Fan and Pape, 1996), Xinjiang (Chao and Zhang, 1998); Croatia (Szpila, 2010); Cyprus (Verves, 1986); Czech Republic: Bohemia (Povolný, 1997), Moravia (Jacentkovský, 1941); Denmark (Lundbeck, 1927); Finland (Tiensuu, 1939); France: mainland & Corsica (de Jong *et al*. 2014; Séguy, 1941); Germany (Meigen, 1824); Greece (de Jong *et al*. 2014); Hungary (Mihályi, 1979); Italy: mainland (Bezzi, 1895), Sardinia (Raffone, 2009), Sicily (Raffone, 2009); Japan: Honshu (González *et al*., 2004); Kazakhstan (Verves, 1986); Kyrgyzstan (Verves, 1986); Libya (Venturi, 1960); Lithuania (Valenta and Podenas, 1985); Macedonia (Coe, 1960); Malta: Malta I. (Schembri *et al*., 1991); Moldova (Verves, 1986); Mongolia (Rohdendorf and Verves, 1980); Morocco (Séguy, 1941); Poland (Draber-Mońko, 2007); Romania (Verves, 1986); Russia: *European part*: Voroniezh (Skufyin and Khitzova, 1967), *North Caucasus*: Checnia (Verves, 1980), Ingushetia (Verves, 1980), Karachai-Cherkesia (Khitzova, 1977), *East Siberia*: Chita (Rohdendorf and Verves, 1980), *Far East*: Primorye (Khitzova, 1977); Serbia (Szpila, 2010); Slovakia (Povolný, 1997); Slovenia (Szpila, 2010); Spain (Séguy, 1941); Sweden (Enslin, 1922); Switzerland (Pape and Merz, 1998); Tajikistan (Gajei, 1963); The Netherlands (de Jong *et al*. 2014); Tibet (Zhang *et al.,* 2011); Tunisia (Pape, 1996); Turkey (Kara and Pape, 2002); Turkmenistan (Verves, 1986); Ukraine: Cherkasy (Verves, 1998), Chernigiv (Verves and Khrokalo, 2014), Crimea (Fateryga and Ivanov, 2009), Kharkiv (Yaroshevski, 1882), Kyiv (Verves, 1998), Poltava (Yaroshevski, 1882), Zakarpattia (Verves and Khrokalo, 2018); United Kingdom (Emden, 1954); Uzbekistan (Verves, 1986).
Oriental: India: Jammu & Kashmir (Pape, 1996).
Comments: The faunistic data from Albania on "*Amobia signata*" sensu Pape, 1996: 74, are really on *Amobia oculata* (Kara and Pape, 2002).

Data on hymenopterean hosts (in a list).
Vespidae (Eumeninae)

Allodynerus delphinalis (Giraud, 1866) [Enslin, 1922; Lundbeck, 1927].
Ancistrocerus Wesmael, 1836, sp. [Myers, 1927].
A. auctus (Fabricius, 1793) [Verves and Khrokalo, 2014].
A. gazella (Panzer, 1798) [Deeming, 1985; Harris, 1994].
A. nigricornis (Curtis, 1826) [Chevalier, 1923a, b, as "*Odynerus callosus* Th."; Verves and Khrokalo, 2014].
A. parietinus (Linnaeus, 1761) [Weis, 1960].
A. parietum (Linnaeus, 1758) [Chevalier, 1923a, b].
Discoelius zonalis (Panzer, 1801) [Chevalier, 1923a, b].
Eumenes Latreille, 1802, sp. [Chevalier, 1923a, b].
E. pomiformis (Fabricius, 1781) [Séguy, 1941].
Euodynerus disconotatus (Lichtenstein, 1884) [Verves and Khrokalo, 2014].
E. notatus (Jurine, 1807) [Pekkarinen, 1988].
E. quadrifasciatus (Fabricius, 1793) [Pekkarinen, 1988].
Gymnomerus laevipes (Shuckard, 1837) [Fateryga, 2012; Verves and Khrokalo, 2014].
Katamenes flavigularis Bluethgen, 1951[Fateryga and Ivanov, 2009; Verves and Khrokalo, 2014].
Odynerus reniformis (Gmelin, 1790) [Lundbeck, 1927; Malyshev, 1911].
O. spinipes (Linnaeus, 1758) [Pape, 1987].
Synagis Latreille, 1802, spp. [Bequaert, 1918].

Apoidea (Sphecidae, sensu lato**)**

Cerceris rybyensis (Linnaeus, 1771) [Else, 1998].

Clytochrysus lapidarius (Panzer, 1803) [Séguy, 1941].

C. ruficornis (Zetterstedt, 1838) [Séguy, 1941].

Chalibyon spinolae (Lepeletier de Saint Fergau, 1845) [Srba, 2010].

Crossocerus Lepeletier & Brullé, 1834, sp. [Srba, 2010].

C. walkeri (Shuckard, 1837) [Lomholdt, 1984; Richards, 1980; Séguy, 1941, as "*Coelocrabro walkeri* Th."].

Ectemnius Dahlbom, 1845, sp. [Pape, 1987].

E. lapidarius (Panzer, 1803) [Séguy, 1941, as "*Clytochrysus chrysostomus* (Lep.)"].

E. ruficornis (Zetterstedt, 1838) [Séguy, 1941, as "*Clytochrysus planiofrons*"].

Lionotus delphinaris (Giraud, 1866) [Lundbeck, 1927].

Mimumesa atratina (Morawitz, 1891) [Lomholdt, 1984; Srba, 2010].

Odynerus Latreille, 1802, sp. [Malyshev, 1911].

O. reniformis (Gmelin, 1790) [Lundbeck, 1927].

O. spinifes (Linnaeus, 1758) [Pape, 1987].

Pemphredon Latreille, 1796, sp. [Bezzi, 1907; Baer, 1921; Lomholdt, 1984; Lundbeck, 1927; Srba, 2010].

P. lugubris (Fabricius,1793) [Chevalier, 1923a, b; Lomholdt, 1984; Séguy, 1941; Srba, 2010].

P. rugifer (Dahlbom, 1844) [Séguy, 1941, as "*Cenomus unicolor* Fab."]

Pison insigne Sichmann, 1894 [Antropov, 1990].

Psenulus sp. [Srba, 2010].

Psenulus pallipes (Panzer, 1798) [Bitsch *et al.* 2001; Chevalier, 1925, as "Psenulus atratus F."; Lomholdt, 1984; Séguy, 1941, as " *Psen atratulus* Latr.."].

Sceliphron caementarium (Drury, 1773) [Campadelli, 1984; Campadelli *et al.*, 1999].

S. destillatorium (Illiger, 1807) [Campadelli and Pagliano, 1987; Mader, 2013].

S. spirifex (Linnaeus, 1758) [Séguy, 1941; Srba, 2010].

Trypoxylon albitarse Fabricius, 1804 [Lundbeck, 1927 ; Srba, 2010].

T. attenuatum Smith, 1851 [Gorobchishin, 2006; Lefeber, 1979; Séguy, 1941; Srba, 2010].

T. clavicerum Lepeletier & Serville, 1825 [Gorobchishin, 2006; Kazenas, 1987; Lefeber, 1979; Lomholdt, 1975, 1984].

T. figulus (Linnaeus, 1758) [Séguy, 1941; Srba, 2010].

Apoidea (different bees)

Andrena cineraria (Linnaeus, 1758) [Grobov *et al.*, 1988; Séguy, 1941].

A. fulvida Schenck, 1853 [Grobov *et al.*, 1988; Séguy, 1941].

A. haemorrhoa (Fabricius, 1781) [Grobov *et al.*, 1988; Séguy, 1941, as"*Andrena albicans* L."].

Megachile centuncularis (Linnaeus, 1758) [Grobov *et al.*, 1988; Séguy, 1941].

M. rotundata (Fabricius, 1793) [Grobov *et al.*, 1988; Pape, 1987].

Eucera atricornis (Fabricius, 1793) [as"*Osmia atricornis*": Grobov *et al.*, 1988; Séguy, 1941].

Osmia rufa (Linnaeus, 1758) [Grobov *et al.,* 1988; Séguy, 1941].

Protandrena atricornis (Cresson, 1878) [Séguy, 1941, as "*Osmia atricornis* Latr."].

Discussion

As a result, from the recent analysis of the types of trophic connections of *Amobia* larvae it seems that they may be predators of paralyzed arthropods (in the nests of the majority of wasps), necrophages (in nests of wasps with fleshly killed arthropods) or nectarophages and polllinophages (in bee nests). All these types of food can pass into each other; thus, the first stage larvae in the nests of bees first kill the host egg, and only then begin to eat the pollen loaf ("bee bread") (Verves, 1984; Wcislo, 1987). As a rule, in wasp nests provisioned by paralyzed insects or spiders maggots they began feeding as predators, but finished larval development as necrophages. In general, the species of the genus *Amobia* are not very choosy in the selection of hosts for the variety of stored food, but they are clearly specialized for development in clay "jugs" or nests inside hollow stems. A broader

discussion of the results is currently difficult due to fragmentation of data on the ways of invasion of hymenopteran nests by flies, the full spectrums of maggots' feeding, the host range, and other important aspects of the biology of the genus *Amobia*.

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