Two new species of European *Microgaster* Latreille, 1804 (Hymenoptera: Braconidae, Microgastrinae), with host data on some further species

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Abstract

Two new European species of *Microgaster* are described from reared material. *Microgaster nervosae* **sp. nov.** parasitizes *Agonopterix* species (Depressariidae) on *Ulex* and *Genista* in Britain, and a key is provided to separate it from two other British *Microgaster* species that parasitize other *Agonopterix*, with host information. *Microgaster monetae* **sp. nov.**, a parasitoid of *Polychrysia monetae* (Noctuidae), is described from Austrian specimens. The host repertoires of *Microgaster nobilis* and *M. australis*, two European species that are regular parasitoids of Hesperiidae: Pyrginae in the Mediterranean region, are discussed on the basis of reared material in NMS. Some new country records (France, Israel, Portugal, Spain) of already established *Microgaster* species are given.

Key words: *Agonopterix*, *Polychrysia moneta*, Pyrginae, *Microgaster nervosae* sp. nov., *M. monetae* sp. nov., *M. australis*, *M. fulvicrus*, *M. luctuosa*, *M. nobilis*, Britain, Austria, France, Israel, Portugal, Spain.

Introduction

The microgastrine braconid genus *Microgaster* Latreille, 1804 is, by the standard of the subfamily, merely a rather small genus of a little over 100 species, mostly in the Holarctic (Fernandez-Triana *et al.*, 2020) though it is cosmopolitan. Several reasonably modern keys to the European species exist (Nixon, 1968; Papp, 1976; Tobias, 1986 [as *Lissogaster*]). Further British species were added by Shaw (2004, 2012), and *Fauna Europaea* (consulted 30.v.2022) lists 45 species (though those described in 2012 are not yet added). All parasitize Lepidoptera and as far as is known all are solitary except for *Microgaster subcompleta* Nees, 1834, a regular gregarious parasitoid of the nymphalid *Vanessa atalanta* (Linnaeus, 1758) and the crambid *Patania ruralis* (Scopoli, 1763), both of which rest as larvae in rolled *Urtica* leaves.

Reared material in the National Museums of Scotland (NMS) collection includes two new species, described below. The first of these, from Britain and reared from species of *Agonopterix* Hübner, 1825 (Depressariidae) feeding on *Ulex* and *Genista*, may have been referred to by Nixon (1968) as '*Microgaster fulvicrus* Thomson var. A', from non-reared Irish specimens presumably (by implication) in the Natural History Museum, London (NHMUK) which, however, I was unable to find on recent visits. The second is based on an Austrian female in NMS reared from the plusiine noctuid *Polychrysia moneta* (Fabricius, 1787) and on a good series reared from the same host also in Austria found in Biologiezentrum, Linz (BLZ). A further specimen reared from this host with probably similar provenance was also found undetermined in NHMUK among unsorted material.

The opportunity is taken to comment on the host repertoires of two further European (but not British) *Microgaster* species, both strongly associated with Pyrginae (Hesperiidae), as suggested by reared material in NMS.

Materials and methods

Terminology mostly follows van Achterberg & Shaw (2016), with some terms commonly used for Microgastrinae following Nixon (1965). Most photographs were taken in RAW down one arm of a Wild 5A binocular microscope with 20× eyepieces using a Canon PowerShot S110 and processed using Adobe Photoshop Elements, but some images of *Microgaster monetae* **sp. nov.** (i.e., apart from Figs 14, 15, 20–22 and 24) were taken using a Keyence VHX-1000 Digital Microscope, a lens with a range of 13–130× and the multiple images stacked through the software associated with the Keyence System.

Depositories
National Museums of Scotland, Edinburgh (NMS)
The Natural History Museum, London (NHMUK)
Canadian National Collection of Insects and Arthropods, Ottawa (CNC)
Biologiezentrum, Linz (BZL)

DNA Barcoding
Standard protocols outlined in Shaw (2022) were applied, at CNC and the Canadian Centre for DNA Barcoding (Guelph, Ontario). CO1 sequences are (or will be) deposited in the Barcode of Life Data Systems, http://www.boldsystems.org/ (BOLD), with the sample references indicated below.

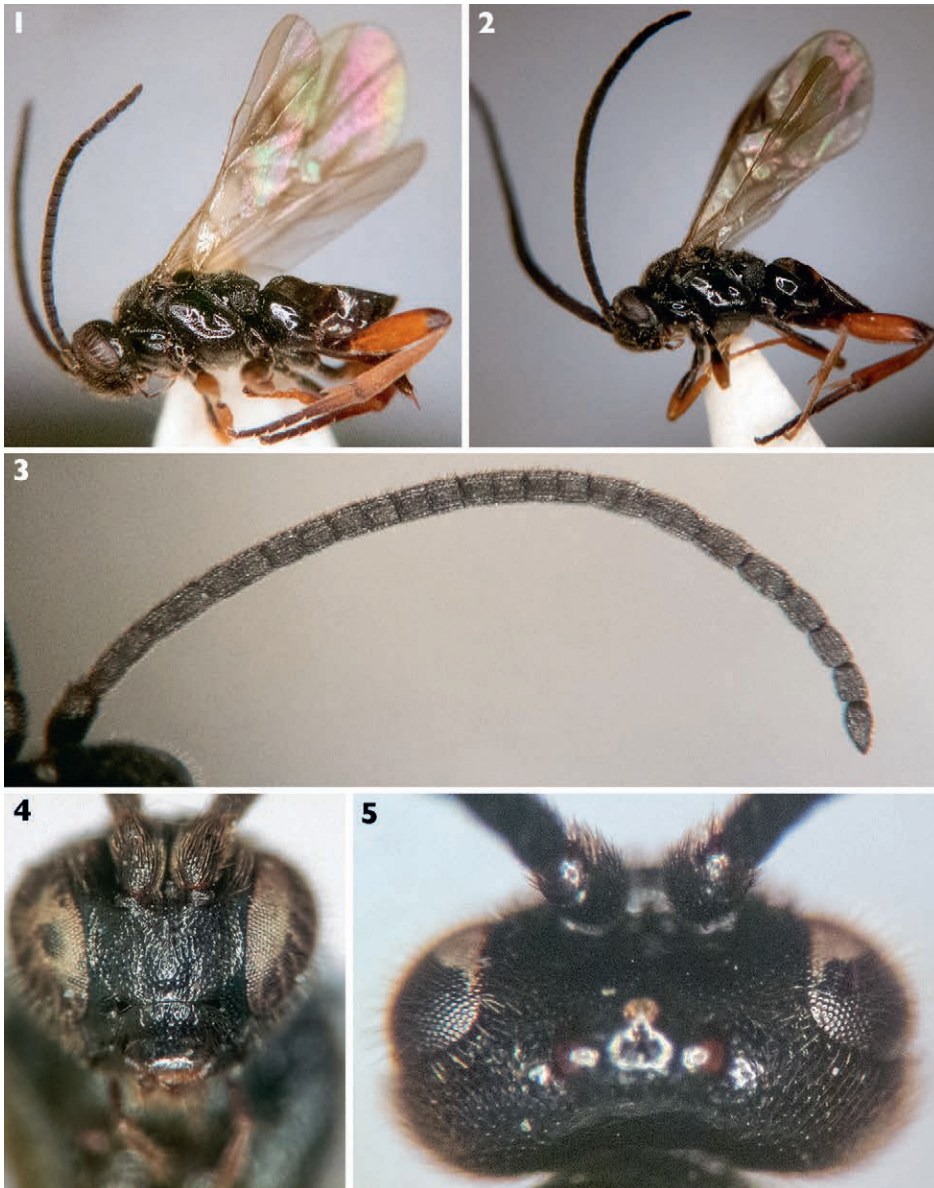### *Microgaster nervosae* sp. nov.
(Figs 1–12)

Nixon (1968) included two species, *M. fulvicrus* Thomson, 1895 and *M. luctuosa* Haliday, 1834 (as *curvicrus* Thomson, 1895; synonymy according to van Achterberg, 1997), with largely punctate faces that parasitize species of the depressariid genus *Agonopterix* (as *Depressaria*). [A further mention of the name '*Depressaria*', as a host of *Microgaster hospes* Marshall, 1885, by Nixon (1968) appears to be a *lapsus* for *Acleris* (Tortricidae).] A third species, *Microgaster nervosae* **sp. nov.**, also with a punctate face, parasitizing *Agonopterix nervosa* (Haworth, 1811) and *A. umbellana* (Fabricius, 1794), is added here, and a key to separate these three probably closely related species is included. All three overwinter in the cocoon and appear to be routinely univoltine (but see a possible exception under *M. nervosae* **sp. nov.**). Hosts, including those recorded by Nixon (1968), and based otherwise on specimens in NMS, are listed and discussed below. Keys (Papp, 1976 [also 1981]; Tobias, 1986) to European *Microgaster* subsequent to Nixon (1968) are mostly strongly derivative, although with the incorporation of several additional species, and pay almost no regard to hosts; in any case the new species does not appear to be treated as it will always run to *M. fulvicrus*.

Description
Holotype ♀, length (excluding ovipositor) 3.3 mm, of fore wing 3.6 mm. Head in dorsal view 1.7× wider than long; temple as long as eye, subparallel near eye and then evenly rounded;

OOL 2.4× and POL 2.0× diameter of posterior ocellus; tangent to posterior ocelli just touching anterior ocellus; stemmaticum smooth with vertex and frons almost so, shining; face 1.7× wider than high, coarsely punctured, often moderately rugose centrally, without vermiculate rugosity near eyes; clypeus mostly rugose with punctures indistinct; anterior tentorial pits at lower level of eyes, which converge slightly below; malar space about 0.9× basal width of mandible; antenna 0.9× as long as fore wing, preapical segments about 1.3× longer than wide, weakly swollen. Mesoscutum shiny, strongly and almost discretely punctured anteriorly, where notaulic courses shortly are weakly marked by more crowded smaller punctures, posteriorly

Figs 1–5. *Microgaster nervosae* sp. nov. 1, 3–5 female; 2 male. **1, 2,** habitus; **3,** antenna; **4,** face; **5,** head in dorsal view.

becoming smooth with weak setiferous punctation; prescutellar groove deep and strongly crenulate; scutellum shiny with a few scattered shallow punctures; mesopleuron largely shiny, with rugulose and weakly punctate sculpture in precoxal area and at anterior edge; metapleuron with upper division shiny, otherwise dull, closely rugulose; propodeum with strong usually (but variably) largely transverse rugae and a clear median longitudinal keel. Fore wing with setae in basal and subbasal cells fairly evenly distributed; pterostigma moderately deep, about 2.3× longer than deep, emitting the evenly curved r near distal third; termination of metacarp not sharp, attenuating from about 0.55× distance from pterostigma to apex of marginal cell; 1CU-1 slightly longer than 1CU-2. Hind wing cubitellan cell about 0.6× as high as long. Hind leg with coxa shining, laterally practically immaculate and dorsally weakly rugulose punctate; femur 3.2× longer than wide, shiny but with coarse though weak setiferous punctures; tibia slightly curved, evenly widening to apex, 5.4× longer than maximum width, 1.2× longer than femur, its inner spur just longer than outer and surpassing middle of basitarsus; tarsus rather slender, basitarsus 5.3× longer than wide; claw neither abnormally bent nor large, weakly swollen subbasally with ca 3 fine spines. Metasoma with T1 and T2 coarsely rugose and T3 largely smooth; T1 about 0.7× as long as wide; T2 about 3.9× wider than long; T3 about 1.3× as long as T2; hypopygium tightly folded with creases, 0.7× as long as hind tibia, descending at about 60° with almost no attenuation (this is prone to distortion); setose part of ovipositor sheath just over half as long as hind tibia; ovipositor weakly and evenly downcurved.

Black (including tegula, humeral plate and usually palpi completely); mandible subapically brown; legs black except as follows: fore femur dorsally in apical half and its tibia and tarsus yellow/brown; mid femur sometimes partly orange/brown in limited areas with its tibia and tarsus yellow/brown; hind femur usually orange except apically and often at extreme base but sometimes more extensively darkened, its tibia orange except at extreme apex, tarsus brownish and darkening distally. Wing membrane somewhat unevenly tinged brownish yellow.

*Male.* Like female except for sexual characters. Palpi sometimes orange apically.

Variation. Most obviously in leg colour, sometimes the hind femur being extensively darkened (but never completely so in the material seen), or the mid femur being partly (usually obscurely) orange/brown. There is also variation in the sculpture of the face centrally, and the propodeum (as indicated in the description).

MATERIAL EXAMINED
Holotype ♀ 'Scotland: Edinburgh, Blackford Hill, ex Agonopterix nervosa, Ulex europaeus coll. 31.5.2018, em. 11.5.2019 M.R. Shaw' (in NMS). Paratypes (9♀, 11♂, all in NMS unless indicated otherwise): 3♀, 4♂ same data as holotype except em. 23.iv (♀), 2.v (♀), 23.iv (♂), 29.iv (♂ in CNC), 1.v (♂), 16.v (♂) and coll. 6.vi.2021, cocoon 28.vi.2021, em. 7.v.2022 (♀); 1♀ same data except ex *A. umbellana* (as *ulicetella*), coll. 24.vii. 1983, em. 19.v.1984 (K. P. Bland); 1♂ (in BZL) same data except not reared, 17.v.1984 (M. R. Shaw); 1♀ Scotland: Argyll, Ardgour, ex *A. nervosa* coll. 1.vii.1998, cocoon 15.vii.1998, em. 10.v.1999 (T. H. Ford); 1♂ Scotland: Edinburgh, Corstorphine Hill, 23.v.1981 (A. D. Liston); 3♀ (1 in NHMUK, 1 in CNC), 2♂ England: London, Totteridge, ex *A.* ? *nervosa* on *Genista tinctoria* coll. vi.1978, cocoons 19.vi.1978, em. 14 (1♂) & 15.v.1979 (3♀) and coll. v.1978, cocoon vi.1978, em. 15.v.1979 (1♂) (R. I. Lorimer); 1♀ (in BZL), 1♂ England: London, Hampstead Heath, ex *A. nervosa* on *U. europaeus* coll. 29.v.1984, cocoon 5.vi.1989, em. 1990 (R. A. Softly); 1♂ England, Kent, Dartford Heath, ex *A. nervosa* (as *Dep. costata*) cocoon 25.vi.1954, em. 1.vi.1955 (R. L. E. Ford) (in NHMUK); 1♂ England: Cornwall, Carn Brea, ? *Agonopterix* on *U. europaeus* flowers 1.vii.2006, em. 14.vii.2006 (J. L. Gregory) [as labelled; note anomalous phenology].

Key to the European species of *Microgaster*
that parasitize *Agonopterix* species

(None of the included species has clearly developed vermiculate rugosity on the face near the eyes, nor pectinate claws. They fall within couplets 10 to 13 in
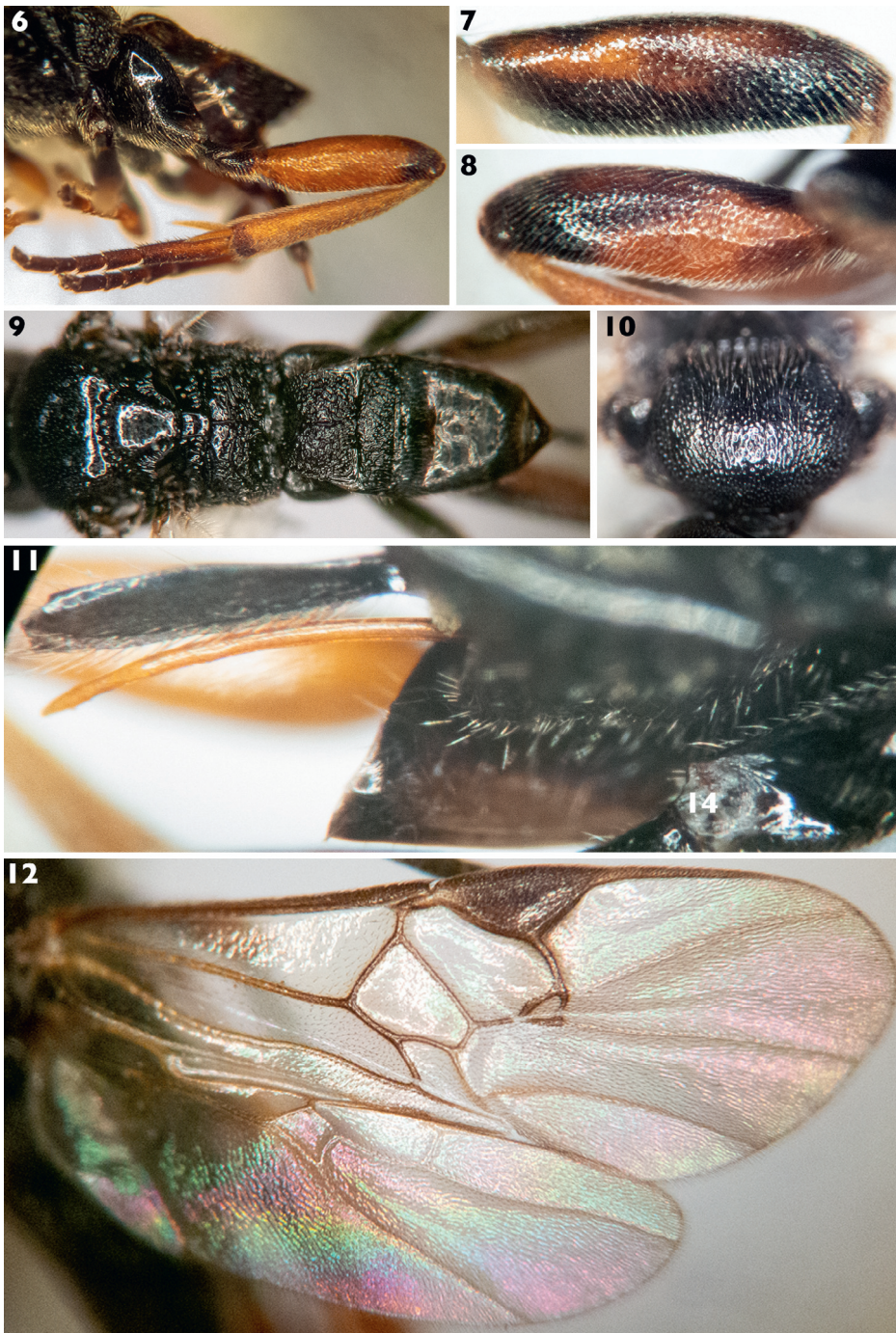
Figs 6–12. *Microgaster nervosae* sp. nov. 6, 8–12 female, 7 male. **6,** hind leg with normal coloration; **7, 8,** abnormally darkened hind femur; **9,** alitrunk; **10,** mesoscutum in anterodorsal view; **11,** ovipositior, sheath and hypopygium; **12,** wings.

Nixon's 1968 key, and all have the metasomal tergites entirely black (unlike *M. obsepiens* Nixon) and the setose part of the ovipositor sheath clearly less than three quarters as long as hind tibia (unlike *M. erro* Nixon)).

1   Hind femur wholly black. Face with punctures moderately sharp, any rugose element slight. (Preapical antennal segments of female cylindrical) . . . . *luctuosa* Haliday, 1834
(= *curvicrus* Thomson, 1895)
–   Hind femur entirely or at least extensively orange. Face predominately punctate but sometimes with a clear rugose element centrally 2
2   Hind and mid femora (almost) entirely orange. (Preapical antennal segments of female barrel-shaped; punctures on mesoscutum less strong; wing membrane a little lighter; body more gracile) . . . . *fulvicrus* Thomson, 1895
–   Hind femur blackish at least at apex, often more extensively so but with central parts at least partly orange; mid femur mostly black. (Preapical segments of female slightly longer thus appearing more cylindrical, less barrel-shaped; punctures on mesoscutum stronger; wing membrane a little darker; body more robust) . . . . *nervosae* **sp. nov.**

Hosts and phenology of the *Microgaster* species parasitising *Agonopterix* in Britain

Microgaster fulvicrus. Nixon (1968) gives as host *Agonopterix ocellana* (Fabricius, 1775), which feeds on *Salix*, and remarks that host larvae were collected at Witherslack (now in Cumbria) in June, with emergence of the parasitoids the following May. In NHMUK there are 2♀, 4♂ with these data seen by Nixon. In NMS there is the following reared material: 6♀ from *A. ocellana* on *Salix cinerea* (2 localities, Cumbria and Perthshire, M. R. Shaw), coll. vi (in Perthshire vii), em. v the following year; 1♀ labelled as from *Acleris hastiana* (Linnaeus, 1758) (Tortricidae) on *Salix* (Isle of Coll, K. P. Bland), coll. vii, em. v the following year; 1♂ labelled as from Geometridae sp. on *Salix* (Stirlingshire, E. C. Pelham-Clinton), coll. viii, em. v the following year. The last two specimens lack host remains and, despite the eminence of the rearers, I am inclined to regard the host determinations as doubtful, in the first case owing to superficial similarity in the larval stage between *Agonopterix ocellana* and *Acleris hastiana*, and in the second case perhaps due to an initially unobserved parasitoid cocoon introduced with foodplant (the widespread *A. ocellana* is expected to occur at both sites). There are also 6♀, 7♂ non-reared British specimens in NMS, collected in v–vi(vii). At least provisionally, I interpret *M. fulvicrus* as a univoltine specialist parasitoid of *A. ocellana*. Two recently reared specimens (Cumbria) have been selected for barcoding, to be available in BOLD under sample IDs MRS_JFT0999 and MRS_JFT1000. A non-reared specimen in NMS from Poland has already been barcoded (sample ID in BOLD MRS_JFT0932).

Microgaster luctuosa. Nixon (1968, as *curvicrus*) gives *Agonopterix pallorella* (Zeller, 1839), which feeds mainly on *Centaurea*, as host stating that the larvae were collected in July with parasitoid adult emergence the following May. He also states that adults were swept commonly from broom (*Cytisus*) in June by R. L. E. Ford in S. England. I have examined the material in NHMUK corresponding to these data. In NMS the following reared specimens are present. 6♀, 2♂ from *Agonopterix arenella* ([Denis & Schiffermüller], 1775): 2♀, 1♂ on *Carduus/Cirsium* spp. (Edinburgh, M. R. Shaw), coll. vii, em. vii the following year; 1♀, 1♂ on *Centaurea* sp. (Anglesey, M. R. Shaw), coll. vii, em. vi the following year (one selected for barcoding, available in BOLD under sample ID MRS_JFT0765); 1♀ on *Centaurea nigra* (E. Lothian, E. C. Pelham-Clinton), coll. viii, em. vii the following year; 2♀ on *Arctium lappa* (W. Ross, M. R. Shaw), coll. vi, em. v/vi the following year; 1♀ from *Agonopterix heracliana* (Linneaus, 1758) on *Anthriscus sylvestris* (Cairngorms, J. R. Langmaid), coll. vii, em. vi the following year; 1♀ from *A. heracleana* [presumably on Apiaceae] (Fife, K. P. Bland), coll. vii, em. end vi the following year; 1♀ from *Agonopterix rotundella* (Douglas, 1846) [presumably on *Daucus*] (Cornwall, J. L. Gregory), coll. vii, em. not recorded; 2♀ from *Agonopterix* (as *Depressaria*) *scopariella* (Heinemann, 1870) on *Cytisus scoparaius* (Kent, J. M. Chalmers-Hunt), coll. vii, em.

'spring' the following year; 1♀, 1♂ from *Phycitodes* (as *Rotruda*) *saxicola* (Vaughan, 1870) (Pyralidae) [presumably in Asteraceae flowerhead] (Cumbria, L. T. Ford), coll. viii, em. iii (stated forced) the following year; 2♀, 1♂ from an uncertain microlepidopteron on *Melilotus altissimus* (S. Wiltshire, G. Smith), coll. date not recorded, em. mid v. the following year. In addition, 1♂ from *Agonopterix cachritis* (Staudinger, 1859) on *Smyrnium olusatrum* (Portugal, M. F. V. Corley), coll. iii, em. the following ii. Non-reared British material in NMS comprises 16♀, 6♂, collected in (v)vi–vii. The origin of the specimens from the unidentified microlepidopteron on *Melilotus altissimus* is at first sight puzzling, as little specialises on that plant apart from *Coleophora trifolii* (Curtis, 1832), which indeed was what Godfrey Smith (in litt.) had and was trying to rear. The *Microgaster* cocoons were recovered, without adjacent host remains although they were sought, loose among the foodplant. The most likely explanation is that *C. trifolii* (which is a relatively large species of the genus, quite large enough to support this parasitoid) was indeed the host and the parasitoid larvae, having completed their feeding, egressed from the *Coleophora* cases to make their cocoons externally, free of the constraint that might otherwise have compromised the emergence of the adult parasitoid – if so, perhaps an interesting example of foresight! At any rate, although clearly centred on *Agonopterix* species on field layer plants including Apiaceae and Asteraceae, the host repertoire of this species evidently extends beyond that, to include Lepidoptera in other families (i.e., it is a univoltine niche oligospecialist in the terminology of Shaw, 1997). I could find no consistent differences between the series reared from *Agonopterix* and non-*Agonopterix* hosts, though within each group the material is quite variable in respect of intensity of sculpture and the proportions of T2. According to Fernandez-Triana *et al.* (2020) Portugal is a new country record.

***Microgaster nervosae* sp. nov.** As stated above, it seems possible that Nixon (1968) had recognised a segregate that he called '*M. fulvicrus* var A' corresponding to this species (agreeing in all details given by Nixon except for the setosity of the median cell; though if this is correct it is strange that Nixon did not mention the obvious colour difference of the mid femora), but the seven female specimens he mentioned, from Ireland, could not be found in NHMUK. They were in any case not reared. There is, however, a male in NHMUK reared in England from *A. nervosa* (as *Depressaria costosa*) in 1955 but Nixon may not have examined this specimen as it was found by me only recently among unsorted material. The 19 reared specimens to hand (as fully listed above) are from *A. nervosa* (or *A. ?nervosa*) feeding on *Ulex europaeus* (14, five sites) and *Genista tinctoria* (5, one site), all collected in (v)vi(vii) and emerging the following v with the exception of one male that is labelled as emerging in vii in the year of collection and one female from the appreciably later-feeding *A. umbellana* on *U. europaeus*, collected in late vii and emerging the following v (at a site where *A. nervosa* was used more than a month earlier). These two rearings suggest either that there is a partial same-summer emergence and/or that the adult female of *M. nervosae* **sp. nov.** can live for at least a month, perhaps longer. I have not seen any reared from *Agonopterix scopariella* on *Cytisus scoparius* and indeed it was not reared from a large collection of this host made in Stirlingshire in mid-vi which (after deduction of other parasitoids) yielded 61 moths. I interpret *M. nervosae* **sp. nov.** as an essentially univoltine taxon oligospecialist (sensu Shaw, 2017) of only some *Agonopterix* species on Fabaceae. Three reared specimens from *A. nervosa* (Edinburgh) have been selected for barcoding, two of which are available in BOLD under sample IDs MRS_JFT0801, MRS_JFT0802 (the third, MRS_JFT0998, has not yet been sequenced).

Barcode distances of the three species parasitising *Agonopterix*

Based only on the specimens cited above that are already barcoded (*M. fulvicrus* MRS_JFT0932; *M. luctuosa* MRS_JFT0765; *M. nervosae* **sp. nov.** MRS_JFT0801 and MRS_JFT0802), *M. fulvicrus* has 4.8% bp difference from *M. luctuosa*, and 4.6% bp difference from *M. nervosae* **sp. nov.** The last two are the closest, with 4.0% bp difference. Similar, though slightly smaller, differences are seen from the much larger numbers of sequences under these species names available in BOLD, again showing *M. fulvicrus* to be the most separated, but I

have not examined the specimens (which were in any case not reared) and, moreover, those sequences suggest the possibility of a further species within specimens ascribed to *M. luctuosa* (investigation of which is beyond the scope of this paper).

From sequences available in BOLD these three species are assigned Barcode Index Numbers (BINs: Ratnasingham & Hebert, 2013) as follows. All sequenced *M. fulvicrus* belong to BIN BOLD:ACU0512; all *M. nervosae* to BIN BOLD:ACR4142; while those of *M. luctuosa* are divided between BIN BOLD:AEI4844 (most specimens) and BIN BOLD:AAH1056.

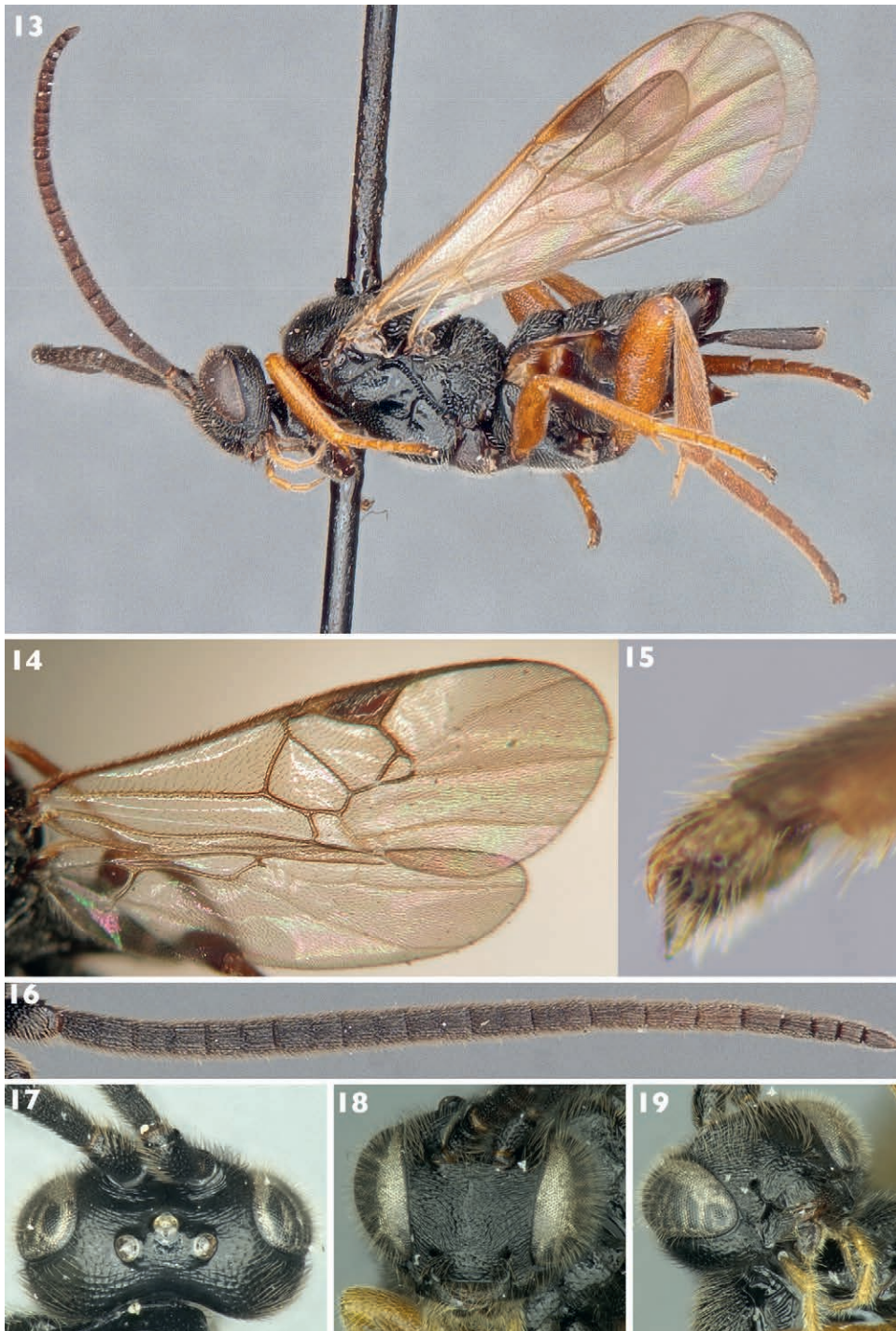### *Microgaster monetae* sp. nov.
(Figs 13–25)

I had for a long time failed to identity a female specimen of *Microgaster* in NMS reared as a solitary parasitoid in Austria by J. Connell from the plusiine noctuid *Polychrysia moneta*, suspecting it to be undescribed. Finding in BZL a good series of the same species from the same host, again from Austria (four sites), and a single reared female also from *P. moneta* from another locality (un-named, but probably at least collected by a German-speaker as the month is given 'Juli') among unsorted material in NHMUK, prompts me to describe it.

Diagnosis. It is difficult to give a suite of completely diagnostic characters, but in all keys to the European fauna it founders in various ways, running closest to species with which it doesn't compare, and I have been unable to find similar specimens among named material in museum collections. Face rugulose (upwards directed striation near eyes); antenna bristly, of female with preapical segment *ca* 1.3 times longer than wide; hind leg (after the trochanter), including tibial spurs and most of the tarsus, practically completely yellow/orange, tibial spurs long, claws evenly curved and simple (small spines present basally); metasoma dorsally completely black; hypopygium clearly creased in death; setose part of ovipositor sheath just over half as long as hind tibia.

Description
Holotype ♀, length (excluding ovipositor) 4.5 mm, of fore wing 4.6 mm. Head in dorsal view 1.9× wider than long, widest at eye, temple 0.8× as long as eye, roundly narrowing behind eye; OOL 1.8× and POL 2.2× diameter of posterior ocellus; tangent to posterior ocelli just cutting anterior ocellus; stemmaticum, posterior part of vertex and frons with coarse transverse rugae (but smooth between eye and posterior ocellus), weakly shining; face 1.3× wider than high, coarsely rugose centrally, with coarse (not finely vermiculate) striae sweeping upwards towards eye; clypeus rugose; anterior tentorial pits above lower level of eyes which are subparallel in lower half of face; malar space 0.6× basal width of mandible; antenna about as long as fore wing, flagellum bristly with preapical segments about 1.3× as long as wide, cylindrical. Mesoscutum only moderately shining, rugose-punctate anteriorly but becoming mostly smooth (setiferous punctate) in posterior 0.2, notaulic courses distinct as broad bands of weak transverse rugulose sculpture extending over 0.7 length of mesoscutum; prescutellar groove moderately deep and rather finely crenulate; scutellum rather smooth and shiny with minute setiferous punctures, strongest at sides; mesopleuron partly shining with precoxal area rather deeply indented with weakly differentiated sculpture, rugose-punctate anteriorly and below; metapleuron with upper division smooth and shiny, otherwise coarsely rugose; propodeum very coarsely rugose, with strong median longitudinal keel usually prominent. Fore wing with rather long setae in basal and subbasal cells fairly evenly distributed; pterostigma 2.7× longer than

Figs 13–19. *Microgaster monetae* sp. nov. female. **13,** habitus; **14,** wings; **15,** hind tarsal claw; **16,** antenna; **17,** head in dorsal view; **18,** face; **19,** face in anteroventral view.

deep, emitting almost straight r at 0.6 its length; metacarp about as long as pterostigma but its distal termination indistinct, attenuating from about 0.6× distance from pterostigma to apex of marginal cell; 1CU-1 1.7× (in holotype; but as little as 1.2× in some paratypes) longer than 1CU-2. Hind wing cubitellan cell about twice as long as high. Hind leg with coxa variably punctured and/or coriaceous below, narrowly smooth laterally and weakly punctate-rugose above; femur 3.6× longer than wide, shiny but rather coarsely rugose; tibia 1.2× longer than femur, evenly widening to apex and about 5.2× longer than its maximum width, inner spur much longer than outer and extending to 0.7 length of basitarsus; tarsus moderately robust, basitarsus about 4.2× longer than wide; claws simple. Metasoma with T1 and T2 coarsely rugose, T3 weakly rugulose over anterior 0.8 of tergite (sometimes less); T1 rather deeply excavate anteriorly and 0.7× as long as wide; T2 3.3–3.5× wider than long; T3 about 0.7–0.8× as long as T2; junction between T2 and T3 appearing deep and wide, crenulate (although actually it is part of T2); hypopygium tightly folded with creases, 0.7× as long as hind tibia, descending at about 60° but in most specimens appearing shortly attenuated at 40° owing to incurling of its posterior margin; setose part of ovipositor sheath just over half as long as hind tibia; ovipositor weakly downcurved, especially centrally.

Black (including tegula, humeral plate and almost entire mandible with only the extreme subapex brown); the three anterior sternites frequently mostly orange. All trochanters more or less brown and trochantelli brownish becoming orange distally; legs except coxae otherwise orange, including tibial spurs and claws, but with 5th tarsal segments and in hind leg most tarsal segments dorsally brownish. Palpi yellowish, sometimes blackish basally. Wing membrane somewhat yellowish, proximal venation yellow/orange, pterostigma brown.

Male. Like female except for sexual characters.

Variation. The extent of yellow/orange colour of the three most anterior sternites is variable in the preserved material to hand, but likely to be strongly evident in living specimens. Occasionally orange colouration is visible dorsally in unsculptured parts of the metasoma, such as the extreme margins of segment 2, but there is no extension onto sculptured parts. Sculpture of T3 rather variable in strength. In some specimens the hind femur is almost imperceptibly graded darker at the extreme apex.

MATERIAL EXAMINED
Holotype ♀ 'Lower Austria, Raglitz Polychrysia moneta 2006 J. Connell' (in NMS). Paratypes (5♀, 6♂, all in BZL unless otherwise indicated): 3♀, 2♂ Austria: Oberösterreich, Brettstein, *P. moneta* e. l. (F. Hofmann) Sengseng(eb). [Sengsengebirge is a mountain range] with emergence dates 2.vii.1984 (♂), 4.vii.1984 (♀, in NMS), 5.vii.1984 (♀), 9.vii.1984 (♂, in CNC) and 12.vii. 1984 (♀); 1♀ Austria: Oberösterreich, Alpkogel, 1500m, *P. moneta* e. l. (F. Hofmann); 1♂ Austria: Oberösterreich, Enns Au, *P. moneta* 9.vi.1937 (E. Kranzl); 3♂ Austria: Oberösterreich, Bad Ischl, Hohe Schrott, Kotalm, 1480m, N 47.72550 E 13.68650, *P. moneta*, emergence dates 5.vii.2004 (2♂, 1 in NMS) and 11.vii.2004 (1♂) (N. Pöll); 1♀ without locality or collector, but labelled '*Plus. moneta* 10. Juli' (NHMUK). None of the above specimens has been barcoded.

The host feeds on *Delphinium* and closely related field-layer Ranunculaceae (of high toxicity). The pure white cocoon is constructed inside a (normally yellow, at least initially) host cocoon formed on the foodplant that, in all cases seen, is substantially undersized, suggesting that the parasitoid had induced the host to prepare, an instar early, a structure analogous to its cocoon for normal pupation. The host remains within are also apparently penultimate instar. An alternative explanation could be that the parasitoid massively stunts the growth of the host through the normal number of its instars, but this seems much less probable. It is notable that *Microgaster* species, with an ectophagous final larval instar (illustrated by Shaw, 2004), can only effectively use hosts that rest or pupate in concealment; in this case in an apparently precocious cocoon induced by the presence of the parasitoid. Precocious prepupation by parasitized hosts is known

in a variety of situations, smetimes as a venom effect (e.g. Shaw, 1981) but it can occur also in groups such as the microgastroid-clade genus *Chelonus* Jurine, 1801 (pers. obs.) in which venoms seem unlikely to play a direct role.
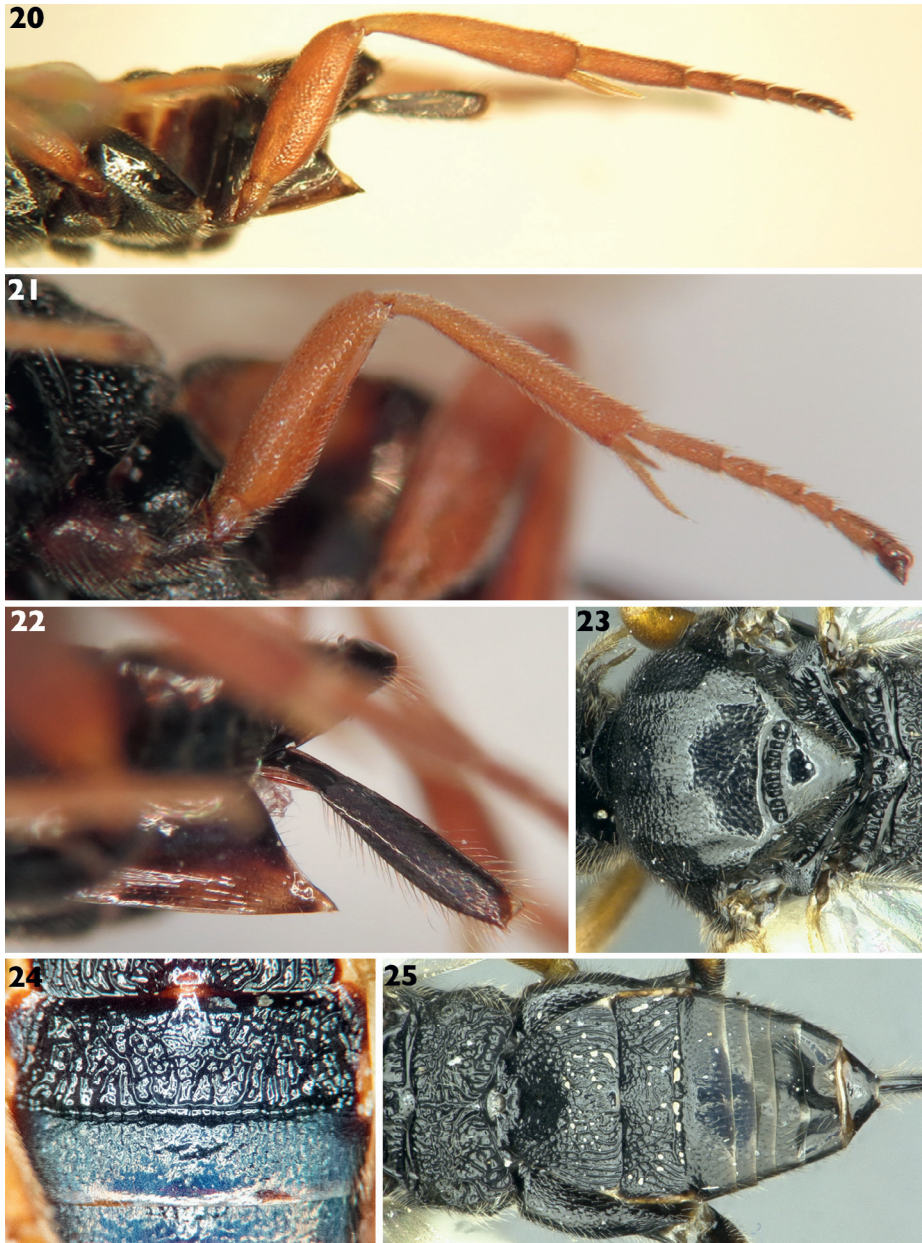
Figs 20–25. *Microgaster monetae* sp. nov. female. **20,** hind leg; **21,** mid leg; **22,** ovipositor sheath and hypopygium; **23,** mesoscutum and scutellum; **24,** second and third metasomal tergites; **25,** propodeum and metasoma.

Host repertoires of two European *Microgaster* species associated with Pyrginae (Hesperiidae)

Thanks to the kindness of several European Lepidopterists specializing in Hesperiidae, among others, the NMS collection includes many reared specimens of two species of *Microgaster* commonly parasitizing Pyrginae (but not other Hesperiidae) in Europe (neither occurs in Britain). One, *M. nobilis* Reinhard, 1880, appears from the material in NMS to be possibly specialised to the host group (a taxon oligospecialist sensu Shaw, 2017). The other species, *M. australis* Thomson, 1895, which is more widespread (Fernandez-Triana *et al.*, 2020), is represented by just a few rearings from other hosts developing under similar circumstances as well (making it a niche oligospecialist sensu Shaw, 2017). Both kill the host as a final instar larva or prepupa, in its retreat. Some of the data on both species have already been included by Shaw, Stefanescu & Nouhuys (2009) and by Toro-Delgado *et al.* (2022) (though in the latter paper only when the specimen or its host had been barcoded: an asterisk (⋆) is added in these cases to avoid double-scoring if records are abstracted). The sample ID codes are given in square brackets for specimens in NMS that have been barcoded and the sequence deposited in BOLD. It is of interest that, despite large overlaps in the host repertoires of these two *Microgaster* species, *M. nobilis* seems to be particularly associated with *Carcharodus* and the closely related *Muschampia* (feeding on respectively *Malvaceae* and *Lamiaceae*), while *M. australis* evidently also (and perhaps more frequently) parasitizes *Pyrgus*, *Spialia* and *Erynnis* species feeding on a wide range of Rosaceae. If real, these differing preferences may support the coexistence of the two species where they overlap spatially; whether or not it reflects an ancestry involving divergence of a nascent specialist is a question requiring a detailed phylogeny of *Microgaster* species.

Microgaster nobilis. Curiously, Nixon (1968) did not include this distinctive species in his key, but it is covered in later keys to European species (Papp, 1976; Tobias, 1986). It is easily recognised by its finely punctured shiny face; metasoma (beyond T1), hind femur and tibia largely orange; only weakly rugulose T2; and brownish wings.

Carcharodus alceae (Esper, 1780): 30 from 3 sites (France: Var, 28 from one intense survey (M. R. Shaw), Spain: Madrid (G. E. King, J. Hernández-Roldán [MRS_JFT0035]⋆)); *Muschampia baeticus* (Rambur, 1839): 7 from 5 sites (France: Bouches-du-Rhône (M. Albrecht [MRS_JFT0148]⋆), Vaucluse (M. Albrecht), Spain: Zaragoza (R. Vila, V. Dincyrgus & J. Hernández-Roldán⋆), Cáceres (J. Hernández-Roldán), Girona (T. Lafranchis)); *Muschampia proto* (Ochsenheimer, 1808): 3 from 2 sites (Spain: Zaragoza (G. E. King), Madrid (J. Hernández-Roldán)); *Pyrgus onopordi* (Rambur, 1839): 2 from 1 site (Spain: Madrid (J. Hernández-Roldán [MRS_JFT0033, MRS_JFT0034]⋆⋆)).

The rearing data include emergence periods soon after host collection through the summer, demonstrating plurivoltinism, and in one case emergence in mid-February from a cocoon formed in late autumn the year before, showing that the winter is passed as a cocooned stage. According to Fernandez-Triana *et al.* (2020) mainland Spain is a new country record, although the relevant specimens have been cited in Toro-Delgado *et al.* (2022).

Microgaster australis (=*deprimator* (Fabricius, 1798), misident.). This species is readily identifiable from Nixon's (1968) key.

Carcharodus alceae: 1 (Israel: Judea & Samaria (D. Benyamini)); *Muschampia baeticus*: 1 (Spain: Zaragoza (R. Vila & V. Dinca [MRS_JFT0246]⋆)); *Muschampia proto*: 2 from 2 sites (France: Pyrénées-Orientales (J. Hernández-Roldán [MRS_JFT0032]⋆), Spain: Segovia (J. Hernández-Roldán)); *Muschampia stauderi* (Reverdin, 1913): 64 from one intense survey (Greece: Kalymnos (M. Albrecht [MRS_JFT0313, MRS_JFT0314]⋆⋆)); *Muschampia tessellum*

(Hübner, 1803): 1 (Greece: Florina (J. Pateman [MRS_JFT0090]★) + 1 query this host or *M. hieromax* Hemming, 1832 (Israel: Upper Galilee (D. Benyamini [MRS_JFT0923, in prep.])); *Muschampia* sp. on *Marrubium*: 1 (Spain: Madrid (J. Hernández-Roldán)); *Spialia rosae* Hernández-Roldán, Dapporto, Dincă, Vicente & Vila, 2016: 1 (Spain: Granada (J. Hernández-Roldán [MRS_JFT0247]★)); *Erynnis tages* (Linnaeus, 1758): 1 (Austria: Niederösterreich (J. Connell [MRS_JFT0312]★)); *Pyrgus armoricanus* (Oberthür, 1910): 1 (Spain: Salamanca (J. Hernández-Roldán★)); *Pyrgus malvoides* (Elwes & Edwards, 1897): 3 from 3 sites (France: Hautes-Alpes (T. Lafranchis [MRS_JFT0113]★), Var (P. & B. Kan [MRS_JFT0204]★), Spain: Avila (J. Hernández-Roldán★)); *Pyrgus onopordi*: 3 from 2 sites (France: Hérault (T. Lafranchis [MRS_JFT0115]★), Spain: Cáceres (A. Blásquez)); *Pyrgus serratulae* (Rambur, 1839): 1 (Spain: Salamanca (J. Hernández-Roldán)); *Pyrgus* sp. on *Potentilla asturica*: 2 from 2 sites (Spain: Avila★, Salamanca (both J. Hernández-Roldán)); ?*Agonopterix* sp. on *Centaurea*: 2 from 1 site (France: Hautes-Alpes (M. R. Shaw)).

The last rearing was from cocoons collected in folds on the foodplant: host remains were present and seem to be compatible with *Agonopterix* (or a tortricid) but certainly not with Hesperiidae. In addition, in NMS there are a few non-reared specimens from France and Hungary, some collected in sites such as reedbeds where Pyrgini seem unlikely to have been present. Emergence dates are throughout the summer, always within a small number of weeks following collection, demonstrating plurivoltinism. The data do not indicate the means of overwintering, but it is likely to be as a cocooned stage. According to Fernandez-Triana *et al.* (2020) France and Israel are new country records, although the relevant specimens from France have been cited in Toro-Delgado *et al.* (2022).

These two *Microgaster* species commonly reared from Pyrginae do not appear to be very closely related (at least 6% bp differences in barcodes) but, even within specimens reared from Pyrginae, apparent *M. australis* includes several strongly divergent hapolotypes that may indicate a species-complex (Toro-Delgardo *et al.*, 2022).

Acknowledgements

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