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Sympiesis notata (Hymenoptera: Chalcidoidea: Eulophidae), a gregarious parasitoid of Hesperiidae (Lepidoptera), and some records of other Chalcidoidea associated with skipper butterflies in the Western Palaearctic

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ABSTRACT

Sympiesis notata is a gregarious ectoparasitoid of skipper butterfly caterpillars. Other Lepidoptera larvae in leaf mines and leaf folds are attacked by the same morphospecies, but on these smaller hosts *S. notata* is usually a solitary parasitoid. Other Chalcidoidea recorded as reared from hesperiid hosts are mostly species of *Brachymeria* (Chalcididae) and *Elasmus* (Eulophidae), which are primary parasitoids, and *Catolaccus* (Pteromalidae) which are pseudohyperparasitoids attacking cocooned ichneumonoid primary parasitoids. Species of *Pteromalus*, *Baryscapus* and *Tetrastichus* are also reported as secondary parasitoids from hesperiid hosts.

Keywords: Microgastrinae, Ichneumonidae, Chalcididae, Pteromalidae, Eulophidae, Hesperiidae, primary parasitism, secondary parasitism, multiparasitism

INTRODUCTION

Species of *Sympiesis* Förster are mostly known as moderately polyphagous, solitary (rarely gregarious), ectoparasitoids of small Lepidoptera larvae that feed in concealed or partly concealed situations such as leaf-mines, leaf folds, and shelters. A number of species may be facultative secondary parasitoids, developing on other chalcidoid ectoparasitoids or on ichneumonoid primary parasitoids after these have left the bodies of their hosts (pseudohyperparasitoids). A few species are reported as primary parasitoids of Coleoptera (especially Chrysomelidae), Hymenoptera (Tenthredinidae) and Diptera (Agromyzidae, Ephydridae) (Noyes 2021).

Sympiesis notata (Zetterstedt, 1838) (= *sandanis* Walker) is common throughout most of Europe in limestone grassland, sand dunes, upland grassland and other open situations, but host records are rather few. Bouček & Askew (1968) list three species of Gracillariidae (*Phyllonorycter*) and three of Tortricidae (*Pandemis*, *Syndemis*) with a very dubious, old record of a sawfly (Tenthredinidae). Gambaro (1968) and Kerrich (1969) add four more species of Tortricidae (*Ancylis*, *Argyroploce*, *Choristoneura*, *Cnephasia*) and one of Gelechiidae (*Phthorimaea*), and a species of *Cosmopterix* (Cosmopterigidae) is reported as a host by Rizzo & Massa (2002). These records are all from endophytic or concealed hosts and, when stated, of solitary as opposed to gregarious parasitoids. We present here some new records of rearings of *S. notata* from Lepidoptera; especially notable are the large gregarious broods from Hesperiidae. The material is preserved in the personal collection of the first author.

Sympiesis notata associated with Hesperiidae:

12♀♀3♂♂ ex *Pyrgus* sp. larva with *Cotesia* sp. near *glabrata* (Telenga) (Braconidae; Microgastrinae) but almost certainly multiparasitoid rather than pseudohyperparasitoid as none of the gregarious *Cotesia* cocoons had been parasitised, collected 20.vii.2009, emerged 28.vii.2009. Switzerland, Kanton Bern, Gastlosen, Wandfluh, 1660m. M. Albrecht.

34♀♀(+ 3 unemerged ♀ pupae) 1♂ ex *Muschampia* ?*flocciferus* (Zeller), multiparasitoid with *Cotesia* sp. near *glabrata*, collected 20.vii.2009, emerged 28.vii.2009. Switzerland, Kanton Bern, Gastlosen, Wandfluh, 1660m. M. Albrecht.

32♀♀13♂♂ ex *Muschampia flocciferus* larva found dead, gregarious primary parasitoids, 31.vii.2010, emerged viii.2010. France, Hautes-Alpes, Cervières, 2200m. T. Lafranchis.

9♀♀3♂♂ ex *Muschampia orientalis* (Reverdin), apparently multiparasitoid with *Cotesia* sp. near *glabrata* as no braconid cocoons were found to have been parasitised, collected 7.vi.2009, emerged 14.vi.2009. Greece, Kalymnos, Chorio, Profitis Ilias. M. Albrecht.

22♂♂ ex *Muschampia boeticus* (Rambur), with *Cotesia* sp. near *glabrata*, either as hyperparasitoid or multiparasitoid, collected 21.vi.2012. France, Var, Bargemon, Col du Bel Homme. P. & B. Kan.

3♀♀ (probably only part of brood) ex *Gegenes nostrodamus* (Fabricius) larva 4th instar, 3.x.2009. Spain, Madrid Province, Chinchón, Laguna de San Juan, 505m, UTM 30TVK54. J.C. Vicente.

Sympiesis notata associated with other Lepidoptera, new host records:

1♀ ex *Caloptilia azaleella* (Brants) (Gracillariidae) on *Azalea*, a solitary parasitoid, 1976. England, Hampshire, Bournemouth. A.M. Emmet.

2♀♀ ex *Phyllonorycter junoniella* (Zeller) (Gracillariidae) two leaf-mines on *Vaccinium vitis-idaea*, solitary parasitoids, 2012. Scotland, Perthshire, Cairnwell. M.R. Shaw.

1♂1♀ ex Lepidoptera leaf roll on *Centaurea*, apparently a brood of two, collected 20.vii.1984. France, Alpes-de-Haute-Provence, Castellane. M.R. Shaw.

2♀♀ ex *Cnephasia* sp. (Tortricidae) on *Plantago lanceolata*, solitary parasitoids, collected 29.v and 9.vi.2015. England, Avon, Long Ashton and Pensford near Bristol. E. Villa-Galaviz. Partial DNA barcodes have been obtained from both of these specimens and are in the BOLD database (http://v4.boldsystems.org/) with codes JMBPB822-17 and JMBPB833-17 respectively.

Of particular interest are the several records of large broods of *S. notata* being associated with larvae of Hesperiidae (skipper butterflies), behaving as a gregarious primary ectoparasitoid but sometimes attacking host caterpillars that have also been attacked by endoparasitoid species of *Cotesia*. Although it is possible that *S. notata* can also be a hyperparasitoid, developing on the cocooned larvae or pupae of Braconidae after these have left the body of the host hesperiid, we have seen no direct evidence of this. Also, the very high frequency of parasitism of pyrgine hesperiids by *Cotesia glabrata* and close relatives (MRS, unpublished) suggests that the multiparasitism recorded here is probably simply incidental rather than being of particular significance.

Whilst usually solitary when attacking the relatively small larvae of microlepidoptera, *S. notata* is, in contrast, a gregarious parasitoid of Hesperiidae. We are unable to find consistent morphological differences between material from the two categories, though it is of course possible that the morphospecies comprises two separate cryptic species. Most species of *Sympiesis* are solitary parasitoids, although the development of many larvae on a single host larva is known in *S. capeki* Bouček and *S. viridula* (Thomson), in addition to *S. notata.* Fifteen females and one male *S. capeki* were reared from a single larva of *Tethea or* (Denis & Schiffermüller) (Drepanidae: Thyatirinae) (Bouček 1959), and five broods of

11 ♀♀, 10 ♀♀ 2 ♂♂, 5 ♀♀ 1♂, 4 ♀♀ 1 ♂ and 4 ♀♀ were reared from single larvae of *Clostera pigra* (Hufnagel) (Notodontidae) collected in 1986 and 1993 in south-east France (MRS). Parker & Smith (1933) record 57 larvae of *S. viridula* on one larva of *Ostrinia nubilalis* (Hübner) (Pyralidae). The gregarious habit enables these *Sympiesis* species to exploit relatively large hosts, as do species of the allied genus *Eulophus*, although there is no evidence that these *Sympiesis* species employ a venom similar to that used by *Eulophus ramicornis* (Fabricius), which arrests the host only after a period of additional feeding (Shaw 1981 as *E. larvarum*).

Arboreal hosts are not usually attacked by *S. notata.* It was not represented among over 1,700 specimens of *Sympiesis* reared from mines of *Phyllonorycter* collected from deciduous trees (Askew & Shaw 1974), and it is significant that the three species of *Phyllonorycter* (= *Lithocolletis*) listed as associates of *S. notata* (Noyes 2021) all mine the leaves of herbaceous plants or creeping shrubs.

The earliest mention of *Sympiesis* attacking Hesperiidae appears to be of 4 ♀♀1♂ *S. enargiae* Miller being reared from an unidentified hesperiid larva (or larvae?), Canada, British Columbia, Waldo, 28.iv.1958 (Miller 1970: 44). The holotype of *S. enargiae* was reared from the noctuid *Enargia.* Gupta, Gawas & Bhambure (2015) provide the only other two cases that we can find of parasitism of Hesperiidae by *Sympiesis* species, both from India (Goa): *Sympiesis thyrsisae* Gupta, Gawas & Bhambure is described from a female and male reared as ectoparasitoids of a single caterpillar of *Gangara thyrsis* (Fabricius) on *Cocos nucifera* (coconut), and a single male of an unidentified *Sympiesis* was reared from a larva of *Coladenia indrani* (Moore).

OTHER CHALCIDOIDEA ASSOCIATED WITH HESPERIIDAE IN THE WEST PALAEARCTIC

The pre-adult stages of European species of Hesperiidae are not easy to find and in consequence are rather seldom collected except by specialists. Their caterpillars live in tent-like shelters, rather loosely constructed of spun, sometimes folded, leaves of the food plant, and pupate in flimsy, silken cocoons close to the ground. Often these structures are found already to contain parasitoid cocoons. Our records of primary or secondary chalcidoid parasitoids of Hesperiidae in France, Spain, Portugal and Israel, but excluding egg parasitoids, are presented here.

Chalcididae

Brachymeria ?*argentiopilosa* (Radoszkowski) (= *persica* (Masi)) 1♀, ex *Gomalia elma levana* Benyamini on *Arbutilon fruticosum*. Israel, Dead Sea, Nahal Mazin, -360m, 2008. D. Benyamini. Solitary pupal parasitoid, probably primary.

Brachymeria tibialis (Walker) 6♀♀, ex *Muschampia stauderi* (Reverdin) on *Ballota acetabulosa*. Greece, Kalymnos, Chorio, Profitis Ilias, collected as pupae 6.vi.2012, emerged 28.vi.–5.vii.2012. M. Albrecht. Solitary pupal parasitoids. Carl (1968) found *B. tibialis* (recorded as *B. intermedia* (Nees)) to be a frequent though unimportant parasitoid of *Thymelicus lineola* (Ochsenheimer) in Europe.

Brachymeria tibialis 1♂, a pseudohyperparasitoid ex *Carcharodus alceae* (Esper) larva mummified by *Hyposoter ebeninus* (Gravenhorst) (Ichneumonidae) on *Alcea rosae*. Italy, Imperia, Apricale, collected 9.vi.2014, emerged 19.vi.2014. P. Kan.

PTEROMALIDAE

Catolaccus ater (Ratzeburg) 13♀♀3♂♂ [with *Pteromalus vibulenus* and *Baryscapus galactopus*, see below], ex *Cotesia glabrata* cocoons ex *Carcharodus alceae.* France, Vienne, Couhé, 1990. M.R. Shaw.

Catolaccus ater 2♀♀, ex larval mummies (2) of *Carcharodus alceae* parasitised by *Hyposoter* ?*ebeninus*. Spain, Barcelona, Can Liro, collected 28.viii.2006, emerged 11.ix.2006. C. Stefanescu.

Catolaccus ater 1♀, ex *Microgaster* sp. (Braconidae) cocoon ex *Pyrgus malvoides* Elwes & Edwards. Spain, Ávila, San Martin de Pimpollar, Venta de Rasquilla, 5.viii.2017. J. Hernández-Roldán.

Catolaccus crassiceps (Masi) 1♀, ex *Sinophorus* sp. (Ichneumonidae) cocoon ex *Muschampia proto* (Ochsenheimer). Spain, Navarra, Montes de Gerzo, Tudela, leg. 25.iv.2007. J. Aguiz.

Catolaccus crassiceps 1♀, ex *Microgaster australis* Thomson cocoon ex *Muschampia proto.* France, Aude, La Clape, 16.v.2011. T. Lafranchis.

Catolaccus crassiceps 1♂, ex Microgasterinae cocoon ex *Muschampia proto.* Spain, Cordoba, Sierra Gallinera, Carcabuey, 20.iv.2012. R. Obregón Romero.

Catolaccus crassiceps 10♀♀, ex *Cotesia glabrata* cocoons ex *Carcharodus alceae*. France, Var, Callas, La Ferrage du Ray, 2012. P. Kan.

Catolaccus crassiceps 7♀♀1♂, ex *Cotesia glabrata* cocoons ex *Carcharodus tripolinus* (Verity). Portugal, Lagos, Bensafrim, 2010. M. Albrecht.

Catolaccus crassiceps 3♀♀1♂, ex *Cotesia glabrata* cocoons ex *Carcharodus tripolinus*. Portugal, Lagos, Praia Dona Ana, 2010. M. Albrecht.

Pteromalus vibulenus (Walker) 12♂♂ [with *Catolaccus ater* and *Baryscapus galactopus*], ex *Cotesia glabrata* cocoons ex *Carcharodus alceae*. France, Vienne, Couhé, 1990. M.R. Shaw.

EULOPHIDAE

Elasmus viridiceps Thomson 5♀♀, ex cocoon mass of *Cotesia glabrata* ex *Carcharodus alceae* on *Malva.* France, Indre-et-Loire, Tours, collected vi.2007 emerged vi/vii.2007. M.R. Shaw.

Elasmus viridiceps 1♀, ex *Carcharodus alceae* larva as primary parasitoid. France, Var, Callas, La Ferrage du Ray, 26.vii.2012. P. Kan.

Elasmus viridiceps 2♀♀3♂♂, ex *Carcharodus alceae* larvae on *Alcea rosae*, apparently as primary parasitoids. France, Var, Callas, La Ferrage du Ray, collected 28–31.vii.2013 emerged 2–8.viii.2013. P. & B. Kan.

Baryscapus galactopus (Ratzeburg) 1♀ [with *Catolaccus ater*, *Pteromalus vibulenus*], ex *Cotesia glabrata* cocoon ex *Carcharodus alceae*. France, Vienne, Couhé, 1990. M.R. Shaw.

Tetrastichus sp. indet. 2♀♀ [in *legionarius*-group (Graham 1991)?], ex *Gegenes nostrodamus*, unclear whether primary or secondary parasitoids. Spain, Madrid Province, Chinchón, Laguna de San Juan, 505m, UTM 30TVK54, 3.x.2009. J.C. Vicente.

Two species of *Catolaccus* dominate the rearing records of chalcidoids associated with Hesperiidae. Both *C. ater* and *C. crassiceps* behave as pseudohyperparasitoids, attacking ichneumonoid primary parasitoids after the latter have formed their cocoons. The primary parasitoids are either microgasterine Braconidae (especially *Cotesia*, which is more frequent than *Microgaster*), or campoplegine Ichneumonidae.

Baryscapus galactopus is also a well-documented parasitoid in cocoons of Microgasterinae (mostly *Cotesia*) from a broad range of Lepidoptera hosts (Noyes 2021). The *Cotesia* larva is attacked just before or very soon after leaving its caterpillar host, but it is not killed before it has formed a cocoon (Askew & Shaw 2005). In the record listed above, the single specimen almost certainly had parasitized *Cotesia* rather than one of the pteromalid pseudohyperparasitoids.

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