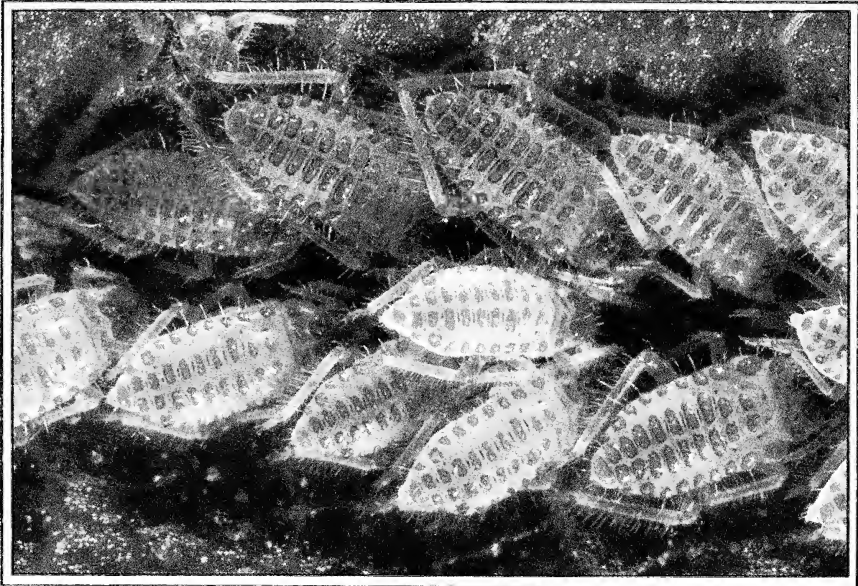


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THE EFFECT OF MOTH TRAP TYPE ON CATCH SIZE AND COMPOSITION IN BRITISH LEPIDOPTERA

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ABSTRACT

Light trapping is a common method for collecting flying insects, particularly Lepidoptera. Many trap designs are employed for this purpose and it is therefore important to know how they differ in their sampling of the flying insect fauna. Here we compare three Robinson-type trap designs, each of which employs a 125W mercury vapour bulb. The first uses a standard bulb; the second uses the same bulb with the addition of a Pyrex beaker, often deployed to prevent bulbs from cracking in the rain, and the third uses a bulb coated with a substance that absorbs visible wavelengths of light (also known as a black light). The black light trap caught fewer moths than either of the other traps, and had lower macromoth species richness and diversity than the standard + beaker trap. This lower species richness could be accounted for by the smaller number of moths caught by the black light trap. Furthermore the black light caught a different composition of both species and families to the other two trap types. Electromagnetic spectra of the three trap types showed the black light trap lacked peaks in the visible spectrum present in both of the other traps. We therefore conclude that the addition of a beaker to a Robinson-type trap does not make catches incomparable, but use of a black light does. These differences are probably due to lower total emission of radiation in the black light trap, thus catching fewer moths overall, and the lack of visible radiation produced, meaning that moths most sensitive to visible wavelengths are not attracted.

INTRODUCTION

Light trapping has long been used as a method for collecting Lepidoptera for a variety of purposes, from biodiversity monitoring (Conrad *et al.*, 2006) to pest detection (Hendricks *et al.*, 1975). In recent years the analysis of long-term light trapping datasets has revealed drastic declines in many species of British moth (Conrad *et al.*, 2006). With such a wide range of uses it is important to know what affects the catch of a moth trap.

A variety of factors are known to affect the numbers and identities of moths caught in a trap. The phase of the moon affects the catch, as does the temperature and degree of cloud cover (Yela & Holyoak, 1997). These factors are not generally under the control of the person carrying out the survey and cannot be manipulated directly. Those which can be controlled include the placement and design of the trap. The height of the trap above the ground can affect the catch (Baker & Sadovy, 1978), but the majority of traps are set at, or near to, ground level. Perhaps the single most important feature is that of trap design.

A wide range of designs are currently used (Muirhead-Thomson, 1991) making comparisons between studies problematic. The Rothamsted trap has an incandescent

tungsten filled 200W bulb and often uses a killing jar as the receptacle for insects. The Robinson trap, on the other hand, uses a mercury vapour bulb, and insects are kept alive. The portable Heath trap uses a low wattage strip light and can therefore be run from a car battery (Majerus, 2002). Black lights, which emit predominantly ultraviolet wavelength light, can be used in a variety of traps where light pollution may be an issue, or where the target group is attracted mainly to those wavelengths. Taylor and French (1974) found that a Robinson-type trap caught four times as many moths as a Rothamsted-type trap, demonstrating the large effect trap type can have on catch size. The use of planes of material in proximity to the light source (baffles) to intercept insects is also common (Southwood, 1987). Yela and Holyoak (1997) claim that the most important factor affecting catch size is that of light intensity, with more moths being caught at higher intensities. But this cannot be the only important factor as Williams (1951) found that a 125W ultraviolet bulb caught greater numbers of moths than a 200W standard bulb. Blomberg *et al.* (1976) showed that a black light trap caught fewer moths than a mercury vapour light trap, but there is no mention of the locations of the two traps being rotated between nights, and the black light bulb was considerably less powerful (125W) than the mercury vapour light bulb (160W). So the wide range of trap designs employed is likely to catch differing samples of moths. To our knowledge there is no study which assesses the efficiency of commonly used Robinson-type traps with different bulb set-ups.

This study compares three such trap set-ups. All three traps are of Robinson-type and use three pin bayonet fitting 125W mercury vapour bulbs (supplier: Watkins and Doncaster Entomological Suppliers). One uses a standard bulb only (standard, S), one uses a standard bulb with the addition of a Pyrex beaker to protect it from cracking in the rain (standard + beaker, Bk), and one uses a standard 125W mercury vapour black light bulb (black light, Bl). This consists of a standard bulb coated with a substance which absorbs most visible wavelengths, as supplied by Watkins and Doncaster Entomological Suppliers. We hypothesise that the reduction in visible wavelengths in the black light treatment may reduce catch, while the addition of a beaker might either absorb certain wavelengths, thus reducing the catch, or act as a baffle increasing the catch.

METHODS

Study site

The three traps were placed in an equilateral triangle of side 4.5m by the weather station of Juniper Hall Field Centre, adjacent to a field and also to the field centre gardens. While the close proximity of the traps probably led to some mixing of the moths attracted to the different lights this meant that we could be confident that the same moth community was being sampled by all three traps. They were run for six nights between 20.00 BST and 06.00 BST from 29 June to 4 July 2001. The traps were not run on the night of 1 July. The traps were rotated each night to control for any effects of position on moth catch. Although the traps were run for only a short period of time we feel that since the traps were all in close proximity, observed differences were due to trap design rather than trap location (we were unable to test for this due to small sample size). The weather was warm and dry during the study period with a daytime maximum temperature range of 21.4°C–28.5°C and a night time minimum range of 10.6°C–15.1°C. Cloud cover at 09.00 BST ranged from 0/10 to 8/10 and the total rainfall for the period was 0.6mm.

Identification

Macrolepidoptera were identified to species using Skinner (1998). Microlepidoptera were identified to family using Chinery (1993) and Goater (1986). Note that the micromoth family Pyralidae is employed *sensu lato* to include the subfamilies Pyralinae, Pyraustinae and Crambinae (Goater, 1986).

Statistical methods

Differences across trap types in total moth abundance and macromoth species richness per trap were tested using ANOVA. Moth abundance was logged as population processes are inherently multiplicative (Ian Woiwod, pers.com.). Logged moth abundance was included as a covariate in the analysis of species richness. All residuals were normally distributed with homogeneous variances. Tukey's pairwise comparisons were used to compare individual trap types with each other. Diversity was calculated using Fisher's α (Fisher *et al.*, 1943) as this index is not biased by small sample size and has good site discriminant ability when used on light trap macrolepidoptera data (Taylor *et al.*, 1976). The index was calculated for the accumulated data for each trap type as this helps to reduce biases caused by small sample size. Fisher standard errors for the diversity index were calculated analytically for the accumulated data (Taylor *et al.*, 1976; Magurran, 1988). Pairwise differences in diversity were tested using t-tests (assuming unequal variance). Differences in family composition across the three trap types were tested using chi-square tests on the data summed across all six nights, with an initial test across all three trap types being followed by pairwise tests between trap types. Less abundant families were collapsed into "other" for these tests to avoid expected values less than five. EstimateS 7.5 was used to calculate Fisher's α and its standard error (Colwell, 2004). The ordination technique Detrended Correspondence Analysis (DCA) was used to assess differences in family composition and macrolepidoptera species composition. Species occurring in only a single trap on a single night were excluded from these ordination analyses. Minitab 13.31 was used for all statistical analyses with the exception of the ordinations, which were carried out in Community Analysis Package 1.50.

Electromagnetic Spectra

300-850nm electromagnetic spectra of all three traps were taken using a UV/visible spectrometer in order to relate differences in the wavelengths of emitted light to their moth catches. Total radiation emitted across all wavelengths was calculated by summing the area beneath the spectra.

RESULTS

Abundance, species richness and diversity

In total 4168 moths were caught in the three traps over six nights. These consisted of 689 macromoths (eight families, 95 species, see Appendices 1 and 2) and 3479 micromoths (five families, see Appendix 2). Fewer moths were caught in the black light trap than in either of the other traps (Fig. 1a, ANOVA: $F_{2,15} = 18.05$, $P < 0.001$, Tukey's pairwise comparisons: S-BI, $P = 0.002$; S-Bk, $P = 0.290$; BI-Bk, $P < 0.001$). There was no difference in the numbers of macromoths caught by the different trap types (Fig. 1b, ANOVA: $F_{2,15} = 3.54$, $P = 0.055$), although the trend was similar to

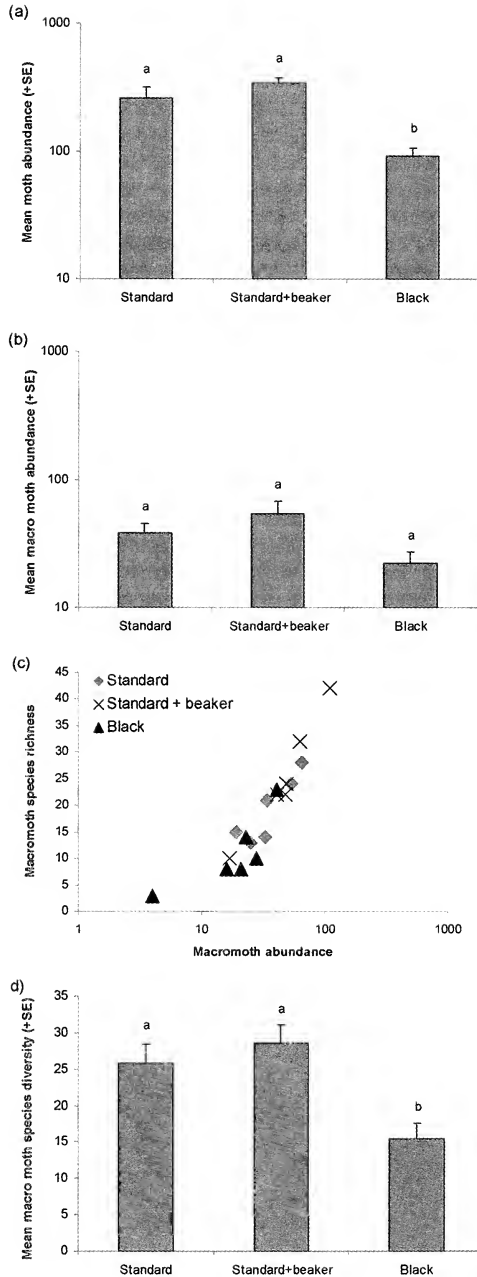


Fig. 1. Comparisons between the three trap types of: (a) total moth abundance, (b) macromoth abundance, (c) macromoth species richness in relation to macromoth abundance, (d) macromoth species diversity (Fisher's α index). Different letters indicate significantly different means.

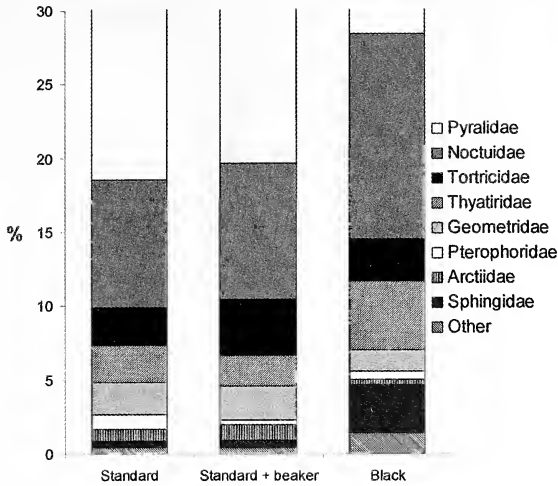


Fig. 2. Relative abundances of moths of different families found in the three trap types summed over all six nights. Note that the y-axis ends at 30%, as the majority of moths caught in all three trap types were pyralids. Families with less than ten individuals in total were summed as "other". These were: Coleophoridae, Drepanidae, Hepialidae, Notodontidae and Tischeriidae.

that seen for total moth abundance. Absolute macromoth species richness was higher in the standard + beaker trap than in the black light trap, while the standard trap did not differ in species richness from either of the other two trap types (ANOVA: $F_{2,15}=4.63$, $P=0.027$, Tukey's pairwise comparisons: S-BI, $P=0.227$; S-Bk, $P=0.414$; BI-Bk, $P=0.022$). But once macromoth abundance had been taken into account macromoth species richness did not differ among trap types (Fig. 1c, ANCOVA: $F_{2,14}=0.91$, $P>0.05$, see Appendix 1 for details of the species caught). The macromoth diversity (Fisher's α) was lower in the black light trap than that in both the standard trap and the standard + beaker trap, while the diversity of the standard and standard + beaker traps did not differ (Fig. 1d, T-tests: S-BI, $t=7.30$, d.f. = 10, $P<0.001$; S-Bk, $t=1.86$, d.f. = 10, $P=0.090$; BI-Bk, $t=9.67$, d.f. = 10, $P<0.001$).

Family and species composition

The representation of the moth families differed across the three trap types ($\chi^2=96.1$, d.f. = 16, $P<0.001$, Fig. 2, see Appendix 2 for family abundances). The catch of the black light trap differed from that of the other two trap designs (S-BI, $\chi^2=58.5$, d.f. = 8, $P<0.001$; BI-Bk, $\chi^2=68.4$, d.f. = 8, $P<0.001$), while those of the other two trap designs were not different (S-Bk, $\chi^2=14.3$, d.f. = 8, $P=0.075$). There was a greater proportion of sphingids, thyatirids and noctuids, and a smaller proportion of pyralids in the black light trap. The high proportion of pyralids caught in all trap types was due mainly to large numbers of grass moths (i.e. *Crambus* spp.). These differences in family composition are also clearly shown in the ordination. The

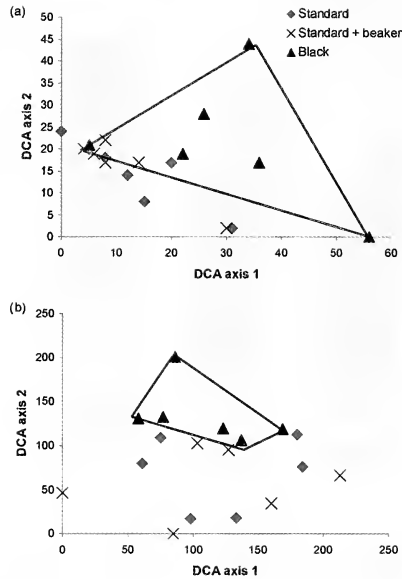


Fig. 3. Ordinations (DCAs) of: (a) family composition and (b) macromoth species composition. Points in close proximity represent traps with a similar moth community, while those far apart represent those with a dissimilar moth community. Polygons show the distribution of the black light trap points. Families and species represented at only one trap on only one night were excluded from the analyses.

points representing black light trap catches cluster in the upper right of the plot (with the exception of a single point) showing that the family composition of this trap differs from that of the other two trap types (Fig. 3a). The family compositions of the standard and standard + beaker traps are similar, as shown by overlapping sets of points representing the catches of these two trap types. The different trap types show a similar pattern to that seen at the family level in terms of macromoth species composition (Fig. 3b). Here the black light catch is completely distinct from the catches of the other two trap types, which are again similar to one another. A Venn diagram of the macromoth species caught in the three trap types shows that the majority of species caught were present either in the standard trap or the standard + beaker trap or both (Fig. 4).

Electromagnetic spectra

The electromagnetic spectra from the standard and standard + beaker traps both show a single peak in the ultraviolet region at 366nm and then further large peaks in the visible region at 405nm, 436nm, 546nm, 578nm and 618nm with a smaller peak on the border of the visible and infrared regions at 698nm (Fig. 5). The spectrum for the black light shows only the 366nm peak in the ultraviolet region, all other peaks being absent. The total amount of radiation emitted was similar for the standard trap and the standard + beaker trap at $0.206\mu\text{W}/\text{cm}^2$ and $0.253\mu\text{W}/\text{cm}^2$ respectively, and considerably less for the black light trap at $0.012\mu\text{W}/\text{cm}^2$.

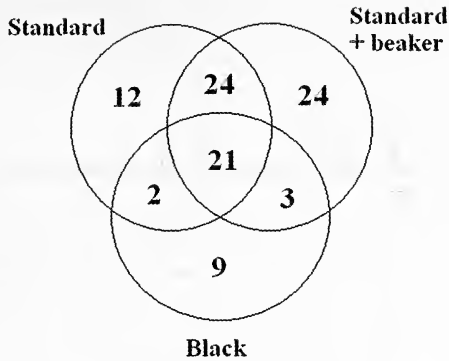


Fig. 4. Venn diagram showing macromoth species caught in the three trap types.

DISCUSSION

The black light trap caught fewer moths overall, catching only 36% and 27% of the numbers caught in the standard and standard + beaker traps, respectively. There were also fewer macromoth species and a lower macromoth diversity in the black light trap compared to the standard + beaker trap. The smaller number of species in the black light trap is what would be expected if one was sampling fewer individuals from the same population as the other two traps. But this does not explain the differences between catches entirely as the black light trap caught a different set of species and families from the other two trap types. So not only will the use of a black light trap give fewer moths, but it gives a different impression of the moth community. Furthermore, out of the 95 species of macromoth caught in total only nine were unique to the black light trap and all of these were singletons. Therefore the use of a black light in place of a standard mercury vapour bulb does not catch extra species of macromoth, but instead catches a characteristic subset of those species caught using the standard set-up.

Is it possible to explain the differences observed in terms of the electromagnetic spectra of the different bulbs? The addition of the beaker does not change the spectrum of the bulb, and this is reflected in the fact that no differences were observed in abundance, species richness, or composition between the standard trap and the standard + beaker trap. Nor does it seem to act as a baffle, although there is a non-significant increase in the overall moth catch of 32% ($P=0.29$). It is possible that the small catch size of the black light trap is partly due to the reduction in total radiation emitted, as found by Yela and Holyoak (1997). But the difference in community composition between the black light trap and the other two traps, particularly with respect to the pyralids, indicates that the black light is attracting a particular subset of the taxa found in those two traps. Hendricks *et al.* (1975) found that some noctuid pests preferred fluorescent black lights while others preferred green lights, so this is not without precedent. One possibility is that those moths most sensitive to visible wavelengths of light are not attracted to the black light trap.

Certain wavelengths repel some species, as may be the case with the sphingids in this study. There were a greater number of them in the black light trap than the other two traps, indicating that perhaps the visible light emitted by the other traps deters

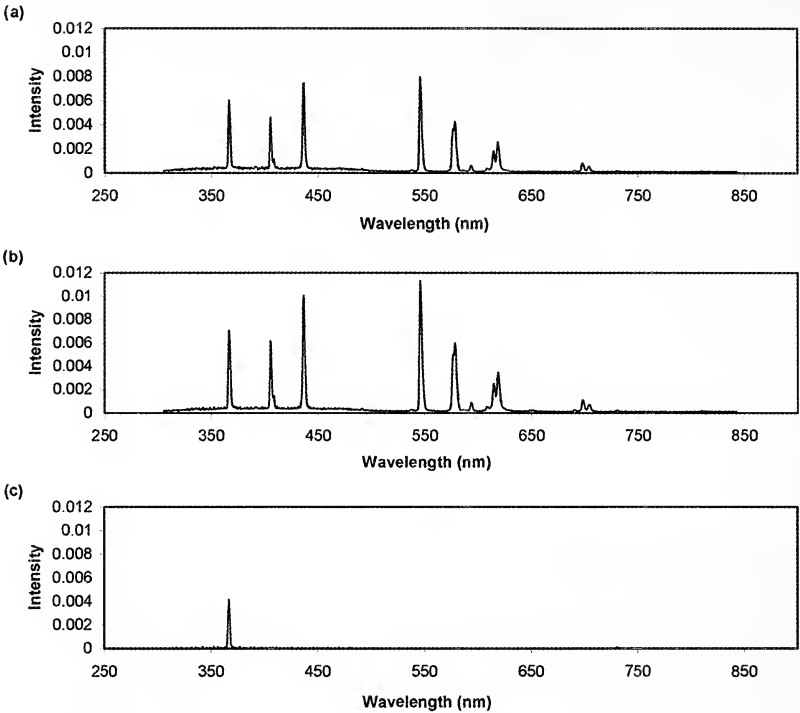


Fig. 5. Electromagnetic spectra (300–850nm) of (a) standard trap, (b) standard + beaker trap and (c) black light trap. This range includes ultraviolet radiation (200–380nm), visible light (380–750nm) and infrared radiation (750nm and above). The unit of intensity is $\mu\text{W}/\text{nm}/\text{cm}^2$.

them from entering. Hsiao (1972) has shown that when moths approach very close to a bright light source they are often repelled by it, so this explanation seems likely. It is possible that each species has sets of wavelengths to which it is most attracted or repelled.

In conclusion, the addition of a beaker to a standard Robinson-type trap does not affect the moth catch significantly, whereas painting the bulb with a visible light-reducing coating reduces the total moth catch and macromoth species richness and diversity, catching only a subset of the moths caught by the other two traps. Observation of electromagnetic spectra in relation to this suggests that species respond in different ways to certain wavelengths of light, with species attracted by visible light not being present in the black light trap. Comparative studies of such responses, in conjunction with studies of the species' ecology may shed light on the unsolved mystery of why moths are attracted to light.

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Appendix 1. Macromoth species caught summed over all six nights

		Standard	Standard	Black
			+ beaker	
Hepialidae				
<i>Hepialus humuli</i> (L.)	Ghost Moth	3	1	1
<i>Hepialus lupulinus</i> (L.)	Common Swift	0	1	0
Thyatiridae				
<i>Habrosyne pyritoides</i> (Hufn.)	Buff Arches	38	35	26
<i>Tetheella fluctuosa</i> (Hb.)	Satin Lutestring	0	1	0
<i>Thyatira batis</i> (L.)	Peach Blossom	1	6	0

Appendix 1. (Continued)

		Standard	Standard + beaker	Black
Drepanidae				
<i>Drepana falcataria</i> (L.)	Pebble Hooktip	0	1	0
Geometridae				
<i>Alcis repandata</i> (L.)	Mottled Beauty	1	3	0
<i>Apeira syringaria</i> (L.)	Lilac Beauty	1	1	0
<i>Biston betularia</i> (L.)	Peppered Moth	2	4	1
<i>Campaea margaritata</i> (L.)	Light Emerald	6	8	0
<i>Camptogramma bilineata</i> (L.)	Yellow Shell	0	1	0
<i>Chloroclysta truncata</i> (Hufn.)	Common Marbled Carpet	1	1	0
<i>Cidaria fulvata</i> (Forst.)	Barred Yellow	1	0	0
<i>Epirrhoe rivata</i> (Hb.)	Wood Carpet	0	0	1
<i>Eulithis pyraliata</i> (D. & S.)	Barred Straw	0	3	0
<i>Eulithis testata</i> (L.)	The Chevron	1	0	0
<i>Eupithecia pimpinellata</i> (Hb.)	Pimpernel Pug	1	1	0
<i>Eupithecia satyrata</i> (Hb.)	Satyr Pug	0	1	0
<i>Eupithecia subfuscata</i> (Haw.)	Grey Pug	0	0	1
<i>Eupithecia succenturiata</i> (L.)	Bordered Pug	0	3	0
<i>Eupithecia tantillaria</i> Boisid.	Dwarf Pug	1	2	1
<i>Eupithecia tenuiata</i> (Hb.)	Slender Pug	0	1	0
<i>Eupithecia valerianata</i> (Hb.)	Valerian Pug	1	0	0
<i>Eupithecia venosata</i> (Fabr.)	Netted Pug	1	0	0
<i>Eupithecia vulgata</i> (Haw.)	Common Pug	0	1	0
<i>Hemithea aestivaria</i> (Hb.)	Common Emerald	0	0	1
<i>Horisme tersata</i> (D. & S.)	The Fern	0	2	0
<i>Idaea aversata</i> (L.)	Riband Wave	6	3	1
<i>Idaea biselata</i> (Hufn.)	Small Fan-footed Wave	2	0	1
<i>Idaea dimidiata</i> (Hufn.)	Single-dotted Wave	1	2	0
<i>Idaea straminata</i> (Borkh.)	Plain Wave	1	0	0
<i>Idaea trigeminata</i> (Haw.)	Treble Brown Spot	0	2	0
<i>Lomasipilis marginata</i> (L.)	Clouded Border	1	2	0
<i>Lomographa temerata</i> (D. & S.)	Clouded silver	1	0	0
<i>Melanthia procellata</i> (D. & S.)	Pretty Chalk Carpet	1	0	1
<i>Pasiphila rectangulata</i> (L.)	Green Pug	1	0	0
<i>Peribatodes rhomboidaria</i> (D. & S.)	Willow Beauty	2	4	0
<i>Philereme vetulata</i> (D. & S.)	Brown Scallop	0	1	0
<i>Xanthorhoe fluctuata</i> (L.)	Garden Carpet	0	1	0
Sphingidae				
<i>Deilephila elpenor</i> (L.)	Elephant Hawk-moth	2	4	2
<i>Deilephila porcellus</i> (L.)	Small Elephant Hawk-moth	2	1	6
<i>Laotioe populi</i> (L.)	Poplar Hawk-moth	0	2	2
<i>Mimas tiliae</i> (L.)	Lime Hawk-moth	0	1	1
<i>Smerinthus ocellata</i> (L.)	Eyed Hawk-moth	0	0	1
<i>Sphinx ligustri</i> (L.)	Privet Hawk-moth	3	2	6
Notodontidae				
<i>Notodonta dromedarius</i> (L.)	Iron Prominent	0	1	0
<i>Stauropus fagi</i> (L.)	Lobster Moth	1	3	1

Appendix 1. (Continued)

		Standard	Standard + beaker	Black
Arctiidae				
<i>Eilema lurideola</i> (Zink.)	Common Footman	0	4	0
<i>Spilosoma lubricipeda</i> (L.)	White Ermine	2	3	0
<i>Spilosoma luteum</i> (Hufn.)	Buff Ermine	8	11	2
<i>Tyria jacobaeae</i> (L.)	The Cinnabar	2	4	0
Noctuidae				
<i>Abrostola tripartita</i> (Hufn.)	The Spectacle	1	1	2
<i>Acronicta leporina</i> (L.)	The Miller	1	1	0
<i>Acronicta psi</i> (L.)	Grey Dagger	0	1	0
<i>Agrotis clavis</i> (Hufn.)	Heart and Club	14	21	8
<i>Agrotis exclamationis</i> (L.)	Heart and Dart	41	54	30
<i>Apamea lithoxyla</i> (D. & S.)	Light Arches	7	7	6
<i>Apamea monoglypha</i> (Hufn.)	Dark Arches	9	12	7
<i>Apamea remissa</i> (Hb.)	Dusky Brocade	0	0	1
<i>Autographa gamma</i> (L.)	Silver Y	1	0	0
<i>Autographa pulchrina</i> (Haw.)	Beautiful Golden Y	2	3	0
<i>Axylia putris</i> (L.)	The Flame	3	0	0
<i>Blepharita adusta</i> (Esp.)	Dark Brocade	1	0	0
<i>Charanyca trigrammica</i> (Hufn.)	Treble Lines	1	2	0
<i>Craniophora ligustri</i> (D. & S.)	The Coronet	1	6	2
<i>Diachrysis chrysitis</i> (L.)	Burnished Brass	1	6	0
<i>Diarsia mendica</i> (Fabr.)	Ingrailed Clay	0	0	1
<i>Euxoa nigricans</i> (L.)	Garden Dart	1	3	2
<i>Hada plebeja</i> (L.)	The Shears	0	4	1
<i>Herminia grisealis</i> (D. & S.)	Small Fan-foot	1	2	0
<i>Hoplodrina blanda</i> (D. & S.)	The Rustic	3	7	8
<i>Hypena proboscidalis</i> (L.)	The Snout	6	10	0
<i>Lacanobia oleracea</i> (L.)	Bright-lined Brown-eye	1	1	0
<i>Lacanobia w-latinum</i> (Hufn.)	Light Brocade	0	0	1
<i>Laspeyria flexula</i> (D. & S.)	Beautiful Hooktip	0	2	0
<i>Lygephila pastinum</i> (Treit.)	The Blackneck	0	1	0
<i>Melanchra persicariae</i> (L.)	Dot Moth	3	2	0
<i>Melanchra pisi</i> (L.)	Brom moth	0	2	0
<i>Mesapamea secalis</i> (L.)	Common Rustic	0	0	1
<i>Mythimna comma</i> (L.)	Shoulder-Striped Wainscoat	1	1	3
<i>Mythimna ferrago</i> (Fabr.)	The Clay	2	0	0
<i>Mythimna impura</i> (Hb.)	Smokey Wainscot	11	10	0
<i>Mythimna obsoleta</i> (Hb.)	Obscure Wainscoat	0	0	1
<i>Mythimna pallens</i> (L.)	Common Wainscot	1	4	0
<i>Noctua pronuba</i> (L.)	Large Yellow Underwing	3	5	0
<i>Ochropleura plecta</i> (L.)	Flame Shoulder	3	3	0
<i>Oligia strigilis</i> (L.)	Marbled Minor	9	12	2
<i>Photedes minima</i> (Haw.)	Small Dotted Buff	0	1	0
<i>Polia trimaculosa</i> (Esp.)	Silvery Arches	0	1	0
<i>Protodeltote pygarga</i> (Hufn.)	Marbled White-spot	0	1	0
<i>Pseudoips prasinana</i> (L.)	Green Silver Lines	0	1	0
<i>Rivula sericealis</i> (Scop.)	Straw Dot	3	7	0
<i>Rusina ferruginea</i> (Esp.)	Brown Rustic	1	0	0
<i>Xestia c-nigrum</i> (L.)	Setacious Hebrew Character	0	2	0
<i>Xestia triangulum</i> (Hufn.)	Double Square-spot	2	3	1
Total abundance		229	327	133
Total species richness		59	72	35

Appendix 2. Numbers of individuals of each moth family caught summed over six nights

	Standard	Standard + beaker	Black
Hepialidae	3	2	1
Thyatiridae	39	42	26
Drepanidae	0	1	0
Geometridae	33	47	8
Sphingidae	7	10	18
Notodontidae	1	4	1
Arctiidae	12	22	2
Noctuidae	134	199	77
Coleophoridae	3	2	4
Pterophoridae	16	6	3
Pyralidae	1266	1646	397
Tischeriidae	0	0	2
Tortricidae	40	78	16
Totals	1554	2059	555

SHORT COMMUNICATION

Physatocheila smreczynskii China (Hemiptera: Tingidae) in the Tamar Valley of Cornwall and Devon. – The apple-tree lacebug has a very restricted distribution across the southern English counties. It has been known in Devon for some time – ‘not common’ (Bignell, 1906) – but no details of the old Devon records have yet been found and there appear to be no subsequent records. The discovery of a population at Slew Orchard, Sydenham Damerel (SX4074), 23.viii.2004, is therefore worth reporting. This orchard is predominantly old cherries but also includes a few old apple trees. Another population was found on a group of three remnant old orchard apple trees at Haye Farm, Bohetherick, St Dominick (SX4167), in East Cornwall, 20.vii.2006.

In both cases the lacebugs were associated with a very small number of apple trees. The St Dominick area has many other remnant orchards but no other populations could be found. Similarly in south Devon in 2004, two other areas of apple orchards failed to produce any lacebugs. This suggests that the species is capable of surviving on small groups of old apple trees but is of very restricted occurrence and relatively immobile – it appears not to readily colonise other apple trees even when relatively close by. The St Dominick site is the second known from Cornwall (Alexander, 2005).

The Slew survey was part of a wider English Nature commissioned project on orchard wildlife, while the St Dominick work was part of a survey of the National Trust's Cotehele Estate. There is now a Tamar Orchards project. The increasing interest in the conservation of traditional orchards is good news. – KEITH N.A. ALEXANDER, 59 Sweetbrier Lane, Heavitree, Exeter EX1 3AQ.

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**THE PLATANUS LACE BUG, *CORYTHUCHA CILIATA* (SAY)
(HEMIPTERA: TINGIDAE), A NEARCTIC PEST OF PLANE TREES,
NEW TO BRITAIN**

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ABSTRACT

In September and October 2006, *Corythucha ciliata* (Say) was reported in Bedfordshire. This is the first record of this Nearctic tingid in Britain. It was causing feeding damage to imported London plane (*Platanus × hispanica*) and Oriental plane (*P. orientalis*) trees at two commercial plant nurseries, and to mature plane trees (*Platanus* sp.) growing in adjacent hedgerows. It has been introduced to several other European countries where it has become an important pest of plane trees. In northern Italy *C. ciliata* can cause decline and death of trees in combination with two fungi, *Ceratocystis fimbriata* Ellis & Halsted f.sp. *platani* Walter and *Apiognomonina veneta* (Sacc. & Speg.) Höhn.. The host range, biology, geographical distribution and economic importance of *C. ciliata* are reviewed.

INTRODUCTION

The Plant Health and Seeds Inspectorate (PHSI) of the Department of Environment, Food and Rural Affairs (Defra) inspected a commercial plant nursery, East of Bedford, Bedfordshire on the 28th September 2006. Inspectors collected leaf mine samples from Oriental plane *Platanus orientalis* L. (Platanaceae) trees imported from France and submitted them to the Central Science Laboratory (CSL) for diagnosis. The leaf mines were caused by the larvae of *Phyllonorycter platani* (Staudinger) (Lepidoptera: Gracillariidae), an introduced species that has become naturalised in southern England since 1989 (Emmet, 1991). Also present in the samples were fourth and fifth-instar lacebug nymphs, suspected to be *Corythucha ciliata* (Say) (Hemiptera: Tingidae). This was confirmed by rearing the nymphs to adulthood in quarantine at the Central Science Laboratory under licence (No. PHL 251C/5482/C09/2006), which took three days at 21.5°C. The Plant Health & Seeds Inspectorate reinspected the nursery on the 6th and 10th October 2006 and found large numbers of *C. ciliata* nymphs and adults causing chlorosis, in some cases severe, to the foliage of over one hundred *P. orientalis* and London plane (*Platanus × hispanica* Muenchh.) trees (up to 7 m tall) imported from France, and on mature plane (*Platanus* sp.) trees (up to 15 m tall) growing in a hedge approximately 50 metres from the nursery. A second commercial nursery was visited in Bedfordshire on the 11th October and *C. ciliata* nymphs and adults were found on *Platanus* spp. imported from Italy and on six-year-old *Platanus* trees grown at the nursery from cuttings. This is the first time that *C. ciliata* has been found in Britain. The presence of this new pest was publicised by Defra (Malumphy *et al.*, 2006) and by a special interest group (Malumphy & Reid, 2006). The purpose of this communication is to publish collection details for the first time and review the host range, biology, geographical distribution and economic importance of *C. ciliata*.

Corythucha ciliata is commonly known as the 'sycamore lace bug' in North America (Halbert & Meeker, 1998), where *P. orientalis* is known as American sycamore. However, the name sycamore lace bug could be confusing in Britain, as it does not feed on sycamore (*Acer pseudoplatanus* L.). 'Platanus lace bug' would be a

more accurate designation in the UK and be consistent with the common names used in Europe, for example in Austria and Germany, 'Die Platanen Netzwanze' (Billen, 1985; Hopoltseder, 1984; Hopp, 1984), France, 'Le tigre du platane' (D'Aguilar *et al.*, 1977; Anon., 1986), Italy, 'La tingide del platana' (Arzone, 1975) and Spain, 'tigre del platano' (Serra Planas, 1982).

Adult (Fig. 1) specimens of *C. ciliata* have been deposited at the Central Science Laboratory, the Natural History Museum, London (BMNH), the Hungarian Museum, Glasgow and National Museum Wales, Cardiff.

DETECTION AND IDENTIFICATION

Adults and nymphs of *C. ciliata* feed on the underside of leaves causing chlorosis and desiccation of tissue (Fig. 2), first near the veins, and subsequently affecting the entire leaf, which may drop prematurely (Maceljski & Balarin, 1973; Venturi, 1976; Chauvel, 1988). Heavy infestations cause conspicuous chlorosis, which is easily observed some distance away from the infested tree (PHSI, pers. comm., 2006). The tingids also produce droplets of liquid frass, which dry out as black spots on the lower surface of the leaves (Fig. 3); the leaves are also covered in nymphal skins, which have remained attached to the leaf after moulting (Chauvel, 1988).

The eggs are elliptical, brown, with a lighter operculum; 0.5 mm long by 0.2 mm wide; laid in groups of 3–8 in the angles of the main vein on the undersides of the leaf (Maceljski & Balarin, 1974; Hopoltseder, 1984). There are five nymphal stages (Horn *et al.*, 1979). The nymphs (Fig. 4) are dorso-ventrally flattened, oval in shape, black and spiny. The adult bodies are almost black in colour but this is hidden beneath a grey/cream net or lace-like structure on the upper surface (Figs. 1 and 5). They attain a length of 4 mm; the females are slightly larger than the males.

Detailed morphological descriptions of the adult are given by Maceljski & Balarin (1972, 1974) and are illustrated by Maceljski & Balarin (1974), Tomic & Mihajlovic (1974), D'Aguilar *et al.* (1977), Hopoltseder (1984), Gessler & Mauri (1987) and Chauvel (1988). The fifth instar nymph is described and keyed out by Horn *et al.* (1979). Maceljski & Balarin (1974) describe all developmental stages.

For practical purposes, the association with *Platanus* should be diagnostic for this species in Britain as no other tingid species feed on this genus in Britain.

GEOGRAPHICAL DISTRIBUTION

Corythucha ciliata is of North American origin and occurs in the eastern USA and southern Canada (Baker, 1972; Halbert & Meeker, 1998). It was accidentally introduced into Europe being first recorded in Padova, Italy in 1964 (Arzone, 1975). It has since spread throughout Italy (Battisti & Giulini, 1983; Marletto & Menardo, 1984; including Sicily, Hoffmann, 1978), and Austria (Hopoltseder, 1984; Zukrigl & Hobaus, 1989), Bulgaria (Josifov, 1990), Croatia (Maceljski & Balarin, 1972, 1973), France (D'Aguilar *et al.*, 1977; D'Aguilar, 1982; Duverger, 1983; Anon., 1986; Chauvel, 1988; Decoin, 2006), Germany (Hopp, 1984; Billen, 1985; Heckmann & Rieger, 2001; Hoffmann, 2003), Greece (Tzanakakis, 1988), Hungary (FAO, 1977; Saly & Ripka, 1989), Russia (Voigt, 2001; Gninenko & Orlinskii, 2004), Serbia (Tomic & Mihajlovic, 1974; Vasic, 1975), Slovenia (Maceljski & Balarin, 1972), Spain (Gil Sotres & Mansilla Vazquez, 1981) and Switzerland (Maceljski & Balarin, 1972; Gessler & Mauri, 1987; Wyniger, 2003).

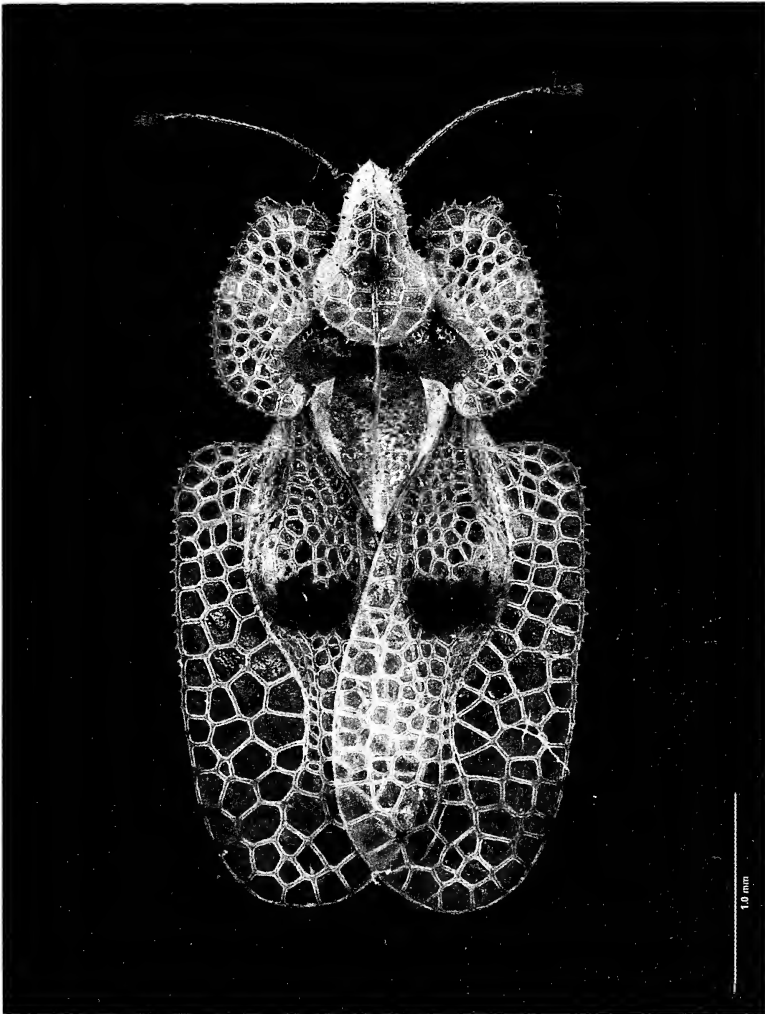


Fig. 1. *Corythucha ciliata* adult (Photo: James Turner of the National Museum Wales).

It has recently been introduced to Asia: China (Streito, 2006), Japan (Tokihiko *et al.*, 2003) and South Korea (Chung *et al.*, 1996;); and South America: Chile (Prado, 1990).

HOST PLANTS, BIOLOGY AND NATURAL ENEMIES

The preferred host of *C. ciliata* is reported to be *P. occidentalis* (Maceljski & Balarin, 1972, 1973; Rogers *et al.*, 1982; Halbert & Meeker, 1998) and in southern Europe it is also commonly found on *P. × hispanica* (= *P. × acerifolia* Willd.)



Fig. 2. *Corythucha ciliata* feeding damage to upper surface of leaf (CSL).

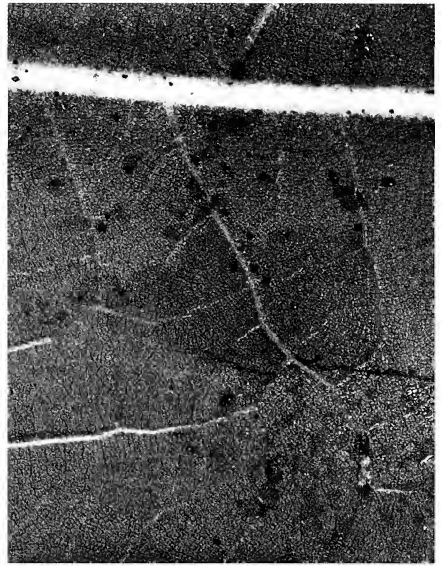


Fig. 3. *Corythucha ciliata* frass deposited on lower leaf surface (CSL).

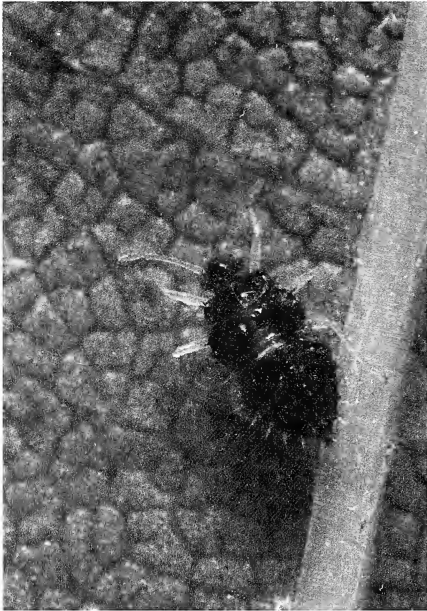


Fig. 4. *Corythucha ciliata* nymph (CSL).



Fig. 5. *Corythucha ciliata* adult (CSL).

(Balarin, 1972, 1973; FAO, 1977; Maceljski & Rogers *et al.*, 1982; Hopoltseder, 1984; Battisti *et al.*, 1985). Other *Platanus* hosts include *P. orientalis* L. (Maceljski & Balarin, 1972; Battisti *et al.*, 1985), *P. racemosa* Nutt. (Rogers *et al.*, 1982) and *P. wrightii* S. Wats. (Rogers *et al.*, 1982).

Several other host plants are listed in the literature, including *Broussonetia papyrifera* (L.) L'Hér. ex Vent. (Moraceae) (Rogers *et al.*, 1982; Halbert & Meeker, 1998), *Carya ovata* (Mill.) K. Koch (Juglandaceae) (Baker, 1972; Rogers *et al.*, 1982; Halbert, & Meeker, 1998), *Chamaedaphne* sp. (Ericaceae) (Rogers *et al.*, 1982; Halbert & Meeker, 1998), *Fraxinus* sp. (Oleaceae) (Baker, 1972; Rogers *et al.*, 1982; Halbert & Meeker, 1998), *Morus* sp. (Moraceae) (Baker, 1972) and *Quercus laurifolia* Michx. (Fagaceae) (Baker, 1972).

The biology and ecology of *C. ciliata* has been studied in France (Chauvel, 1988), Korea (Park *et al.*, 1999), Hungary (Oszi *et al.*, 2006) and Italy (Venturi, 1976; Battisti *et al.*, 1985). *Corythucha ciliata* adults overwinter under loose bark, leaf litter and crevices, and tolerate extreme temperatures as low as -30°C (Chauvel, 1988). The exfoliation of the outer bark, especially in *P. \times hispanica*, may be determinant in the successful use of Platanaceae by *C. ciliata*. Overwintering occurs, by preference and often in large dense aggregations, under exfoliated bark platelets *in situ* (Paul F. Whitehead, pers. comm., 2007). The adults congregate on the developing leaves in the following spring. The females deposit up to 350 eggs on the lower surface of the leaves, (D'Aguilar *et al.*, 1977), with an average of 100 eggs per female (Battisti *et al.*, 1985). Nymphs stay close together at first, only moving to new leaves after they reach the fourth instar. In the south of France it takes 43 to 56 days to complete the life cycle, and in Italy just 29 to 36 days (Chauvel, 1988); two or three generations can occur each year. In Italy, the eggs of the first generation are laid at the end of April or beginning of May, those of the second at the end of June or beginning of July, and the third in August-September (Venturi, 1976). The optimum temperature for egg and nymph development was estimated to be 25°C in Korea, and the longevity of adults were 41 days and 37 days for females and males, respectively (Park *et al.*, 1999).

Maceljski (1986) reported that the adults are good fliers, whereas Wade (1917) reported that the wings of the adults are very delicate, and they rarely fly very far; however, supported by wind they can be blown over many kilometres. Both authors suspect that human activity is the main cause of its spread over long distances.

Twenty-eight species of natural enemies of *C. ciliata* have been recorded in Italy (Travella & Arizone, 1987).

ECONOMIC IMPORTANCE

Infestations of *C. ciliata* on *Platanus* can cause severe chlorosis, partial defoliation, reduction in growth and thinning of fronds (Venturi, 1976; Chauvel, 1988), particularly in young trees (Maceljski, 1986). Damage is most noticeable on plane trees planted for ornamental purposes in parks and urban areas and increases through the year from July to September (Battisti *et al.*, 1985). Several consecutive years of severe lace bug damage, combined with other stress factors, may kill the trees. Damage is more severe during dry weather. In northern Italy, the lace bug in combination with two fungi, *Ceratocystis fimbriata* Ellis & Halsted f.sp. *platanii* Walter (Ascomycetes: Ceratocystidaceae) and *Apiognomonina veneta* (Sacc. & Speg.) Höhn. (Ascomycetes: Valsaceae), can cause decline and death of trees (Anselmi *et al.*, 1994). The former fungus is a quarantine-listed pest in the EU and the latter is native to the UK. It is suspected that the lace bugs may serve as vectors for these fungi.

Although *C. ciliata* has been found feeding on other host genera in the USA, it has not been recorded damaging these plants.

Corythucha ciliata is also reported to be a major public nuisance as large numbers of *C. ciliata* land on people in parks and open-air cafes in southern Europe. They may also invade homes in large numbers (Maceljski, 1986) and have even occasionally been reported 'biting' humans (Venturi, 1976).

CONCLUSIONS

Corythucha ciliata has been introduced into the UK on imported plane trees from either or both of Italy and France. The presence of this pest in northern France (Decoin, 2006) suggests that it will be able to naturalise and spread in Britain. The extent of the infestations at the nurseries where the pest was first discovered and the presence of the pest on trees off the nursery premises indicates that it is likely to have been present for more than one season and thus may have already been transported to new locations by trade.

The size of some of the trees being imported into the UK and the scale of the trade make it very difficult for the Plant Health & Seeds Inspectorate to conduct effective inspections of these plants. Not all trees, which are moved between EU member states with a plant passport, such as *Platanus* sp., are inspected by the PHSI and the current inspection regime is probably inadequate to prevent further introductions. The import of large trees from southern Europe is likely to continue to provide a pathway for the introduction of other non-native plant pests into Britain. For example, the American oak lace bug, *Corythucha arcuata* (Say), was introduced into Italy in 2000 and spread to Switzerland in 2001/2002 (Forster *et al.*, 2005) and is likely to spread within Europe both naturally and over large distances by trade. This oak pest is on the European and Mediterranean Plant Protection Organisation (EPPO) alert list.

Any suspected findings of non-indigenous insects on recently imported plants should be passed to the local Defra PHSI or to the Plant Health & Seeds Inspectorate Headquarters, York (Tel.: 01904 455174, email: planthealth.info@defra.gsi.gov.uk).

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**TWO SPECIES OF THRIPS (THYSANOPTERA) NEW TO BRITAIN,
 NEOHEEGERIA DALMATICA SCHMUTZ AND
 FRANKLINIELLA PALLIDA (UZEL), WITH AN UPDATED KEY
 TO THE BRITISH SPECIES OF FRANKLINIELLA KARNY**

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ABSTRACT

Two species of thrips are each reported for the first time in Britain. The first, *Neoheegeria dalmatica* Schmutz (Phlaeothripidae), was found on *Stachys byzantina* Koch at two locations during 2007, initially in a domestic garden in York in June, and then again in July, in a domestic garden in Ashford, Kent. The second, *Frankliniella pallida* (Uzel) (Thripidae), was collected from *Sedum acre* L. at Denham, Buckinghamshire, in July 2006. Information on the identification and biology of these species is provided, along with an updated key to the British species of *Frankliniella*.

NEOHEEGERIA DALMATICA

A well established clump of lamb's ear, or lamb's tongue, *Stachys byzantina* Koch (Lamiaceae), in a domestic garden in Rawcliffe, York, was noted to be infested with adult phlaeothripid thrips. Specimens were first collected by the author on 03.vi.07 and four females and three males slide-mounted. These were identified as *Neoheegeria dalmatica* Schmutz (Thysanoptera: Phlaeothripidae) using information, and a key, provided by Minaei *et al.* (2007), and the identification was subsequently confirmed after comparison with specimens of this species supplied by Bert Vierbergen of the Plant Protection Service, the Netherlands. Further specimens, male and female, were subsequently collected from the plants at intervals.

Alerted by the above finding, a colleague of the author examined the single *S. byzantina* plant at his daughter's garden in Willesborough, Ashford, Kent, on 19.vii.07 (R. P. Hammon). This, too, was found to be infested with *N. dalmatica*. Three of the twelve flower heads (the upper whorls only) were brought back to the laboratory and from these 37 adults and 94 first-instar larvae were extracted. These thrips were also collected from an established plant, one that was already present in the garden before the present occupants moved into the house in 2005. No other member of the Lamiaceae was present in the garden.

The host plants in the garden in York had been purchased as young plants and planted out between 2002 and 2004 (Heather Johnson, *pers. comm.*); the original four plants have subsequently developed into a conspicuous grouping with 40+ stalks. The thrips were initially all located at the base of the developing flower spikes, but on later occasions were seen crawling across the whole flower heads. Thrips were only occasionally seen on the leaves. Numbers increased over the course of several weeks, with several hundred adults present on the clump of lamb's ear on 23.vi.07; adults were still present in large numbers on the plants on 05.vii.07, this despite several intervening periods of sustained and, at times, very heavy rain in a very wet June. Mating behaviour was observed a number of times between 23.vi.07 and 05.vii.07 with one adult dorsally mounting the length of the other and the two then bringing their tubes alongside for no more than 4–5 seconds at most, before disengaging. A

small number of eggs were first noted at the base of the flower heads, on the lower whorls, on 01.vii.07. These were oval-cylindrical, cream to pale-orange in colouration, apparently lacking sculpture on the surface, and approximately 0.425×0.175 mm in size. On the plants, the eggs looked as if they were simply held in place by the tangled downy matrix, but closer examination of an egg under a high-power microscope revealed the presence of a small pedicel at one end suggesting that these were probably glued to the plant as is found in other phlaeothripids (Lewis, 1973). One flower head (the upper whorl only) was removed to the laboratory on 02.vii.07 and kept inside a Universal tube in an incubator at $22^{\circ}\text{C} \pm 1$. Within 48 hours live larvae were seen and after a further five days the tube was washed out with alcohol and 93 larvae were recovered. Only three eggs had been visible on the outer surfaces of the flower head, indicating that the majority of the eggs had been deposited deep in the downy matrix, presumably as protection from predators. Outdoors, first-instar larvae were first seen on the plants on 07.vii.07, but only small numbers were ever seen and later instars were never found. The last sighting of thrips on the plants was that of a single adult and two larvae on 24.vii.07. The rest of the plants in the garden were searched at intervals but *N. dalmatica* remained restricted to the *S. byzantina* plants. Only one other member of the Lamiaceae was present in the garden, a solitary mint plant, *Mentha* sp. No related plants were visible in adjacent gardens.

Following a recent redefinition of the genus *Neoheegeria*, which has restricted the taxon to just four species (Minaei *et al.*, 2007), it seems clear that the genus is primarily associated with the flowers of Lamiaceae. *Neoheegeria dalmatica* is found on downy plants in the genera *Phlomis* and *Stachys*, with records from *S. byzantina* recorded by Pelikan (1995) (as *N. hammani* Priesner), Mantel & Vierbergen (1996) and Vierbergen (2001). The species' range is primarily across the southern Palearctic, at warmer latitudes, from Spain to Azerbaijan, although Fauna Europaea (<http://www.faunaeur.org/>) records the species from France, Germany, the Netherlands and Poland. The species has apparently only been recorded twice in the Netherlands, once in 1967 and once at the beginning of this decade (Mantel & Vierbergen, 1996; Vierbergen, 2001). The Dutch cases were both associated with swarming behaviour by the thrips, in one case with large numbers found overwintering behind wallpaper in a domestic living room. No hint of swarming behaviour can be attached to the British findings.

The fact that the two British populations were found so far apart, in each case on well established plants, suggests that *N. dalmatica* is likely to be established here. Vierbergen, however, has suggested that the species would not be able to survive in the Netherlands without a means of overwintering under protected conditions, such as within heated buildings. Here the thrips were highly visible on the plants, not least because of the numbers present. Thrips were not noticed on the plants in previous years, although in the York case the householder is a keen gardener. Nevertheless, it remains possible that the thrips were present, possibly in lower numbers, and were introduced with one or more of the plants; but this would have required the population to have survived at least three winters. Lamb's ear is commonly grown in British gardens, and is also present across the country as a garden escape. Together, with other potential hosts in the Lamiaceae, this provides a reservoir of plants from which these particular infestations might have originated, although the precise date of introduction (natural or mediated by man) can only be a matter of conjecture. Whether the species will be found on the same plants in future years, or indeed elsewhere in Britain, remains to be seen.

Neoheegeria dalmatica is a medium to large brown haplothripine species (Fig. 1), with four sense cones on antennal segment IV, a well developed maxillary bridge, and medially constricted forewings with duplicated cilia. However, unlike members of the genus *Haplothrips*, the species has three strong sense cones on antennal segment III (*Xylaplothrips subterraneus* (Crawford) [treated as *Haplothrips subterraneus* Crawford in Mound *et al.*, 1976], which similarly has three sense cones on antennal segment III is restricted to lily bulbs and is only present on the British list due to the quarantine interception, by the United States, of the type series on exported British bulbs). It may additionally be characterised by the presence of the following characters: predominantly brown antennal segments, although many specimens have patches of yellow diffusing upwards into the brown from the bases of segments III–VI; long, pale, pointed postocular setae; well developed, long or moderately long, pale, pointed major setae on the pronotum (anteromarginals, anteroangulars, midlaterals, epimerals, and posteroangulars); maxillary stylets widely separated in the head; clear wings, apart from at the base, where three long, pale pointed setae are set in a triangular rather than linear arrangement; brown mid- and hind-tarsi; a normally-sized fustis; no development of metathoracic sternopleural sutures extending backwards from the mid-coxal cavities. The females mostly lack a fore tarsal tooth, although a few individuals were found to have a very small tooth on one or both tarsi. In the male, the fore tarsal teeth are well developed (there is variable allometric growth with some individuals displaying both larger fore femora and larger fore tarsal teeth). The male pseudovirga is slender, but widened at the apex to give a clasper-like effect. No other phlaeothripid is associated with *S. byzantina*. The first-instar larva is pale with light brown sclerotisation on the antennae, thorax, legs and abdominal segments IX–X (Fig. 2).

FRANKLINIELLA PALLIDA

Seven adult female and one adult male *Frankliniella pallida* (Uzel) (Thysanoptera: Thripidae) were collected from flowers of biting stonecrop, *Sedum acre* L. (Crassulaceae), growing on small patches of wasteland near to a small car park at Denham Quarry, Denham, Buckinghamshire, on 19.vi.06. The species determination was made using keys by Vierbergen (1995) and Strassen (2003), and after comparison against specimens of *F. pallida* and other species in the collections of the Natural History Museum, London (NHM). *Thrips tabaci* Lindeman and *T. fuscipennis* Haliday were also beaten from the same plants.

Frankliniella pallida is a flower thrips feeding on pollen, found across continental Europe and further east to Kazakhstan and Iran (Strassen, 2003). It has also been recorded from Tunisia (Nakahara, 1997) and China (Feng, 1992). One specimen held by the NHM is labelled as having been collected from Siberia without more specific location details (*Polygala sibirica*, 18.viii.1928, O. Skolop). The species is polyphagous, with records from the following plant genera: *Helianthemum* (Asteraceae); *Brunellia* (Brunelliaceae); *Dianthus* (Caryophyllaceae); *Sedum* (Crassulaceae); *Dipsacus* (Dipsacaceae); *Lotus*, *Genista*, *Ononis*, *Trifolium* (Fabaceae); *Thymus* (Lamiaceae); *Polygala* (Polygalaceae) (specimen collection labels, NHM, London; Bagnall, 1934; Mound, 1968). However, Vierbergen (1995) notes that the preferred host in the Netherlands is *S. acre*.

Nakahara (1997) recorded 159 species in the genus *Frankliniella*, the majority of which are found in the New World. *Frankliniella pallida* is one of just four species found naturally in Europe (the others being *F. intonsa* (Trybom), *F. nigriventris* (Uzel) and *F. tenuicornis* (Uzel)); a further three species are synanthropic, introduced



Figure 1. *Neoheegeria dalmatica*, adult male.



Figure 2. *Neoheegeria dalmatica*, first-instar larva.

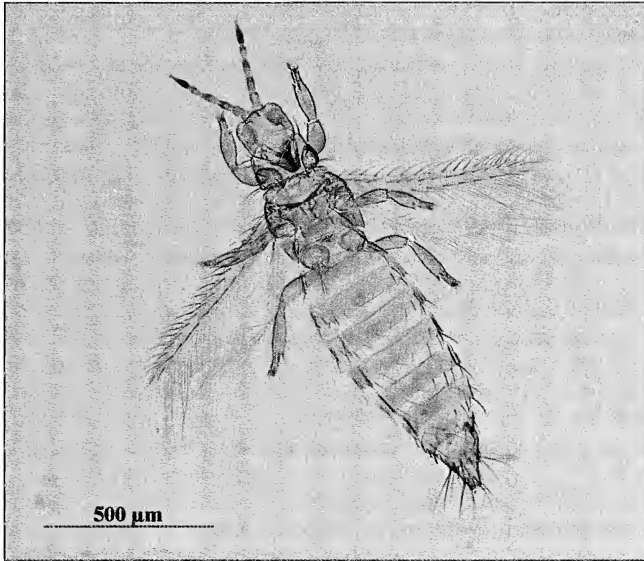


Figure 3. *Frankliniella pallida*, adult female.

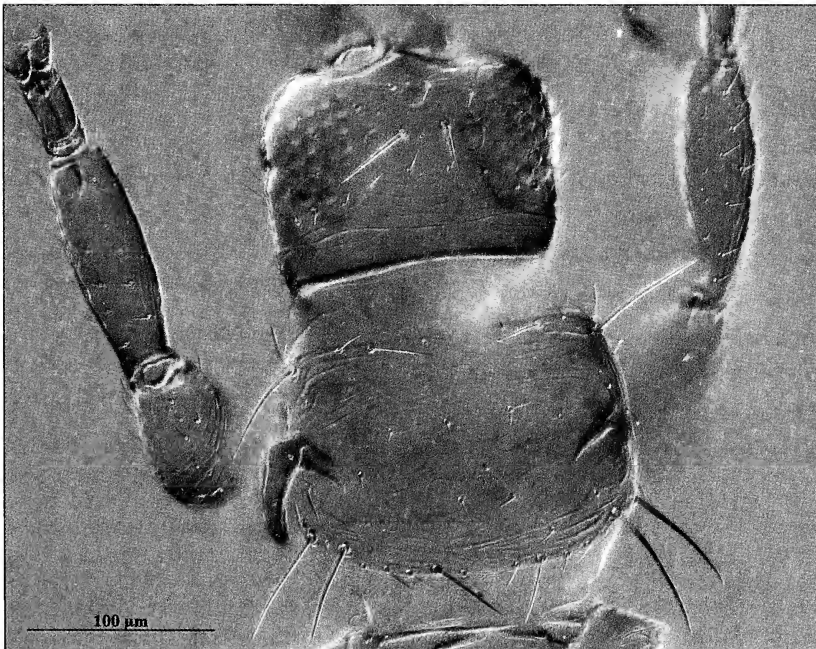


Figure 4. *Frankliniella pallida*, chaetotaxy of the head and pronotum.

species associated with commercial horticulture (*F. fusca* (Hinds), *F. occidentalis* (Pergande) & *F. schultzei* (Trybom)).

Frankliniella pallida is a predominantly pale yellow species with light brown patches on the abdominal tergites (Fig. 3). Strassen (2003) notes that occasionally the head and thorax are yellow brown, or the abdomen is brown. Of the other *Frankliniella* species recorded from Britain, *F. intonsa* and *F. tenuicornis* are both predominantly brown in colouration, making them visually distinct from the paler *F. pallida* even in the field. *Frankliniella schultzei* is restricted to quarantine interceptions and unlikely to be encountered in the wild (Collins, 2006). In Britain, *F. pallida* is most likely to be compared with the introduced pest species, *F. occidentalis*, even though that species is confined to protected cultivation. The latter is, however, widely distributed in commercial glasshouses, and has been occasionally found outdoors in the immediate vicinity of glasshouses in the summer months. There is no documentary evidence that *F. occidentalis* has survived and persisted outdoors in Britain independent of a protected environment and such a finding would be of considerable interest to agricultural scientists (e.g., see McDonald *et al.*, 1997). The two species can be separated by differences in the chaetotaxy of the head and pronotum as described below in the key.

Frankliniella pallida is not the only species in the genus to have been introduced to Britain since the publication of the key to British species of thrips in the relevant Royal Entomological Society handbook (Mound *et al.*, 1976); *Frankliniella occidentalis* was first introduced to British commercial glasshouses in 1986 (Baker *et al.*, 1993). An updated key to the species of *Frankliniella* recorded from Great Britain is therefore presented below. Mound *et al.* (1976) regarded *Iridothrips iridis* (Watson) as an aberrant species of *Frankliniella* and included it in their key for the British *Frankliniella*. This was not generally accepted and current practice (e.g., Strassen, 2003) is to treat *Iridothrips* as a valid genus, although Mound (2002) argues that the two species in the genus, *I. iridis* and *I. mariae* Pelikan are probably not closely related at all. *Iridothrips iridis* is included in the key below in order to allow it to be used as a continuation from the generic key for the Thripidae presented in the RES Handbook.

KEY TO THE SPECIES OF *FRANKLINIELLA* FOUND IN BRITAIN

1. Internal furca of mesothorax without a median spinula; sense cone on antennal segment III simple; ♀ usually micropterous, ♂ always micropterous; metanotal median setae slim, no more than half as long as the metanotum; tergites sculptured between median pair of setae; head strongly prolonged in front of eyes *Iridothrips iridis* (Watson)
In leaf sheaves of Iris pseudacorus.
- Internal furca of mesothorax with a median spinula; sense cone on antennal segment III forked; both ♀ and ♂ always macropterous; metanotal median setae three-quarters the length of the metanotum; tergites not sculptured between median setae. **2. (British species of *Frankliniella*)**
2. Metanotum without campaniform sensillae **3**
- Metanotum with two campaniform sensillae. **5**
3. Head relatively long, clearly projecting forwards (but by no more than the length of the diameter of an ocellus) between anterior margin of eyes and the base of the antennae; female body colouration dark brown, male paler; antennal segments III–IV pale, V uniformly dark; posterior margin of abdominal

- segment VIII with an irregular comb of broadly-based, but very short, microtrichia. *tenuicornis* (Uzel)
Relatively common and widespread; in grasses.
- Head not extended so in front of the eyes 4
4. Ocellar setae III placed well in front of a line joining the anterior margins of the posterior ocelli; posterior margin of abdominal segment VIII with the comb present and developed medially in the female, comb absent in the male; base of sense cone on antennal segment VI normal; female body colouration brown, male paler; antennal segments III-IV and at least the base of V pale *intonsa* (Trybom)
Relatively common and widespread; polyphagous, in flowers.
- Ocellar setae III located close together (placed apart about four times the diameter of one of the setal bases) and placed on, or just behind, a line joining the anterior margins of the posterior ocelli; posterior margin of abdominal segment VIII with sparse, short, microtrichia in the lateral thirds only, or the comb absent; base of sense cone on antennal segment VI enlarged, more oval than circular (can be difficult to see); female body colouration brown or pale *schultzei* (Trybom)
Species found around the world but with a very restricted distribution in Europe; in Britain, commonly intercepted on imported cut flowers; only one female ever found in Britain outdoors (Pinus, Berkshire, 1914).
5. Postocular seta S4 about three times the length of the other postocular setae and nearly as long as ocellar setae III; pronotal anteromarginal setae nearly as long as the anteroangular setae; usually four minor setae between the anteromarginal setae (occasionally 2 or 3); female of adventive form usually with dark yellow/orange head and thorax, and brown abdomen *occidentalis* (Pergande)
The 'western flower thrips'; first introduced into Britain in 1986, now commonly found in commercial glasshouses, particularly those growing ornamental flowers; polyphagous, in flowers.
- Postocular seta S4 sometimes a little longer than the other postocular setae but at most about twice as long, clearly shorter than ocellar setae III; pronotal anteromarginal setae much shorter than the anteroangular setae, about half as long (Fig. 4); two minor setae between the anteromarginal setae; female predominantly pale with light brown patches on the abdominal tergites *pallida* (Uzel)
Known from one population (Sedum acre flowers, Denham, Buckinghamshire, 2006).

DISCUSSION

This paper records the first British findings of two species of thrips known from continental Europe, *Frankliniella pallida* and *Neoheegeria dalmatica*. Because the distribution of British, and indeed European, thrips records is heavily influenced by the collecting activities of a very small number of researchers, it is difficult to draw hard conclusions from isolated records as to the current distribution of more rarely collected species, and the nature and speed of their spread. Nevertheless, both species here were found on the host plants with which they are particularly associated in the Netherlands (albeit with only two records in the case of *N. dalmatica*), where the nearest continental geographic records are to be found. It is reasonable to predict that *F. pallida* will be found more widely, at least in southern England. The (relatively) high visibility of *N. dalmatica* on *S. byzantina* in domestic gardens should

mean that entomologists alerted by this paper will soon be able to confirm, or refute, the suggestion that the species is established in Britain.

Voucher specimens of both *F. pallida* and *N. dalmatica* have been deposited in the collections of the NHM, London, and the Central Science Laboratory (CSL), York.

ACKNOWLEDGEMENTS

The author is grateful to Roger Hammon for locating the second population of *N. dalmatica*, to Jon Martin for allowing access to the collections at the NHM, London, to Bert Vierbergen for the loan of specimens of *Neoheegeria dalmatica*, and to Dan Pye (CSL) for the photography.

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MOTHS WHICH HAVE COLONIZED THE ISLE OF WIGHT IN RECENT YEARS (PART 2)

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INTRODUCTION

Since the previous paper (Knill-Jones, 1998) a further seventeen species of moths (twelve micros and five macros) have colonized the Isle of Wight bringing the total number of Lepidoptera recorded from the Island to more than 500. Details of their establishment, dates, localities and abundance are given here. Records for the Microlepidoptera have been extracted from Langmaid & Young (1998–2006). During the last ten years the Island has experienced milder winters and warmer summers as has been the trend in the previous two decades giving further evidence for global warming.

These conditions have been conducive to the spread of rapidly colonising species. However, it is probable that more species with localised distribution have disappeared due to habitat changes and that the total number present on the Island may have declined.

ECTOEDEMA HERINGELLA MARIANI (NEPTICULIDAE)

On 3.ii.07 D.T.B. examined a previously uninspected plantation of holm oak, *Quercus ilex* on the Osborne House estate on the Island and was surprised to find that every leaf of every tree was affected by the upper surface corridor mines of this moth. The identity of the causer was confirmed by Dr J.R. Langmaid. Later that month it was clear that the rest of the Osborne estate holm oak population was affected and it was known that these trees had not been affected the previous year. During the spring of 2007 mined leaves caused by this species were found in six of the Island's ten-kilometre squares. Until 2001 this moth was only known from the Mediterranean islands, Corsica, Sicily and Cyprus, and from Italy, Yugoslavia and Greece. An imago had been taken in South Kensington in 1996 but was not positively identified until 2001 (Honey, 2002). By 2005 it was only known from Greater London but by mid-2007 it had been recorded from all along the south coast from Hampshire and the Isle of Wight to Suffolk and from the inland counties of Middlesex, Surrey, Hertfordshire and Cambridgeshire (*pers. comm.* J.R.L.).

PHYLLONORYCTER PLATANI STAUDINGER (GRACILLARIIDAE)

This species was discovered new to Britain in October 1990 by A.M. Emmet in the grounds of Imperial College, South Kensington, mining the leaves of London plane, *Platanus × hispanica* (Emmet, 1991). By 1998 it had spread across London to southeast England and north to the midlands. It appeared in Hampshire in 1998 and was first found on the Island 27.ix.04 at Fairlee, near Newport, on a tree which had been inspected the previous year and which was then unaffected. The find by D.T.B. was confirmed by J.R.L. The mine starts as an inconspicuous corridor alongside the main vein and later develops into an inflated tentiform blotch which deforms the leaf.

The moth is spreading slowly across the Island with trees now in three ten-kilometre squares affected. Originally the moth was native to south-eastern Europe where its host is Oriental plane, *Platanus orientalis*, which is found eastwards to India. The moth has spread throughout Europe in recent years, reaching the Netherlands in 1965, Denmark 1978 and Sweden 1991. By 2007 it has been found in southern England, East Anglia, the midlands and north to Lincolnshire and Lancashire (*pers. comm.* J.R.L.).

PHYLLONORYCTER LEUCOGRAPHELLA ZELLER (GRACILLARIIDAE)

First recorded for Britain in February 1989 from Wickford in Essex by A.M. Emmet, it was soon found to exist throughout south and east Essex (Emmet, 1989). The larva causes a conspicuous silvery tentiform blotch on the upper surface of the leaf of firethorn, *Pyracantha coccinea*, centred over the midrib and flecked with small rusty red spots. By 1998 it was known from across southern England and across the Midlands to N.E. Yorkshire. It was first recorded from Hampshire in 1998 and from the Island 31.iii.01 when 146 mines were counted, some tenanted, some vacated, from one yellow-berried *Pyracantha* bush in Gurnard (D.T.B., confirmed by J.R.L.). It has now been found in eight of our ten ten-kilometre squares, on hawthorn, *Cotoneaster* and apple as well as *Pyracantha*. Originally native to Europe south of the Alps the moth has spread through northwest Europe during the last 40 years as planting of *Pyracantha* has increased, particularly on new housing developments. So far as the U.K. is concerned it is now found right up to southern Scotland (J.R.L.).

CAMERARIA OHRIDELLA DESCHKA & DIMIC (GRACILLARIIDAE)

This now notorious invader was first found on the Island as tenanted mines on horse chestnut, *Aesculus hippocastanum* at Pelham woods, Ventnor, 15.ix.04 (D.T.B.). The first British record had been from Wimbledon, south London in July 2002. It was found in Oxford in 2003 and in Hampshire in 2004. It is now found right across the Isle of Wight. Deschka and Dimic described it as a new species in 1986, it having been found in Macedonia for the first time in 1985 (Deschka & Dimic, 1986). Since then it has spread rapidly northwestwards across Europe, reaching Austria in 1989, Germany 1992 and the Netherlands by 1999. The larvae produce multiple elongated pale brown blotch mines on the upper surface of the leaves of *A. hippocastanum* but so far on the Island not on red chestnut, *A. × carnea*. By mid-2007 the moth had been reported from the whole of southern England, East Anglia and the Midlands north to Cheshire (J.R.L.).

PHYLLOCNISTIS XENIA HERING (GRACILLARIIDAE)

This species was first recorded in Britain on 9.ix.74 by E.C. Pelham-Clinton from near Dover, Kent (Pelham-Clinton, 1976). He had found some superficial upper-surface leaf-mines on grey poplar, *Populus × canescens*. The mines were characterised by a thick central track of frass and the long sinuous silvery mines ended at the leaf margin where pupation occurred in a small leaf fold. It was found near Canterbury in 1982 and in Devon 1992. The first Island record was of mines on white poplar, *P. alba* on St Helen's Duver 17.viii.02 (Sue Blackwell and Bill Shepard, identified by D.T.B. and confirmed by J.R.L.). The only other Island site so far recorded is Osborne where tenanted mines were found 15.vi.07 by D.T.B. on *P. alba*. The moth

is found in Europe from Poland to Spain but is reported to be local and uncommon. By mid-2007 it was known from coastal counties from Dorset to Norfolk (J.R.L.).

TACHYSTOLA ACROXANTHA MEYRICK (OECOPHORIDAE)

This adventive colonist was first recorded on the Island from Gurnard 11.viii.02 (D.T.B., identified by J.M. Cheverton, confirmed by J.R.L.). Its first appearance in England had been in South Devon in 1908. It is a native of S.E. Australia. After the initial record in 1908 only three more specimens were found until 1970. Since then it has spread, reaching Somerset in 1981, Cornwall 1985, Hampshire 1994, London 1996 and Kent 1999. By mid-2007 records had been received from coastal counties from Cornwall to Suffolk and from the West Midlands north to Lancashire. The larva lives in leaf litter and the adult moth can be found from April to November.

BLASTOBASIS LACTICOLELLA REBEL (BLASTOBASIDAE)

This moth is a native of Madeira but it appeared in London in 1946 and has spread from there, initially slowly into the southeast of England. Since about 2000 it has spread much more rapidly and much further afield, now (2007) being found from the south coast of England to the north of Scotland (J.R.L.). It first appeared in Hampshire in 1993 and on the Isle of Wight 14.vi.1999 at Freshwater (S.K.-J.). The larva feeds on fresh and dead plant material, dead insect material and bird droppings.

MOMPHA STURNIPENNELLA TREITSCHKE (MOMPHIDAE)

A deformed seed-pod of rosebay willowherb, *Chamerion angustifolium* was found in Bouldnor Forest 26.viii.1998 (D.T.B.). It was taken home and from it hatched 11.ix.1998 a *Mompha* sp. which was identified as this species by J.R.L. The first confirmed English record was of an adult hatched from galls found at Oxshott, Surrey in 1950. Since then it has spread slowly and it is now found (2007) from Dorset to Norfolk, in the Welsh Marches and Midlands, north to Lancashire and Yorkshire. It first appeared in Hampshire in 1995. Its native range is from central and northern Europe across to Central Asia and the Russian Far East.

COSMOPTERIX PULCHRIMELLA CHAMBERS (COSMOPTERIGIDAE)

Just before Christmas, 22.xii.2006, mines of this new Island moth were found at Shanklin on pellitory-of-the-wall, *Parietaria judaica* (D.T.B., confirmed by J.R.L.). One contained a larva. Since then heavy infestations of the moth have been found at two other sites in the southeast of the Island. The moth first appeared in England in Dorset (2001) and Cornwall (2004) (Sterling, 2004). Its original range was from France and Switzerland through southern Europe to Greece and former Yugoslavia. The larva forms a conspicuous white blotch on the upperside of the leaves. Plants growing in shaded situations seem to be preferentially mined. By mid-2007 the moth had been recorded from Cornwall, Devon, Somerset, Dorset, Hampshire, Sussex and Berkshire (J.R.L.).

COCHYLIS MOLLICULANA ZELLER (TORTRICIDAE)

The occurrence of the above species in Britain is documented by John Langmaid (Langmaid, 1994), following his discovery and dissection of a specimen taken in his light trap at Southsea on 21.viii.1993. It was later found that two earlier specimens had been taken at Portland, Dorset, in late June 1991 and at Lyme Regis, Dorset, in early July 1993. In 1994, larvae were found in great abundance in heads of bristly ox-tongue *Picris echioides*, on waste ground at Southsea, Portsmouth. Since then it has colonised the south coast of England. On 5.viii.2006 lights were set up in Parkhurst Forest and Tim Norris later identified one of the tortrices as this species which was new to the Isle of Wight. This species is probably widespread in the Mediterranean region.

CROCIDOSEMA PLEBEJANA ZELLER (TORTRICIDAE)

The earliest record of this species appears to be that of a specimen taken by E.R. Banks on 10.x.1900 at Street, South Devon and the next specimen was taken at light on 13.viii.1922 in North Devon. In September, 1957 H.C. Huggins and R.M. Mere confirmed that this species was breeding on Tresco, Isles of Scilly, by obtaining larvae in the leaf axils and ripening fruits of tree-mallow *Lavatera arborea*. It was first found in Hampshire at Martyr Worthy in 1961 (Goater, 1974) and now appears to have become established at low density along the coast of South Hampshire and the Isle of Wight. On the Isle of Wight it was first taken at Freshwater on 27.ix.1983 and again on 18.xi.1990 and 1.xii.1991. It was recorded inland at Binstead on 1.xi.1999. It is now regularly taken at Totland in the late autumn.

EVERGESTIS LIMBATA L. (PYRALIDAE)

Simon Colenutt was the first person to record this species in this country when he took two examples on 23.vii and 30.vii.1994 in his light trap at Chale Green on the Isle of Wight (Colenutt, 1995). He recorded two further examples on 14.vii and 21.vii.1995 and S.K.-J. took it for the first time at Freshwater on 3.vii and 10.vii.1999. Since then it has been regularly recorded along the south coast of the Island and there is also evidence of a second brood as it has been taken in September. It has also been discovered in Sussex. It is easy to rear on its foodplant garlic mustard *Alliaria petiolata* and the larva has been found with success in the wild. It is to be found also at a low density in Hampshire.

NOCTUA JANTHINA BORKH. (NOCTUIDAE)

On 9.vii.2001 John Langmaid found a specimen of the above species in his garden moth trap in Southsea, Hampshire (Langmaid, 2002), which was the first time that it had been taken in Britain. This moth was recorded in small numbers in Kent and Sussex in 2003 and has since been extending its range along the south coast of England (Clancy, 2002). On 26.vii.2006 it was taken at Bonchurch on the Isle of Wight by James Halsey and will most likely become established on the Island in future years.

DRYOBOTA LABECULA ESPER (NOCTUIDAE)

This south European species was first noted on Jersey, Channel Island in 1991 and specimens were reported from Guernsey in 1995 and several more the following year

suggesting residency. Terry Rogers took the first example for mainland Britain at Freshwater on 15.x.1999 (Rogers, 2000) and S.K.-J. captured one at light at Freshwater on 22.xi.1999. It was recorded again at Freshwater in 2000 and 2001 whence it was unrecorded until 2004 when several more were taken at Freshwater. It was taken for the first time at Luccombe on 21.x.2004 and at Bonchurch where six were recorded at the end of October. This species is now well established on the south coast of the Isle of Wight and over sixty examples were recorded in 2006. It now is established on the mainland at Dorset and Hampshire.

CRYPHIA ALGAE FABR. (NOCTUIDAE)

In July 1859 two specimens were said to have been taken at Disley, Cheshire and in 1873 another was reported from Hastings, East Sussex (Waring & Townsend, 2003). Over one hundred years passed before the species reappeared in England with a capture at Southsea, Hampshire, on 21.viii.1991. From that date it has occurred in small numbers mostly in the south of England between mid-July and early September and in recent years has become established in several localities. It was first recorded on the Isle of Wight on 27.viii.1992 at Freshwater; at Ninham on 23.viii.1996 at at Brading Marsh on 29.vii.2001. Since that date several have been recorded every year at Bonchurch and in 2006 eight examples were taken at Bonchurch and one at Totland which is evidence that it is now established in the south of the Island.

PLATYPERIGEIA KADENII FREYER (NOCTUIDAE)

This south-eastern European species were recorded for the first time in Britain on 3.x.2002 at New Romney, Kent (Clancy & Honey, 2003). Four more were taken in the Dungeness area the following year and since then it has rapidly extended its range along the south coast of England. It was first recorded on the Island at Bonchurch on 26.ix.2005. Further records followed from Bonchurch with singles on 26 & 28.xi with two more each on 23 & 26.x; one was taken at Totland on 16.x. In 2006 48 examples were reported from Bonchurch, Shanklin & Totland which is evidence that this species is now firmly established on the Island.

HYPENA OBSITALIS HÜBN. (NOCTUIDAE)

This species was first recorded in Britain at Bloxworth, Dorset on 21.ix.1884. Since then it has been recorded six times before the first was noted on the Isle of Wight at Shanklin on 27.i.1968. One was caught by Peter Cramp in his porch at Ventnor on 5.xii.2004 and another was found hibernating in a cave at St. Lawrence on 19.i.2005. This species has been recorded from St. Lawrence, Ventnor, Bonchurch and Totland and there were five records in 2006 which suggest that it may be established at these localities where the larvae feed on pellitory (*Parietaria*) and possibly nettle. It overwinters as an adult. It has been considered to be resident in the Channel Islands since the early 1960s, and on mainland Britain from 1990 following its discovery near Torquay, South Devon. Larvae have been found on numerous occasions and the species is now known to be well established in the Torbay district of Devon.

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up to mid-2007. Thanks also go to Simon Colenutt, Peter Cramp, James Halsey and Terry Rogers for their records and other information.

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Ant Hills in Acid Grassland by Nigel Reeve (2006). The Royal Parks, Richmond.

This new colour leaflet published by The Royal Parks will be of interest to everyone working in nature conservation as it provides a simple and straightforward explanation of the lives of yellow meadow ants *Lasius flavus* and why they build such prominent nest mounds in old pastures. The ecological value and nature conservation management aspects are also discussed. The leaflets are available free from Nigel Reeve at The Royal Parks, Holly Lodge, Richmond Park, London TW10 5HS.

KEITH ALEXANDER

**THE SPECIES OF *COTESIA* CAMERON
(HYMENOPTERA: BRACONIDAE: MICROGASTRINAE)
PARASITISING LYCAENIDAE (LEPIDOPTERA) IN BRITAIN**

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ABSTRACT

A key is given to five species of *Cotesia* (*C. astrarches* (Marshall), *C. cuprea* (Lyle), *C. inducta* (Papp), *C. saltatoria* (Balevski) and *C. tenebrosa* (Wesmael)) that parasitise the larvae of Lycaenidae in the British Isles. Two (*C. inducta* and *C. saltatoria*) are newly recorded from Britain and one (*C. astrarches*) is raised from synonymy. Taxonomic notes, host records and distributional data are given for all species. A lectotype is designated for *Apanteles astrarches* Marshall, 1889.

INTRODUCTION

Species of *Cotesia* Cameron (Braconidae: Microgastrinae) are endoparasitoids of Lepidoptera larvae, especially (but not exclusively) those of so-called "macro-lepidoptera". They are koinobionts – that is, the host continues its life for a time after being parasitised – and different species are either solitary or gregarious with respect to their host. Usually oviposition is into an early instar of the host larva, and the fully-fed *Cotesia* larva(e) erupts from a later host instar to spin its sometimes characteristic cocoon(s) externally: often the host does not die immediately after parasitoid eruption, but is left in a voluntarily quiescent state and dies only some days later. These parasitoids are often reared by entomologists who collect caterpillars but *Cotesia* is a large genus and reliable identification sometimes proves troublesome, even though most species have quite narrow host ranges. This paper treats the species that parasitise Lycaenidae in Britain.

Nixon (1974), in his revision of N.W. European species of the part of the traditional genus *Apanteles* that was later (Mason, 1981) recognised as *Cotesia*, included only two species with rearing records from Lycaenidae in Britain, that he called *Apanteles arcticus* Thomson (in error for (Thomson)) and *Apanteles cupreus* Lyle. Subsequently Papp (1986) showed that in mainland Europe two species had gone under the name *A. arcticus*, which he called *A. arcticus* and *A. tenebrosus* (Wesmael), but he did not record the former from Britain. Because Nixon (1974) had included *Apanteles astrarches* Marshall (described from Britain) as a synonym of *A. arcticus*, Papp (1986) was obliged to assign it and he tentatively (but erroneously) placed it as a synonym of *A. tenebrosus*.

Largely through the generosity of many people who have donated reared parasitoids, a considerable quantity of British *Cotesia* reared from various Lycaenidae has been amassed at the National Museums of Scotland, in which five species are present. In addition to the recognition of *C. astrarches* as a valid species distinct from *C. tenebrosa*, two species, *C. inducta* (Papp) and *C. saltatoria* (Balevski), are newly recorded as British. The identity of the true *C. arctica* (Thomson), which might either be a different (non-British) species or a junior synonym, is not addressed.

All of the species treated here are plurivoltine; *C. inducta* overwinters in its cocoon but the other species do so only as (presumably first instar) larva(e) in an

overwintering host larva. Two species, *C. inducta* and *C. saltatoria*, are strictly solitary but the others are gregarious with respect to the host. *Cotesia inducta* is obviously not closely related to the other four species, but even among these four only *C. astrarches* and *C. tenebrosa* seem likely to form a natural group (though formal phylogenetic assessment is lacking).

Females can be identified through the information given below, and in a following section a commentary is given for each species to clarify its nomenclature and host relations.

Unless indicated otherwise, all material is in the National Museums of Scotland (NMS).

IDENTIFICATION

Notes on recognition, characters and terminology

Microgastrinae, to which *Cotesia* belongs, can be separated from other Braconidae through keys given by Shaw & Huddleston (1991) or van Achterberg (1993). General features are their 18-segmented antennae, small or only moderate size, usually rather robust build, and comparatively large hind coxae. As well as through Mason (1981), *Cotesia* can be fairly reliably recognised among Microgastrinae by the combination of a more or less strongly rugose propodeum (= the posterior part of the mesosoma, which is the middle body section) that usually also has a medial longitudinal carina, the first tergite of the metasoma parallel-sided or somewhat widening towards its posterior, at least the apical part of tergite 1 and much of tergite 2 more or less rugose, the ovipositor normally comparatively short and its sheaths extending at most only a little beyond the apex of the hypopygium (and then for a distance not exceeding the length of the hind basitarsus), and venation of the fore wing in which the 2nd submarginal cell (= 2nd cubital cell, sometimes also called the areolet) is open – that is, vein 2rs-m in Shaw & Huddleston (1991) = r-m in van Achterberg (1993) is absent (this last is the character that defined the traditional, but polyphyletic, “*Apanteles*” sensu lato). The bodies of most *Cotesia* species are essentially black (a few exceptions occur). As far as parasitoids of British Lycaenidae are concerned, any braconid whose larva (or larvae) comes out of the host larva to spin a silken cocoon (or cocoons) that is not suspended on a thread will probably be a species of *Cotesia*, though there are some campoplegine ichneumonid parasitoids of Lycaenidae that do this, and care should also be taken not to confuse the brown, tanned cuticular puparia of Tachinidae (Diptera) as cocoons.

Antennal segments are numbered from the head so as to include the scape and pedicel; thus the first in the flagellum is the third antennal segment. As all Microgastrinae have 18, segment 15 (which is used in the key for comparative purposes as it is less prone to collapsing or loss through breakage than the more distal segments) is therefore the 4th from the end. The malar space is the shortest distance from the eye to the mandibular socket. The conspicuous anterior tentorial pits are situated near the upper margin of the clypeus laterally and measurements are taken from their middle (deepest part); ratios refer to a facial view. The height of the face plus clypeus is measured perpendicularly from the level of the lower margin of the antennal sockets to the lower margin of the clypeus at its centre. The width of the face is the shortest distance between the eyes. The metasoma is the posterior body part (also known as the gaster), and T1, T2 and T3 refer respectively to its first (anterior), second and third tergites (the SEM illustrations given here have T2 and T3 in plane but often not T1, the length of which is therefore difficult to appreciate).

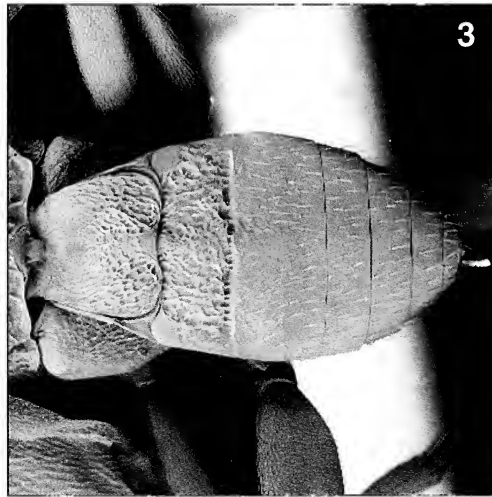
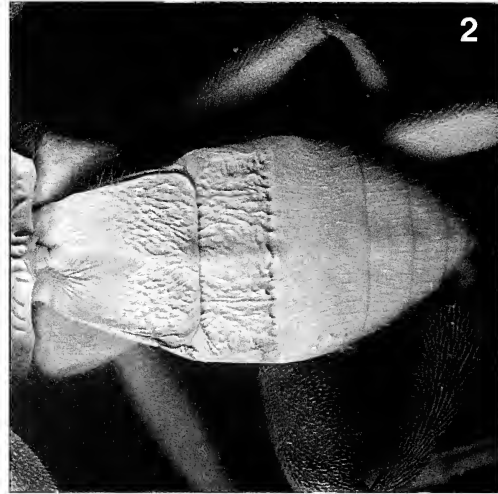
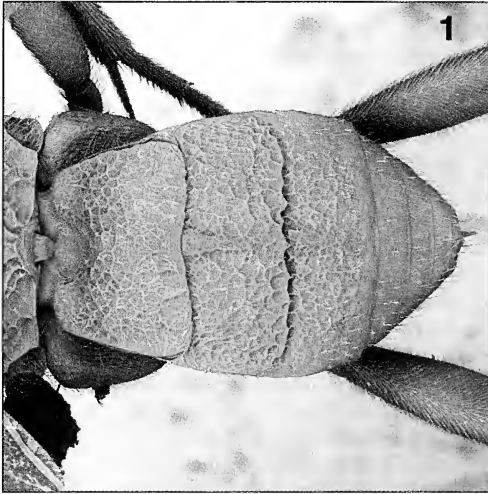
Although fused, T2 and T3 have a clearly visible suture between them. The hypopygium is the enlarged posterior sternite of the metasoma that is modified to support the ovipositor. The metacarp is the vein of the fore wing that extends along the anterior margin distal to the pterostigma towards the wing apex, and the radial cell is the (poorly defined) cell beneath it.

Cotesia inducta is easily recognised (in both sexes), but the other four species are less easy to separate. All four have the hind femur black and the hind tibia more or less reddish over about its basal half with subequal spurs that only just reach, or fall slightly short of, the mid-length of the basitarsus. The truncate or subacute hypopygium is developed to a comparable degree, and the ovipositor sheaths are rather long and slender, frequently appearing to be cylindrical and projecting well beyond the hypopygium (but this is very variable in death, and in some species a more tapered and dagger-like manifestation is also seen). Useful characters are present in the proportions of the face and eyes, the antennae, the basal (i.e. anterior three) tergites of the metasoma, and wing venation. Unfortunately, however, there is considerable variation in each of these in the long series available; therefore in the key several characters are expressed in each couplet, and majority rather than total agreement should sometimes be expected. Cocoon colour seems to be reliably consistent (although cocoons lose colour both with age and from immersion in alcohol). As is the general situation in *Cotesia*, males (which have much longer antennal segments and hence antennae) show weaker character development and are also more variable than females, and the key given below does not accommodate them at all well.

Females of the five British species can be distinguished by the key that follows. Obviously the key cannot be used to identify specimens that have not been reared from Lycaenidae, and it should be noted that further species parasitise Lycaenidae in mainland Europe. Italicised characters in brackets are confirmatory rather than dichotomous. Figs 1–14 were taken on a CamScan MX 2500 scanning electron microscope at 15 kV and spot size 2. Generic placement of butterfly names follows Lafranchis (2004).

Key to females of species of *Cotesia* parasitising Lycaenidae in Britain

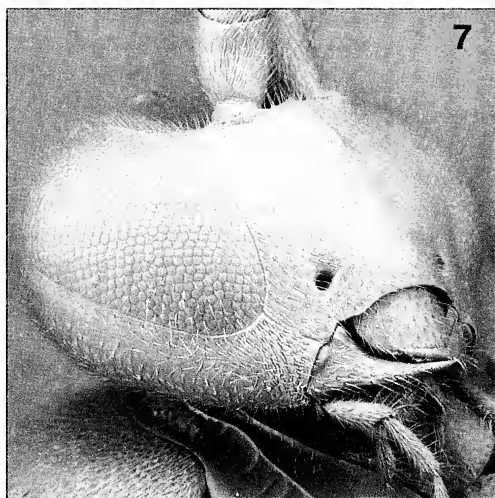
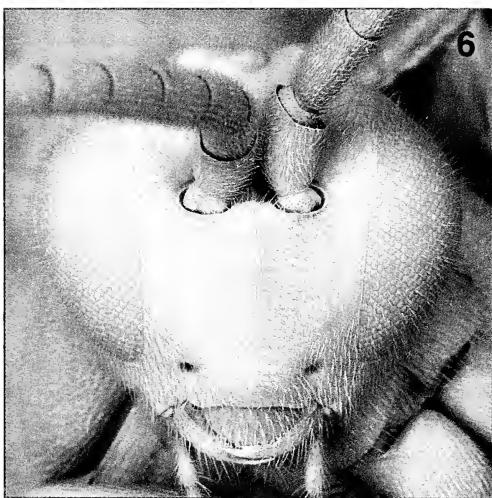
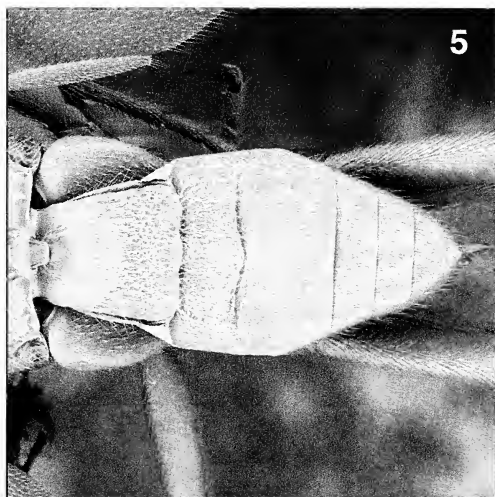
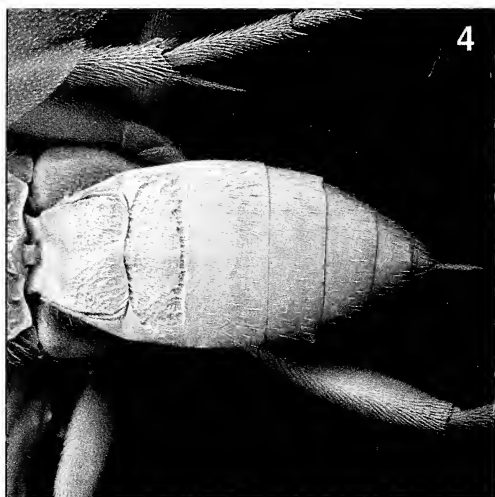
1. T3 not or scarcely longer than T2 and with rugose sculpture over almost all of its surface, almost as intense as on T2 (Fig. 1); hind femur largely orange, infusate at extreme apex or sometimes (especially in overwintering generation) a little more extensively; hind tibia orange, weakly infusate in at most apical fifth; underside of scape usually strikingly orange (but often black in overwintering generation); overwintering in cocoon. (*Mesonotum* and hind coxa with rather distinct deep punctures. Solitary. Cocoon lemon yellow)
 - *inducta* (Papp)
- T3 obviously longer than T2 and largely unsculptured, in any case clearly contrasting with the more or less strong rugose sculpture of T2 (Figs 2–5); hind femur usually entirely black; hind tibia more or less reddish basally, becoming infusate over at least most of apical half; underside of scape always black; overwintering inside host larva 2
2. Eyes relatively large, usually at least slightly converging (downwards) for almost whole length of face (Fig. 6), and height of eye ca 4.0 times malar space; face ca 1.1 times as wide as height of face plus clypeus (Fig. 6); malar space ca 0.8 times basal width of mandible (Fig. 7); hind tibial spurs a little longer, more or less reaching middle of hind basitarsus; a large species, ca 3 mm; solitary. (*Antenna* ca 0.9 times as long as fore wing, its segment 15 usually ca 1.2–1.3 times longer



Figs 1–3. *Cotesia* species, metasoma in dorsal view. 1. *Cotesia inducta* (Papp). 2. *Cotesia saltatoria* (Balevski). 3. *Cotesia cuprea* (Lyle).

than wide. T1 usually strongly and often rather linearly widening posteriorly; T2 ca 3.3 times wider than long (Fig. 2). Distance between eye and anterior tentorial pit usually ca 0.4 times distance between pits (fig. 6). Metacarp ca 2.2–2.5 times as long as its distance from apex of radial cell. Cocoon bright yellow)

- *saltatoria* (Balevski)
- Eyes smaller, diverging or at most parallel at middle of face and below (Figs 8–11), and height of eye at most ca 3.8 times malar space; face at least 1.2 times as wide as height of face plus clypeus (Figs 8–11); malar space at least as long as basal width of mandible (Figs 12–14); hind spurs shorter, not quite reaching middle of hind basitarsus; smaller species, usually not more than 2.5 mm; gregarious [but broods of 1 could occur] 3



Figs 4–7. *Cotesia* species. 4, 5. Metasoma in dorsal view. 6. Head in facial view. 7. Head in ventro-anterio-lateral view. 4. *Cotesia tenebrosa* (Wesmael). 5. *Cotesia astrarches* (Marshall). 6, 7. *Cotesia saltatoria* (Balevski).

3. Antenna thin, about as long as fore wing, its segment 15 usually 1.5–2.0 times longer than wide; outer side of hind coxa basally dull; malar space about as long as basal width of mandible (Fig. 12); distance between eye and anterior tentorial pit 0.4 or less times distance between the pits (Fig. 8); T2 slightly less transverse, ca 3.0 times wider than long, almost its whole surface often more or less evenly rugose (posteriorly) or at least the anterolateral sulci usually poorly developed (Fig. 3); metacarp ca 2.4–2.7 times its distance from apex of radial cell. (*T1 strongly, sometimes roundly, widened towards apex. Ovipositor sheaths usually appearing slender and cylindrical. Face ca 1.2 times wider than height of face plus clypeus (Fig. 8). T3 sometimes slightly sculptured basally. Cocoons white*)
 *cuprea* (Lyle)
- Antenna more robust, about three quarters as long as fore wing, its segment 15 usually 1.0–1.2 times (rarely up to 1.4 times) longer than wide; outer side of hind coxa basally rather shiny; malar space at least ca 1.2 times longer than basal width of mandible (Figs 13,14); distance between eye and anterior tentorial pit at least 0.5 times distance between the pits (Figs 9–11); T2 slightly more transverse, ca 3.2 times wider than long, and usually with fairly distinct anterolateral sulci separating less sculptured margins (Figs 4, 5); metacarp usually less than 2.4 times its distance from apex of radial cell. (*Ovipositor sheaths often appearing to be more tapered, but very variable in death. T3 smooth basally*). 4
4. Eyes smaller, strongly diverging below, their lower margin well above level of anterior tentorial pits (Figs 9, 10); face ca 1.3 times wider than height of face plus clypeus and ca 1.2 times wider than height of eye (Figs 9, 10); cheeks sometimes appearing very bulging (Fig. 10) and the lower part of the face and clypeus produced centrally; distance between eye and anterior tentorial pits ca 0.7–0.8 times distance between pits (Figs 9, 10); malar space ca 0.5 times height of eye and ca 1.5 times basal width of mandible (Fig. 13); metacarp shorter, ca 1.7–2.0 times its distance from apex of radial cell; T1 very variable but usually more strongly widening posteriorly (Fig. 4, but note that T1 is not in plane), sometimes strongly so; cocoons whitish *tenebrosa* (Wesmael)
- Eyes larger, less strongly diverging below, their lower margin only a little above level of anterior tentorial pits (Fig. 11); face ca 1.25 times wider than height of face plus clypeus and about as wide as height of eye (Fig. 11); cheeks scarcely bulging (Fig. 11) and the face flatter; distance between eye and anterior tentorial pit ca 0.5–0.6 times distance between pits; malar space ca 0.3 times height of eye and ca 1.25 times basal width of mandible (Fig. 14); metacarp longer, ca 2.0–2.4 times its distance from apex of radial cell; T1 very variable but usually less widened posteriorly (Fig. 5), sometimes hardly widened at all; cocoons distinctly yellow. *astrarches* (Marshall).

TAXONOMY, DISTRIBUTION AND BIOLOGY

Cotesia astrarches (Marshall), **stat. rev.**

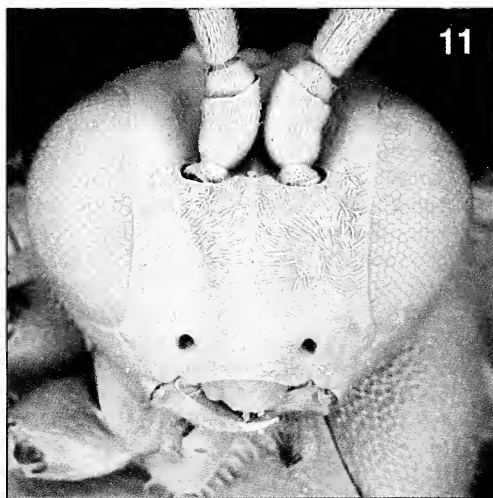
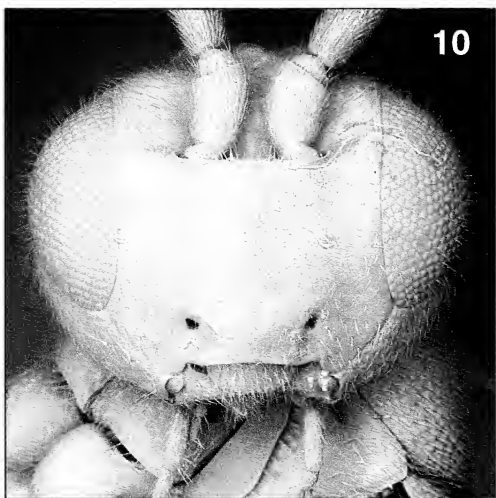
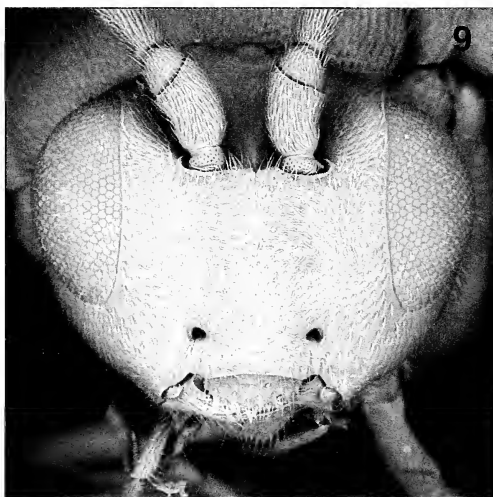
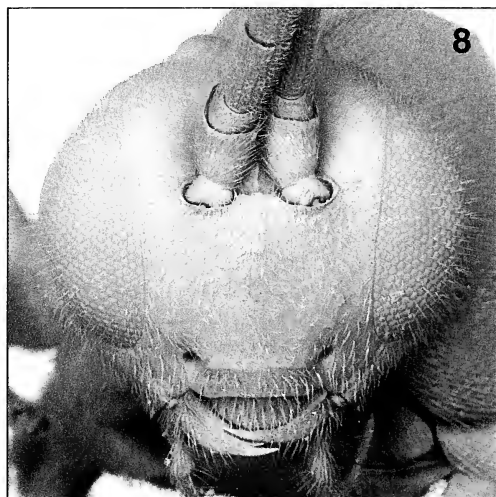
Marshall (1889) described this species from four specimens reared in England from a larva of “*Lycaena astrarche*”, now *Aricia agestis* (Denis & Schiffermüller), by [G.C.] Bignell, stating them to be 1 ♀, 3 ♂. Nixon (1974) placed *Apanteles astrarches* Marshall, 1889, in synonymy with *Microgaster (Apanteles) arcticus* Thomson, 1895 (which was described from non-reared material), making no comment other than the

indication “syn. nov.” despite his placing the nominal taxon with the earlier name (*astrarches*) as the junior synonym; an anomaly which has been widely followed (e.g. Fitton *et al.*, 1978). Nixon’s curious action is possibly explained by his statement that he had seen the type of *arcticus* without his mentioning the type material of *astrarches*, which was in Plymouth museum and which he presumably had not examined. Subsequently Papp (1986), who had previously (Papp, 1973b) seen the type of *arcticus*, separated two species in *A. arcticus* sensu Nixon, that he called *A. arcticus* and *A. tenebrosus* (Wesmael), putting “? *astrarches*” in synonymy with the latter, remarking that [*Cotesia arctica*] (described from Arctic Norway) is a rare species, and (by implication) recording only [*Cotesia tenebrosa*] from Britain.

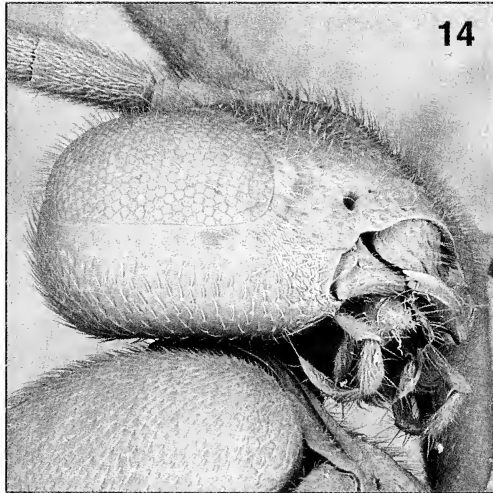
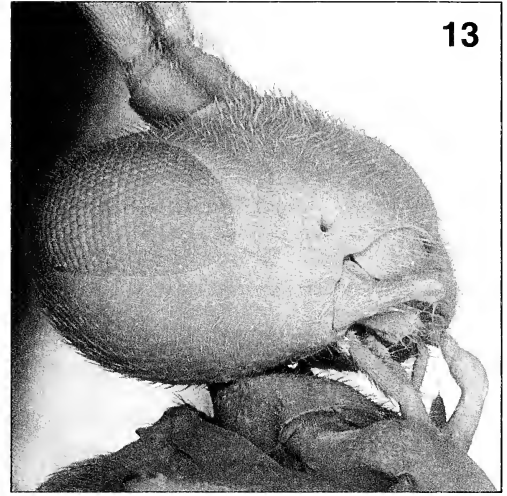
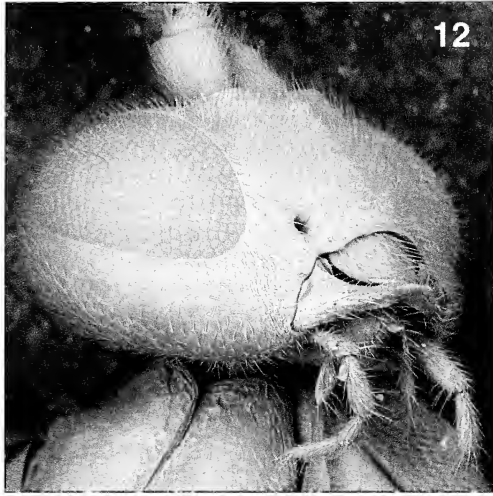
There is considerable material in NMS conforming to [*Cotesia arctica*] sensu Nixon which fairly readily falls into two groups, one corresponding to *C. tenebrosa* (q.v.) and the other, comprising numerous broods (see below) reared from *Aricia agestis* and *A. artaxerxes* (Fabricius), agreeing with the syntype material of *Apanteles astrarches* Marshall, which I have examined (Bignell collection, Plymouth City Museum and Art Gallery). The type series comprises four specimens glued more or less face down to a card, with the labels “3064”; “Type [word inside red circle]”; “*Apanteles astrarches* Marsh.”; and “*Ap. Astrarches* n. sp. next *octonarius*”. Although the series is of 2 ♀, 2 ♂ rather than the 1 ♀, 3 ♂ stated in the original description, it clearly should be accepted as authentic and I here designate the top left specimen, a female, as the **lectotype** in accordance with my labelling and indication attached to the mount. Incidentally, the recognition of the two closely related species (together comprising *arcticus* sensu Nixon) as *C. tenebrosa* and *C. astrarches* fortuitously somewhat dodges the importance of the identity of the true *C. arctica* in this context as, even if it is conspecific with one or the other (which seems unlikely and it should be noted that it was not described from reared material), *C. arctica* would be a junior synonym in either case.

In NMS there are 56 broods of between two and 13 individuals (usually about four to six, but often around 12 – possibly representing additional oviposition visits?) of *C. astrarches* reared from *Aricia agestis* in central E. England and N. Wales (45 broods; VCs 49, 54, 57, 61, 62, 64; *R. Menéndez Martínez*, *R. Wilson*) collected on all three of its main foodplants *Helianthemum nummularium*, *Geranium molle* and *Erodium cicutarium*, and from *Aricia artaxerxes* in eastern C. and S. E. Scotland and N. England (11 broods; VCs 65, 66, 69, 81, 82, 90; *P. Summers*, *M. R. Shaw*) collected on *H. nummularium*. The impression of a northern distribution of this species in Britain probably simply reflects a massive sampling bias (cf. Shaw, 1996 and unpublished; Menéndez *et al.*, in prep.).

All of the British *C. astrarches* seen to date have been reared from *Aricia* species, with the possible exception of one brood, doubtful because only a single male emerged, from *Cupido minimus* (Fuessly) collected in S. E. Scotland (VC 81; *A. Buckham*). While two broods reared from *Tomares ballus* (Fabricius) in Spain (Granada; *M. Ginés Muñoz*) and two broods from ? *Polyommatus thersites* (Cantener) (or possibly *Agrodiaetus* sp.) in Greece (N. Peloponnese; *T. Lafranchis*) that appear to be morphologically compatible with *C. astrarches* (and had similarly pale yellow cocoons) might suggest a wider host range, it is unsafe to determine them as this. In addition to the possibility that these specimens may belong to one or more additional biological species, the situation in mainland Europe is complicated by the presence of the extremely similar *Cotesia specularis* (Szépligeti), although that seems to be a slightly smaller species that generally produces larger broods and has white cocoons. *C. specularis* parasitises *Iolana iolas* (Ochsenheimer) and *Lampides boeticus*



Figs 8–11. *Cotesia* species, head in facial view. 8. *Cotesia cuprea* (Lyle). 9, 10. *Cotesia tenebrosa* (Wesmael). 11. *Cotesia astrarches* (Marshall).



Figs 12–14. *Cotesia* species, head in ventro-anterio-lateral view. 12. *Cotesia cuprea* (Lyle). 13. *Cotesia tenebrosa* (Wesmael). 14. *Cotesia astrarches* (Marshall).

(Linnaeus) regularly in southern Europe, but it might have a wider host range and it is unclear whether its cocoon colour is constant.

Cotesia cuprea (Lyle)

This gregarious species was described as *Apanteles cupreus* by Lyle (1925) from four broods reared from *Lycaena phlaeas* (Linnaeus) in England, and has been redescribed in detail by Wilkinson (1945). It is a well-known and often common parasitoid of *L. phlaeas*, and a brief account of its causing repeated local extinctions

within a metapopulation of this host in England is given by Ford (1976). It probably parasitises most or all other *Lycaena* species in Europe: it is recorded by Nixon (1974) from *L. helle* (Denis & Schiffermüller), and from *L. dispar* (Haworth) below.

Wilkinson (1945) included single series supposedly reared from each of *Polyommatus icarus* (Rottemburg) and *Plebejus argus* (Linnaeus) in France in his redescription of *Apanteles cupreus*. While the former could not easily be reassessed, the latter brood (also recorded by Nixon (1974)) is in the BMNH and, having seen it, I concur with the identification of the specimens, though the host determination is less easy to accept. Two series of *Cotesia* reared on separate occasions from *Lampides boeticus* collected in France at St Jean de Luz, Basses-Pyrénées, that were recorded by Nixon (1974) as *A. cupreus* (and erroneously stated to be from two sites) are also in BMNH, and one specimen carries a Nixon determination label dated 1955 [there is no evidence that he re-examined the specimens in the course of his 1974 revision]. The specimens are in rather poor condition, but they are certainly not *C. cuprea* and are provisionally referred to *C. specularis*, which appears to be a regular parasitoid of this host in mainland southern Europe (see note under *C. astrarches*, above). There are several literature references to [*C. cuprea*] as a regular parasitoid of polyommatine Lycaenidae (e.g. Fiedler *et al.*, 1995) but, in the absence of clear confirmation of any, *C. cuprea* would appear, from the material in NMS, to be strongly specialised to Lycaenini and not to parasitise Polyommadini regularly.

In NMS there are ten typically coloured broods reared from *L. phlaeas*, nine collected in England (VCs 29, 30, 32, 33, 60; *R. L. E. Ford*, *P. Marren*, *R. Revels*, *D. Stokes*, *P. Tebbutt*, *I. P. Tuffs*) and one in France (Ariège; *D. Corke*). Two additional broods reared in autumn from this host collected in S. E. Scotland (VC 82; *P. Summers*) have the hind tibia almost completely reddish (rather than being strongly infusate on about its apical two fifths, as is usual in both early summer and autumn broods), but they appear to belong to this species. There are also two broods reared on separate occasions from semi-captive stock of *Lycaena dispar* in England (VCs 21, 31; *P. W. Cribb*, *L. Martin*), and a brood from an unidentified *Lycaena* species from Finland (Åland; *S. van Nouhuys*). Brood sizes range from 2–28; most are in the upper teens.

Cotesia inducta (Papp)

New to Britain (cf. Revels, 2006). This species was described from non-reared material as *Apanteles inductus* from Hungary (Papp, 1973a) and later recorded also from Slovakia, Bulgaria and Turkey (Papp, 1986), though its hosts had remained unknown (cf. Papp, 1990). During the 1990s I received separate lots of reared specimens from Spain as follows: 2 ♀, 1 ♂, Nevada, Mijas, ex *Celastrina argiolus* (Linnaeus) [cocoon received with the specimens are on *Hedera* flower buds], em. 14.xi.1993 (*J. E. Pateman*); 1 ♀, Girona, El Cortalet, Aiguamolls de l'Emporda National Park, ex *C. argiolus* on *Rubus ulmifolius*, em. 17.vii.1996, (*C. Stefanescu*); and 1 ♀, Barcelona, Can Riera de Vilardell, ex *Glaucoopsyche melanops* (Boisduval) on *Dorycnium hirsutum*, coll. 23.v.1999, em. v/vi.1999 (*C. Stefanescu*). This demonstrated that *C. inducta* is a solitary parasitoid of certain polyommatine Lycaenidae and suggested that it is widespread in Southern Europe. It was, nevertheless, surprising to receive British specimens for determination, first reared in 2004 by Richard Revels from *C. argiolus* in Bedfordshire (VC 30), where it has subsequently proved to be well spread and abundant from this host, both in the autumn generation on *Hedera* and in early summer on *Cornus* (cf. Revels, 2006). Further examples of *C. inducta* reared from *C. argiolus* in the British Isles have been

received from Bob Aldwell in 2006 reared from host larvae collected in the autumn of 2005 on *Hedera* in the south-eastern suburbs of Dublin (Ireland, VC H21), and from Peter Summers who collected parasitised larvae on *Hedera* at three sites in N. Yorkshire (VC 64) in the autumn of 2006. A single specimen received from Richard Revels reared from *Satyrrium w-album* (Knoch) on *Ulmus glabra* in 2006 in Bedfordshire, as well as further material from Spain (Granada) reared in 2006 from both *Callophrys avis* Chapman (5) and *Tomares ballus* (Fabricius) (1) by Miguel Ginés Muñoz, added members of the tribe Eumaeini to its host spectrum and suggest that a substantial range of Lycaenidae are probably susceptible to parasitism by this species. More hosts in Britain are likely to become known: it is noteworthy that the host range known so far for *C. inducta* not only spans two tribes of Lycaenidae but also involves species feeding on low plants as well as shrubs. It would be interesting to know if it is capable of overwintering as a larva inside a diapausing host larva: if not, then this might limit its host range.

Revels (2006) includes a good colour photograph of a living female: when present, the orange scape is a particularly easy recognition feature, though British specimens from overwintering cocoons generally have the scape black or nearly so.

The ease with which *C. inducta* is now found as a parasitoid of *C. argiolus* in the British Isles and the lack of records prior to 2004 suggests that it is a fairly recent arrival, as *C. argiolus* has been regularly collected in the larval stage over the years, and the adults of *C. inducta* are strikingly and conspicuously unlike other British species of *Cotesia*. Papp (1987) states that the N. American species *Cotesia cyaniridis* (Riley), which was described from "*Cyaniris pseudargiolus*" (now regarded as a subspecies of *C. argiolus*), is "very similar" to *C. inducta*, which might suggest a transatlantic origin for the British (and presumably European) population. However, it is clear both from the original description of *Apanteles cyaniridis* Riley in Scudder (1889) and from Muesebeck's (1921) key to North American species of *Apanteles* (sensu lato), that *C. inducta* and *C. cyaniridis* are different species (indeed, according to an illustration in Fiedler *et al.* (1995), *C. cyaniridis* would appear to be a gregarious species). It is therefore presumed that the British population has resulted directly from the presence of *C. inducta* further south in Europe, and that it is a genuine member of the Palaearctic fauna.

Cotesia saltatoria (Balevski)

New to Britain. This species was described as *Apanteles saltatorius* from non-reared material collected in Bulgaria (Balevski, 1980), and it appears that it was J. Papp who was responsible for recognising it as a solitary parasitoid of polyommata Lycaenidae (cf. Baumgarten & Fiedler, 1998, who record it from *Lysandra coridon* (Poda) and *Polyommatus icarus*). Reared material in NMS had remained unidentified for many years (e. g. recorded as *Cotesia* sp. in Shaw, 1996), but Papp's interpretation is followed here.

In NMS there are 14 British specimens reared from *P. icarus* collected from a wide spread of localities in England, and in S.E. Scotland (VCs 2, 11, 54, 58, 61, 83; *K. P. Bland, R. L. H. Dennis, J. L. Gregory, M. Oates, R. Menéndes Martínez*), eight specimens from *Aricia agestis* collected from both *Geranium molle* and *Erodium cicutarium* in central E. England (VCs 28, 53, 54; *R. Menéndes Martínez*), and four from *Aricia artaxerxes* collected on *Helianthemum nummularium* in S. E. Scotland and N. England (VCs 57, 69, 81, 82; *P. Summers*). Additionally there is a specimen from *Lysandra coridon* collected in Germany (Bavaria; *K. Fiedler*; don. J. Papp), three specimens from *?P. icarus* collected in France (Var, Hautes-Alpes; *M. R. Shaw*),

two from *Polyommatus amandus* (Schneider) collected in Spain (Granada; *F. Gil-T, M. Ginés Muñoz*), and one from either *Aricia cramera* (Eschscholtz) or *A. agestis* also from Spain (Asturias; *M. Ginés Muñoz*).

A few of the individuals seen from *Aricia* are rather small, with somewhat more divergent eyes and consequently a relatively wide face. While they could be mistaken for specimens of *C. astrarches* with a brood size of one, others from *Aricia* are more typical of *C. saltatoria* and, even in the less typical examples, the anterior tentorial pit is only marginally closer to the mandible than the eye (cf. Figs 7 and 14) and the cocoon colour is bright. Therefore the variation seen is interpreted as the result of the relatively small size of the host species compared with *Polyommatus*.

Cotesia tenebrosa (Wesmael)

Although the type material of *Microgaster tenebrosus* Wesmael was not reared, there is no reason to doubt the current interpretation (Papp, 1986). The appearance of the name on the British check list (Fitton *et al.*, 1978, who list *Apanteles tenebrosus* as a synonym of *A. saltator* (Thunberg) [a non-British species] following Shenefelt, 1972) has, however, been at variance with this, as can be seen from the various non-lycaenid hosts listed for it by Shenefelt (1972). Papp (1986) showed that Nixon's (1974) interpretation of "*Apanteles arcticus* Thomson" was incorrect, but the situation is more complicated than Papp's (1986) conclusion that [*Cotesia*] *tenebrosa* is the correct name, and that *Apanteles astrarches* Marshall is probably a synonym, as the two species had been confounded in Nixon's (1974) concept (see under *C. astrarches*, above).

In NMS there are British broods of *C. tenebrosa* from *Lysandra bellargus* (Rottemburg) (ca seven broods, *J. A. Thomas*), *L. ?coridon* (*A. Harmer*) and *Plebejus argus* (*K. Murray*) from S. England (VC 9), and *Polyommatus icarus* from both N. Wales and central E. Scotland (VCs 48, 90; *M. J. Morgan, R. M. Lyszkowski*). In addition there are broods from *P. argus* collected in Finland (Åland; *V. Hyryläinen*), *L. bellargus* in Andorra (*J. Dantart*), *?P. icarus* (two broods) in France (Var; *M. R. Shaw*) and a total of five broods in Spain, from *Everes alcetas* (Hoffmannsegg) (Girona; *M. Ginés Muñoz*), *Lysandra arragonensis* (Gerhard) (Albacete; *M. Ginés Muñoz*), *L. albicans* (Herrich-Schäffer) (Granada; *M. Ginés Muñoz*), *L. coridon* (Lerida; *M. Ginés Muñoz*), and *Meleageria daphnis* (Denis & Schiffermüller) (Burgos; *M. Ginés Muñoz*).

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SHORT COMMUNICATIONS

Host plants of the Pale Mottled Willow *Paradrina clavipalpis* (Scop.) (Lepidoptera: Noctuidae). – With reference to Len Winokur's communication (2007) about finding a larva of *P. clavipalpis* within a spun leaf of goat willow *Salix caprea*, near Winchester (VC 12), one needs to decide whether it is a realistic food plant or not.

The Victorian, Edwardian and pre-war II lepidopterists, not having the advantages of ultra-violet light to find species, had to rely mainly on fieldwork. Scorer (1913) listed Poaceae (grasses), *Pisum* (pea) and seeds of *Plantago* (plantains). Allan (1949), a renowned fieldworker and author, listed *Plantago* spp., *Stellaria media* (chickweed), *Triticum vulgare* (wheat), on the grains and *Pisum sativum* (field pea), on the seeds. I have beaten and searched *Salix* at a number of sites in VC 11 and 12 (Dobson, 1989) where *P. clavipalpis* imagines have occurred at light, but never found the larvae on bushes or trees. I think it is evident that *P. clavipalpis* is not arboreal and that *Salix* is not its food plant and that it is simply a 'tourist' i.e. a non-predatory species that has no lasting association with the plant, but may be attracted for shelter, sun-basking or sexual display (Moran & Southwood, 1982).

I have witnessed, though rarely, other species exhibiting apparently unusual behaviour. One example was of the copper underwing *Amphipyra pyramidea* (L.) an arboreal species; I found a larva feeding on prostrate *Cotoneaster horizontalis* in a garden far removed from shrubs and trees at Sparsholt College (VC 11). The most puzzling host association occurred in April 1964, when I collected a disused song thrush's nest, which was 1 m up in a thick hedge at Cullompton (VC 3). In school, the children in my class carefully dismantled the nest to discover its composition. To our surprise there was a noctuid pupa within the base. I retained the pupa and on 24.v.1964 an adult clouded-bordered brindle *Apamea crenata* (Hufn.) emerged. This species, like *P. clavipalpis* is also a ground level feeding species, firstly on the flowers and immature seeds of Poaceae and later on the foliage; the pupa is in a loose cell spun amongst the roots of grasses (Emmet & Heath, 1983). Perhaps the reason for the larva spinning in the bird's nest was that its composition appeared like a tangle of roots. A clue for the *clavipalpis* larva's behaviour might be wood; it has been stated 'the pupa is in a tough cocoon of silk and other available material such as abraded wood and vegetable debris (ibid. p. 281). Was the larva attracted to the base of *Salix* by its woody stem? Why did both individual larvae climb up from ground level? Perhaps both were escaping adverse conditions on the ground.

I have experienced larvae of *P. clavipalpis* feeding well above the ground, because of human activity. On 5.i.1990 I answered a request for help by visiting Mr. & Mrs. Frith's cottage in Chestnut Avenue, Eastleigh (VC 11). They were being inundated by numerous larvae dropping from the thatch and falling down the chimneys. The cottage had been re-thatched the previous year with wheat reed on which, I presumed, many ova of the culprit, *P. clavipalpis*, had been laid. Barry Goater (1974) stated that, 'it was frequent in towns . . . and throughout the agricultural belt, where the larvae could be a minor pest in grain stacks and in growing wheat at harvest (CHD); the larva probably also feeds on wild grasses in chalk pasture.' C.H. Dixon lived at Northbridge Farm, Micheldever just under seven kilometres from where Winokur's larva was found. Changes in agricultural practices have removed this species from wheat and pea crops grown there and elsewhere.

I do agree with Len Winokur that *S. caprea* is a popular food plant for Lepidoptera. In an unpublished paper (1984) produced for the local Wild Life Trust, I compiled a list of food plants of Lepidoptera found in North Hampshire (VC 12) and the number of larval species per plant to show the relative importance of certain

plants to Lepidoptera, as a guide for conservation. The compilation was based on Lepidoptera species listed in Goater (1974), but excluding species with fewer than five specimens recorded and non-breeding migrant species. Food plants were listed from my experience and the literature: Scorer (1913), Stokoe (1948), Allan (1949), Emmet (1988) and Emmet and Heath (1979 & 1983). Top of the list for host trees were *S. caprea* (goat willow) and *Quercus* spp. (deciduous oaks), with 180 species each, followed by *Betula* spp. (birch) 175, and *Crataegus* spp. (hawthorns) 150. – A.H. DOBSON, 282 Britten Road, Basingstoke RG22 4HR.

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***Holcostethus vernalis* (Wolff) (Hem.: Pentatomidae) and *Bathysolen nubilus* (Fallén) (Hem.: Coreidae) in Hampshire.** – On 29 May 2007, I swept an adult male *H. vernalis* from a rough grassy glade in an abandoned orchard in Lock's Heath, South Hampshire (VC11) (SU5006). This appears to be the first record of this species in Hampshire (Bernard Nau, *pers. comm.*), and my second coming after another single male from the former Ore Power Station, Hastings, East Sussex (TQ8210) on 22 September 2003.

On 4 June 2007, I visited part of the old Royal Aircraft Establishment at Farnborough, North Hampshire (VC12) (SU8654), where a large area of black medick *Medicago lupulina* had developed on foundations of a building demolished in 2002. Having found *B. nubilus* in similar places in Essex and Kent in recent years, I was unsurprised to find adults under the first rosette examined. These appear to be the first seen in Hampshire, and a westerly extension to its known range, lying some 35km from Surbiton, where I found it new for Surrey in 1998. JONTY DENTON, 29 Yarnhams Close, Four Marks, Hants, GU34 5DH.

BENHS INDOOR MEETING

13 March 2007

The President, Mr N. M. HALL chaired the last meeting of the British Entomological & Natural History Society to be held in the rooms of the Royal Entomological Society, due to the premises at 41 Queen's Gate, London SW7 being sold.

The death was announced of Mr ERIC GOWING-SCOPES, (librarian helper at the RES Library for many years) who joined the Society in 1936.

Mr K. MERRIFIELD showed a specimen of an ephydrid fly, *Linnellia quadrata* (Fallén) found on the outside of a window at Eastcote, Middlesex on 10.iii.2007. He also showed a scale insect, probably *Coccus hesperidum* L., on a pot plant cyclamen.

Mr P. HODGE showed an oil beetle, *Meloe proscarabaeus* L. taken at Peasmarsh, Sussex.

Dr R. BOOTH noted that the first larval or triungulin stage in the life cycle of oil beetles needs to be picked up by certain species of soil-nesting solitary bee if the larvae are to complete their development. This means that adult oil beetles can appear in places where they have not previously been recorded, thanks to solitary bees providing a means of dispersal. He also said that identification keys for oil beetles that are based on colour differences are unreliable.

Mr A. J. HALSTEAD showed an infestation of the Acacia sucker or psyllid, *Acizzia uncatoides* (Ferris) on the shoot tips of *Acacia retinodes* Schlecht. from a private garden in East Molesey, Surrey. This non-native pest was first recorded in Britain in 1990 and it continues to come into the country on imported *Acacia* spp.

Mr J. BADMIN showed a recently published test version of the Field Studies Council's AIDGAP key to adult caddis flies.

The following persons were approved by Council as members of the Society:

Mr Michael Bailey, Mr Andrew Banthorpe, Miss Stella Beavan, Mr Michael Blencowe, Mr David Bradley, Mr Kevin Coker, Mrs Faith Darlow, Mr Ronald Elliott, Mr Mark Hammond, Mrs Jan Heaney, Mr David Hodges, Mr Christopher D. Jones, Mr Anthony J Kingston, Mr Ashley Leftwich, Mr Vlad Prolov, Dr Michael Snow and Mr Evan S. White.

The Hon. Secretary asked the people at the meeting to contribute to a collection for the RES caretaker, Mr David Beeson, to show the Society's appreciation of the assistance given to the BENHS during the time it had been holding its meetings at 41 Queen's Gate.

There were no Communications and the Ordinary meeting was then followed by the Annual General Meeting (*BJENH* 20:95-110).

Dipterists Forum Fly Identification Workshops

Preston Montford Field Centre. Friday 7-Sunday 9 March 2008

Beginner's Workshop: How to get going on identification of Diptera. Tutors, Stuart Ball and Roger Morris.

Advanced Workshop: Tackling parasitic flies – Tachinidae and Rhinophoridae. Tutors, Matt Smith and Chris Raper.

For more details contact Tel: 0845 330 7378, Email: enquiries.pm@field-studies-council.org.

BOOK REVIEWS

Six Legs Better – A cultural review of myrmecology by Charlotte Sleigh. (Johns Hopkins University Press, Baltimore, 2006). 302pp. Hard cover £36.50. ISBN 0-8018-8445-4.

As someone who has spent a lifetime working on the ecology and population dynamics of ants I usually describe myself as “a professional myrmecologist”. I was fascinated to read about the origins of the term myrmecology in Charlotte Sleigh’s book: *Six legs better – A cultural history of myrmecology*. Apparently I and many others, now use the term more generally than was intended when William Morton Wheeler, the famous American ant specialist, first used it in 1906. Sleigh points out that he used ants as exemplars to understand the evolution of complex behaviours by making detailed holistic studies of their life-styles in relation to their taxonomy. Wheeler was anxious to ensure that his work would not be dismissed as mere “natural history” by the majority of laboratory-based biologists. Similar slurs – “Of course he’s only interested in ants” – were still in vogue as late as the mid 1970s when I developed aspects of Michael Brian’s detailed experimental studies of queen control and brood development of the red ant *Myrmica rubra*, to try to understand the ecological basis of why very closely related species have quite different social structures. The importance of such comparative studies was not fully appreciated until Edward O. Wilson published “*Insect Societies*” in 1971, where among many other things he highlighted the importance in many ecosystems of social insects in general and ants in particular. In Britain this was given practical credence when my colleague Jeremy Thomas and I demonstrated the vital importance to practical nature conservation in Europe, of understanding the role of ants in the life cycle of Large blue butterflies (there are five species belonging to the *Maculinea arion* complex in Europe and all figure on Red Data lists).

Wilson has become a world figure in biology especially as an authority on biodiversity and in the field he called sociobiology, which brings us back to Charlotte Sleigh’s *Six legs better*. The crux of her book is the thesis that myrmecology (as defined by Wheeler) right up to the present has been shaped and developed by three giants – the Swiss Auguste Forel 1848–1931 and the Americans William Morton Wheeler 1865–1937 and Edward O. Wilson 1929– . While nobody can deny that they are probably the three greatest “ant-men” I find it hard to understand why no exploration is made of William Hamilton’s impact via his theory of “Inclusive fitness” other than a transient mention that Wilson favoured his ideas. The predicted consequences of Hamilton’s theory for behaviour and sociality in insects, especially ants, has been the preoccupation of most ant-biologists throughout the second half of my career, especially geneticists who have tested the predictions “*ad nauseam*”.

The book is very American-centric, which is not surprising given that it is based on the published and unpublished works and correspondence of the primary characters, it would be strange if over their careers much of their scientific interactions had not been with their own compatriots. This makes the book slightly irritating for a British reader and no doubt some other European audiences. It is written in an historian’s style with facts, hearsay and anecdotes mixed together, which I found interesting and readable when I dipped into any of the various sub-titled sections but made the historical chain of argument hard to follow.

The are three parts, more or less in the chronological order of the three giants under the headings Psychological ants (41pp, 2 chapters), Sociological ants (100pp, 5 chapters, the last of which is an interesting essay entitled “Ants in the Library – an interlude”) and Communicational ants (56pp, 2 chapters) followed by a short conclusional chapter, a list of notes numbered by chapter and a very interesting short Essay on the Sources. Forel’s early life is outlined in part I, and is set into context

with the great events of the times and his development of a love for ants which first influenced his interest in psychiatry and later was influenced by his work with the mentally ill. While undoubtedly specialists and historians such as Sleigh, will always be interested in that aspect of his work, Forel joined the immortals among ant-men mostly through his pioneering work on ant taxonomy. I knew he was a prolific author but until I read this book I didn't know that Forel's collection comprised 3,500 species all described by himself. Therefore a substantial part of this section is devoted to Forel's interactions with and influence on other ant taxonomists of his time.

Charlotte Sleigh portrays Forel as a serious, puritanical and somewhat obsessed personality who, in the end, falls out with most rival scientists with the exception of Carlo Emery. From my reading it seems that Forel was 'The Authority', all was well as long as people deferred to his opinion, sent him material and did not become rivals, as did Wheeler in later life. People like our own W.C. Crawley are accused of obscurantism and being too frivolous for the austere Forel, while Horace Donisthorpe "extended the tradition of Englishmen who failed to understand or refused to accept the etiquette of exchange". There is no doubt that Donisthorpe is a pygmy ant-taxonomist compared to Forel but just possibly such "junior" members of the taxonomist's race sent material to their "senior" and found it named and described with no acknowledgement of themselves. Believe it or not, such things are not unknown today.

I am not sure how I would get on with Forel if I had access to a time machine but Wheeler on the other hand, seemed to be a different kettle of fish. In the first paragraph of section II Sleigh paints a picture of a man who I would have loved to have met and discussed ants with, and perhaps sampled some of his "bootlegger's goods". This section includes a potted biography of Wheeler and shows how he struggled to place the study of ants into what I suppose we would call a "modern scientific context", taking it beyond mere natural history of the 19th century (Isn't God's creation complex and wonderful? and all that) or the attempts of seeing ants' behaviour as some sort of psychological continuum culminating in our own. Much of this is concerned with the influence of natural history on the science of the time particularly in an American context, while interesting it seems rather irrelevant to a European audience. Running through this section is the concept of an ant colony as a sociological unit or super-organism bound together by mutual feeding or trophallaxis, later shown to be regulated by chemical signalling often seen as control by one part of the society over another. Certainly this was the prevailing view when I started working on ants in 1961.

By the time I was doing my first research on ants Wilson had already been working with ants for almost 15 years, during which time he had made quite a name for himself, particularly in his development of ideas of biodiversity in relation to island biogeography. Sleigh shows how at that time he was already gathering the data and formulating the ideas that lead to his (in terms of ant research) three most influential books *The Insect Societies*, *Sociobiology* and *The Ants* (the latter with his colleague Bert Hölldobler). Apparently, Wilson rejected the importance of trophallaxis and the idea of the colony as a super-organism preferring to emphasise the importance of pheromones in social interactions and behaviours of individuals. Arguably this is why so many biologists turned to ants when trying to test predictions based on Hamilton's inclusive fitness theory. On the three or four occasions I have met Wilson I found him to be a very perceptive, knowledgeable and nice man. However his career has not always been a tranquil one, he once told me how, in the middle of a public lecture, he was symbolically tarred and feathered (albeit only with molasses) by students of colleagues who violently disagreed with his views on the importance of

inheritance in determining behaviour. Sleigh gives one a flavour of such rivalries in these chapters.

So, who is going to read this book? It surely will be better received in America than in Europe, where it might be useful to students on history of science courses. I am not sure how many practising ant-researchers will read it cover-to-cover. As I said earlier, I found it very interesting to dip into but hard to follow as a whole. Maybe non-myrmecologists will find it fascinating and accept the causal connections uncritically. In the end I was left with a feeling that not many of my older European colleagues (many now dead) would have recognised such a clear chain of intellectual descent as that proposed. Perhaps my problem will be typical for other myrmecologists who specialise within the specialism of myrmecology; after 45 years study I know too much to accept Sleigh's account uncritically and too little to really evaluate it as a "true" history of myrmecology. Despite this I recommend it to any younger scientist studying ants if only to discover that myrmecology did not begin in 1990 with the publication of *The Ants*.

GRAHAM W. ELMES

Atlas of the Millipedes (Diplopoda) of Britain and Ireland by Paul Lee, with a contribution from Paul T. Harding. Photographs by Steve Hopkin and Paul Richards. Pensoft, Sofia-Moscow, 2006, 216pp. Pensoft Series Faunistica 59. Hardback. €32.00. ISSN 1312-0174, ISBN 978-954-642-277-4.

This Atlas is the culmination of a considerable amount of recording activity by members of the British Myriapod and Isopod Group. A Preliminary Atlas was published by the UK Biological Records Centre in 1988 but the offspring is in a different class altogether. The core of the book is the series of distribution maps for each species known from Britain and Ireland, showing the general coverage achieved by the recording scheme with positive records superimposed, which gives an at-a-glance comparison of distribution in relation to effort. The coverage is impressive for such an 'unpopular' group of invertebrates. Alongside each distribution map is a page of information which discusses what is known about the species' biology and ecology. While interpretation of the densities of 10km squares with records are always difficult to assess, the broader picture illustrates the ranges of the species very well. Thus my favourite millipede, the bristly *Polyxenus lagurus*, is shown to be widespread across much of southern and south-eastern England, but to be sparsely distributed elsewhere, where coastal situations are more frequent than inland ones. This certainly accords with my own experience of the species. A total of 56 species distribution maps is presented.

The maps are preceded by a foreword by Desmond Kime, introductory text on the British and Irish fauna, ecology, life histories, collecting and recording, identification and keys by Paul Lee, plus a review of millipede recording in Britain and Ireland by Paul Harding. A full and up-to-date checklist is a particularly useful feature. The most recent Scheme Recording Cards have included a structured classification of habitat associations and environmental features, and this data set is analysed towards the end of the book. There follow short sections on conservation and future recording – three species have been identified as Priority Species in the UK Biodiversity Action Plan: *Metatulus pratensis*, *Polyzonium germanicum* and *Trachysphaera lobata*, and the rationale is briefly outlined.

Overall, this is a key publication for those of us involved in the study and conservation of invertebrates, and will also be especially valuable for local records centres, translating obscure scientific names into knowledge of distribution and ecology.

KEITH N. A. ALEXANDER

Guide des papillons nocturnes de France edited by Roland Robineau. (Delachaux & Niestle SA, Paris, 2007). 288pp. ISBN 978-2-603-01429-5, €28.

I obtained a copy of this wonderful book two days before embarking on a collecting trip in the French Alps and found that it was hardly out of my hands, it became the only moth book in my travelling library that I consulted. Since becoming interested in European moths a few years ago this is the book I have been waiting for; a concise, well illustrated treatment of the French moths, a French 'Skinner', in fact.

The book, which is in French, has been written by a collective of amateur entomologists and contains a preface by Pierre Viette. Nobody should be put off by the language, with only the most pathetic schoolboy French at my command I have only had to look up one or two words. After a brief introduction comes a systematic list of the 1620 species covered, in which the modern ideas of Hausmann and Mironov and Fibiger, Ronkay and Beck are reflected. Numbers used in the check lists of Leraut (1997) and Karsholt & Razowski (1996) are given to facilitate cross referencing. The traditional 'macro' families with which English readers will be familiar are covered with the exception of Zygaenidae and Sesiidae and the addition of families not represented in the British Isles, Thyrididae, Lemoniidae, Axiidae and Castniidae. I should perhaps say that in spite of the title diurnal species are included. There follows a section describing changes to the nomenclature, additions and deletions since Leraut's check list with notes explaining and referencing them. There is also a page on wing morphology, a list of abbreviations and a useful two page description of the various zoogeographic areas before the main body of the work.

The species descriptions which follow are brief but comprehensive. In each case the scientific name is given in full, followed by the French vernacular name or names. Then follow the distribution of the species, distribution in France, comments on the preferred habitat and altitude extent. There are no distribution maps in order to save space and because in many cases a species' distribution is not well enough known. Comments on behaviour and such points as sexual dimorphism, larval foodplants and preferences, flight period and voltinism follow. All this information is typically included in less than ten lines, in a half page column. Each species is referenced by number to a plate. The plates are photographs of set specimens against a white background, the majority of which are by Yann Baillet and are of such high quality that I originally thought they were by David Wilson; they certainly follow his style. The plates are clearly printed with high definition in marked contrast to some recent works. The majority of plates are life size but some of the smaller species, pugs and so on, are magnified. The magnification is clearly shown on each of the 55 plates. Each species is typically illustrated with only one photograph unless there is marked dimorphism when there can be up to five. In addition there are a number of line drawings by Yves Doux illustrating critical identification points in a way that has now become familiar to us. Again, these drawings are clear and of high quality. It is interesting to note a number of identification points on common English moths which I had not seen highlighted previously, as for example the underside characters of *Plusia putnami* (Grote) and *P. festucae* (L.). There are 36 of these sets of similar insects, in the case of the Footmen, nearly a whole page, but inevitably I would have liked to see these drawings extended to some other groups where I have particular identification problems!

The volume concludes with a bibliography, glossary, index and a fascinating little section on the entomologists cited in this work; I am astounded to learn from this that Duponchel published 7600 pages in only ten years; and finally a list of societies, groups, addresses and websites.

My copy was delivered to my door for just over £22 and it is difficult to see how a book of this quality could have been produced so cheaply, one can only hope that it will enjoy the high sales it deserves. This volume is very much an identification guide and is not intended to compete with the major works on European Noctuidae and Geometridae which are ongoing, although the authors have tried to include the latest information. In its format, it is case bound 255mm x 205mm without a dust jacket, it is easy to accommodate in one's luggage and I cannot recommend it highly enough to those with an interest in Lepidoptera visiting France and neighbouring countries and also to those who do not collect abroad, but who wish to see what the next new migrant may be.

A. J. PICKLES

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Fleas (Siphonaptera) by Amoret P. Whitaker. 2007. Handbooks for the Identification of British Insects. Volume 1 Part 16 (2nd Edition). 177pp. Published for the Royal Entomological Society by the Field Studies Council, Shrewsbury. Softback. £19.00. ISBN 978-0-90154-685-2.

The RES Handbook on fleas by Frans Smit published in 1957 has remained the standard identification guide to species of British Siphonaptera for over half a century. Distribution data on each flea species was printed as a separate publication as a supplement to the Handbook (Smit, 1957). Since this time the main features used for identification of fleas have remained virtually unchanged and so the author has retained the general outline of the original keys and concentrated on simplifying the wording with the aim of reaching a wider audience. The text has been expanded to include six additional species, making a total of 62 found in the British Isles.

The Introduction includes sections on biology, morphology, distribution, epidemiological significance, systematics and techniques for the collection and preservation of fleas. The high conservation status attributed to our native mammals and birds today means that a licence is necessary to handle most vertebrate hosts. The alternative is to persuade colleagues who trap these species for scientific survey to search for fleas on your behalf. Nowadays many counties have their own mammalian and avian study groups and can be approached for assistance. No species of flea is currently considered to be endangered, but if a host species were to become critically reduced in numbers, any flea specific to that host would naturally also become endangered.

In 1957 two superfamilies were recognised: Pulicoidea and Ceratophylloidea. Today the Order is divided into five superfamilies: Pulicoidea, Ceratophylloidea, Hystrichopsylloidea, Vermipsylloidea and Malacopsylloidea, as recognised by Smit (1982). The Malacopsylloidea are not represented in the British fauna. One taxon in the 1957 Handbook, *Ctenophthalmus bisoctodentatus occidentalis* Smit has been synonymised with *C. bisoctodentatus heselhausi* (Ouedemans). The species added to the British list are *Ischnopsyllus variabilis* (Wagner), *Ceratophyllus fionnus* Usher, *Ceratophyllus chasteli* Beaucournu *et al.*, *Ceratophyllus anisus* Rothschild, *Palaepsyllus soricis vesperi* Smit and *Chaetopsylla trichosa* Kohaut.

The main section (120pp) is devoted to the keys. Most of the figures are from the original publication but more than 30 additional figures have been included in the new Handbook. All are of an extremely high standard and have an intrinsic beauty

of their own. A glossary of terms and 7 figures are provided to illustrate the general morphology of fleas showing the position of the characters used in the keys and descriptions. The author recommends that those unfamiliar with fleas should first identify their specimens to family level using the basic family key which will then direct them to one of the keys for each of the seven families. Each couplet of the key is accompanied on the same page by two or more figures making the key easy to use. Species can be further checked with additional descriptions given later in the book, together with published distributional data. For each species the data are broken down to: host species, with county and distribution reference numbers in brackets, thereby allowing all the existing literature on that species to be accessed, a remarkable achievement.

For example, four sets of distributional records are given for the human flea *Pulex irritans* L. This species is widely recognised as being associated with humans, but no other primates are generally infested with fleas, and it is probable that man may be a secondary host, the primary ones being mammals which nest such as the fox, badger and domesticated animals such as dogs and cats. Host records are split into *Homo sapiens*, secondary hosts, accidental hosts (e.g. otter) and 'unspecified host, generally "house" ' – even Surrey and London are listed here, all neatly cross-referenced.

The Handbook is a delight to use and the author and the Royal Entomological Society are to be congratulated in publishing a fully comprehensive, extremely well illustrated key to a small, but important Order of British insects. A spur to further work will occur when an updated Atlas of British Fleas by Robert George is published in the near future.

JOHN BADMIN

ANNOUNCEMENT

Conserving Scotland's Invertebrates – a fresh approach. – No-one can doubt the importance of invertebrates for the environment whether it is for their contributions to ecological services like pollination and waste disposal or for the simple pleasures of seeing butterflies and bumblebees in gardens and countryside alike. Yet many invertebrates in Scotland are threatened and need conserving.

The Initiative for Scottish Invertebrates is at present a non-constituted alliance of individuals and organisations working on Scottish invertebrates. The group is currently consulting with as wide a range of interested parties as possible to gather opinions and data towards developing a conservation strategy for Scottish invertebrates.

The Conserving Scottish Invertebrates project, funded by Scottish Natural Heritage and coordinated by Buglife – The Invertebrate Conservation Trust, will seek a broad consensus among entomologists and conservationists around the actions detailed in the strategy. In addition, it aims to raise awareness of Scotland's important and distinctive invertebrate fauna amongst the public, conservation organisations and decision makers.

This is a timely and unique opportunity to make a difference for invertebrates in Scotland. For the project to succeed we need to engage with as many individuals as possible with an interest in Scottish invertebrates.

We hope you will respond positively to this opportunity and contribute to the development of the conservation strategy. In the meantime, if you would like to learn more about the project or join the Scottish Invertebrate discussion forum then please contact Craig Macadam at the address below.

Craig Macadam, Conservation Officer (Scotland), Buglife – the Invertebrate Conservation Trust, Balallan House, 24 Allan Park, Stirling, FK8 2QG. Tel: 01786 447504. Email: craig.macadam@buglife.org.uk

Bugs Britannica: We want your help

I am fielding a new project about insects and other invertebrates which I hope you will consider contributing to. It is called Bugs Britannica. The basic idea is to collect as much information we can find about the ways in which the British people interact with British invertebrates, whether as visitors to our gardens and homes, as objects of superstition or symbolic power, or as a significant presence in poetry, art, film and fiction. We are interested in any local names, such as cheesy-bugs for woodlice or forky-tails for earwigs. We would be interested to know of any restaurants named after insects (or other invertebrates), or products that use them in some way.

In other words, we are looking at the ways in which invertebrates enter and enrich our lives. Hence Bugs Britannica will not be an encyclopaedia of invertebrate natural history, or a guide to identification, but an exploration of the common ground between invertebrates and ourselves. Bugs Britannica will be about the things the field guides and textbooks leave out.

The project is to be written up as a book of which I am the main author, along with Richard Mabey, author of *Flora Britannica* and co-author of *Birds Britannica*. Bugs Britannica shares the same publisher, and the same philosophy, as these highly-praised and successful book projects. Like them, the book will be richly illustrated and full of imagination and insight (and the odd joke). Of course, it will have to cover far more species than its predecessors, especially as I aim to include all land and freshwater invertebrates, and also those of the seashore down to low tide level. Hence it will include not only slugs and garden snails but cockles and oysters, not only woodlice and centipedes, but crabs and prawns. However, since Bugs Britannica, almost by definition, will be about familiar animals that attract attention to themselves, it does not need to pay close attention to species known only to specialists and have no English name. Indeed much of the content is likely to be about generic groups of invertebrates, slugs rather than *Deroceras* and *Testacella*, blow-flies and horse-flies, not species by species, since it is that form, mostly, that they enter our literature and popular discourse. On the other hand, I can envisage an entry for every British butterfly, and many grasshoppers, dragonflies, leeches and moths. It will, I'm pretty confident, be a riveting, informative and amusing read, and contain perhaps surprising explanations for many common names, nursery rhymes, everyday expressions, and historical incidents.

Perhaps I should apologise for the title. Not everyone likes their favourite species described as a bug. Please read 'bugs' as a necessarily punchy short-hand title for the market, and not in any demeaning sense. All 'bugs' are interesting, wonderful, and worthy of respect, whether they are dragonflies, silverfish, maggots, cockles, earthworms or crabs (and I agree, a cockle isn't in any normal sense a bug).

You can find more details of the project at: www.randomhouse.co.uk/bugsbritannica. This site includes a blog with 160 contributions logged by the start of October.

If, as I hope, you would like to contribute to Bugs Britannica, you can do so either through the blog (which is best suited to short messages), through the Society, or by writing to me at: Bugs Britannica, PO Box 1375, London SW1V 2SA. All contributions will be acknowledged in the forthcoming book.

As to when Bugs Britannica is to be published, this depends on various imponderables, but most likely in 2009 or 2010. I hope to drop in a progress report from time to time.

PETER MARREN

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