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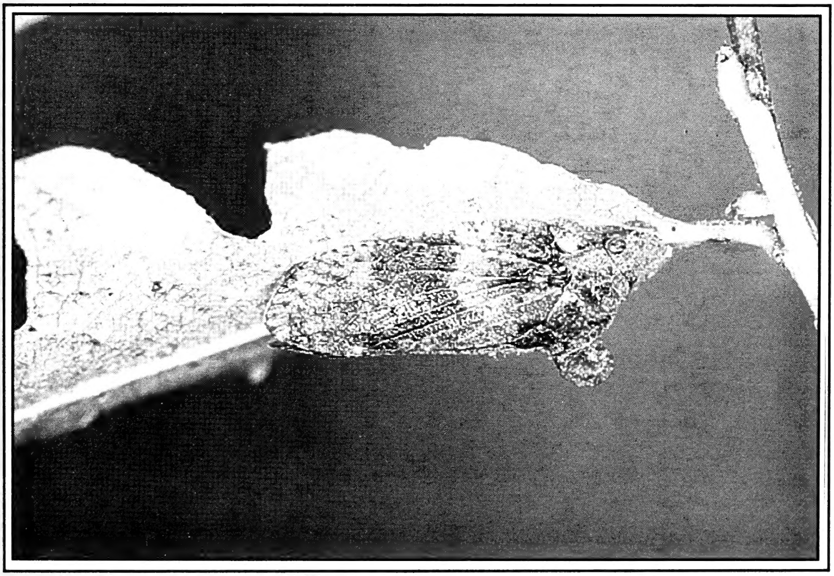

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Cover illustration: adult *Ledra aurita*, the largest European leafhopper. photo: A. J. A. Stewart

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AN ESTIMATE OF THE RANGE AND POPULATION LEVELS OF FISHER'S ESTUARINE MOTH (*GORTYNA BORELII LUNATA* FREYER), (LEP.: NOCTUIDAE) IN ESSEX, JULY AND OCTOBER 1996

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Fisher's estuarine moth (*Gortyna borelii lunata* Freyer) was first discovered in 1968 by Mr Ben Fisher at a lighted window of his home at Beaumont-cum-Moze in Essex. It was soon realized that the only home of this insect in the United Kingdom is the islands and inlets of nearby Hamford Water where it is an internal feeder on hog's fennel (*Peucedanum officinale* L.). The moth is illustrated in Skinner (1984) Plate 39, Fig. 3. The Essex Wildlife Trust has monitored the population of adults by mercury vapour light and by searching with torches on its Skipper's Island reserve almost every year since 1971. This monitoring has generally yielded very small numbers of moths, with three years showing none, and an average of under 14 individuals in years when the insect appears. Recent years have generally been better and 33 adults were recorded in 1995 (Table 1). These results have led to the conclusion that the moth exists at relatively low population levels and is subject to wide fluctuations in numbers from year to year. My understanding is that no attempt is made to standardize recording effort and methods, and it seems possible that this may contribute to the variation in results. Larval surveys have also been undertaken but the results are not available. BENHS members who have visited the Hamford Water area over the years report that the larvae are easy to find and often common in June and July, and that adults are fairly common at mercury vapour light later in the year. It has been reported to us that sixteen adults were recorded at light one night in the autumn of 1995. At a council meeting of the BENHS in 1996 concern was shown

Year	Skipper's Island	Beaumont Quay
1971	7	–
1972	9	–
1973	0	–
1974	0	–
1975	1	–
1976	25	–
1978	12	–
1979	40	–
1981	0	–
1983	13	–
1986	4	–
1994	11	–
1995	33	–
1996	9	~17
1997	–	14

Table 1. Essex Wildlife Trust annual survey for adults of *G. borelii*.

The number of damaged stems on a plant	The number of plants showing this damage
1	20
2	16
3	24
4	18
5	12
6	4
7	6
8	3
9	2
10	0
11	2
12	1
16	1
19	1
22	1
25	1

Table 2. Frequency of damaged stems per plant.

over the disparity between the abundance of *G. borelii* as reported by the Essex Wildlife Trust and in reports from our own members, particularly as this information may be used as the basis for legislation. In addition the exact range of the species within the Hamford Water area was not known with certainty. In an attempt to reconcile these facts a survey was organized to gain information about the current range of the moth together with an indication of population levels at some of the sites.

METHODS

Two main methods of surveying for *G. borelii* were considered. The first was searching for larval workings in the summer and the second was attracting adults to mercury vapour light and searching with torches in October. A survey of larvae in July was considered to be the most effective for a number of reasons. In early July the larvae feed by mining the lower part of stems of the foodplant. They are growing rapidly at this time and produce copious amounts of white frass from the holes in the stem which makes their presence easy to detect. Many plants can be searched and several sites surveyed with relative ease during the course of a day. The white frass is unique to *G. borelii*; no other insect is known to feed on hog's fennel in this way. If mercury vapour lights were used to attract the adults this would be subject to the uncertainties of the autumn weather and other factors which define a good or bad night. On a given night not all adults may fly; when both lights and searching are used about half the records are of moths quietly at rest on or near the foodplant. Some moths may not yet have emerged from the pupa; others may have flown away or died. Finally, with one set of lights only one site can be surveyed per night. In the event both methods were used although the larval survey produced almost all the records.

THE LARVAL SURVEY

The survey team consisted of Reg Arthur, Joe Firmin, Colin Hart, Alan Jenkins, Colin Plant and Bernard Skinner. We arranged to meet near Beaumont Quay on the morning of 12 July 1996 and searched a few plants which grow alongside the B1414 road. We soon discovered that most of the plants had several stems which showed signs of feeding damage but did not contain larvae. Our original information was that the larva enters a stem of hog's fennel at a leaf axil a metre or so above ground and mines its way down, finally leaving the stem near ground level. Closer examination of several plants showed a pattern of stems with progressively larger entrance holes and larger frass pellet size. In stems with smaller holes there was a tendency to yellowing of leaves and stem. On a typical plant there would be three damaged stems and sometimes a pile of frass on the crown of the plant suggesting a larva was now feeding on the underground stem. We confirmed the presence of a larva in a stem only about three or four times. This was because we wanted to minimize disturbance to the larva and its foodplant, and also it is much quicker to count stems exuding frass than to split each stem open and search for the larva within. Without further detailed research we cannot prove that each larva feeds in about three stems before going down to the rootstock, but our field observations suggested that this is probably the case (Table 2). An alternative view is that each larva feeds in only one stem and mortality at this stage is very high, although this seems less likely.

In the early 1970s Don Down reared *G. borelii* through its whole life cycle and found that the second and third instar larvae move from one stem to another when the pith on which they feed is mostly exhausted. This was seen when larvae were reared in boxes and also when feeding on a growing plant of hog's fennel (D. Down, *pers. comm.*). The larvae are dark purple in colour with a pale band between each segment; almost all larvae which are internal feeders are entirely pale coloured. When removed from their feeding place the larvae are active and able to move relatively quickly; both these factors are characteristic of species which move from one stem to another as part of their normal feeding pattern. We assumed that each larva utilized about three stems and for this reason we divided the number of damaged stems recorded on a plant by three to estimate the number of larvae on that particular plant.

The season was slightly advanced and to judge from the conical piles of frass on some of the rootstocks a number of larvae were now feeding underground. The team felt that this did not detract from the survey as the damaged stems exuding frass remain visible for some weeks after the larva has left the stem. A few plants had a large number of damaged stems; 25 was the highest number recorded on a single plant. At this site every plant large enough to support a larva showed signs of feeding damage. It is known that larvae can be cannibalistic when feeding in the rootstock, so on smaller plants only one larva may reach maturity.

We moved on, monitoring a line of plants which grow on the bank of a small brook between the road and the farm near Beaumont Quay. On reaching the sea we were presented with a long area of coastal grassland which stretched along the sea-wall towards Landermere and extended back to the borrowdyke drainage system. This area was scattered throughout with hog's fennel plants. We split into three groups of two and spent the rest of the morning counting plants and larvae in this area on the south side of the inlet (Table 3). A large number of plants were examined and larvae were found on approximately one plant in three. In total 12 man hours were spent on the morning survey.

In the afternoon, having first obtained permission for the visit, CH, AJ, CP and BS visited Exchem Organics at Bramble Island and spent the rest of the day surveying several sites in this extensive locality. In some places hog's fennel was abundant, forming the dominant vegetation over a considerable area. One stand of foodplant was estimated to be half an acre in extent (locally identified as building M17) and another over an acre (P4-Z4). Each site must have contained thousands of plants. Rabbits were present and their grazing had affected the ground vegetation considerably. Rabbits will only eat hog's fennel when their normal food is in short supply, possibly because hog's fennel is distasteful, but almost all other low plants were heavily grazed almost to the point of extinction. With no competition the hog's fennel had formed dense patches up to six feet in height. On these sites it was unrealistic to survey all the plants and so one or more sample areas were paced out and all the plants within the area were monitored. Despite the abundance of foodplant we found relatively few stems damaged by larval feeding (Tables 3 and 4). However, one remote site on Bramble Island resembled the Beaumont Quay-Landermere site in that it consisted of an isolated stand of six mature plants amongst dense grass. All the plants here showed signs of feeding. The afternoon survey occupied 12 man hours.

On the following day two of us (CH and BS) searched other areas surrounding Hamford Water but with very poor results. We searched for colonies of hog's fennel at several sites where the plant had been recorded previously (Thornton, 1990). Only one stand of the plant was found and this was near to a marina at the channel called The Twizzle (TM 247232). The site was a few yards outside the marina fence and contained only twenty plants, many of them tiny. Despite the isolation and small size of the site eight of the plants were inhabited by larvae.

Site description	Total number of plants examined	Plants damaged by borelii larvae	Samples of numbers of damaged stems per plant	Average number of larvae per damaged plant at this site	Estimated total number of larvae
Beaumont Quay—roadside	15	15	3,8,7,4,12,3,11,3,4,2,5,5,5,3,3	1.73	26
Beaumont Quay—N. side of road	22	17	3,7,11,5	2.17	37
Beaumont Quay—riverbank	8	5	4,5,6,16,22	3.53	18
Beaumont Quay—sea wall	13	9	5,5,9	2.11	19
Beaumont Quay—sea wall JF	32	26	25,1,4,3,1,4,6,3,5,1,4,4,1,4,19,2,3,1, 3,3,5,3,2,4,4,7	1.56	41
Beaumont Quay—marsh JF	20	15	1,1,2,7,1,8,3,1,1,5,4,1,4,2	0.98	15
Beaumont Quay JF	9	5	4,2,3,3,3	1.00	5
Beaumont Quay—behind sea wall	9	6	8,4,6,6	2.00	12
Beaumont Quay—to concrete sluice	37	34	5,2,9,3,2,3,1	1.19	40
Beaumont Quay—sea wall to E.	11	7	7,3,3,	1.44	10
Kirby Quay—west side	5	0			0
Kirby Quay—east side	2	0			0
Birch Hall west	0	0			0
Birch Hall east	0	0			0
Opposite Skipper's Island	0	0			0
Kentshill Farm—roadside	0	0			0
Bramble Island—old jetty shed	6	6	4,4,2,2,2,1	1.00	6
Bramble Island—balsa grinding	6	1	1	1.00	1
Marina—eastern edge	20	8	3,3,4	1.00	8
			Estimated total larvae =		238

Table 3. *G. borelii* larval data at sites where all plants were examined.

Site	Site name	Estimated total site area (acre)	Percentage of area sampled	Total number of plants examined	Plants damaged by borelii larvae	Number of damaged stems per plant on a sample of damaged plants (generally 1 plant in 5)	Average number of larvae per damaged plant at this site	Estimated total number of larvae in sample area	Estimated total number of larvae at each site
A	Bramble Island—M17			32	9	2,1,2,1,1	0.47	4.20	
A	Bramble Island—M17 near pond	0.5	2%	25	11	1,2,3,3	0.75	8.25	318
A	Bramble Island—M16			12	12	1,1,2,2	0.56	6.66	
B	Bramble Island—expl test P4-Z4	1.25	4%	38	11	7,5,4	1.77	19.47	486
						Estimated total larvae =			804

Table 4. *G. borelii* larval data at two sites on Bramble Island, Essex, where a sample of plants were examined.

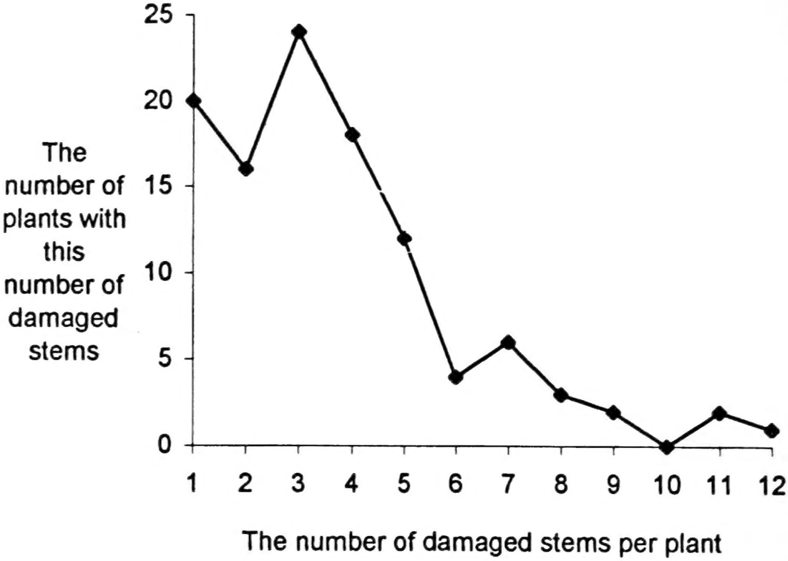

Fig. 1 Frequency of damaged stems on hog's fennel plants.

Fig. 2. Running lights for *G. borelii*, Bernard Skinner, Malcolm Braithwaite, Joe Firmin, Reg Arthur and an Exchem employee.

A few days later CP returned to the area to survey other mainland sites. At Kirby Quay only seven plants were seen and no larvae. Three sites near Birch Hall and facing Skipper's Island were covered with soil from dyke working, apparently in 1993 or 1994, and the plants appeared to have been destroyed.

Most of the sites we visited contained a limited number of plants which allowed every plant to be examined individually for larval damage. We recorded the total number of plants present, and the number which showed signs of feeding larvae. One in every five plants which showed signs of feeding was examined more closely and the number of damaged stems on that plant was counted and recorded.

In the few localities with large stands of foodplant one or more representative areas were selected and all the plants in those areas were examined as before. The total number of larvae was estimated from the proportions of the sample areas to the whole area.

It was earlier mentioned that we formed the opinion that each larva mines about three stems before feeding in the rootstock. This information was unexpected. However, as we had counted all the damaged stems on over 100 plants it was possible that this data may indicate that there were more plants with three and six damaged stems than other numbers. Fig. 1 shows the numbers of plants with each number of damaged stems and does show a peak at 3 stems and may show a second at 7. It must be pointed out that the number of plants with more than 6 damaged stems is low and that this data has not been subjected to any statistical analysis, therefore no firm conclusions can be drawn.

THE SURVEY FOR ADULTS

On 10 October 1996 six members of the BENHS and about eight Exchem employees gathered at the Exchem works on Bramble Island to search and run lights for *G. borelii* (Fig. 2). Six mercury vapour lights were run in two large stands of hog's fennel, the first at P4-Z4, and the second nearby, adjacent to the main access road. An additional area near building M17 was searched by torchlight. Despite over a dozen people actively searching for three hours, only one moth, a freshly emerged female, was found. This moth was discovered at rest on the foodplant near to the access road. It was admired by all present and was photographed before being released at the end of the evening. It was not a good night for running lights as the weather that day was cold and wet, but at least the rain held off for the evening. Despite the poor conditions the Exchem employees searched with enthusiasm and showed a genuine interest in their special moth. I was very thankful that we did find at least one Fisher's estuarine moth to show them. The six mercury vapour lights produced only seven macro species between them. On the way home at about 11 pm we stopped at Beaumont Quay for a quick look over a few easily accessible plants. One moth, again a female, was seen clinging to a dead flower head of hog's fennel.

Although not part of this survey an account of an adult moth attracted to a light states, 'It approached a light at 2300 hours, arrived at high speed and crashed in and around like a large yellow underwing before dropping into the Skinner trap. It gave the appearance of being strongly attracted' (R. Arthur, *pers. comm.*).

CONCLUSIONS

It has been suggested (P. Waring, *pers. comm.*) that the population of *G. borelii* in the Hamford Water area constitutes a single large colony. This means that there is annual mixing of sub-populations from different sites, and even a few moths on a handful of isolated plants can still be part of the main colony. The discovery of about six larvae on a small isolated stand of foodplant (at The Twizzle) tends to support this view. With only two exceptions we found larvae present wherever we found a few plants of hog's fennel. On some sites almost every plant showed signs of feeding damage. *Gortyna borelii* is also present on Skipper's Island and probably other islands which we did not visit. The situation on Bramble Island is very different. Here there is plenty of foodplant but the population density appears to be much lower than at other sites. Research is needed to find out why this apparently excellent resource is not better used. We did notice that pheasants were present at Bramble Island and rabbit grazing was very heavy, resulting in an almost complete absence of grass cover in some areas.

In 1990 Thornton's survey of hog's fennel identified twenty colonies of the plant. In 1996 the current survey visited fourteen of these colonies and found that hog's fennel had disappeared altogether from three of the smaller sites. It was worrying to see that there was a marked reduction in the number of plants at several other sites. This reduction has been caused by dumping soil from dredging or sea defence work and certain farming activities, including ploughing.

Hog's fennel is a robust plant; once established the underground stem can withstand drought, severe cutting as part of scrub clearance, and being buried, at least by a couple of feet of soil. However, dumping several feet of soil onto a plant in the course of channel dredging or reinforcing sea defences will kill it, together with any larvae which may be present. General farm activities such as ploughing and re-seeding rough pasture which previously contained hog's fennel have seriously reduced the number of plants in the fields around Beaumont Quay.

Probably the most serious single threat to the survival of *G. borelii* is mowing the hog's fennel to discourage scrub invasion. In early summer the insect is present as small larvae feeding high up in the stems of hog's fennel. If a site is mown at this time of year it will kill almost all the larvae present. A single cut, taken in August when the larvae are feeding in the underground stems, will greatly reduce the risk to this species. The overwintering eggs are laid on dead grass and hog's fennel stems and leaves. This material should be left *in situ* at the end of the summer and not tidied up or burnt. On many sites the amount of foodplant has reduced over the last ten or fifteen years and this gave us cause for concern. Conservation efforts should be directed towards maintaining a healthy population of hog's fennel plants, especially in those areas identified as favoured habitats for *G. borelii.*

SUMMARY

In a survey which spanned only three days and did not visit several good sites on islands, we found evidence for nearly 1000 larvae; the true population can only be guessed at but must be at least several times this figure. With two exceptions larvae were found at every site which still carried the foodplant, although at some sites the population density was low. At favoured sites all mature plants carried larvae and at most other sites about 30% of plants showed feeding damage. It was not clear why some sites had a very high level of larval damage while at other sites quite close by damage was rare. At all the favoured sites we noticed that hog's fennel grows amongst long rank grass which had to be parted to see the base of the stems. At Bramble Island, where larvae were rare, we noticed that rabbits and pheasants were common and hardly any ground layer vegetation was present. Further research is needed to find the exact conditions which *G. borelii* requires in order to thrive. While breeding the moth in the 1970s Don Down found that eggs were laid in rows tucked

into the sheaths surrounding the stems of long grass, in a very similar manner to that adopted by the White-point (*Mythimna albipuncta* D. & S.) and other members of this genus.

The overall impression is of an insect which is common as a larva in some favoured areas and appears to have increased in numbers in the past few years, but exists at a low level in adjacent and superficially similar areas.

Since the survey was completed it has become generally agreed that considerable mortality occurs between half-grown larvae and adult moths. This will clearly have an effect on results of the larva survey and the cause of this loss is an urgent area for further research. One result of this survey is to highlight the fact that our knowledge of the exact habitat requirements and life history of *G. borelii* is far from complete. Research is needed in several areas and BENHS members should continue to play their part. Amateurs often have more time for monitoring and research than the professional who is necessarily driven by contracts and deadlines. An unintentional side-effect of this survey has been to unearth information on egg-laying and larval feeding which may have considerable conservation importance. One effect of Schedule 5 listing would be to curtail this unofficial amateur research.

In January 1998, just before this report was completed, news of the Essex Sea Wall Management Experiment was received from English Nature. This experiment will subject sections of the sea wall which hold *G. borelii* to four different management regimes. In coming years the fauna and flora will be monitored in detail to record the impact of the different regimes. I should add that all four regimes appear to be an improvement on the management practised up to 1996. The most appropriate regime will be considered for management of other sea walls in Essex and will contribute to the Biodiversity Action Plans for *Gortyna* and *Peucedanum*. It should be remembered that the first priority of a sea wall is to maintain the sea defences, but maintenance of hog's fennel and *G. borelii* are also high priority. The note concludes with the sentence: 'If . . . interested parties would like to take part in the relevant aspects of this experiment in future years, I would love to hear from you.' Interested members should contact Dr Chris Gibson, English Nature, Harbour House, Hythe Quay, Colchester, Essex CO2 8JF.

CAUTION

Many of the sites for *G. borelii* are private property and some of the landowners do not tolerate trespass. Bramble Island is a prohibited area and permission is rarely given for access. We were accompanied by Exchem staff at all times. The conservation of *G. borelii*, its foodplant and environment depend on co-operation between entomologists, conservation bodies and local landowners and this should not be jeopardized.

ACKNOWLEDGEMENTS

I should like to thank the following people for assistance with the surveys: Bernard Skinner, Colin Plant, Alan Jenkins, Joe Firmin, Reg Arthur and Ian Rose. Dr Malcolm Braithwaite of Exchem Organics for permission to survey part of the site, Dr Peter Frith, and other employees of Exchem Organics for their interest and time, The Essex Wildlife Trust for permission to survey The Naze, and English Nature (Eastern Office) for help and advice.

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POSTSCRIPT

In early 1997 the Department of the Environment invited submissions from interested parties on the proposed addition of *G. borelii* to schedule 5 of the Wildlife and Countryside Act (1981). On 4 June 1997 a draft of this paper together with a covering letter setting out the views of Council were submitted to the Species Conservation Branch of the D.O.E. in Bristol.

SHORT COMMUNICATION

Troilism in *Sicus ferrugineus* (L.) (Diptera: Conopidae)—I was interested to read the recent account in this journal of delayed mating in two males and one female of *Conops quadrifasciata* Degeer (Uffen, R. W. J. *Br. J. Ent. Nat. Hist.* 1998; **11**: 30, Plate I, Fig. 2). Many years ago I remember finding three specimens of *Sicus ferrugineus* locked together as one and running around in the sun on a sycamore leaf. At the time I was more interested in the discovery of what was to me then a new and exciting fly than the possibility that I had observed some sort of mate-guarding behaviour.

My memory was jogged a couple of years ago when another interesting short note in this journal reported two males of the sand wasp *Ammophila sabulosa* (L.) (Hymenoptera: Sphecidae) jostling for the attention of a single female (Callow, N. A. *Br. J. Ent. Nat. Hist.* 1991, **4**: 96, Plate IV, Fig. 2). I thought then to write a short comment on my conopid observations, but time slipped by until the appearance of the recent *Conops* note.

The three specimens of *Sicus* still stand in my collection: two males and a female of *Sicus ferrugineus*, taken together '*in copula*' on a sycamore leaf in the sunshine, in the woods above Denton, East Sussex, 30.vii.1970. I clearly recall taking the threesome on a hot July day. Unlike Uffen's tenacious trio, the three *Sicus* separated in the net; one male crawled loose while the true mating pair remained together.

Mate guarding must be quite common in the Conopidae; I have several times seen pairs sitting about on flowers, a male and a female, clinging together, but obviously not coupled. In Nunhead Cemetery and other sites in south-east London I regularly see unattached 'couples' of both *Conops quadrifasciata* and *Conops ceriaeformis* Meigen (the commonest species in this area), sitting together, especially on ragwort flowers.

As with other examples of mate-guarding behaviour, it is probably competition for females which drives the males to invest time and effort in hanging around after the copulatory act. Certainly male conopids always seem to outnumber females, both in the field and also in dipterists' collections.—RICHARD A. JONES, 13 Bellwood Road, Nunhead, London SE15 3DE.

A 'BEE-LOUSE' *BRAULA SCHMITZI* ÖRÖSI-PÁL (DIPTERA: BRAULIDAE) NEW TO THE BRITISH ISLES, AND THE STATUS OF *BRAULA* SPP. IN ENGLAND AND WALES

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The Braulidae ('bee-lice') is a family of wingless and otherwise atypical acalyptrate flies living as inquilines or kleptoparasites (larvae) and as kleptoparasites (adults) in honey bee (*Apis* sp.) colonies. It is a family with a rather chequered taxonomic history, particularly regarding its proposed affinities with related groups (Grimaldi & Underwood, 1986; Peterson, 1987). The genus *Braula* comprises five species and one subspecies (Örösi-Pál, 1966b), and is associated exclusively with *Apis mellifera* L. The only other genus in the family, *Megabraula*, comprises two large species (*M. antecessor* and *M. onerosa*) described by Grimaldi & Underwood (1986) from Nepalese material, and which are both associated with the largest species of honey bee, *Apis laboriosa* Smith.

A map of the international distribution of *Braula* spp. is given by Nixon (1982), and Papp (1984) records three members of the genus as resident in the Palaearctic region: *B. coeca* Nitzsch, *B. orientalis* Örösi-Pál and *B. schmitzi* Örösi-Pál. International records of *B. coeca*, the most ubiquitous species, are detailed by Smith & Caron (1985). However, it is not always possible to gauge from the literature whether specimens recorded as *B. coeca* have been examined critically or have been recorded as that species by default. It is suspected that the latter is sometimes the case, and records of other members of the genus are therefore likely to be more reliable. Papp (1984) gives international records of *B. schmitzi*, which is widely distributed in Europe including France and Italy. *B. kohli* Schmitz, *B. pretoriensis* Örösi-Pál and *B. coeca* ssp. *angulata* Örösi-Pál are all Afrotropical in origin, but *B. coeca* ssp. *angulata* is recorded as an introduction to Italy, and there is a questionable record of *B. kohli* from Belgium. To date, only one member of the family, *B. coeca*, has been recorded from the British Isles (Kloet & Hincks, 1976).

Adults of *Braula* spp. are phoretic on adult honey bees (scanning electron micrograph, Muggleton, 1992; photograph, Morton & Brown, 1996) and disperse between bee colonies by this means. In addition they may be spread as a result of bee keeping practices. *Braula* spp. are not generally considered to cause any significant harm to honey bees, and the main impact of *B. coeca* occurs when the wax-lined larval tunnels spoil the appearance of honeycombs intended for show or sale.

Hive floor inserts and hive debris samples from England and Wales are submitted on a voluntary or statutory basis to the Central Science Laboratory National Bee Unit (NBU) for diagnosis of the Varroa mite, *Varroa jacobsoni* Oudemans, a serious pest of honey bees first discovered in the British Isles in South Devon (VC 3) in 1992 (Bew, 1993). In addition to Varroa, these samples contain specimens of other invertebrates, which have been either killed by varroacidal agents administered to the colony, or are present due to natural mortality. At the author's request, a number of specimens of *Braula* were taken from these hive samples in the period Autumn 1994–Spring 1995. The resulting pooled sample of *Braula* was given to the author (an employee of the NBU at that time) for detailed examination. 157 specimens were examined for characters described and illustrated by Örösi-Pál (1966a, 1966b) and it was apparent on the basis of external features that some specimens conformed to Örösi-Pál's 'schmitzi group' (comprising *B. schmitzi* and *B. orientalis*). Examination of the characteristic female cerci confirmed the presence of *B. schmitzi* in significant numbers in the sample, and it is added to the British fauna on this basis.

Subsequent examination of the male terminalia revealed clear differences between the aedeagi of *B. coeca* and *B. schmitzi* (Figs 3, 8), and the two species are distinguished on that basis for the first time.

The NBU sample comprised 116 *B. coeca* (80 males, 36 females; sex ratio (m/f) 2.2 : 1) and 41 *B. schmitzi* (22 males, 19 females; sex ratio 1.2 : 1). As these specimens were from a pooled sample, the data can only be given as England and/or Wales, autumn 1994–spring 1995. The specimens of *B. schmitzi* may have come from one bee colony or many, so the relatively high numbers of this species in the sample do not indicate whether it is local or widespread in England and Wales.

A sample from a hive at Hatch End, Middlesex collected on 2 March 1997, and kindly made available by J. Telfer, comprised 36 specimens of *B. coeca* (23 males, 13 females; sex ratio 1.8 : 1). The large excess of males in both samples of *B. coeca* may reflect the situation in nature. On the other hand it may be an artefact of the sampling method; for example if the sexes favour different areas within a hive, or exhibit a differential susceptibility to varroacidal agents.

The few UK specimens of *Braula* held by the Natural History Museum, London, and stored in alcohol are all *B. coeca*. Carded specimens, where the abdominal venter was inaccessible, were not examined.

B. schmitzi is almost certainly an introduced species. Active honey bees need to feed regularly, and it is thought extremely unlikely that they would be capable of flying across the English Channel (M. A. Brown, pers. comm.) and that phoretic *Braula* spp. adults could colonize England by this means.

The activities of bee keepers play an important role in determining the international, national and regional dispersal of *Braula* spp. Both commercial and amateur bee keepers seek to improve the honey yield and/or behaviour of their colonies *via* the introduction of strains of queen with the required characteristics. These strains of honey bee may originate from different countries, and the international transport of honey bees is regulated in Europe and elsewhere. In addition, very large numbers of honey bee colonies are transported long distances each year by road to act as pollinating agents for commercial crops, or to obtain honey derived from a specific source (e.g. heather). The international transport of bees within and into the EU is subject to restrictions and health checks under a variety of legislation implemented under the BALAI Directive (92/65/EEC) and the Veterinary Checks Directives (90/425 and 90/675/EEC), and in the UK through Orders under The Bees Act 1980. The import of honey bees into the UK is permitted only from a small number of approved countries, and the movement of bees to sites outside the Statutory Infected Area (SIA) in the UK (introduced to slow the spread of the Varroa mite) is permitted only under licence. Infestation with *Braula* is not, however, a notifiable bee disease, and an import/export or movement licence would not be withheld due to its presence. In spite of the existing regulations, there is some degree of illicit traffic in bees. Live queens may be successfully packaged and posted between countries, accompanied by a small number of attendant workers. Alternatively, queens of desirable strains may be carried between countries in hand luggage.

Historically, there has been importation of honey bee strains into the UK on a massive scale, particularly following the epidemic of the enigmatic 'Isle of Wight disease' early this century. These bees originated mainly from Europe but also, more recently, from Israel and the USA. Statutory controls on importation are a relatively recent development under the Bees Act 1980. In addition, invertebrates living largely within honey bee colonies such as *Braula* spp. are not subject to the same climatological constraints to their distribution as free-living species, since environmental conditions within a honey bee colony are closely regulated by the bees.

Thus there are a number of mechanisms by which human intervention may lead to the colonization of new areas, countries and continents by species of *Braula*, and for this reason Papp (1984) lists all known members of the genus as potential additions to the Palaearctic fauna. It is thought that these same mechanisms are also in part responsible for the spread of the Varroa mite. It is perhaps not surprising then that *B. schmitzi* has colonized the UK, and it is thought likely that additional species, such as *B. orientalis*, may be found here eventually.

Nothing is known of the distinction between the biology of *B. coeca* and *B. schmitzi*, although the biology of *B. coeca* has been discussed by a number of authors (e.g. Hassanein & Abd El-Salam, 1962; Grimaldi & Underwood, 1986; Morse, 1987; Smith & Caron, 1984; Ramírez & Malavasi, 1992). Örösi-Pál (1966b) states that *B. coeca* oviposits on the inner surface of the cappings of partially sealed honey cells, while *B. schmitzi* oviposits on the outer surface. Smith & Caron (1984) point out, however, that *B. coeca* has been observed to oviposit both on the underside and on the external surface of honey cell cappings. It would be convenient if the two species could be distinguished on the basis of a macroscopic characteristic of their larval tunnels, and it is hoped that future observations might clarify this possibility.

Örösi-Pál (1966a) records coexisting populations of *B. coeca* and *B. schmitzi* in hives in Yugoslavia and Sicily, as well as coexisting populations of *B. pretoriensis* and *B. coeca* ssp. *angulata* from colonies in Natal. It is not known whether two species of *Braula* are normally able to maintain a stable coexistence within a single bee colony, or whether the reported associations were, for example, artefacts of apiary management.

Adult *Braula* are found, normally singly, on the thorax or gaster of drones and workers. Mated (but not virgin) queens may, however, harbour large numbers of *Braula* about their body. Smith & Caron (1984) report various levels of infestation in the United States, up to 29 *B. coeca* on a queen in one case, and J. Morton (*pers. comm.*) has observed about 40 specimens of *Braula* on a queen in the UK. It is not known to what extent, if any, this level of infestation might affect a queen's behaviour and hence colony performance. It is of interest that 18 individuals of *Braula* were recorded on a drone in a queenless honey bee colony in South Africa by Skaife (1921).

The adults of *B. coeca* live as kleptoparasites on regurgitated material (protein- and fat-rich secretions fed to the queen and larvae), which is taken directly from the bee's mouth-parts, where it appears in response to stimulation by the fly. Skaife (1921) quotes a description by A. I. Root of *Braula* feeding on 'honey' regurgitated by a bee in response to stimulation of its mouthparts by the feet of the adult *Braula*. Argo (1926) describes *Braula* feeding on material regurgitated from the mouthparts of a bee in response to the fly 'frantically clawing' at the bee's clypeus with its two anterior pairs of tarsi. Skaife (1921) notes that the contents of the crop of dissected adults of *Braula* tasted of honey.

The period between hatching of ova and the emergence of adults in *B. coeca* (in Egypt) is 16–24 days (Hassanein & Abd El-Salam, 1962). The longevity of adults, and the period between emergence and oviposition is unknown, and Smith & Caron (1984) state that adults over-winter in bee colonies. Peak breeding in *Braula* is likely to coincide with periods of maximum nectar-flow, when most honey cells are capped by the bees. A number of authors (e.g. Argo, 1926; Örösi-Pál 1966a; Smith & Caron, 1984) and bee keepers (*pers. comms.*) note a pronounced autumn peak in the numbers of *Braula* adults, as well as a spring minimum, the latter, according to Smith

& Caron (1984), coinciding with the death of females following oviposition. Voltinism and adult longevity in *Braula*, and the seasonal relationship between fecundity in *Braula* and the activities of bees, requires further investigation.

The anatomy of the adult and larva of *B. coeca* is detailed by Peterson (1987), and the early stages of this species are described by Ferrar (1987) and Smith (1989). The ova of *Braula* spp. are equipped with a pair of membranous flanges, possibly associated with flotation in a viscous medium, and hence gas exchange. Characters described by Örösi-Pál's (1966b) distinguishing the ova of 'coeca group' from 'schmitzi group' species are based entirely on these flanges, and for this reason may appear questionable.

Authors differ in their interpretation of the larval pabulum of *B. coeca*, and Ferrar (1987) considers this problem unresolved. Imms (1942) states that the digestive system of the larvae contains wax and often pollen grains, and cites Örösi-Pál's (1938) suggestion that the micro-organisms present in the epithelial cells of the mid-intestine of the larvae are capable of digesting wax. Hassanein & Abd El-Salam (1962) describe larvae feeding on honey cell cappings, while Smith & Caron (1984) state that the larvae develop as commensals in the wax cappings of honey cells, obtaining nourishment from debris in the wax. Morse (1987) also reports larvae in cappings feeding on honey, pollen and perhaps wax. While it appears that the larvae of *B. coeca* ingest a variety of substance in cell capping material, which of these is/are required for larval development is unknown. Pupariation is generally held to occur within larval tunnels in cell cappings (e.g. Ferrar, 1987).

Skaife (1921) states that newly hatched lavae of '*B. coeca*' enter brood cells and obtain their nutrition from food supplied to the larvae by nurse bees. The same author reports finding puparia and exuvia exclusively in sealed drone cells following a search of a (queenless) bee colony in South Africa. These observations, which associate the immature stages with sealed brood cells rather than honey cell cappings, appear anomalous and deserve further comment. Skaife's illustrations of the dissected reproductive organs of both sexes of '*B. coeca*' (Figs 9 and 10 of that author) show terminalia which correspond most closely with those of *B. pretoriensis* as illustrated by Örösi-Pál (1966b) (*B. pretoriensis* was described as a new species by Örösi-Pál in 1938, on the basis of material from Natal Province (Papp, 1984)). In addition, Skaife's illustration of the ovum of his species corresponds most closely with that of *B. pretoriensis* as illustrated by Örösi-Pál (1966b), in that both authors illustrate an ovum with a well-defined rounded protrusion at each apex, a feature unique to that species according to Örösi-Pál's illustrations. Further, the larval cephalopharyngeal skeleton illustrated by Skaife differs from that of *B. coeca* as illustrated in Ferrar (1987) (Skaife specifies the length ('about 2 mm'), but not the instar of the larva illustrated. Comparison with dimensions of the larval instars of *B. coeca* cited by Hassanein & Abd El-Salam (1962) (second instar 1.24 mm, third instar 2.07–2.25 mm) is indicative, but does not establish, that Skaife's illustration is of a third instar larva). It appears then, that Skaife's pioneering study gives a useful and probably unique account of the biology and early stages of *B. pretoriensis*, and that, if Skaife's observations are repeatable, this represents the only published account enabling clear differences between the biology of species of *Braula* to be demonstrated. The early stages of *B. pretoriensis* appear to occupy an area in the bee colony (sealed brood cells) which is spatially distinct from that occupied by *B. coeca* (honey cell cappings). The larvae of *B. pretoriensis* are apparently kleptoparasitic on food supplied to the bee larvae, and their pabulum is thus closely related to that of the adult. The larvae of *B. coeca* seem to be strict inquilines in cell capping material. Any observations recording distinctions between the life-histories of *B. coeca* and *B. schmitzi* will be of particular interest.

It is probable that the erroneous descriptions of the larvae of *B. coeca* developing in brood cells, which appear widely in standard texts on Diptera (e.g. Colyer & Hammond, 1968; O'Toole, 1978; Cogan, 1980 (who incorrectly refers Skaife's species to *B. coeca* ssp. *angulata*) and Smith, 1989) are the result of propagation of Skaife's early description of the life-history of '*B. coeca*', which was published before *Braula* was resolved into several species.

STATUS OF *BRAULA* SP. IN ENGLAND AND WALES

The NBU has an extensive data-set of records of *Braula* sp. from England and Wales, and a map compiled from this unpublished data for the period 1 January 1992–13 July 1995, shows that it is recorded from every Vice-County, and from more than 90% of 10 km squares in the area. Paxton & Mwale (1993) conducted a survey by questionnaire of bee pests and diseases in England and Wales in 1991. Only *Braula* sp. and *Galleria mellonella* L. (greater wax moth) showed significant regional variation in incidence. The percentage of bee keepers reporting the presence of *Braula* in their colonies in the south-west region was 73%. The figures for other regions range from 34% ('west region' = Wales) to 50% (central England), and display no discernible geographical trend. The same authors identified a statistically significant higher reporting of *Braula* sp. from bee keepers practising migratory bee keeping, and suggest that the movement of colonies may be a stress factor favouring colonization by the fly. *Braula* is recorded from Scotland (G. E. Rotheray, *pers. comm.*) and from the Irish Republic (P. J. Chandler, *pers. comm.*), but there is no data available to the author regarding its prevalence in these areas. It probably occurs with honey bees throughout the British Isles, but does not often come to the attention of entomologists.

Varroosis indirectly affects the populations of honey bee-associated organisms such as *Braula*, both through the decline in numbers of managed and feral bee colonies, and through the toxicity of varroacidal agents to non-target species. While many bee keepers (*pers. comms.*) feel that the loss of bee colonies due to varroosis is likely to be dramatic, it will be some years before the actual impact becomes clear. The use of varroacides is currently the norm in all regions of the world subject to Varroa infestations, and the only major geographical regions in which Varroa is so far unrecorded are Australasia and southern Africa (J. Morton, *pers. comm.*).

The list of acaricides licensed as varroacides by the EU includes flumethrin (e.g. Bayvarol), fluvalinate (e.g. Apistan), amitraz (e.g. Apivar), formulations based on thymol and other essential oils, as well as a variety of other agents (Morton & Brown, 1996). In addition, treatment using unlicensed substances such as lactic- and formic acid is not uncommon. Flumethrin formulated as 'Bayvarol' strips is the only substance currently licensed for this use in the UK.

The toxicity of these substances to *Braula* and other honey bee-associated invertebrates remains largely uninvestigated, but Kulincevic *et al.* (1991) show that, while both fluvalinate and amitraz are effective against Varroa, fluvalinate has significantly greater toxicity than amitraz towards *Braula* adults 7 days post-treatment. The use of amitraz as a varroacide, however, is far less common overall than treatment with pyrethroids. While amitraz is a formamidine acaricide, both flumethrin and fluvalinate are synthetic pyrethroids and are therefore fat-soluble. Liu (1992) shows that fluvalinate is absorbed into beeswax, and the early stages of *Braula* are therefore likely to be exposed to it, although the effect of such agents on the early stages is unknown.

There is little doubt that *Braula* suffers significant mortality due to the widespread application of varroacidal agents, and that this is likely to be the case internationally.

Following conversations with bee keepers based in England and Wales, no clear consensus has emerged as to whether a noticeable decline in the population of *Braula* has occurred to date. Some have noted that *Braula* has become less common since the arrival of Varroa, while others have always regarded *Braula* infestation as an infrequent occurrence (*pers. comms.*). *Braula* was present in honey bee colonies in the same apiary in London, in both July 1997 and July 1998, where these colonies had received several (*c.* 3–6+) treatments against Varroa, mainly with Bayvarol (J. Morton, *pers. comm.*). While this might indicate that *Braula* has developed some resistance to flumethrin, both flumethrin and fluvalinate are unusual among pyrethroids in that they are significantly less toxic to insects than to mites, and this differential toxicity is probably a factor in determining the ability of *Braula* to persist in flumethrin-treated honey bee colonies.

The development of resistance to fluvalinate in the Varroa mite was first reported by Sugden *et al.* (1995) in the USA. Fluvalinate resistance in Varroa has subsequently been recorded in EU countries such as France and Italy, and these mites also show resistance to flumethrin (Morton & Brown, 1996). As resistance becomes more prevalent, and currently licensed pyrethroid varroacides lose their efficacy, there will be a switch to alternative treatments. These are likely to exhibit significantly greater toxicity to non-target species such as *Braula* than currently licensed compounds. While it is vital that Varroa infestation is managed by all appropriate means, it is also important to be aware of the indirect effects of varroosis on populations of honey bee-associated invertebrates such as *Braula*.

NOTES ON IDENTIFICATION

Specimens derived from hive debris etc. are desiccated and brittle, and many are in relatively poor condition. Most males from this source have the aedeagus extended, and as a result it is often broken. Examination of a number of males may thus be necessary to locate those with the aedeagus entire. In practice, however, worn specimens can often be identified as long as the abdominal venter is clearly visible.

Subsequent to softening specimens for examination by soaking them overnight in 10% KOH, a brief (*c.* 30 seconds) boiling in this solution will dissolve adherent wax particles, which may otherwise obscure diagnostic features. The terminalia may sometimes be exerted in softened specimens of both sexes by gently 'pumping' the abdominal venter with a blunt object.

The shape of the abdominal sternites is rather variable between individuals of *Braula*. For example, the anteriolateral extensions of synsternite 1+2 may be either pointed (Figs 1, 5) or truncate in both sexes of *B. coeca* and *B. schmitzi*. Sternite 3 is often quite short with curved or divergent lateral margins in *B. coeca* (Fig. 1), and significantly longer with parallel lateral margins in *B. schmitzi* (Fig. 5). This feature is too variable, however, to reliably separate the species.

In a few specimens of both species from the NBU sample a 'false posterior margin' was present on synsternite 1+2 (Fig. 6). This weakly defined suture may or may not represent a partial reversion to the plesiomorphic state, in which sternites 1 and 2 are separate.

Nomenclature of abdominal sternites follows Peterson (1987), which differs from that adopted by Örösi-Pál (1966b).

DETERMINING SEX IN *BRAULA*

Four fully formed and pigmented median ventral abdominal sclerites (sternites 1+2–5) clearly visible (Fig. 5). Sternite 6 is present, but it is very short and turned under the posterior margin of sternite 5, where it is often visible as a crescent-shaped silhouette (Fig. 5). Aedeagus (Figs 3, 8) frequently extended in samples from hive debris, although sometimes broken in these specimens. Aedeagal apodeme/hypandrium normally visible in silhouette within the abdominal cavity. . . . Males

Five entire and fully pigmented median ventral abdominal sclerites (sternites 1 + 2–6) clearly visible (Fig. 1) [*The posterior margin of sternite 6 may be darkened in some females, and this should not be confused with the silhouette of sternite 6 as seen in males*]. Cerci (Figs 4, 9) usually visible in part when the tip of the abdomen is viewed ventrally, although may be substantially obscured in some specimens. . . . Females

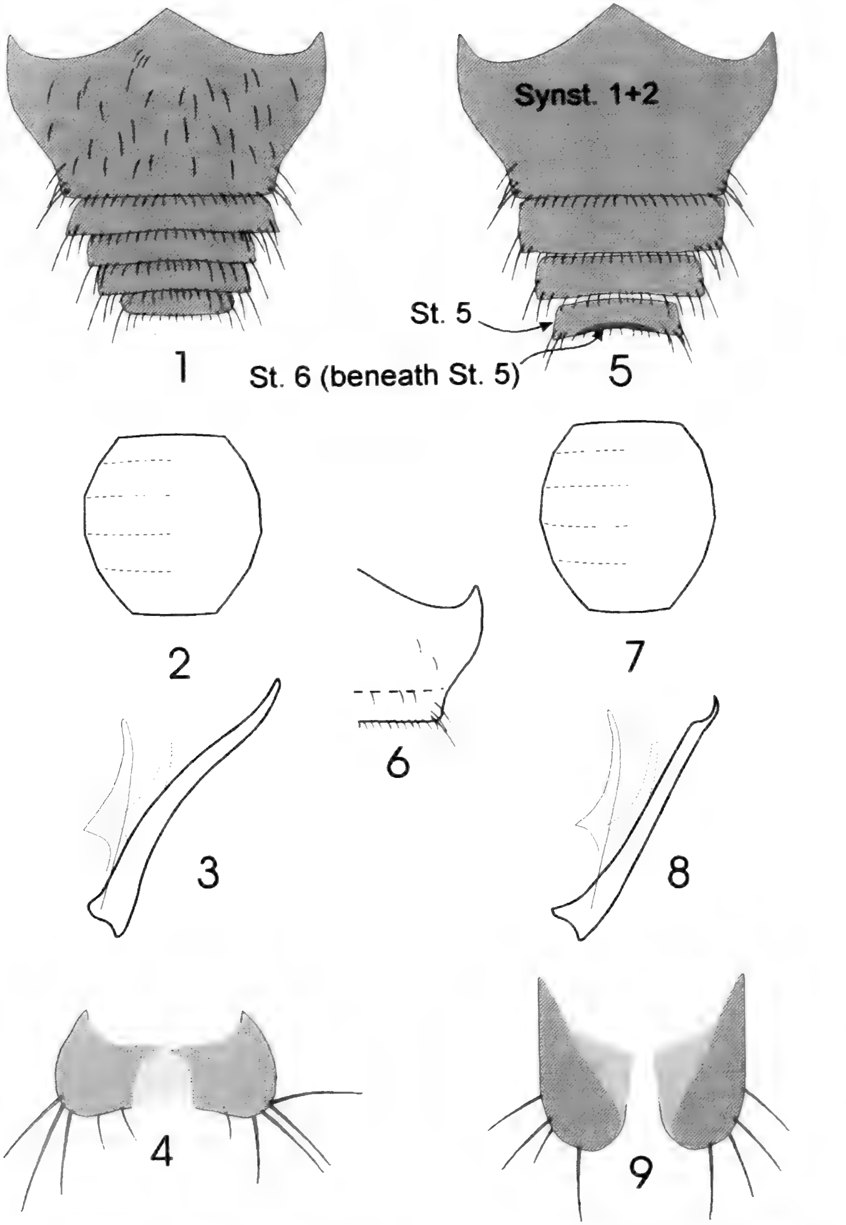
KEY TO BRITISH SPECIES OF *BRAULA*

1 Both sexes: Synsternite 1 + 2 with a moderate to sparse covering of irregularly arranged hairs on disc (Fig. 1) [*The hair-pits can be seen by oblique transmitted light in worn specimens*]. Abdomen 'barrel-shaped' in dorsal view (Fig. 2).
Males: Aedeagus sinuous, extending well beyond parameres and tapering uniformly to tip (Fig. 3).
Females: Cerci not longer than wide, broadly contiguous but unpigmented medially on the apical margin, which forms a shallow curve (Fig. 4) [*High magnification e.g. ×80 is required to see the un-pigmented median region of the cerci*]
. . . . *coeca*

2 Both sexes: Disc of syntergosternite 1 + 2 normally without hairs (Fig. 5). If a few hairs are presented they often trace out the path of a 'false posterior margin' (Fig. 6) [*The latter condition also arises in occasional specimens of* B. coeca, *and intermediates occur in respect of this character*]. Abdomen 'vase-shaped' in dorsal view (Fig. 7).
Males: Aedeagus more-or-less straight, extending only slightly beyond parameres and hardly tapering. Tip narrowing abruptly to form a hook-shaped process (Fig. 8).
Females: Length of outer margins of cerci about twice their width. Cerci unpigmented basally on their median margins (Fig. 9)
. . . . *schmitzi*

ADDITIONAL SPECIES

As has already been discussed, all species of *Braula* are potential additions to the UK fauna. Örösi-Pál (1966b) keys all species, but it would appear that for a number of species only females are clearly separable on the basis of his key. While external characters would normally run a specimen to one, or a pair of species, Örösi-Pál's illustrations of female cerci are diagnostic at this level. On the other hand, both the illustrations and descriptions of male terminalia are often difficult to interpret. The aedeagus appears to be broken or missing in all Örösi-Pál's photographs of male terminalia and the aedeagal characters described in the present article, which clearly separate males of *B. schmitzi* and *B. coeca*, are not keyed or discussed. Examination of the aedeagi of male type material of the genus may prove fruitful in this respect. The following notes (based on the key and illustrations in Örösi-Pál, 1966b) should highlight the possible presence of additional species in suspect female specimens.



Figs 1–9. *B. coeca*. 1. female, abdominal sternites 1 + 2–6. 2. dorsal view of abdomen. 3. aedeagus and parameres. 4. female cerci. *B. schmitzi*: 5. male, abdominal sternites 1 + 2–6. 6. synsternite 1 + 2 showing 'false' posterior margin. 7. dorsal view of abdomen. 8. aedeagus and parameres. 9. female cerci. *Abbreviations:* St.—Sternite. Synst.—Synsternite.

Syntergosternite 1 + 2 hairy, abdomen 'barrel-shaped' (as *B. coeca*). Female cerci distinctly broader at apex than at base.

?*B. pretoriensis* [or *B. kohli*]

Keys to *B. coeca* but sternite 3 hairy on disc and apical margin of female cerci forming a well defined angle of about 120° at the mid line.

?*B. coeca* ssp. *angulata*

Keys to *B. schmitzi* but female cerci deeply divided medially, the inner margins pigmented and setose as *per* the outer margins.

?*B. orientalis*

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SHORT COMMUNICATION

***Ulopa trivia* Germar (Homoptera: Cicadellidae) in Wales**—Two species of the cicadellid (leafhopper) genus *Ulopa* are found in Britain (Le Quesne, 1965). Both species are usually flightless, with convex thickened forewings, and are found near ground level. *Ulopa reticulata* (Fab.) is found commonly under *Erica* and *Calluna* over almost all Britain. *Ulopa trivia* Germar is a very local species (designated Notable B by Kirby, 1992) with scattered records in southern England (Morris, 1971; Kirby, 1992). It is a species of chalk and limestone grassland and calcareous dunes, although its hosts plants are not known with certainty. An association with *Plantago* is possible (Morris, 1971). It appears that the species is univoltine with females overwintering to lay eggs in the spring. A short visit on 4.ix.98 to Whiteford Burrows NNR (SN437944) on the north Gower coast in south Wales (VC 41, Glamorgan) produced 4 females of *U. trivia* by vacuum sampling. The site was a large, warm, south facing, dune slack with short, rabbit-grazed vegetation. Poor weather prevented further examination of other areas of the dunes on this occasion. This record appears to be the first for the species in Wales, and is some distance from other recorded sites (the nearest being Brean Down, nr Weston-super-Mare, N. Somerset, according to Morris, 1971).—M. R. WILSON, Department of Biodiversity and Systematic Biology, National Museums and Galleries of Wales, Cardiff CF1 3NP.

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A BREEDING EXPERIMENT WITH *MANIOLA JURTINA* L. AB. *FRACTA* ZWEIGLT (LEP.: SATYRIDAE)

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Maniola jurtina ab. *fracta* Zweiglt is a scarce and highly distinctive aberration. During fieldwork over 17 years I have found it in seven separate locations in Dorset, Wiltshire, Somerset and the Isles of Scilly. It has occurred in all grades of expression, from examples barely distinguishable from the type form, through to the most extreme expressions (Fig. 8).

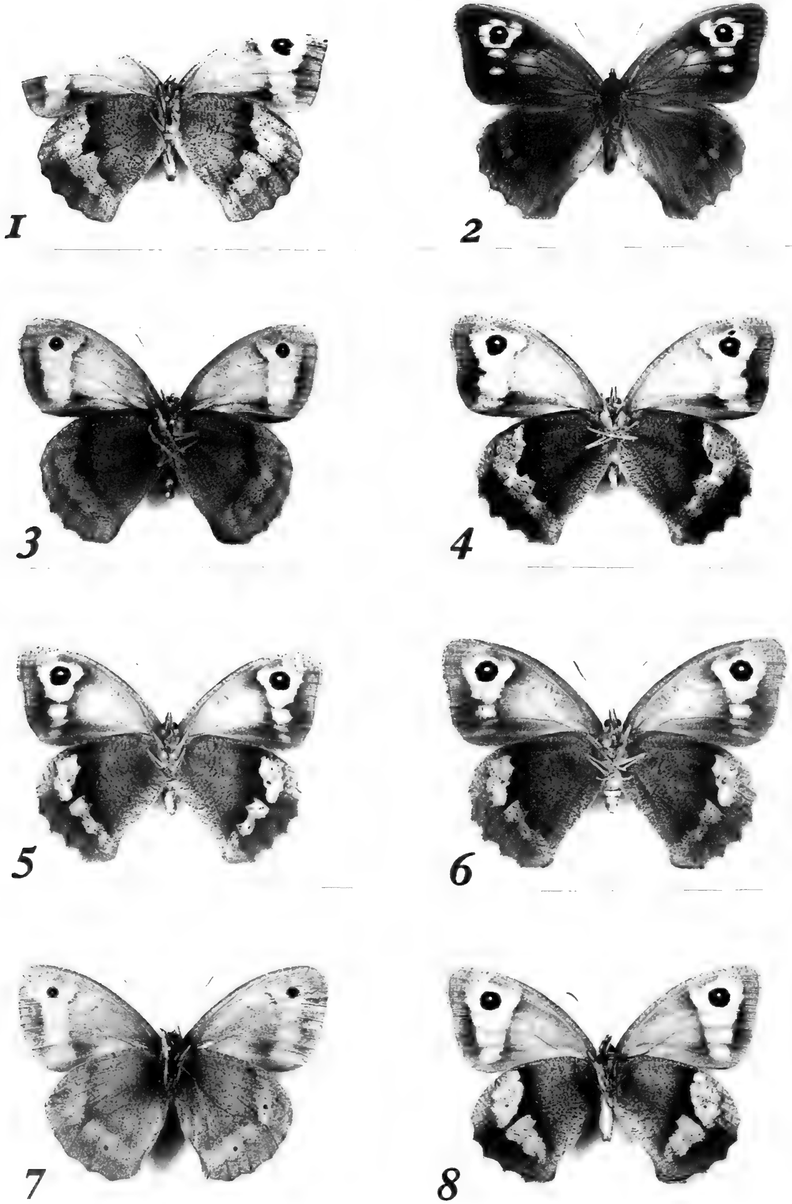
M. jurtina ab. *fracta* can be described, in the fully developed form, as having a single strip of dark scaling crossing the pale median band on the underside of the hindwings (Russwurm, 1978). This always runs along the anterior side of vein 4 (English numbering system) or vein M3 (using the Universal Comstock System). This connects the darker basal and marginal areas (Figs 5–8). R. M. Craske, who has a lifelong experience of this species and its varieties in the field, has described the form as having a 'great stab right across the pale band'. I can think of no more graphic description than that. In the field, extreme examples invariably give the impression of a type specimen with a heavy tear in the wing. Only close inspection reveals it to be this lovely aberration. It occurs in both sexes, although the male specimen illustrated (Fig. 7) is the only example of that sex (compared to over twenty female specimens) that I have found, despite careful scrutiny.

In some specimens the variation may be visible on the upper surface of the hindwings (Fig. 2). Some female specimens also show ab. *antiaurolancea* Leeds on the upperside of the forewings (Fig. 2). This consists of a reduction of the fulvous coloration between the veins. The most extreme expressions have only a ring of fulvous remaining around the apical spot (although the fulvous in the 'cell' area remains, as the effect of the aberrant genes seems to be restricted to the median band area of the wings only). This variation also occurs on the upperside of ab. *postmultifidus* Lipscomb. *Postmultifidus* is described as having 'the top half of the band on the underside of the hindwings entire, the lower half broken up into well separated segments' (Lipscomb, 1980). While I have captured and bred examples of *postmultifidus* showing the extreme expression of *antiaurolancea* on the upperside, I have not seen extreme *antiaurolancea* on a specimen of *fracta*.

While some satyrid aberrations may occur as analogous forms across a range of different species which share the relevant pattern elements (e.g. variation in submedian spot size, shape or number) there seems to be nothing similar to *fracta* recorded in those satyrid species which share the hindwing underside band pattern element.

The original female for the breeding experiment (Fig. 1) was captured on 1 July 1995 in a North Dorset hay meadow where this aberration has appeared regularly since 1983. It is clearly a very minor expression of the form with just the first sign of the dark strip pushing into the median band from the basal area of darker coloration.

Approximately 250 eggs were laid, resulting in an F_1 brood of 86 adults in June 1996. The brood was graded from typical specimens to those with the median band distinctly narrowed (much like the F_2 specimens in Figs 3 and 4). There was no sign of any development of the *fracta* hindwing cross-band. A number of these forms were paired and about 1000 eggs were laid.



Figs 1–8. *Maniola jurtina* ab. *fracta* 1. Female transitional to *fracta*. Captured Dorset 1.vii.1995. 2. Female ab. *fracta* + *antiaurolancea* Bred F_2, v. 1997. 3. Male transitional to *fracta*. Bred F_2 v. 1997. 4. Female transitional to *fracta*. Bred F_2 v. 1997. 5. Female *fracta*. Bred F_2 v. 1997. 6. Female *fracta*. Bred F_2 v. 1997. 7. Male *fracta*. Captured Dorset 11.vii.1983. 8. Female *fracta*. Captured Dorset 12.vii.1983. All specimens coll. R. Barrington.

The F_2 generation contained 118 adults (45 male and 73 female). The brood was graded from type through to full *fracta* (Figs 5 and 6), with typical insects predominating. Three females were fully developed *fracta* and two others nearly so. Two males were weak expressions of *fracta*. The female specimens of *fracta*, and a number of the transitional female forms, were also *antiaurolancea*, though none was extreme (Fig. 2).

The hindwing median band width in specimens of *fracta* ranges from Fig. 8 in which the width is unaffected, through to the bred examples (Figs 5 and 6) in which the band is considerably narrowed, so the dark *fracta* cross-band is shorter. Fieldwork throws up all degrees of median band width between these two extremes, so probably this variable narrowing is part of the expression of *fracta*. In my experience full *fracta* with the median band of normal width (i.e. Fig. 8) is the rarest of all expressions.

The above results suggests that *fracta* is controlled by a multifactorial gene complex, in which a number of genes operate in an additive manner to give broods graded from type to full aberrations. There is no differentiation into distinct groups as there is when an aberration is under the control of a single mutant gene.

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FIELD MEETING REPORT

Sidney Wood, Dunsfold, Surrey
20 June 1998

Leader: **John Phillips**. Totally against the trend of extremely adverse weather conditions being experienced in June, the day chosen for this meeting turned out to be virtually ideal, being hot although overcast during the afternoon, but humid during the evening.

Four members plus the leader attended the afternoon session including Gail and Stephen Jeffcoate, who are responsible for managing nearby Oaken Wood Reserve on behalf of Surrey & SW London Branch of Butterfly Conservation, and David Baldock who initiated the group into the mysteries of the Hymenoptera. Butterflies were conspicuous by their absence, the only species of real interest being a female Wood White *Leptidea sinapis* (L.); this complex of woodland being one of its well known strongholds.

Bees and wasps seemed to fare somewhat better however, although, the only species of note was *Ectemnius borealis* (Zett.) RDB3 taken at umbellifer flower; nationally this is only known from about five sites in East Hampshire and West Sussex and was first recorded for Surrey in 1996 in Botany Bay, a few miles east of Sidney Wood.

Fig. 1. Sidney Wood, Surrey. l–r Stephen & Gail Jeffcoate, Sylvia Bucknell, David Baldock (photo: J. W. Phillips).

MV light trapping in the evening attracted three members plus the leader; this was somewhat disappointing bearing in mind the quality of the site and the perfect weather conditions. This may have had something to do with the rival attraction of a simultaneous society meeting being held at Ranmore Common, Dorking, or of course world cup football, heaven forbid!

Six MV lights were operated in various areas of this extensive block of deciduous woodland and 130 species of macro-lepidoptera were recorded, notable of which were *Elaphra venustula* (Hb.) (rosy marbled), *Meganola strigula* (D&S) (small black arches), *Pechipogo strigilata* (L.) (common fan-foot) and *Paracolax tristalis* (Fab.) (clay fan-foot). One additional surprise was the appearance on the sheet of a *Synanthedon vespiformis* (L.) (yellow-legged clearwing), this being the first time I have ever recorded a sesiid at light.

A full species list has been prepared and forwarded to Forestry Commission and the Surrey County Moth Recorder, as well as being retained by the Society.

My sincere thanks to Forest Enterprise for allowing BENHS access for the meeting and to all those that made the effort to attend.

THE FOOD-PLANTS OF THE BROWNTAIL MOTH *EUPROCTIS CHRYSORRHOEA* L. (LEP.: LYMANTRIIDAE) IN EAST LONDON

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The stature of *Euproctis chrysorrhoea* L., the browntail, as a pest in east London is well-documented: Chalmers-Hunt (1977), Plant (1993) and Hoyle (1993) describe browntail infestation in the London Borough of Newham, with the first two named authors referring to plagues in the 1970s. Chalmers-Hunt (1977) specifically named Wanstead Flats and Tower Hamlets. Hoyle (1993) detailed Newham in the context of infestation across most of London. Data on specific food-plants used in east London, or in urban areas generally, are restricted to Hoyle (1993) and Plant (1993), with additional unpublished data being available from certain London boroughs. Voute & van der Linde (1963) described the food-plants used by the browntail in the Netherlands, and the frequency with which certain plants were used over others. This field study aimed to look at the plants used by *E. chrysorrhoea* in east London over two years (1995–1996) and to assess food-plant preferences.

If compared with other Western European Lymantriidae, *E. chrysorrhoea* is not untypical in terms of it being a polyphagous insect, this being understood to include those species whose larvae consume host plants from more than *two* plant families (Cates, 1981; Bernays & Chapman, 1994). Table 1 details recognized food-plants for *E. chrysorrhoea* according to British and continental European data. A total of fifteen plant families are detailed, with 32.7% of the plant species belonging to the Rosaceae. Unfortunately the references do not indicate the frequency with which the species uses the food-plants detailed, with the exception of Sterling (1989), who made a distinction between those plants attacked on infrequent occasions and especially when the species reached outbreak proportions, that is unorthodox larval food-plants, and those attacked on a more regular basis. In addition, Torrosian *et al.* (1988) further emphasized the difference between those plants which may act as food-plants but which do not support the hibernacula. The term 'hibernacula' refers to the silken nests that the larvae manufacture in order to pass the winter. Although it is generally assumed that the larvae construct the overwintering nest (in the 3rd instar) on the *host plant*, before hibernation commences in early September (Soria, 1987), this cannot always be taken for granted. However, one of the plants listed in Table 1, *Cornus sanguinea*, was indeed seen to serve in both capacities in east London, as a food-plant as well as a site for the winter nest (King, 1995; 1996).

METHODS

Sterling (1989) described browntail hibernacula as being easy to count on leafless trees and shrubs, with data from this simple method being used to assess future population sizes (Calinski *et al.*, 1959; Tseitgamel, 1974). An extensive field study of the food-plants of *E. chrysorrhoea* took place between January 1995 and April 1996, in effect over two winters. The logistics of data collection involved counting the hibernacula on bushes and trees throughout the London borough of Newham, visiting the borough from north to south covering a distance of 4.98 km^2. In addition to the winter larval webs being counted, observations of the spring re-emergence of

Table 1. Larval food-plants of *E. chrysorrhoea*

Family	**Food-plant**	**References (authors 1–10)**	**Food-plants utilized in Britain on occasion, especially following defoliation of more orthodox food-plants (Sterling, 1989)**	**Larval food-plants *not* known to support winter nests of *E. chrysorrhoea* larvae (Torrosian, *et al.* 1988)**
Betulaceae	*Alnus glutinosa*	10	*Betula pendula*	*Alnus glutinosa*
	A. lanuginosa	10		*A. lanuginosa*
	Corylus avellana	10		*Corylus avellana*
	Betula pendula	10, 9		
	Carpinus betulus	10		
Fagaceae	*Quercus robur*	9		*Castanea vulgaris*
	Q. pyrenaica	3, 8		
	Quercus spp.	10		
	Fagus spp.	3, 2		
	Castanea vulgaris	10, 3		
Polygonaceae		9	*Rumex crispus*	
			R. obtusifolius	
Tiliaceae	*Tilia* sp.	10		
Ulmaceae	*Ulmus procera*	9		
	U. glabra	9, 3, 2		
	U. campestris	10		
Urticaceae		9	*Urtica dioica*	
Salicaceae	*Salix fragilis*	9		
	S. caprea	9		
	S. cinerea	9		
	S. alba	10		
	Populus tremula	10		
	P. nigra	10		
Ericaceae	*Arbutus unedo*	3. 6. 4		
Rosaceae	*Rubus fruticosus*	10, 9, 3, 1	*Cotoneaster* spp.	*Ribes uva-crispa*
	R. idaeus	10	*Filipendula ulmaria*	
	Rosa canina group	9		
	Rosa ('wild' & 'cultivated')	3	*Rubus idaeus*	
	Prunus spinosa	10, 9	*R. caesius*	
	P. institia	9	*Potentilla anserina*	
	P. domestica	10, 9	*P. reptans*	
	P. armeniaca	10, 3	*Geum urbanum*	
	Prunus spp.	9	*Agrimonia eupatoria*	
	Crataegus monogyna & other *Crataegus* spp.	9		
	Crataegus spp. e.g. *C. oxyacantha*	10, 3		
	Sorbus aucuparia & other *Sorbus* spp.	9		
	Pyrus pyraster	9		
	Pyrus sp.	10		
	Malus domestica group & other *Malus* spp.	10, 9		
	Ribes uva-crispa	10, 1		
	Fragaria sp.	1		

Table 1. *(continued)*

Family	**Food-plant**	**References (authors 1–10)**	**Food-plants utilized in Britain on occasion, especially following defoliation of more orthodox food-plants (Sterling, 1989)**	**Larval food-plants *not* known to support winter nests of *E. chrysorrhoea* larvae (Torrosian, *et al.* 1988)**
Fabaceae	*Robinia pseudoacacia*	10		*Robinia pseudoacacia*
Cornaceae	*Cornus sanguinea*	10, 5		*Cornus sanguinea*
Eleaegnaceae	*Hippophae rhamnoides*	10, 9, 3		
Hippocastanaceae	*Aesculus* spp.	7		
Aceraceae	*Acer pseudoplatanus*	9	*Acer platanoides*	
	A. campestre	10		
Juglandaceae	*Juglans* spp.	1		
Buddlejaceae	*Buddleja davidii* & other *Buddleja* spp.	7, 11		
Oleaceae	*Forsythia* sp.	10, 1		*Fraxinus excelsior*
	Fraxinus excelsior	10, 3, 2		
	Ligustrum sp.	2		
Asteraceae		9	*Senecio jacobaea* *Tussilago farfara* *Pulicaria dysenterica* *Achillea millefolium*	
Gramineae		9	*Holcus lanatus*	

Key to authors: 1. Carter (1984) 2. Gómez de Aizpúrua (1986) 3. Gómez Bustillo (1979) 4. King (pers. ob.) 5. King (1995) 6. Passos de Carvalho & Corley (1995) 7. Plant (1993) 8. Soria (1987) 9. Sterling (1989) 10. Torrosian, Torrosian & Roque (1988) 11. West (1992)

the larvae were also taken, both to ascertain host-plant and to check for parasitoids. In order to be provided with an idea of the abundance of broad-leaved plants in Newham and to assess whether the moth was choosing the most common plant available, a transect of 724 trees and shrubs was undertaken of the whole borough (King, 1997).

RESULTS

The trees and shrubs upon which larval nests of *E. chrysorrhoea* were found over the winters of 1995 and 1996 are shown in Table 2. Of the 22 plant species detailed, 62% are rosaceous plants (13 species), with the remaining nine species belonging to seven plant families, two of these being Fagaceae and Salicaceae. Fifteen plants were noted supporting the larval nests over *both* winters, although the degree of 'usefulness' was not consistent; for example, the percentage of *Crataegus* dropped from 26.9% of the total in the first winter of the study to only 7.9% of the total in the second winter. However, this may be a function of the smaller number of hibernacula counted that year, although an apparently 'minor' role played by *Cotoneaster* in

Table 2. Percentage of total hibernacula on plants in Newham, London: 1995–1996

Plant species: total: 22		Jan.–Apr. 1995 total nests: 1,744 % of total nests	Sept.–Apr. 1996 total nests: 493 % of total nests
Family	Species		
Betulaceae	*Betula pendula*	0.5	n/a
Fagaceae	*Quercus* sp.	9.1	0.8
	Fagus sp.	5.4	0.2
Tiliaceae	*Tilia* sp.	n/a	1.0
Ulmaceae	*Ulmus* sp.	0.2	n/a
Salicaceae	*Populus nigra*	0.9	n/a
	Salix sp.	1.5	0.6
Rosaceae	*Crataegus* sp.	26.9	7.9
	Sorbus sp.	20.8	17.4
	Prunus vars.	11.7	14.4
	Cotoneaster sp.	4.0	23.3
	Pyracantha sp.	3.0	7.7
	Prunus spinosa	3.3	0.4
	Malus vars.	2.5	0.8
	Rosa vars.	2.9	0.8
	Cydonia sp.	0.5	n/a
	Rubus fruticosus	0.1	0.6
	Prunus laurocerasus	0.06	7.3
	Amelanchier sp.	0.5	7.9
	Pyrus sp.	n/a	1.0
Cornaceae	*Cornus sanguinea*	0.6	n/a
Aceraceae	*Acer pseudoplatanus* & other *Acer* spp.	5.9	7.7

1995, at 4.0% of the total, was followed by the same plant being 5.8 times more 'attractive' the following season.

PRINCIPAL, SECONDARY AND ACCESSORY FOOD-PLANTS

Eleven of the twenty-two species of plants recorded in the field study should be regarded as being less important as food-plants, or as sites for the winter webs, at least in terms of the insect in London. These plants were either noted in one winter only, or if noted across both years, did not provide important figures. *Betula* is one such tree, being included in 1995 at only 0.52% of the 1,744 webs seen that year. Indeed, Sterling (1989) for this very reason includes it in the list of 'occasional' host-plants (see Table 1). Torrosian *et al.* (1988) also make a distinction between principal host plants, and secondary and accessory host-plants, describing all *Quercus* species in the first-named category. Secondary host plants would include *Carpinus betulus*, *Acer campestre*, *Ulmus campestris* and fruit trees, especially *Malus*. In the category of accessory host plants are included: *Ulmus*, *Tilia*, *Salix* and *Populus*. The east London field study supports the observation that the last-named trees are accessory food-plants, as winter nests were not counted on these trees in *both* winters (except *Salix*), and none of the four were seen to be actively consumed by the larvae, either before or after the winter period. The London Borough of Redbridge gave similarly unimportant figures (1994, unpub.) for hibernacula on lime: 2/40 trees in 1993, and for birch: 1/25 trees in 1994. However, two species of trees mentioned previously are described as being defoliated in Spain, these being elm and poplar (Romanyk & Cadahia, 1992). Of the other six plants which were found to play a marginal role, five plants are rosaceous; these included *Rosa*, *Prunus spinosa*, and *Rubus*. Despite this, Torrosian *et al.* (1988) described *P. spinosa*, *Rubus fruticosus* and *R. idaeus* as being major food-plants in the French Mid-Pyrenees. Table 1 includes two species related to bramble, *R. caesius* and *R. idaeus*, regarded by Sterling (1989) as being minor food-plants in Britain. The east London field study suggests that *R. fruticosus* is also used less often as well. Rose is described by Gómez Bustillo (1979) and Sterling (1989) as a food-plant. However, the east London data would suggest that its role as anything other than a winter nest-support is marginal, given that larvae were not seen feeding on it. In addition, the London borough of Redbridge's nine plant species (1994) listed as being infested by browntail winter webs did not include *Rosa* in 1992–94, as playing host to hibernacula. Interestingly *Rosa* is a common plant accounting for 10.4% of a transect of the trees and shrubs in the London Borough of Newham (King, 1997) but it does not seem to be used. Neither *Pyrus* nor *Malus* were seen as playing important hosts to the larval webs in London, despite apple being included by Torrosian *et al.* (1988), as a major, but secondary host plant in the Mid-Pyrenees.

UNRECORDED FOOD-PLANTS

Three of the plants which were recorded as supporting the hibernacula over the two winters, are not detailed as browntail food-plants. These are *Pyracantha* sp., *Amelanchier* sp. and *Prunus laurocerasus* L., all of which are rosaceous. One other plant is not mentioned either, *Cotoneaster* spp., but Sterling (1989) (see Table 1), does include it as an occasional food-plant. As a note of caution, although *Cydonia* and *Amelanchier* were noted providing structural support for the larval nest, it cannot be assumed that these plants were actively consumed by the larvae, during the spring and early summer of either season, and thereby acting as *bona fide* food-plants. However, given that *Amelanchier* was seriously infested by the species in such a limited area, it would be highly likely that it was used as a food-plant. On this note, data supplied by Redbridge in 1994 (unpub.) refers to three specimens of *Amelanchier* as playing host to winter nests in 1994, but not in the winters of 1992 or 1993, suggesting its marginal role. The dominance that the Rosaceae play in the diet of *E. chrysorrhoea* is illustrated by the additional plants included by Sterling (1989) (see Table 1), when he cites six species of rosaceous plants, which might be called 'low plants'. None of these were noted being attacked by the larvae in London; all rosaceous plants which were attacked were 'woody', indeed the larvae were not seen attacking low plants at all. Whether *Pyracantha*, *Cotoneaster*, *Amelanchier*, *Cydonia* or *Prunus laurocerasus* were utilized by the larvae as food-plants, or as support structures for the winter webs, what they all have in common is the fact that they are exotic cultivars. In addition, with the exception of *Cydonia* and *Amelanchier*, they are also evergreens. Sippell (1957) and Hodson (1941) discuss the reasons why certain trees are selected by the females for egg-laying; they came to the conclusion that an important factor was early-leafing dates, with the earliest leafers being selected in preference, providing as example, *Malacosoma disstria* Hübn. in Canada, whose females choose to lay on poplar rather than oak, the former coming into leaf sooner. Of the poplars Sippell (1957) describes the importance of two species, *Populus* *grandidentata* and *P. tremuloides*, with the latter taking pride of place as the ovipositional host.

THE IMPORTANCE OF EXOTIC CULTIVARS

The two years of the east London field study illustrated the adaptablity of *E. chrysorrhoea* to a wide range of plant species, twenty-two overall, with twenty being utilized in the first year of the study, and seventeen in the second. However, as was to be expected, rosaceous plants provided most of the data, twelve species being used in 1995, and twelve also being used in 1996. Two plants in the Rosaceae were not used in both years, these being *Cydonia* sp. and *Pyrus* sp. Five other plants in different families were also not used across both years of the field study, these being *Betula pendula*, *Tilia* sp., *Ulmus* sp., *Populus nigra* and *Cornus sanguinea*. The moth did not appear to be consistent in terms of plants used, with 'favourite' plant species (i.e. those which gave relatively high percentage rates out of the total numbers of hibernacula counted in the first year) not being used to the same extent in the following year. Yela (1992) described some noctuids (especially polyphagous species, e.g. *Peridroma saucia* (Hübn.)) as attacking certain herbaceous strata, this being the determining characteristic in choosing the food-plant or plants. There may be some structural importance of plants in the dietary choices being made by browntail moth larvae as they mature and disperse, or where the female moth decides to lay the egg-batch. Also, some plant species were utilized to only a limited extent in the first year, whilst in the second year of the study, the same plant was used to a far greater extent. Plants in this category include: *Cotoneaster* sp., *Pyracantha* sp. and *Prunus laurocerasus* (erroneously identified as *Laurus*, King, 1995). One notable point is the willingness of *E. chrysorrhoea* to exploit those plants which are planted for amenity purposes by the local authority. This is in stark contrast to self-seeded or 'wild' plants, for example *Rubus fruticosus* (bramble), which actively seemed to be ignored by the moth. With this in mind, it would appear that if food-plant availability is a factor which contributes in some way to population increases of *E. chrysorrhoea* in a given area, then consciously planting important host-plants for such an injurious pest species is of no help to local people, but of considerable benefit to the moth.

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NEW MOTH RECORDS FOR THE ISLE OF LEWIS

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During a warm dry period in late August 1997, a Skinner trap was operated in the grounds of a cottage at Breascleit (NB219353), on the Isle of Lewis. This site lies at the edge of an extensive mosaic of moorland and blanket bog, within a coastal farmland landscape. The trapping occurred over 6 consecutive nights between 17–22 August, and those moths present inside the trap in the early morning were identified (see Table 1). Although only 24 species were recorded, these included large ear *Amphipoea lucens* (Freyer), crinan ear *A. crinanensis* (Burr.), grey chi *Antitype chi* (L.), flame carpet *Xanthorhoe designata* (Hufn.) and the Tortricid *Epinotia caprana* (Fab.) all new to Lewis. A further 3 species were re-confirmations of species last recorded on this island before 1900, these being small wainscot *Photedes pygmina* (Haw). coast dart *Euxoa cursoria* (Hufn.) and the Pyralid *Eudonia murana* (Curt.)

The northern deep-brown dart *Aporophyla lueneburgensis* (Freyer) was also recorded, a species not listed for the Outer Hebrides. As this moth was formerly treated as a sub-species of deep-brown dart *A. lutulenta* (D. & S.) and has only

Table 1. List of moths recorded from Lewis during August 1997.

Species	English name	No. individuals
Geometridae		
Epirrhoe alternata obscurata (South)	common carpet	1
Eulithis testata (L.)	chevron	5
Hydriomena impluviata (D. & S.)	May highflyer	2
Perizoma didymata (L.)	twin-spot carpet	2
Xanthorhoe designata (Hufn.)	flame carpet	1
X. fluctuata (L.)	garden carpet	2
X. decoloraria (Esper)	red carpet	5
Noctuidae		
Amphipoea crinanensis (Burr.)	crinan ear	1
A. fucosa paludis (Tutt)	saltern ear	7
A. lucens (Freyer)	large ear	2
Antitype chi (L.)	grey chi	1
Apamea monoglypha (Hufn.)	dark arches	4
Aporophyla lueneburgensis (Freyer)	northern deep-brown dart	1
Cerapteryx graminis (L.)	antler moth	12
Euxoa cursoria (Hufn.)	coast dart	3
Hydraecia micacea (Esper)	rosy rustic	27
Mythimna impura (Hübn.)	smoky wainscot	2
Noctua pronuba L.	large yellow underwing	20
Paradiarsia glareosa (Esper)	autumnal rustic	1
Photedes pygmina (Haw.)	small wainscot	1
Xestia xanthographa (D. & S.)	square-spot rustic	1
Pyralidae		
Eudonia murana (Curt.)	–	1
Udea lutealis (Hübn.)	–	4
Tortricidae		
Epinotia caprana (Fab.)	–	1

recently been raised to species status, this might be expected. Older records for deep-brown dart may therefore include this former sub-species.

Only two incidental records from daytime excursions on the island were made, these being dark marbled carpet *Chloroclysta citrata citrata* (L.), frequent on rocky outcrops near Acha Mór (NB295288) on 2 August, and pink-barred sallow *Xanthia togata* (Esp.). The latter had also not been recorded on Lewis, and was collected on 21 August from an aspen *Populus tremula* thicket within a steep coastal ravine (along the Abhainn na Cloich at NB537508).

The lepidopteran fauna of the Outer Hebrides, similar to much of the west coast of Scotland, is still poorly known due to the relative paucity of recorders. In Waterston's review (1981) 352 species of moth are acknowledged (approximately 14% of the British list) since the first records were taken on St Kilda (MacGillvray, 1842). Lewis appears to be one of the better studied islands, with 201 species (57% of total) after including the new records. There is a long but sporadic history of moth recording on this island which began when Weir (1881) established a list of 58 species based on a private collection. This list has been subsequently extended through collections and surveys (South, 1888; Fremlin, 1900; Griffith, 1900; Scott, 1915; Evans, 1916); a series of papers by Harrison between 1938–59 (in particular 1940, 1949, 1953, 1956b and 1956); and most recently Hulme (1978).

It is interesting to note that approximately 33% of moth species known from Lewis are from records which pre-date 1900, further emphasising the lack of active recording. The listings also reveal an apparent disparity in the distribution of species, with 55 species (16% of the Outer Hebridean fauna) having only been recorded on Lewis. While Lewis might possibly possess a greater species richness due to its size and range of habitats, more comprehensive surveying of the moth fauna is clearly needed before comparisons between islands can be made.

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BOOK REVIEW

The natural history of moths, by M. Young. T. & A. D. Poyser, London, 1997, xiv + 272 pages, 16 colour plates, £25.00, hardback.—For an entomologist who always studiously avoided looking at moths because beetles and the 'other' orders always seemed so much more interesting, it came as quite a shock to realize what I had missed. I must admit that in recent years I had already started to pay the Lepidoptera a bit more attention and a lot more respect. It began, not with the stark greenish glow of a mercury vapour light, but with the sight of a copper underwing through a camera viewfinder, and the discovery that I quite liked watching sycamore caterpillars crawl over my hands.

There are various identification guides for adult moths (and their caterpillars) now available, and I have collected a few of them to help me name the fairly common moth species that I occasionally come across. Each guide is useful in its way, but they all seem to concentrate almost exclusively on the Spartan details necessary for initial discovery and identification and with only a cursory glance at the varied natural histories of the moths themselves. I must have neglected to buy Ford's *New Naturalist* on moths and for that easy general ecological introduction to the group, I had nothing on my library shelves. I do now.

In fact, Young claims Ford's book as one of his main inspirations, and goes on to say that he has tried to take off from where Ford stopped. The main emphasis of the book is the biology and ecology of moths—how we came to have our British fauna, what it does here, how it has evolved, how it is changing, how it can be studied and how it can be conserved. And it makes fascinating reading. Although not patronizing in its tone for the experienced entomologist, it is also not too complex and heavyweight for the errant miscreant like myself who comes with only a sketchy knowledge of the British moth fauna.

The author works through a series of very complex and up-to-date discussions, but always in a thoroughly readable and illuminating way. Many of the topics are illustrated with charming and helpful line figures, but I must admit that I sniggered when I saw an artist's impression of the wingless belted beauty *Lycia zonaria* hitching a lift on the bow of a small boat across the sea between the Hebridean islands on which it has its headquarters. There are some excellent colour plates too, showing different aspects of moth biology from resting attitude to larval form.

Often, the real test of a book like this, one on a particular group of insects, is how much can it relate to other orders, and to entomology as a whole—how it fits in and around the reader's existing knowledge and enthusiasm. Young's book passes with flying colours, for whichever section I was reading, I found the discussions and arguments set my mind working off in other directions, on other insects and other fields of enquiry. And every so often I came across an idea I wanted to follow up—no problem because of the extensive reference list.

As I said earlier, I do not have many moth books on my shelves, but Mark Young's is one I now reach for most often.

Richard A. Jones

FROST SURVIVAL BY *CRYPTOLAEMUS MONTROUZIERI* MULS. (COLEOPTERA: COCCINELLIDAE) IN AN OUTDOOR SITUATION

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Cryptolaemus montrouzieri is a ladybird beetle that originates from Australia but has been widely distributed as a biological control of mealybugs. It has been commercially available in Britain since 1980 and is widely used in botanic gardens, butterfly houses and amateur greenhouses and conservatories against mealybugs such as *Planococcus citri* (Risso), *Pseudococcus affinis* (Maskell) and *P. longispinus* (Targioni-Tozzetti) (Hemiptera: Pseudococcidae). Both the adult beetles and their larvae feed on the eggs and active stages of mealybugs.

While the larvae remain on plants, adult *C. montrouzieri* have a tendency to escape from greenhouses by either crawling or flying through open door and ventilators. Constantine & Majerus (1994) recorded two adults within five minutes of each other flying across a school playing field at Skipsea, N. Humberside, on a hot day in July 1991. The optimal temperature range for the development and activity of *C. montrouzieri* is 22–25 °C (Malais & Ravensberg (1992)). At 18 °C the life cycle from egg to egg takes 72 days but this is reduced to 25 days at 30 °C. At 33 °C the beetles stop feeding and they are also relatively inactive at temperatures below 16 °C. Because of the requirement for warm conditions, it has been assumed that *C. montrouzieri* would be unable to survive for long out of doors, except perhaps in the warmest parts of the British Isles, such as the Scilly Isles. Another difficulty facing the beetle is finding a source of food, since mealybugs outside glasshouses are not a common commodity in Britain.

In 1977 a New Zealand mealybug, *Balanococcus (Trionymus) diminutus* (Leonardi), began arriving in Britain on imported plants of New Zealand flax, *Phormium tenax* (Bartlett 1981). Eradication attempts failed and this mealybug is now of widespread occurrence in garden centres and gardens. Unlike most exotic mealybugs, *B. diminutus* is able to withstand hard frost and it occurs at the Royal Horticultural Society's Garden, Wisley, Surrey on *Phormium tenax* Forst. & Forst. and *P. cookianum* Le Jolis. In late September 1997, adults and larvae of *C. montrouzieri* were discovered on a large mealybug-infested *P. tenax* growing in the Monocot Borders about 180 m to the north of the nearest glasshouse from where the beetle might have escaped. A survey of other *Phormium* at Wisley Garden revealed another *montrouzieri* colony on a large *P. tenax* growing 140 m in a south-easterly direction from the main glasshouse range. The plant in the Monocot Border was the more accessible, so observations were made on this plant to see how long the ladybird would persist. The last adult *C. montrouzieri* of 1997 was seen on 22 October but larvae were found on warm sunny days on 27 October, 5, 11 and 26 November, and 10 December. No larvae were seen in 1998 during January to March but a single adult was found on 11 February. It is possible that this might have been a recent escape from a heated glasshouse, but it is unlikely that outdoor temperatures would be sufficient at that time of year to allow flight. The maximum daytime temperature on 11 February was 14.8 °C. Apart from 14.9 °C on 9 January, that had been the warmest day of the year up until then.

Daily weather records are made at Wisley in a meteorological station situated in the Fruit Field about 200 m from the study plant. This *Phormium* is growing in a more sheltered position between two parallel 2 m high yew hedges but temperatures recorded in the Fruit Field give an indication of the weather conditions that *C. montrouzieri* survived. The first air frost of the autumn, −1.7 °C, occurred on 25 October and this was followed by eight consecutive nights with air frosts. The coldest nights were 29 and 30 October with −5.7 °C. November had a total of five air frosts with the coldest being −4 °C on 1 November. December was a relatively mild month with 5 December at −2.8 °C being the coldest of seven nights with air frosts. January and February 1998 had six and four air frosts respectively, with −6.5 °C on 20 January and −5.2 °C on 2 February. There was a prolonged period of cold weather between 20 January and 5 February, when air frosts occurred on ten nights.

Mature plants of *Phormium tenax* are well designed to give insects shelter from inclement weather. The plant in the Monocot Border is approximately 2 m in diameter and consists of a dense mass of upright sword-shaped leaves which are about 2 m tall. The basal part of a *Phormium* leaf is folded upwards almost completely in half and this is where most of the mealybugs reside. Any insects living within the folded leaf bases are going to be sheltered from wind and rain and the temperature there could be several degrees above those recorded in the Fruit Field meteorological station. These observations do, however, show that *C. montrouzieri* has some tolerance of cold conditions. With the trend towards milder winters, it might be able to survive the winter out of doors in sheltered places where it can locate a reliable supply of prey insects.

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FIELD MEETING REPORT

Killiecrankie RSPB reserve, Balrobbie Farm end, Perthshire, 8 & 9 August 1998

Leader: **Paul Waring**. This was a field meeting for which the weather was superb on the day in an otherwise prolonged dull, wet and rather cool period, at least in Scotland and northern England. By contrast, my home in Peterborough had had a glorious week of sun and weather so dry that both our garden water butts were empty and we had had to top up our pond from the mains supply. I drove north as far as Stirling the day before the meeting, in rain from Lancashire northwards, and stayed overnight with RES member Barbara Tigar at her home on open grassy hills at Blackford. That night I operated a Robinson trap all night here, in rough pasture by the house, catching 220 macro-moths of 28 species, largely dark arches *Apamea monoglypha* (Hufn.) and large yellow underwing *Noctua pronuba* L. and other ubiquitous species but also several species common in the north of Britain but

Fig. 1. Field meeting at Killiecrankie RSPB reserve, Perthshire, on 8 August 1998. The flush which produced the small rufous moth *Coenobia rufa*. L–R: Richard Little, Michael Clementson, Barbara Tigar & Betty Clementson. (Photo: Paul Waring)

worthy of mention, including the antler moth *Cerapteryx graminis* (L.) and dotted clay *Xestia baja* (D. & S.), a gold spangle *Autographa bractea* (D. & S.), a gold spot *Plusia festucae* (L.) (not *P. putnami gracilis* Lempke), the rosy minor *Mesoligia literosa* (Haw.), the double lobed *Apamea ophiogramma* (Esp.) and three garden tiger moths *Arctia caja* (L.).

The morning of the meeting was hot and sunny, almost from dawn, as Barbara and I drove north to meet with the RSPB reserve manager Bruce Anderson at the RSPB car park at Balrobbie Farm (NN905628) an hour before the meeting was due to start. BENHS members Mike & Betty Clementson and Richard and Liz Little had already arrived. Another couple of members were expected but failed to show, probably on account of the poor weather still being experienced in some other parts of Scotland.

We had a most enjoyable afternoon's walk along the bank which runs from the car-park to the base-rich flushes which are reported to be some of the most species-rich for plants in Scotland. We saw plants such as grass of parnassus *Parnassia palustris* L., lady's-mantle *Alchemilla vulgaris* agg. and wood sorrel *Oxalis acetosella* L. and great swathes of cotton-grass *Eriophorum angustifolium* Honck. and were glad to take a break from the sun and rest in the shade and humidity of the birch woodland. Butterflies were few. We saw several scotch argus *Erebia aethiops* (Esp.) and recorded the common blue *Polyommatus icarus* (Rott.), large white *Pieris brassicae* (L.) and small tortoiseshell *Aglais urticae* (L.). Several twin-spot carpet moths *Perizoma didymata* (L.) and striped twin-spot carpets *Nebula salicata latentaria* (Curt.) were flushed from birch trunks and a yellow shell *Camptogramma bilineata* (L.) flew up from the grass. A small rufous *Coenobia rufa* (Haw.) flew up and was netted as I walked across one of the flushes. An azure hawker dragonfly *Aeshna caerulea* (Strom.) was on the wing over the cotton-grass and Barbara found a female black and yellow cerambycid beetle *Strangalia quadrifasciata* L. which laid four eggs in a pill-box while awaiting confirmation. A large black slug, probably *Arion ater* (L.), was frequent and one individual was found eating a *Boletus*-type toadstool. In the field below, a male roe deer *Capreolus capreolus* L. courted and escorted a female through the grass.

We walked higher up into heather moorland where several dark green fritillary butterflies *Argynnis aglaja* (L.) were on the wing but searched without success for basking hairy caterpillars as the sun was leaving the hill-side; we were probably too late in the day.

Two buzzards *Buteo buteo* L. were mewing in the nearby birch trees when we returned to the car-park, which we made our overnight camp. After a congenial evening meal together we each set up our light-trapping gear. Barbara and I operated a Robinson light-trap all night, set up wine-ropes and spent dusk netting amongst the cotton-grass though it was at this point cool and clear and there was little on the wing. Richard and Liz operated another Robinson trap until midnight and the Clementsons manned a sheet till midnight. All the lights were spread along the bank above the car-park.

A tawny owl *Strix aluco* L. called as darkness fell and a jay *Garrulus glandarius* L. squawked at dawn. The temperature fell from 13 °C at dusk to a minimum of 9 °C at some point during the night but it was cloudy most of the night and there were lots of moths around the trap when we inspected it in the morning. The total catch was 261 macro-moths of 57 species, the nationally scarcest of which was a single barred carpet *Perizoma taeniata* (Steph.) (Nationally Scarce category A). There are previous records of the barred carpet for this site (e.g. S. Hind, 15 August 1989). Other moths worthy of mention included the following, with the number of individuals recorded at the all night Robinson trap in parentheses: dotted carpet *Alcis jubata* (Thunb.) (Nationally Scarce category B, 9 individuals), plain clay *Eugnorisma depuncta* (L.) (Nationally Scarce category B, 2), beech-green carpet *Colostygia olivata* (D. & S.) (Local, 1), juniper pug *Eupithecia pusillata* (D. & S.) (Local, 1) and scarce silver Y *Syngrapha interrogationis* (L.) (Local, 2). The following common but largely northern species were recorded: antler (13), gold spangle (6), gold spot (2), northern spinach *Eulithis populata* (L.) (5) and twin-spot carpet (2). The most abundant moths were the dark arches (56) and the large yellow underwing (36). The dotted clay (11), the large emerald *Geometra papilionaria* L. (9) and the lesser swallow prominent *Pheosia gnoma* (Fab.) (8) were also frequent. The additional lights added the muslin footman *Nudaria mundana* (L.), tawny-speckled pug *Eupithecia icterata* (Vill.), grey pine carpet *Thera obeliscata* (Hübn.) and a second generation engrailed *Ectropis bistortata* (Goeze) to the list.

A full list of the species we recorded has been sent to the RSPB, to Keith Bland, the moth recorder for Perthshire, and to our BENHS archivists.

I would like to thank Michael and Betty Clementson, Richard and Liz Little and Barbara Tigar for their company on a most enjoyable meeting. Liz Little deserves special thanks for watching over the vehicles and equipment during the afternoon which allowed the rest of us freedom from concern about the security of our cars and generators. I thank the site manager Bruce Anderson and the RSPB Reserves Ecologist for Scotland, David Beaumont, for their co-operation in the organisation of this meeting and in supplying the necessary site maps.

NOTES ON THE DISTRIBUTION OF *LEDRA AURITA* (L.) (HOMOPTERA: CICADELLIDAE) IN BRITAIN

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The cicadellid *Ledra aurita* (L.) is by far the largest of the leafhoppers found in the Western Palaearctic region; adults are nearly two centimetres long and are certainly unmistakable in appearance (see illustration in Chinery (1986) and front cover of this issue). Both adults and nymphs are highly cryptic when resting on lichen and moss covered stems of their host trees. The species is generally associated with oaks, *Quercus* spp., but records occasionally come from other deciduous woodland trees such as hazel, *Corylus avellana*, alder, *Alnus glutinosa*, and lime, *Tilia* spp.

The species appears to have a two-year life cycle (Schwoerbel, 1957), although further work is needed to confirm this. Nymphs of all instars can often be found by beating the lower branches of oaks. Interestingly, this method is rather less rewarding for collecting adults; it is possible that they reside at higher elevations within the canopy of the tree. This theory is further supported by the fact that many records refer to adults attracted to light. Adults are present generally from July to September.

L. aurita occurs through most of Europe (Nast, 1987) and major parts of the Palaearctic region (Nast, 1972). Within Britain, it is sufficiently widely distributed not to be awarded Notable or Red Data Book status (Kirby, 1992). However, it is hardly a common insect judging by the comparative scarcity of records to date.

The purpose of this brief note is twofold. Firstly, we present the most up-to-date distribution map for the species, based on records held by the Auchenorrhycnha Recording Scheme (Fig. 1). This confirms Le Quesne's (1965) observation that the

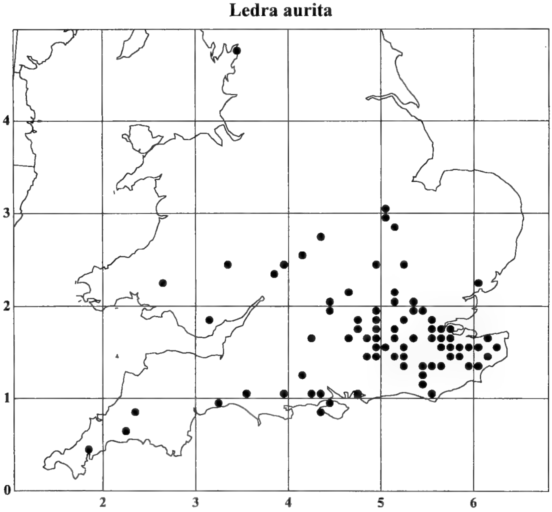

Fig. 1.

species is widely distributed across central and southern England, with a concentration of records towards the south-east of the country. Secondly, we draw attention to two recent records that represent significant extensions to the previously known range. The first of these refers to a single nymph collected in the course of sampling for saproxylic invertebrates at Dinefwr Deer Park (near Llandeilo, Carmarthenshire, Wales) by Brian Levey and Mark Pavett. It was caught in a flight interception trap, operating between 12–21 June 1996. It is fair to assume that the nymph was blown into the trap from the nearest branch! This appears to be only the second record of *L. aurita* for Wales; the first record comes from mixed deciduous woodland just north of Cardiff some 20 years ago (M. F. Claridge, pers. comm.).

The impression of a species that is predominantly southern and eastern in distribution is thrown into doubt by the second interesting record that we highlight. This is of a single nymph beaten from sessile oak, *Q. petraea*, at Gait Barrows NNR in Lancashire on 18 June 1993 by Alan Stewart. This is over 200 km from the nearest record in central England. It is impossible to say whether this represents a northerly outlier or simply another record in what may yet turn out to be a much more extensive distribution. More extensive surveying in this area would be useful. To our knowledge, the species has not been recorded from either Scotland or Ireland.

Most recorded specimens of *L. aurita* have been collected from mature trees. It is possible that the species may be a useful indicator of ancient, or at least old, woodland. Certainly, many of the records are from long established sites that often have high conservation value for other groups. Although not ancient woodland in the usual sense of the term, Dinefwr is certainly one of the finest parkland sites in Wales for invertebrates.

We would like to thank all those who have contributed records. We would welcome any further records for this species, but especially those from Wales and northern England. Is *L. aurita* scarce or absent from these latter areas, or is it simply under-recorded?

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BEMBIDION (PSEUDOLIMNAEUM) INUSTUM DUVAL, (COLEOPTERA: CARABIDAE) AN INTERESTING NEW ADDITION TO THE BRITISH FAUNA

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Two specimens of this scarce European species were captured using flight interception traps at two sites in Wales, while undertaking a survey of saproxylic invertebrates on behalf of the Countryside Council for Wales.

A female was collected at Dinefwr Deer Park, (SN6122), Carmarthenshire, in the period between 12–22.vi.1996. The interception trap was situated in dense shade adjacent to a stony stream at the boundary between young ash/sycamore woodland and open parkland. Further into the woodland the stream discharges into a densely shaded sparsely vegetated marshy area at the edge of an oxbow. A male was collected at Llanover (SO3108), Gwent, in the period 6–13.vi.1996. The interception trap was situated under young ash with blackthorn, bramble and sycamore scrub at the edge of close-grazed pasture. A stony stream was present about 70 m away.

B. inustum is a rare and sporadically occurring, usually montane species, in Europe. It has been found in Central and S.W. Europe, but has not been recorded from Scandinavia. The habitat associations are not well known but it appears to be most commonly reported from the vicinity of running water, perhaps with a preference for shaded areas, which describes the area it was captured in at Dinefwr very well. Limited hand searching at Dinefwr in mid-June 1998 and pitfall trapping from 15.vi.–10.vii.1998 near the point of the original capture failed to find the species. The following Carabidae characteristic of damp and shaded habitats were taken: *Nebria brevicollis* (Fab.), *Elaphrus cupreus* Duftschmid, *Loricera pilicornis* (Fab.), *Patrobus atrorufus* (Stroem), *Bembidion dentellum* (Thunberg), *B. nitidulum* (Marsham), *Pterostichus anthracinus* (Panzer), *P. minor* (Gyllenhal), *P. rhaeticus* Heer, *Agonum albipes* (Fab.), *A. assimile* (Paykull), *A. gracile* Sturm, *A. micans* Nicolai, *A. viduum* (Panzer), *Chlaenius nigricornis* (Fab). There is only sparse information on the activity period of *B. inustum*; adults have been taken in late May and early June according to the published information, so it is possible that our searching and pitfall trapping were too late to capture this species.

B. inustum appears to be nocturnal and possibly spends most of its time in concealment, if it is not truly subterranean. It has been found near a strongly shaded small stony stream in Luxembourg (Braunert, 1994), on the sandy margin of mountain rivers and streams in S. Bavaria (Sowig, 1986), the boggy margin of a small lake in the Black Forest (Renner, 1982) and on muddy banks under decaying leaves of *Petasites* (Freude, 1976). It is also said to frequent caves, cellars, barns, sheds and fissures in walls. It flies at night and is attracted to light (Freude, 1976; Magistretti, 1965; Jeannel, 1941).

IDENTIFICATION

The British specimens keyed readily to the subgenus *Pseudolimnaum* Kraatz, in Trautner & Geigenmüller (1987). *Pseudolimnaeum* can be distinguished from other European subgenera of *Bembidion* in having the following combination of characters: third elytral interval with two dorsal punctures touching the adjacent

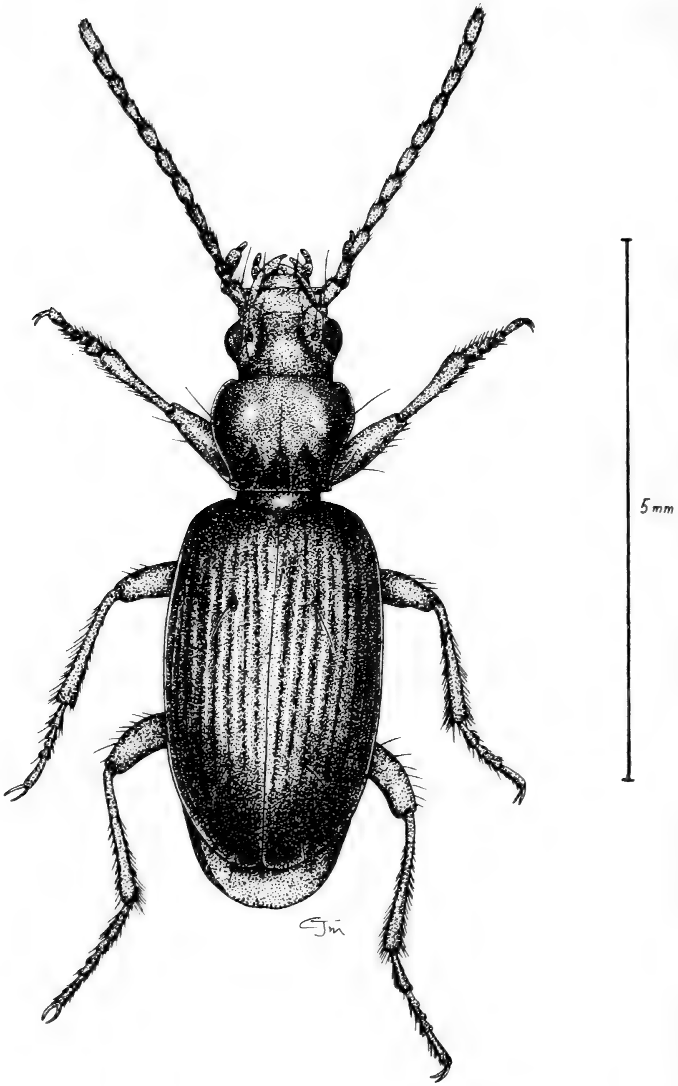

Fig. 1. *Bembidion inustum*, male habitus.

stria, with the anterior puncture situated before the mid-length of the elytra; eighth elytral stria complete and as well defined as the other striae; basal bead of elytra not forming a sharp angle with the lateral bead at the shoulder; lateral margins of pronotum straight near the basal angles; median line of pronotum widened and deepened at base to form a well defined broad deep channel; head with distinct, weakly convergent frontal furrows, which do not extend on to the clypeus. This subgenus contains only two species in western and central Europe, *B. inustum* and *B. doderoi* Ganglbauer (a third species *B. lederi* Reitter is known from the Caucasus and Crimea). The genitalia of the male specimen compared well with the figure given for *B. inustum* in Jeannel (1941). Comparison with two female specimens from La Madeleine, Nice, in the collection of The Natural History Museum, London, confirmed the identity of the species.

B. inustum is unlikely to be confused with any other species of British *Bembidion*. It is perhaps most similar to *B. stomoides* Dejean in general appearance, but it would key to *B. prasinum* Duftschmid in Lindroth (1974). The following description will distinguish *B. inustum* from any other British species of *Bembidion*. Length 5.5–6.0 mm. Colour pitchy-brown with a slight blue reflection, suture and apex of elytra paler; all appendages pale brown; eyes small; head constricted immediately behind the eyes; median line of pronotum widened and deepened at base to form a well defined broad deep channel; elytra rather parallel sided. the striae deeply incised, the seventh stria not markedly weaker than the sixth, the strial punctures small.

It seems unlikely to us, given its rarity in Europe and its life style, that this species has been imported into Britain accidentally. It seems probable, given its nocturnal habits and presumably largely concealed life style, that it is a long established native species that has evaded capture up until now. As it is largely montane in Europe, it might be absent from the well collected lowland areas of southern England, which would be another reason that it has not been found.

ACKNOWLEDGEMENTS

We thank Chris Meechan for the habitus drawing, John Deeming for help with German translation, Darren Mann for supplying recent references and Stuart Hine of The Natural History Museum, London, for the loan of specimens.

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AULAGROMYZA LUCENS (DE MEIJERE) (DIPTERA: AGROMYZIDAE), A SPECIES NEW TO BRITAIN

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Two males of an *Aulagromyza* species whose identity eluded me were found on the Glamorgan coast, S. Wales in 1985. Further attempts over the years to find additional material both at the original collecting site and at others have been fruitless, though a single male specimen was found in a large number of trapped samples from Dinefwr Deer Park, Carmarthenshire in 1996. The species, which is undoubtedly most uncommon, was kindly identified by Dr M. von Tschirnhaus, Universität Bielefeld, Germany as being *Aulagromyza (Rubiomyza) lucens* (de Meijere), described (1924:142) from the Netherlands, known from Germany developing in *Galium aparine*, and recorded also from Finland. It being new to Britain, a description and figures are presented for the convenience of those involved with the British fauna.

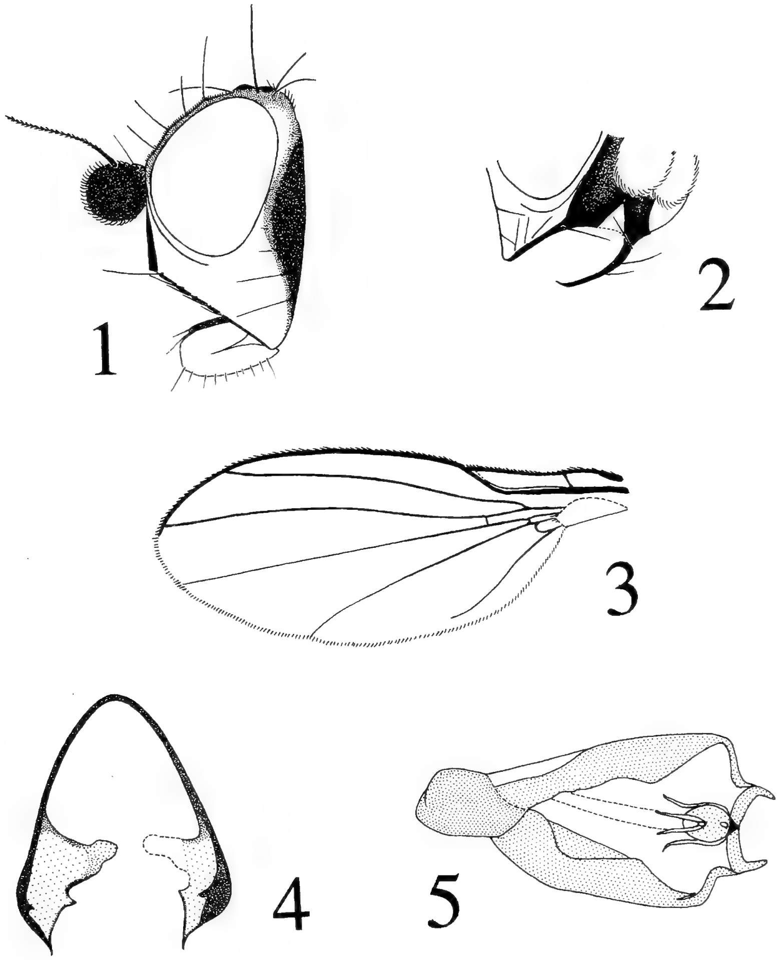
DIAGNOSIS

A black species with all hairs and bristles black, greyish hyaline wings, the proboscis, cheeks and jowls yellow, the frontalia, upper hind eye margin, knees, fore and mid tarsi dirty yellow, the haltere creamy yellow and the squamal margin and its fringe infuscate, the mesonotum strongly subshining through very weak dusting.

Head (Fig. 1): with jowls deeply extended at rear; jowlar margin straight, shining black along its rim; length of frons one half of head width, at level of ocellar prominence its width slightly over half width of head, at fore margin narrowed to 0.375; orbital plates sparsely pruinose, raised above level of interfrontalia, rather broad, at mid length of frons one half of width of interfrontalia, bearing 2 inferior and 2 superior orbital bristles; ratio of length of internal vertical to external vertical bristles = 11:8; postocellars slightly shorter than external vertical; most ventral two setae of the postocular row very long and forwardly-directed; vibrissa and jowlar bristles fine; face (Fig. 2) strongly subshining black with antennal grooves more heavily grey dusted, medially with a distinct triangular epistomal cleft occupied by white membrane; antenna black throughout but base of arista somewhat paler, the third segment with strikingly long pubescence; palpus rod-like, black.

Thorax: Mesonotum strongly convex and strongly subshining through weak grey dust, more heavily dusted on humerus, notopleuron and remainder of pleura; 3 postsutural dorsocentral bristles, which become progressively longer posteriorly, and a single weak presutural dorsocentral; setulae of mesonotum sparse, between the dorsocentral lines in 4 irregular rows; 1 humeral, 1 posthumeral, 2 notopleural, 1 long upwardly-directed propleural; 3 long bristles on hind margin of mesopleuron, 1 long bristle on upper margin of sternopleuron, this preceded by 2 much shorter and weaker setae; scutellum with the usual 2 pairs of marginal bristles, of which the more apical are slightly longer, the distance between their bases two-thirds of that between their bases and those of the more lateral.

Wing (Fig. 3): with somewhat greyish-suffused membrane and brown veins, though stem vein and base of costa obscurely yellowish; posterior crossvein absent on both wings of all 3 specimens examined.



Figs 1–5. *Aulagromyza lucens*. Male. 1. Head in profile. 2. Lower part of head in oblique view. 3. Wing. 4. Hypandrium in dorsal view. 5. Aedeagus in ventral view.

Abdomen: subshining with setae of uniformly fine development; surstylus discrete, almost semicircular in outline and lacking distinctive chaetotaxy; epandrium simple; hypandrium (Fig. 4); aedeagus (Fig. 5); gonite deeply cleft apically. Length about 2 mm, of wing 2 mm.

Material: 2 ♂ Wales: Glamorgan, E. Aberthaw (ST0465), diverse lush vegetation bordering beach, 8.vi.1985, J. C. Deeming; 1 ♂ Carmarthen, Llandeilo, Dinefwr Deer Park (SN6122), Malaise trap, 31.v.–5.vi.1996, B. Levey & P. M. Pavett. All dry mounted and deposited in National Museums and Galleries of Wales.

AFFINITIES

The genus *Aulagromyza* Enderlein, 1936 is better known under the name of its synonym *Paraphytomyza* of the same author and date but published in a separate paper. Papp (1984:309) followed other authors in giving priority to *Paraphytomyza*, but von Tschirnhaus (1991:305) formally reversed this priority. In Spencer's (1972:64) key to British *Paraphytomyza* this species (*lucens*) would trace to *discrepans* (Wulp), but differs from it in having the presutural dorsocentral bristle very weakly developed, the aedeagus of a very different structure from that figured by Spencer (*loc. cit.* p. 62, Fig. 207) and in having all knees yellow. The aedeagus here figured for *lucens* appears very different from that figured for the same species by von Tschirnhaus (1969:285, Figs 8–10) and reproduced by Spencer (1976:317, Fig. 570), which shows greater detail, but my figure is of an unstained genitalia preparation in euparal. In terms of general coloration and aedeagus structure *lucens* most resembles the holarctic *cornigera* Griffiths, which species appears in Spencer's (1972:64) key under the name of *lonicerae* (Robineau-Desvoidy), of which species Spencer & Steyskal (1986:434, Figs 1035 & 1036) figure the aedeagus, but there are significant differences in the mesophallus and base of the distiphallus. The difference between the two species in the presence (*cornigera*) or absence (*lucens*) of the posterior crossvein is not fully reliable, within this genus its presence being to some extent erratic.

The discovery of a species of Agromyzidae on the coastal strip of south Wales and which appears not to be found elsewhere in Britain is not as strange as might at first sight appear, this being an area which remained free of ice during previous glaciations.

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PALLOPTERA ANDERSSONI SP. N. FROM SCOTLAND AND FINLAND (DIPTERA: PALLOPTERIDAE)

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In April 1995 one of us (IM) reared a pallopteran species similar to *Palloptera ustulata* Fallén from under bark of fallen branches of lime, *Tilia europaea* L., at Battleby, Perthshire, Scotland. A conspicuous difference between *P. ustulata* and this material was the lack of shading which is typically present at the tip of the wing in *P. ustulata* (Figs. 255–7 in Morge (1967)). In April of the following year, clear-winged specimens were again encountered, this time reared from under bark of fallen oak branches, *Quercus* sp., at Meikleour, Perthshire. Finally, in March 1997 at Balnaguard, Perthshire, we found acalypterate larvae within bark of fallen birch branches, *Betula* sp. From these larvae we reared more examples of a clear-winged *Palloptera* species.

The consistency of clear wings in all this material was striking, and shading did not develop as specimens aged, suggesting that lack of shading was not a teneral feature, as is sometimes the case with *Palloptera* (Morge, 1967; Stubbs, 1969; P. J. Chandler, pers. comm.). Andersson (1990) recognized female clear-winged specimens from Sweden similar to but possibly distinct from *P. ustulata*, referring to them as var. b. Earlier, Malloch in Malloch and McAtee (1925) described *P. claripennis*, a clear-winged species similar to *P. ustulata*, from California, USA, to which European clear-winged material might be referrable. However, on comparing our clear-winged material with *P. ustulata* from Sweden and *P. claripennis* from California, we were able to determine that an apparently unrecognized species exists. The adult and puparium of this new species is described here.

PALLOPTERA ANDERSSONI SP. N.

Type Material. Holotype, ♂: SCOTLAND, Perthshire, Balnaguard, larva in bark of fallen *Betula* sp. branch, collected 20.iii.1997, emerged vi.1997, G. E. Rotheray. Paratypes, 11♂, 11♀ as follows: 2♂, 1♀: SCOTLAND, Perthshire, Battleby, larvae under bark of fallen lime, *Tilia europaea* L., collected April 1995, Iain MacGowan; 6♂, 10♀: SCOTLAND, Perthshire, Balnaguard, larvae in bark of fallen *Betula* sp. branch, collected 20.iii.1997, emerged vi.1997, G. E. Rotheray; 1♂: SCOTLAND, Perthshire, Killiecrankie, larva under bark of *Acer pseudoplatanus* L., emerged 6.vi.1997, Iain MacGowan; 1♂: SCOTLAND, Angus, Glen Clova, larva under bark of *Betula* sp., emerged 3.vi.1997, Iain MacGowan; 1♂: FINLAND, near Lempola, 3.x.1979, P. J. Chandler. Holotype and all but one male paratype in the National Museums of Scotland, Edinburgh. One male paratype in the private collection of P. J. Chandler.

Etymology—Palloptera anderssoni is named after Hugo Andersson, who first drew attention to the taxonomic distinctiveness of clear-winged specimens similar to *Palloptera ustulata*.

DESCRIPTION

Male.—length (tip of frons to tip of abdomen) 2.25–3.00 mm; thorax including humeri black and almost completely grey-dusted except for the anterior margin of scutum and bases of bristles which lack dusting and the scutellum which is yellow; abdomen mottled yellow and brown; head with black, grey-dusted occiput and ocellar triangle; front of frons yellow, cheeks yellow with white dusting; legs, palpi and halteres yellow; wings clear without shading; bristles black, antennae orange and brown with dark arista bearing short setae (Fig. 1); mesopleuron bare; anterior crossvein meeting discal cell before the middle; dorsal margin of sternopleuron with an isolated row of 4 setae anterior to sternopleural bristle (Fig. 2); aedeagus with curled stipe and setal fringe longer than stipe is wide; glans sclerotized black with equally long accompanying vesicle; apical filaments consisting of an elongate oval section and a longer section widening towards a bifurcated tip of which one arm is longer than the other (Fig. 3a).

Female.—similar to male except humeri tending to be black and grey-dusted but sometimes vaguely paler and yellowish; ovipositor black, stout and lightly sclerotized with dorsal and ventral rows of setae; cerci with 4 pairs of dorsal and ventral setae (Fig. 4); two spermathecae.

Puparium.—length 2.75–3.25 mm, width 0.75–1.25 mm; subcyclindrical in cross-section becoming more rounded posteriorly; tapering anteriorly and posteriorly; surface smooth except for thorax which is coated in transverse ridges and the end segment which is heavily wrinkled (Fig. 5); no evidence of spicules on the prothorax; locomotory welts on first seven abdominal segments consisting of 6–7 complete or interrupted transverse rows of similarly-sized, backwardly-directed spicules with medial spicules of second posterior row larger; anterior spiracles fan-like with 6 lobes; posterior spiracles surrounded by wrinkles and mounted on short projection, about as long as wide; pale to dark brown (Fig. 6), three short spiracular openings; cephalopharyngeal skeleton with robust mouth-hooks (Fig. 7); accessory teeth absent; mouth-hooks with a vague anterior window; dental sclerite comma-shaped; intermediate sclerite elongate and tapering posteriorly with slight ventral projections; parastomal bar elongate and pale posteriorly; pharyngeal sclerite with a dorsal apodeme and diffusely darkened; dorsal bridge with a narrow, dark ventral margin; pharyngeal ridges present.

DISCUSSION

Most *Palloptera* have patterns of shading on the wings which can be used to recognize many species (Morge, 1967). However, *P. anderssoni* is one of a small group of *Palloptera* species which lack shading on the wings. The male of *P. anderssoni* can be distinguished from males of other clear-winged species by the following combination of characters: mesopleuron bare; bristles black; wing with costal fringe consisting entirely of dark setae (pale at base in *P. claripennis*); sternopleuron with an isolated row of 4 setae anterior to sternopleural bristle (Fig. 2a), this row of setae not isolated from other setae in *P. ustulata* (Fig. 2b); male genitalia with a forked filament at the tip of the glans (Fig. 3a), apical filaments arranged differently in *P. claripennis* and *P. ustulata* (Figs 3b,c respectively).

At present female *P. anderssoni* cannot be reliably separated. One problem is the probability that some teneral *P. ustulata* lack shading at the tip of the wing and teneral *P. anderssoni* have yellowish humeri. The three females of *P. ustulata* var. b

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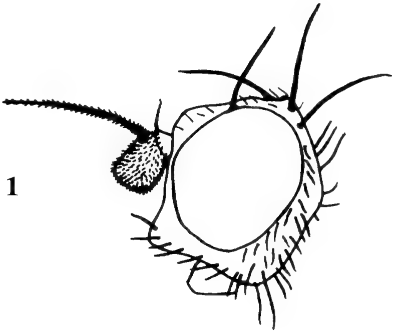

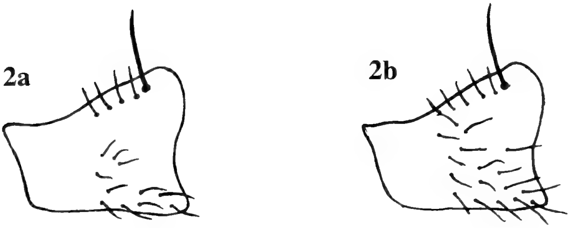

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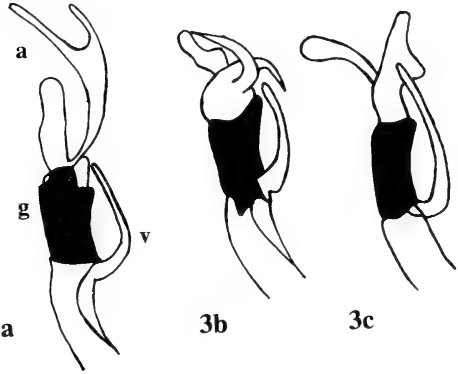

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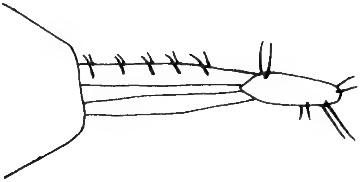
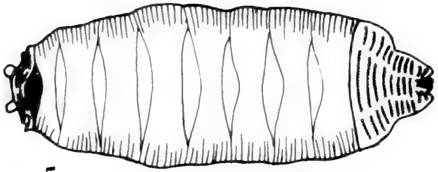


Figs 1–4. *Palloptera* spp. 1: *Palloptera anderssoni* sp. n. ♂ holotype, head, lateral view. 2a: *P. anderssoni* holotype, sternopleuron dorsal view. 2b: *Palloptera ustulata* ♂, sternopleuron, dorsal view. 3a: *P. anderssoni* holotype, tip of the aedeagus, lateral view. 3b: *P. ustulata* ♂, tip of the aedeagus, lateral view. 3c: *P. claripennis* ♂, tip of the aedeagus, lateral view, g = glans, v = vesicle, a = apical filaments. 4: *P. anderssoni* ♀, ovipositor tip, lateral view.



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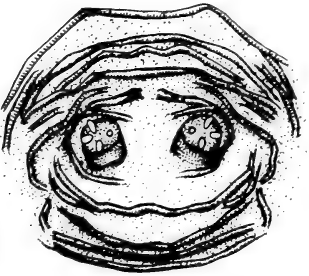
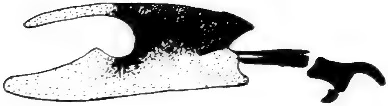


6



7

Figs 5–7. *Palloptera anderssoni.* 5: puparium, ventral view. 6: end segment of puparium, apical view. 7: cephalopharyngeal skeleton, lateral view.

from Sweden and females reared from under bark of *Quercus* at Meikleour, Perthshire appear to be problematic in this way. They are clear-winged, as in *P. anderssoni*, but have yellowish humeri which is more like *P. ustulata*. For this reason they cannot be identified. The puparium of *P. anderssoni* is very similar to that of *P. ustulata*. There are differences in the wrinkling of the end segment and the extent of dark areas of the cephalopharyngeal skeleton, but these are tentative with only one puparium of *P. ustulata* examined.

We found considerable variation in the glans and associated filaments between *P. anderssoni*, *P. claripennis* and *P. ustulata*, and these are apparently different to other Pallopteridae such as *Palloptera usta* Meigen (Czerny, 1949; Morge, 1956) and *Toxoneura superba* (Loew) (McAlpine, 1987). The investigation of these characters appears to be neglected but they may assist in recognizing and defining species limits in other Pallopteridae.

P. anderssoni is a univoltine species breeding under or within the bark of *Acer*, *Betula*, *Tilia* and possibly *Quercus*. It is probably not, however, confined to these three species. Currently it is only known from Perthshire in Scotland, and Finland. It is possibly a species with a northern distribution in Europe. We found larvae actively developing in March where they occurred with larvae of various *Lonchaea* spp. (Diptera, Lonchaeidae) and *Stegana* (Diptera, Drosophilidae). Morge (1956) observed the larvae of *P. usta* and *P. ustulata* attacking beetle and *Stegana* larvae respectively. However, we did not observe predatory behaviour in the larva of *P. anderssoni.* Morge (1956) also records pallopterid larvae in the absence of prey where they were probably feeding saprophagously on materials associated with decaying bark. They are probably facultative predators (Ferrar, 1987). Furthermore, the cephalopharyngeal skeletons of *P. usta* and *P. ustulata* were figured by Morge (1956) and are similar to *P. anderssoni.* They do not seem to be specialized for predation, but are of the usual saprophagous form with well developed pharyngeal ridges; neither do they posses accessory teeth which are a feature of the larva of *Palloptera quinquemaculata* (Maquart) which is phytophagous (Nye, 1958).

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THE INHERITANCE OF A MELANIC FORM OF THE 7 SPOT LADYBIRD, *COCCINELLA SEPTEMPUNCTATA* L. (COLEOPTERA: COCCINELLIDAE)

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Melanism is common among coccinellids, many species having black forms as part of genetic polymorphisms (*sensu* Ford, 1940). However, the 7 spot ladybird, *Coccinella septempunctata* L., the commonest species of ladybird in Britain, is not among these. Melanism does occur in this species, particularly in Asia, but the variation is continuous, resulting primarily from increasing spot size and fusion between spots (Varma, 1954; Rao, 1962; Iablokoff-Khnzorian, 1982) and is controlled multifactorially (Dobzhansky, 1933). Indeed, this species is relatively invariant in its colour pattern in Britain (Majerus, 1994). It has been argued that melanic forms of this species would be disadvantageous because, given its size, such forms would be liable to raised heat levels as a result of the greater heat absorption characteristics of dark compared to pale colours (Stewart & Dixon, 1989). However, a black form, referable to the name f. *anthrax*, has been recorded in Britain as an extreme rarity, and Stephens (1839) noted that the elytra of this species could be 'wholly black'. In this paper we give details of the finding of a melanic form of *C. septempunctata* that appears to be novel, a breeding program based on this individual, the genetical control of the form and we discuss reasons for its rarity.

INITIAL RECORD

On 4 September 1996, an abnormal *C. septempunctata* was noticed among many others on a lawn at North Hangleton, Sussex. It was boxed, and retained for later examination. Initial impression was that the ladybird was all black. On closer examination, several hours later, the ladybird was seen to be dark maroon, inclining to black, with the black spots just discernible. The ladybird was retained in Sussex until 14 October 1996 when it was sent to Cambridge. Microscopic examination showed the ladybird to be a male. The ground colour was very dark purple (similar in colour to 'black' tulips), with the black spots still just discernible under a dissecting microscope, but not with the naked eye. The normally white marks at the anterior outer margins of the pronotum and flanking the scutellary spot, were suffused with red, as just visible in Fig. 1, from a photograph taken on 18 October 1996.

We refer this ladybird, and other phenotypically similar ladybirds produced in crosses originating from this male, as f. *purpuralis*.

MATERIALS AND METHODS

In Cambridge, the ladybird was fed pea aphids, *Acyrthosiphon pisum* (Harris), and after two days was placed in a Petri dish with six virgin F_1 female ladybirds from a Cambridge stock. The male subsequently mated with all of these females over the next four months, the females being isolated as they were mated, with the male being rotated around the six females on a three week cycle. Eggs produced by these females were removed from their parents, and reared. Numbers of eggs laid and egg hatch

Fig. 1. The original melanic male *Coccinella septempunctata* mating with a typical female.

rates were recorded for all crosses. The adults and progeny were maintained and reared following procedures described by Majerus *et al.* (1989).

The F_1 progeny were scored for phenotype 48 hours after eclosion, and again five days later. They were fed for a week on pea aphids and then on an artificial diet (Majerus *et al.*, 1989) for two days before being initially placed in an unheated insectory for two days, and then transferred to a refrigerator, at 4 °C, for six weeks to simulate winter conditions and induce diapause. After six weeks the ladybirds were gradually transferred back into the laboratory (21 °C), where they were fed an artificial diet for two days to allow replenishment of fluid, and thereafter pea aphids. They were rescored for colour and pattern on removal from the refrigerator, and at six weeks intervals thereafter. The original black male, which had been retained at 21 °C throughout, was still alive, and was used in a back-cross mating with daughters of two females that he had been mated with. Other F_1 progeny were mated together. Resulting offspring were reared as before and notes were made of their colour patterns during the first 48 hours after eclosion, and at regular intervals for the next three months. Matings were also made between some of the F_2 adults produced, their progeny being scored as before. Three attempted pairings between F_2 *purpuralis* individuals failed to produce progeny. The longevity of all ladybirds was recorded.

RESULTS

The results of phenotypes of progeny from the various crosses are given in Table 1. Individuals designated as typical were normally coloured throughout adult life. Individuals assigned to f. *purpuralis* appeared normal on eclosion. However, within

Table 1. Details of crosses of *Coccinella septempunctata*, involving f. *purpuralis*.

Cross number	Male parent	Female parent	Progeny		
			f. *purpuralis*	typical	Total
C1	*purpuralis*, Sussex	typical, Cambridge		12	12
C2	*purpuralis*, Sussex (as 1)	typical, Cambridge		27	27
C3	*purpuralis*, Sussex (as 1)	typical, Cambridge		15	15
C4	*purpuralis*, Sussex (as 1)	ex C1, typical	5	8	13
C5	*purpuralis*, Sussex (as 1)	ex C3, typical	3	7	10
C6	ex C2, typical	ex C2, typical	1	7	8
C7	ex C2, typical	ex C3, typical	2	10	12
C8	ex C3, typical	ex C2, typical	3	17	20
C9	ex C2, typical	ex C2, typical	2	11	13
C10	ex C3, typical	ex C2, typical	5	27	32
C11	ex C8, *purpuralis*	ex C10, typical	5	8	13
C12	ex C7, typical	ex C9, *purpuralis*		8	8
C13	ex C6, typical	ex C7, *purpuralis*	6	12	18
C14	ex C9, typical	ex C7, typical	4	21	25
C15	ex C6, typical	ex C10, typical		17	17
C16	ex C8, typical	ex C9, typical		26	26

24 hours, the orange-red pigmentation on the elytra appeared noticeably dull compared with typical individuals of the same age, and by 48 hours could be described as 'dirty'. Dark pigment continued to be laid down over the first week following eclosion, so that by day seven, the ground colour of the elytra was purple. Thereafter, the elytra continued to darken, and by day 42, the black spots were indiscernible by eye.

Three of the original matings between the *purpuralis* male and Cambridge females produced issue, 54 progeny being produced between families C1, C2 and C3. In all cases the colour and pattern of the progeny was normal 48 hours after eclosion, and remained so at other scoring intervals until death. Progeny from the two back-crosses (C4, C5) produced results consistent with the hypothesis that the melanic form is controlled by a single recessive allele, in both cases a 1 : 1 ratio of normal: *purpuralis* progeny being produced. This hypothesis seems to be confirmed by the results of the five test crosses between F_1 progeny (C6–C10 inclusive), each of which gives some typical and some *purpuralis* progeny in a ratio not statistically different from 3 : 1. Of the F_2 crosses, some produced all typical progeny (C12, C15, C16), suggesting one of the parents was homozygous typical. Another (C14) produced a 3 : 1 typical: *purpuralis* ratio. Two of the three crosses involving *purpuralis* parents (C11, C13) produced both *purpuralis* and typical progeny in a ratio that was not significantly different from 1 : 1.

In most families segregating both typical and *purpuralis* progeny, the proportion of *purpuralis* progeny is lower than expectation, although not significantly so in any specific family. When all crosses which should segregate 1 typical: 1 *purpuralis* (C4, C5. C11, C13) are summed, the deficiency of *purpuralis* is significant ($\chi^2 = 4.74$, d.f. = 1, $p < 0.05$). The same is true of crosses expected to segregate into a 3 typical : 1 *purpuralis* ratio (C6–C10 inclusive, C14) ($\chi^2 = 5.35$, d.f. = 1, $p < 0.05$). These deficiencies suggest that the *purpuralis* allele confers significant disadvantage on its carriers when homozygous, and is sometimes lethal, even in captivity when reared under favourable conditions. The stock of ladybirds appeared to have low reproductive success throughout the program. Rate of oviposition was low compared to other *C. septempunctata* stocks in culture at the same time. Egg hatch rates were consistently low, rarely exceeding 50% for any clutch, and with a mean of only 23.7%. This may have been a consequence of inbreeding depression within the stock, in the F_1 and F_2 generations, (inbreeding depression is known to be severe in some coccinellids (Lusis, 1947; Majerus, 1994), but cannot account for the low egg hatch rates in the initial crosses involving the original *purpuralis* male.

Larval mortality was high in most families. Little of this mortality was due to cannibalism because larvae were reared at low density per dish.

The original male survived in captivity at about 21 °C until 17 May 1997. Thus, he lived, in an active state, for at least 255 days. The normal longevity expectation for *C. septempunctata* males kept in the laboratory in Cambridge, at 21 °C, is 80–130 days (MENM, pers. obs.). The longevity of the F_1 and F_2 f. *purpuralis*, and the known heterozygotes carrying the *purpuralis* allele were 156 days (n = 36; S.E. = 8.41) and 129 days (n = 97; S.E. = 4.56) respectively. Cambridge stock individuals being kept under the same conditions during this period had a mean longevity of 113 days (n = 28; S.E. = 9.74).

DISCUSSION

We conclude from the results of the breeding program described here, that *C. septempunctata* f. *purpuralis* is controlled by a single recessive allele, with reduced viability. Another, and unnamed, melanic form of *C. septempunctata* has been described from inbred Finnish stocks (Hämäläinen & Clayhills, 1972). Although this form was shown to have a recessive genetic basis, we recognise that it is not f. *purpuralis* as only part of the elytra turned black. However, interestingly, in crosses between 'black' individuals, most eggs laid proved to be infertile. This may indicate low fitness of the 'black' form, although it is also possibly a consequence of the severe inbreeding depression shown by many coccinellids (Hodek, 1973).

Consideration of the mode and rate of pigment laydown in f. *purpuralis* leads to the deduction that this form is not a melanic of the type found commonly in species such as *Adalia bipunctata* (L.) (e.g. f. *sexpustulata* and f. *quadrimaculata*) or *Harmonia axyridis* (Pallas) (e.g. f. *conspicua* and f. *spectabilis*) where the black pigment is laid down rapidly following eclosion (see Majerus & Kearns, 1989). Rather, the black colour develops relatively slowly, the elytra gradually being suffused with dark pigment. In this, the form appears somewhat analogous to *A. bipunctata* f. *purpurea* (Majerus *et al.*, 1987), and to those forms of *Adalia decempunctata* in which dark pigments develop slowly (Majerus, 1994). In both cases the forms are controlled by a single recessive gene. It is possible that the pigment laid across the elytra of f. *purpuralis* is a phaeomelanin, rather than a eumelanin which is responsible for the black spots in *C. septempunctata*, and the common melanic forms of *A. bipunctata* and *H. axyridis*. However, tests will have to be performed to confirm this.

The cause of the lack of melanic polymorphism in *C. septempunctata* remains obscure. The tenet that this species of coccinellid is too large to be melanic due to potential heat stress is difficult to sustain, given that other species of coccinellid of a similar size show such polymorphism in a diverse array of climates, including some which are very much hotter than those inhabited by *C. septempunctata*. However, the reason why the form described here remains an extreme rarity, is undoubtedly its low intrinsic fitness. The egg hatch rates and larval survival from typical females mated to *purpuralis* males, and the oviposition rate of *purpuralis* females were all low compared to females from normal stock families given the same feeding and diapause regimes.

As the f. *purpuralis* stock appeared to be generally weak, it is perhaps surprising that the longevity of f. *purpuralis* individuals, once they reached adulthood, was not adversely affected. Indeed, if anything, the converse was the case. No differences in the feeding or mating behaviour between the *purpuralis* and typical forms were observed. We can offer no explanation for the exceptional longevity of adult f. *purpuralis*.

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