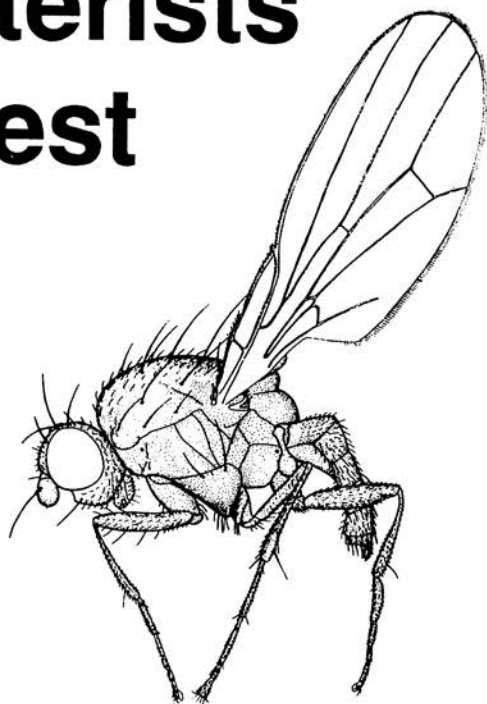


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Dipterists Digest is the journal of the **Dipterists Forum**. It is intended for amateur, semi-professional and professional field dipterists with interests in British and NW European flies. All notes and papers submitted to **Dipterists Digest** are refereed. The scope of **Dipterists Digest** is:

- the behaviour, ecology and natural history of flies;
- new and improved techniques (e.g. collecting, rearing etc);
- the conservation of flies;
- provisional and interim reports from the Diptera Recording Schemes, including maps;
- records and assessments of rare and scarce species including those new to regions, countries, districts etc;
- local faunal accounts and field meeting results specially if accompanied with good ecological/natural history interpretation;
- descriptions of species new to science, and
- notes on identification including deletions, amendments to standard key works and checklists.

Articles may be of any length up to 3,000 words and must not have been accepted for publication elsewhere. Items exceeding this length may be serialised or printed in full, depending on competition for space. Articles should be written in clear and concise English, preferably typed double spaced on one side of A4 paper. Style and format should follow articles published in the most recent issue. References to journals should give the title in full. Only scientific names should be underlined. Tables should be on separate sheets. Figures should be drawn in clear black ink, about twice their printed size and lettered clearly. Descriptions of new species should include a note of which museum or institution type material is being deposited. Material submitted on 3.5" computer disc should be in ASCII, Word or Word Perfect formats and accompanied by hard copy. Authors will be provided with twenty reprints of papers of two or more pages in length.

Articles and notes for publication should be sent to the Editor, Dr Graham E. Rotheray, Royal Museum of Scotland, Chambers Street, Edinburgh, EH1 1JF, UK. Enquiries about subscriptions and information about the **Dipterists Forum** should be addressed to the Membership Secretary, Liz Howe, Ger-y-Parc, Marianglas, Tynyngogl, Benllech, Gwynedd, LL74 8NS, UK.

***Conops vitellinus* (Diptera, Conopidae): a possible British species**

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Conops vitellinus Loew is a widespread and common species on the continent, although not to date recorded from the British Isles. Early in 1995 I was alerted to the possible occurrence of this species following correspondence with Dr Sidney Camras of the Field Museum in the USA, at which time I was sent a male *Conops* specimen from Bournemouth in Dorset, which apparently corresponded with the key criteria for *C. vitellinus* as described by Chvála (1961). Indeed, the specimen would key to this species in most of the main key-works to the European conopid fauna, such as Kröber (1925) and Seguy (1928). Nevertheless, I was quite certain that the specimen represented no more than a typical British specimen of *C. quadrifasciatus* Degeer, being identical to dozens of specimens in my own collection and others to which I have ready access.

The problem appears to lie in the nature of the colour-form of *quadrifasciatus* as it occurs in the British Isles. The European keys referred to distinguish males of these two rather similar species primarily with respect to the extent of the yellow coloration on the abdomen. Specimens in which the abdomen is 'predominantly black' are referred to *quadrifasciatus*, whilst specimens with the abdomen 'predominantly yellow' are referred to *vitellinus*. It is evident from the descriptions given by European authors that continental *quadrifasciatus* typically has the yellow banding confined to the apical edge of the tergite, when viewed from above, seldom extending more than about 30% of the total tergite length (Fig.1). Furthermore, these apical yellow bands tend to be straight along the anterior edge, with specimens in which the band is indented or drawn back in the mid-line being assigned to a distinct variety, var. *triangulifera* Szilady. Many, if not most, British specimens of *quadrifasciatus* are in fact of the *triangulifera* type, and it may be significant that this varietal distinction is largely absent from the British literature, where it has perhaps always been perceived as a 'normal' form. The segregation between *quadrifasciatus* and *vitellinus* is so marked in continental material that Chvála (1961) makes comparison between males of *vitellinus* and *C. ceriaeformis* Meigen, on the assumption that confusion is more likely with this latter species than with *quadrifasciatus*.

Females of *vitellinus* and *quadrifasciatus* are also very similar to one another, but can be distinguished with confidence on the shape of the theca (Figs. 5-6). I have now examined a large number of British-caught females, including those held in the British Museum (Natural History), and can find none that have the distinctive theca of *vitellinus*, suggesting that this species, if it occurs, is likely to be rare in the British Isles.

A similarly large number of British-caught males have also been examined. The majority of these have yellow tergal bands which cover at least 50% of the tergite length, often considerably more. It is highly unlikely that these all represent males of *vitellinus* in the absence of a similar proportion of females. It is also apparent that all stages of intergradation can be found in males between the 'typical' *quadrifasciatus* of the continental literature and the 'vitellinus-like' males referred above. It therefore appears that British populations of *quadrifasciatus* tend to be more extensively marked with yellow than

continental populations, and that more detailed criteria are required for segregating these two species in the British Isles.

Through the kindness of Dr Wyatt at the Natural History Museum, and Dr Chvála at the Charles University, Prague, I have now seen critically determined material of *vitellinus* males and females. This has allowed the development of a character matrix for the separation of male *vitellinus* from yellow variants of *quadrifasciatus*, which is given at Table 1.

Table 1. Character matrix for the separation of male *C. vitellinus* and *C. quadrifasciatus*
Less reliable characters are listed towards the bottom of the table.

character	<i>C. vitellinus</i>	<i>C. quadrifasciatus</i>
outer section of proboscis	Longer; ratio of length to vertical depth of head > 1.3	Shorter; ratio of length to vertical depth of head < 1.2
wing membrane	hyaline or very slightly yellowish sub-hyaline	slightly but distinctly brownish infuscated especially towards the anterior edge
yellow bands on tergites 2-4	typically straight-edged, or drawn back in the mid-line so that the forward edge of the yellow band is not parallel with anterior edge of tergite	sharply drawn back in the mid-line in narrow isosceles triangle, so that forward edge of yellow band on either side is parallel with anterior edge of tergite
tergite 2 from above	yellow band usually occupying < 50% of tergite, rarely more	yellow band usually occupying > 50% of tergite length
tergites 3-4 from above	yellow band usually occupying < 70% of tergite length, rarely more	yellow band usually occupying > 80% of tergite length
yellow colouration of tergites	typically orange-yellow, shining or sub-shining	typically paler canary yellow, matt or sub-shining
abdomen in side view	tergites typically flatter across disc, only bulging slightly towards apical edge	tergites typically smoothly rounded and slightly bulging across full length
legs	all yellow, sometimes with vague brownish patch centrally on femora	all yellow, rarely with vague brownish patch centrally on femora

Examination of the male genitalia of 'good' specimens of *vitellinus* and *quadrifasciatus* revealed no significant differences between these two species, or indeed with *ceriaeformis*. This pattern of poor genitalic differentiation in males is not uncommon in the Conopinae and may be suggestive of recent speciation, perhaps in response to increasing specificity to particular aculeate hosts. By contrast, the females are clearly distinguished, that of *ceriaeformis* being particularly distinctive. These distinctions lie chiefly in the non-genitalic characters of abdomen and theca shape, and may similarly be related to host specialisation.

The following characteristics appear to be significant in distinguishing *vitellinus* from *quadrifasciatus*. In *vitellinus* males the yellow bands of the abdominal tergites extend at least half way up tergite 2 and more than three quarters of the way up tergites 3 and 4, when viewed from above. More importantly, the yellow band is only very narrowly indented in the mid-line of these segments, forming a narrow isosceles triangle of black, and the forward

edge of the yellow band on either side of this is more-or-less parallel with the anterior edge of the tergite (Fig. 4). British-caught males of *quadrifasciatus* often have yellow bands similar to those of *vitellinus*, but in such cases the yellow band is invariably indented more broadly in the mid-line, forming an obtuse or equilateral triangle of black, and the forward edge of the yellow band is not parallel with the anterior edge of the tergite (Figs. 2-3).

In the limited material seen, the outer section of the proboscis of *vitellinus* males is conspicuously shorter than that of *quadrifasciatus* males, a feature referred to by authors such as Tonnoir (1921) and Seguy (1928). A measured sample of male *quadrifasciatus* in which the length of the outer (distal) section of the proboscis (including the tip lamellae, which may be reflexed sideways) was divided by the vertical depth of the head (in mm) gave values of between 1.33 to 1.5, ie greater than 1.3. Similar measurement in *vitellinus* males gave values of between 1.1 and 1.2 (Fig. 9).

A further feature *vitellinus* males is that the wing membrane is usually distinctly brownish infuscated, particularly towards the anterior edge. Males of *quadrifasciatus* usually have the membrane either clear hyaline or no more than slightly yellowish sub-hyaline.

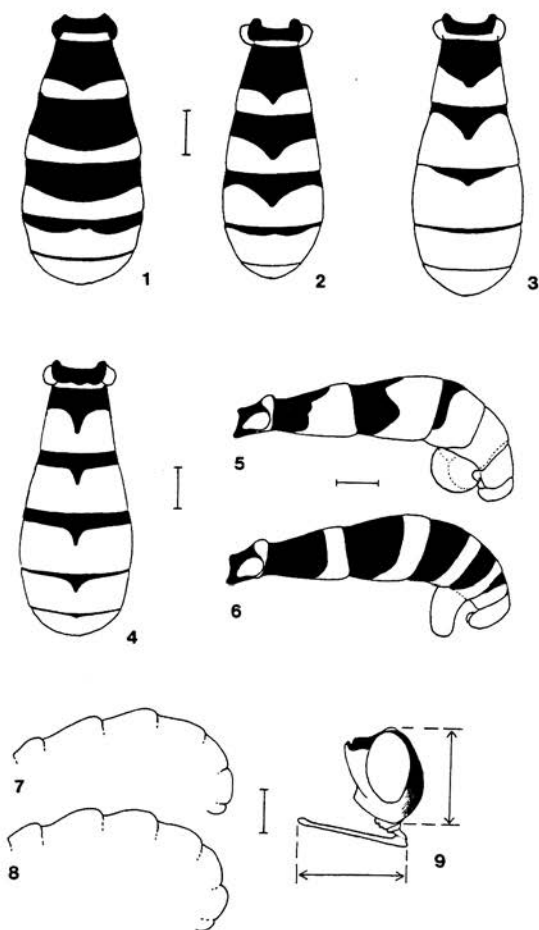
Less reliable features appear to be that the yellow coloration on the abdomen of *vitellinus* males tends to be a somewhat paler canary yellow than the orange-yellow of *quadrifasciatus*, and less shining. In addition, the tergites of *vitellinus* appear smoothly rounded and slightly bulging in side view (although nowhere near so conspicuously as in male *ceriaeformis*), whereas in *quadrifasciatus* the tergites tend to be flatter and only curved towards the apical edge (Figs. 7-8). There may also be a somewhat greater tendency for the femora to have a vague brownish patch in *quadrifasciatus*, but the limits of variation in all of these characteristics clearly overlap.

Females of these two species can be readily separated by the shape of the theca (Figs. 5-6). Females of *vitellinus* tend to have more extensive yellow banding than continental *quadrifasciatus*, and a greater tendency for the yellow band to be drawn back in the mid-line, although again the limits of variation between the two species would probably overlap in Britain.

Conops vitellinus is currently recorded from Belgium, the Netherlands, Hungary, Spain, France, Italy, the former Yugoslavia, Turkey and Romania (Chvála & Smith, 1988).

Key for the separation of *Conops vitellinus* and *Conops quadrifasciatus*, replaces couplet 10 in Chvála (1961)

10	Females (conspicuous theca present beneath tergite 5).	11
-	Males (theca absent).	12
11	Theca (in side view) slimmer, more nearly parallel-sided, the antero-posterior width at base considerably less than height of theca (Fig. 6)	<i>quadrifasciatus</i>
-	Theca broadly hemispherical in side view, the width at base equal to or greater than height of theca (Fig. 5).	<i>vitellinus</i>
12	Yellow banding on tergites 2-4 extending less than 50% of length of tergite, and with the anterior edge either straight or broadly indented in the mid-line (Fig. 1). Wing slightly yellowish sub-hyaline or clear; proboscis/head depth ratio > 1.3.	<i>quadrifasciatus</i>
-	Yellow banding on tergites 2-4 extending 50% or more of length of tergite. Other characters various.	see Table 1



Figs. 1-3. *Conops quadrifasciatus* male abdomens, dorsal view, showing range of variation: (1) typical (France); (2) typical intermediate (England); (3) yellow variant (England). **Fig. 4.** *C. vitellinus* male abdomen, dorsal view. **Figs. 5-6.** female abdomens, side view: (5) *C. vitellinus*; (6) *C. quadrifasciatus*. **Figs 7-8.** Male abdomens, side profile of tergites: (7) *C. quadrifasciatus*; (8) *C. vitellinus*. **Fig. 9.** *C. vitellinus* head, showing measured dimensions. Scale bars = 1mm.

Acknowledgements

Thanks are due to Dr Nigel Wyatt of BM(NH), London, Dr Sidney Camras of the Field Museum, Chicago and Dr Milan Chvála of Charles University, Prague, for the loan of specimens. I am also grateful to Ray Barnett of Bristol Museum for the loan of the Audcent Conopidae collection.

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***Callicera aurata* in Suffolk found breeding in birch** - On 12 March 1995 whilst examining a rot hole at about 1.3m from the ground in a birch tree at Tuddenham Heath, Suffolk, part of the Cavenham Heath National Nature Reserve, I found amongst numerous larvae of *Myathropa florea* several hoverfly larvae with a short tail. Two of these were removed along with a small amount of rot hole material, the remaining larvae and detritus being returned to the cavity. Unfortunately both larvae died within a short time of each other before they could be critically examined and were sent to Graham Rotheray who was able to identify them as *Callicera aurata*.

During March 1996 a more thorough search of the nature reserve was undertaken and although several apparently suitable rot holes in birch were discovered, no more *C. aurata* could be found. A further examination of the original rot hole was conducted and although *M. florea* were again present, no *C. aurata* could be located. Because of the small size of the *C. aurata* larvae found in 1995 it is unlikely that they would have completed their life cycle during that year and it would appear that they must have succumbed, perhaps during the long period of drought which would have reduced the area of suitable habitat, increasing competition and the chance of predation. The fact that mature *M. florea* larvae were present again in 1996 proves that the rot hole did not dry out completely during the summer of 1995.

Although East Anglia has been well served with Dipterists over the last hundred years, as far as I am aware this would appear to be the first record of *C. aurata* from the region. If the species is normally resident in the area it is difficult to see how it would have been missed. The fact that all the larvae found were of the same size and that no further larvae could be located despite extensive searches, indicates that they may have been the progeny of a single wandering female. *Callicera aurata* perhaps uniquely amongst saproxylic hoverflies often turns up in unexpected places, giving rise to the theory that it might be a migrant. However if birch rot holes prove to be a favoured site for development then this may help to explain at least some of the unusual records of this species, away from areas of mature beech in which it is known to develop (Rotheray, G.E. 1991. *Journal of Natural History* 25, 945-969). Indeed investigation may prove it to be resident in breckland area in birch woodland - IVAN PERRY, 27 Mill Road, Lode, Cambridge, CB5 9EN.

Observations on the ecology and oviposition of *Eumerus sabulorum* (Syrphidae) and *Acrosanthe annulata* (Therevidae) (Diptera)

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Eumerus sabulorum

The hoverfly *Eumerus sabulorum* is proving to be widespread along the coast of SW England and West Wales. Though seemingly absent in England between Anglesey and the Scottish border, there are a few records for SW Scotland, including Ayrshire. It has been found inland on very few occasions, as at Holne on the southern edge of Dartmoor (Verrall, 1909, *British Flies* 8). There is a long flight period but June to mid August is best.

In recent years I have had the opportunity of observing this species in various parts of its range. It is elusive and could easily be missed if one is not attuned to search for it. The main problem is that it looks similar to an aculeate with a reddish abdomen in flight: it flies very close to the ground and at rest its dark and compact shape often blends in with the background of grit and debris. On rocky coasts it is most easily found resting on bare paths, banks of bare earth and on bare rock. The vegetation should not be too rank but neither should it be intensively grazed. My experience of this species on dunes is more restricted but sandy patches in the more recently stable dunes seem preferred. On rocky coasts and dunes, it is usually only common very locally though individuals seem to stray widely.

The great puzzle has been the foodplant of the larva. An obvious lead is a coincidence in distribution of the hoverfly and potential foodplants, though a strong match may be too much to hope for. My first candidate was Spring Squill *Scilla verna*, as a bulb plant that is characteristic of rocky coasts in the range concerned. In south Devon and Wales I was able to confirm the frequent presence of seeds heads within short but not over-grazed turf in areas with the fly. That idea started to look weak when on the 1995 field meeting at Ayr the fly was found in an area that the plant had not been recorded, and Liz and Mike Howe were confident that on the dunes of north-west Wales they had seen it commonly in the absence of Squill, and finally the observations given below, in Dorset, were in a county where the plant is absent.

There is of course no guarantee that all *Eumerus* are dependant on bulbs, The reported larval foodplants of *E. strigatus* include bulbs, *Iris* rhizomes and the roots of Wild Parsnip *Pastinaca sativa*. *E. sabulorum* may also have various host plants.

A breakthrough came on 9 August 1995 while I was on Studland NNR, Dorset, with Stuart Roberts. We had gone to a 'sandy quarry' within the *Calluna* dominated part of the dunes where the bee fly *Bombylius minor* had been reported nectaring on Sheep's-bit *Jasione montana*. The area proved to be an old complex of blow-outs, with large patches of *Jasione*. It was quickly apparent that large numbers of *E. sabulorum* were nectaring on these flowers (the fly was in sight about 35% of the time, with up to 5 individuals in sight at one time).

At 2.30pm BST in hot sunny weather a female was observed to settle on a small rosette among other rosettes on sparsely vegetated sand. It seemed to be ovipositing whilst

sitting on top of a rosette only about 1cm across. It was netted to confirm that it was indeed a female, with the ovipositor fully extended. At the time all the tiny rosettes seemed similar but closer inspection revealed a look-alike mixture of *Jasione* and the hawkbit *Leontodon taraxacoides*. *Eumerus sabulonum* was not seen visiting the few flowering plants of the latter. However, females were apparently attracted to *Jasione* plants of all ages as they were seen walking about them, but no oviposition was observed. A patch of *Jasione* on the landward side of the marram dunes at Studland had a couple of *Bombylius minor* nectaring but there was no sign of *Eumerus*.

Reference to a botanical atlas reveals that the coastal distribution of *Jasione* is generously suitable within a mainly western range. The plant also occurs inland in the west, and has rare scattered southern localities across to East Anglia. *Leontodon taraxacoides* is very widespread in England and Wales but is seemingly absent from the part of Ayrshire concerned.

Scrapping back the sand at Studland revealed that *Jasione* has a stout tap root and I believe that this must now be the prime candidate as larval host plant.

Acrosanthe annulata

This species has been better known as *Thereva annulata*, whose silver males are a familiar sight on marram dunes and some inland sandy places. Female therevids have fans of spines on either side of the end of the abdomen which are used when laying eggs but there would appear to be very little literature on oviposition behaviour in the European fauna.

Whilst the above observations were being made in a blow-out on the dunes at Studland NNR, Dorset, a female *Acrosanthe annulata* was seen ovipositing in loose sparsely vegetated sand. Over a period of 5 minutes it walked around a very small area, at intervals going through an oviposition routine.

It sank its abdomen vertically into the sand, until with splayed legs it could go no further; the wings were held in horizontal delta fashion. It took about 5 seconds to sink the abdomen, followed by 16-20 seconds with the abdomen sunk and 2-3 seconds to extract itself. To finish there was a quick shuffle of the back legs which resulted in the sand looking undisturbed.

Some bacteria, fungi and yeast isolated from free-living *Episyrphus balteatus* (Diptera, Syrphidae)

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Insects are exposed to microorganisms throughout their lives, and in the case of flower-visiting species, can act as vectors of microorganisms between plants. Interest in microbial pathogens of insects has increased recently, in order to eliminate disease from a beneficial insect population, or to increase disease to control an insect pest (Glare et al., 1993). Furthermore, evolutionary biologists have become interested in the possibilities for pathogens to increase the likelihood of attracting an insect to the plant they are infecting (and hence increase transmission). Conceivably too, counter-selection pressures might well operate in the insect population to detect and avoid infected plants if the pathogen is harmful to the insect too (Shykoff & Bucheli 1995). The abundance, mobility and flower-visiting of hoverflies makes them potentially important vectors of pathogens, but information on the microorganisms associated with hoverflies is scarce. In the comprehensive review of the entomopathogenic microbes of New Zealand attacking around 150 host species (Glare et al. 1993), only one is a syrphid (*Melangyna novaezealandiae*), host to the fungus *Beauveria bassiana* (Barker et al., 1991)). Migratory species, such as *Episyrphus balteatus* in Europe, are particularly important as vectors of pathogens, potentially able to transmit microorganisms over large distances.

In the present study, bacteria, yeast (unicellular fungi) and hyphal fungi were isolated and identified from the outer surface of free-living *Episyrphus balteatus* obtained from an urban garden in Halifax, England, July 1995. The flies were caught in a net and held individually in sterile plastic tubes in a fridge for 72 hours. Under sterile conditions the heads and legs were detached from the abdomen-thorax, and the three body sections used to inoculate the media plates. The media used were nutrient agar, potato dextrose agar and sabourand dextrose agar, which are enrichment media used for bacteria, fungi and yeast respectively. Standard microbiological techniques were then used to isolate pure cultures of microorganisms (details available from the authors).

Eight different microorganisms were isolated and identified (Table 1). *Penicillium* and *Cladosporium* were the two genera of hyphal fungi identified. Both these contain species found as common environmental contaminants within the normal microflora of many surfaces. Neither genera are true pathogens of insects although each is known to contain opportunistic pathogens. *Cladosporium herbarium*, which the isolate is most likely to be, is regarded as one of the most destructive plant pathogenic fungi (Al-Abed et al., 1993). The most likely source of this fungus was probably any flower visited. *Penicillium* species are also commonly found on many plants and animals. *Cladosporium herbarium* and *P. chrysogenum*, for example, are two of the main fungi found on the leaves or shoot surfaces of plants (Ouf 1993). Both these fungi are more common as plant pathogens than they are as insect pathogens. *Episyrphus balteatus* therefore appears to be a vector of these important phytopathogens.

Two yeast species, *Candida albicans* and *C. ciferri* were isolated from the legs, but

not the head or body, again suggesting that they are picked up from flowers visited. *Candida albicans* is a major opportunistic pathogen of humans and is known to cause some plant diseases. *Candida ciferri*, by contrast has been little studied, but is found as part of the normal microflora of some plants (Canganella et al., 1994).

Table 1. List of microorganisms isolated from *Episyrphus balteatus*

Species	Head	Legs	Body
Fungi			
<i>Penicillium</i> sp.	y*	n	y
<i>Cladosporium</i> sp.	n	n	y
Yeasts			
<i>Candida albicans</i>	n	y	n
<i>Candida ciferri</i>	n	y	n
Bacteria			
<i>Serratia marcescens</i>	n	y	n
<i>Pseudomonas cepacia</i>	n	y	n
<i>Proteus mirabilis</i>	n	n	y
<i>Micrococcus varians/roseus</i>	y	y	y

* y = present; n = not found

Among the four species of bacteria isolated, only *Serratia marcescens* is known to be entomopathogenic, being the cause of high mortality in brown planthoppers, *Nilaparvata lugens* (Kim et al., 1993). *Proteus mirabilis*, *Pseudomonas cepacia* and *Micrococcus* (probably *M. varians* from pigmentation characteristics) are all common environmental contaminants which can be opportunistic pathogens if host defence is weakened.

To develop microorganisms for control purposes, it is necessary to understand the requirements for the high levels of disease transmission characteristic of epizootics. For example, genetic engineering allows for the possibility of transferring genetic material that codes for useful detoxifying enzymes from symbionts into various organisms such as *E. coli*. The microbial flora associated with insects represents an important potential source for genetic material, thus better knowledge of the microbial-insect relationship is needed.

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***Trichopalpus fraternus* (Meigen) (Diptera, Scathophagidae)**

swarming - On 13 September 1995 I saw a large swarm of flies on a heap of vegetation on the banks of an old gravel pit at Little Paxton, Cambridgeshire (VC31, Hunts.) grid. ref. TL195625. I had no net at the time but managed to tube 23 specimens which all proved to be males of the small drab dung fly *Trichopalpus fraternus* (Meigen). The vegetation had been dredged from the water to clear an area for fishing and consisted largely of the thick (6-7cm diameter) fleshy rootstocks of the yellow water lily (*Nuphar lutea* (L.) Sm.) lying partly in the water to one side of the cleared area. Many hundreds of flies, appearing to consist of all the same species, were swarming on the heap and adjacent vegetation in an apparently aimless manner, and some were flying short distances. The upper rootstocks were drying out and shrivelling and those underneath were beginning to rot. I saw no larvae or puparia and circumstances prevented me from a more prolonged examination, or from taking any material home. I have no proof, but it seems likely that *T. fraternus* was breeding in the heap which could well have been available for 2-3 months if fishermen dredged it up soon after the leaves spread on the surface and obstructed fishing. If they had not bred in the heap where had they come from?

J.M. Nelson (1995). Dung-flies (Diptera: Scathophagidae) in birds' nests, with particular reference to *Trichopalpus fraternus* (Meigen). *Entomologist's Gazette* **46**: 285-287) discusses what little is known of the biology of *T. fraternus*. He has reared it from the nest of a coot (*Fulica atra* L.) in Scotland and cites a record of it being reared from the same source in Buckinghamshire. Coot are common along the River Ouse and its flood plain gravel pits while *T. fraternus* seems to be quite scarce and I have never found more than one or two at a time. It is highly improbable that the swarm had assembled from flies emerging simultaneously in such large numbers from local water birds' nests. Nelson (op.cit.) also suggests that *T. fraternus* "may occur in accumulations of vegetable debris on lake shores", and my observation supports this. This species seems to maintain low numbers in water birds' nests, but also to be an opportunist able to exploit an unnatural accumulation of suitable vegetable matter - JONATHAN COLE, 2 Lenton Close, Brampton, Huntingdon, Cambridgeshire PE18 8TR.

***Chrysopilus erythrophthalmus* (Diptera, Rhagionidae) in Scotland and more records from England**

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Chrysopilus erythrophthalmus Loew was added to the British list relatively recently (Cole, 1981). The three previously known specimens come from Swaledale in the Yorkshire Pennines where the species was first recognised as new to Britain, Stoke Plantation which is probably the site now called Haugh Wood in Hereford & Worcester (both records in Cole, 1981), and Lower Horner Valley, Somerset (SS8944) (Stubbs, pers. comm.). The last specimen was taken between 13-17 June 1993 beside a stream flowing through carr woodland in a deep gully on the flank of Exmoor. These sites are moderately upland in character and a small stream runs through or by each of them.

During and just after the annual summer field meeting of the Dipterists Forum based at Ayr, two specimens of *C. erythrophthalmus* were found. The first was collected by CMD in Sheilhill Glen SSSI, Renfrewshire, (NS235724) on 4 July 1995 in a steep, wooded gorge with a stream at its bottom. The exact collection point was not known. Much of the slope was dry and dominated by *Luzula sylvatica* (Huds.) Gaudin but an area of seepages and a small trickle was swept, as well as a length of the bank of the main stream. By the road that passes at the top of the gorge was a boggy area under alders but it is unlikely the species was present here because this area was well worked by Jon Cole at the same time. A second specimen was collected several days later on 15 July by PJC at the River Mousewater near Lockhart Mill, Lanarkshire (NS8745). This specimen was swept from sparsely vegetated hollows under trees by the river at the edge of a cattle-grazed field. The field was relatively unimproved and had marshy areas and a good range of plant species in the lower part near the river. When this site was revisited in hot sunshine on 4 August, no more specimens were found. Both Scottish specimens are females.

During the Forum's summer meeting based at York, the fly was found on the North York Moors. On 16 July, 1996, CMD swept a female from butterbur where the plants bordered a small, partly shaded, stony stream near Hawnby (SE534898). The stream was about 5m wide, about 20 cm deep and at 120m OD. The following day, John Mousley obtained two females from near the stream running through the wooded gorge at Hayburn Wyke (TA009971), and, more surprisingly, Liz Howe swept a female at a small waterfall as the same stream fell onto the sea shore here (TA010971).

Yet another female was taken by CMD at the hamlet of Milltown beside the River Heddon on the north Devon coast, on 31 July 1996 (50m OD). The R. Heddon here is a small stony stream about 3m wide and 10-20 cm deep running through a steep wooded valley, although the point of capture was under a gap in the tree canopy. The specimen was swept from the stream margin where there was almost no vegetation so it is almost certain that the fly was sitting on the stones. Sweeping further along the stream produced no more specimens although there were few openings under the canopy similar to the first site. Searches for *C. erythrophthalmus* along several similar streams in this part of Devon during the same week were unsuccessful.

The dates of capture of the ten British specimens range from about 13 June to 31 July. The 1996 records span a two week period, so the flight period may not be especially short, as was suggested by Cole (1981) as one reason for the species having been overlooked until recently. The altitudes of the two Scottish sites and Horner Wood are between 80 - 100 m OD; the sites on the Yorkshire coast and in Devon were from sea level to 50 m OD. The fly is not, therefore, specifically an upland species but rather it depends upon moderately fast-flowing, stony streams (although the River Mousewater is rather large and sluggish by comparison with the other sites). Some degree of shade may be important but perhaps not closed woodland canopy.

Cole (1981) summarises the biology of *C. erythrophthalmus* as described by Thomas (1978). The larva lives in cool, fast-flowing streams. As this habitat is frequent in upland western Britain, and, as *C. erythrophthalmus* has been found at widely separated sites, it is likely that the species may prove to be more widespread beside wooded streams. However, even on the continent, it may be relatively uncommon as Rozkošný & Spitzer (1965a) describe it as infrequent and local in Czechoslovakia, and the same authors (1965b) give only two rather old records for Yugoslavia. Curiously, Krizelj (1971), who summarises the distribution of rhagionids in western Europe, does not mention this species.

Cole (1981) gives characters to separate *C. erythrophthalmus* from the slightly smaller and much more widespread *C. cristatus* Fabricius (= *auratus* (Fabricius) of continental authors). A character that Cole regarded as distinctive in the females is the silvery-white hairs on the abdomen of *C. erythrophthalmus*; while this is obvious in good specimens, the hairs can rub off easily. Having now obtained three females from southern England to mid Scotland, CMD adds some additional characters that are consistent and which work for hairless specimens.

- The hind femur of *C. erythrophthalmus* is yellow in the basal half, grading to black on the distal half; in *C. cristatus*, the femur is entirely black.
- The thoracic dorsum of *C. cristatus* is conspicuously striped with a pair of dark brown stripes on a pale grey background; in *C. erythrophthalmus* the stripes and the background are two shades of dark brown and the dorsum appears unmarked to the unaided eye.
- The top of the head of *C. cristatus* has usually two or traces of a third or fourth small furrows running from the hind corner of the eye to the back of the ocellar triangle (a specimen from Brittany, France, has only one furrow). These furrows are absent in *C. erythrophthalmus*.

It is curious that no males have been found among the ten British specimens. Cole points out that the males of the two species are less obviously distinct than are the female so *C. erythrophthalmus* may have been dismissed as *C. cristatus* in the past. The observation that one specimen was swept from bare stones in near-shade may give a clue to the paucity of records - this is not a particularly productive habitat for flies (CMD was searching for *Lonchoptera nigrociliata* Duda which is found in this situation and this may account for his three specimens). An alternative reason for the recent flurry of records may be that the species is genuinely increasing in abundance, as *Stratiomys potamida* Meigen appeared to do in the 1980s.

Acknowledgements

We would like to thank John Mousley and Liz Howe for permission to quote their records, and the Natural Trust for permission to quote the record for Horner Wood which was surveyed for the Trust by Alan Stubbs.

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Further British records of *Pherbellia rozkosnyi* Verbeke (Diptera, Sciomyzidae)

- The discovery of *Pherbellia sordida* and *P. rozkosnyi* in Britain by Ivan Perry (1990, *Dipterists Digest* No 6, 41) prompted a belated examination of the genitalia of some male *Pherbellia* in my collection. I was rewarded by finding an overlooked *P. rozkosnyi* under *scutellaris* taken on 14 August 1990 in Castle Eden Dene, Co. Durham (Grid Reference NZ 4138). A third male specimen was taken by Steven Falk in birch-oak woodland at Beeston Common, Sheringham, Norfolk on 6 July 1993. The thorax of *P. rozkosnyi* is a dark greyish brown colour rather than the yellowish brown of typical *scutellaris*, but the latter can be darker, and according to Rozkošný (1984, *Fauna Entomologica Scandinavica* 14) the most reliable characters lie in the male genitalia which he clearly illustrates. The most easily seen difference is the shape of the posterior part of the divided gonostylus which is narrower and more pointed than in *scutellaris*.

The biology of *P. rozkosnyi* is not known, Rozkošný (op.cit.) notes that the larva is probably a parasitoid of terrestrial snails. He gives no information on habitat in continental Europe, but in Britain it appears to be a species of broad leaved woodlands ranging from a damp limestone gorge at Castle Eden Dene, to acid sandy soil at Beeston Common. The three known sites are widely scattered round England on or near the coast, but this may be coincidental as there are no data to suggest that a maritime influence is required and the continent it extends from Scandinavia to central Europe. The flight time in England is from 14 June in Devon (Perry op.cit.) to 14 August in Durham. I am grateful to Steven Falk for permission to include his record - JONATHAN COLE, 2, Lenton Close, Brampton, Huntingdon, Cambridgeshire PE18 8TR.

Ethology and ecology of *Merodon* (Diptera, Syrphidae) in Turkey II: descriptions of new species and notes on other syrphid flies

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Since Hurkmans (1988) was published, which described the behaviour and biotopes of *Merodon*, considerable knowledge of species belonging to this genus has been gained. Marcos Garcia (1988) recorded the occurrence of *Merodon natans* in Spain. This species was previously considered to have a mainly eastern Mediterranean distribution. Zimina (1989) described *Merodon karadaghensis*, and also listed the species present in the Crimea, including the rare *M. bessarabicus* Paramonov and *M. dzhaliata* Paramonov. Marcos Garcia (1989) described *M. escorialensis* as a full species and defined differences in habitat with respect to *M. geniculatus* Strobl. She gave additional data on Spanish species of *Merodon* in another paper, with the comment that, 'it is probable that the montane distribution of the species discussed depends on the feeding requirements' (Marcos Garcia 1990). Gatter and Schmid (1990) in their study on the migration of hoverflies conclude that *Merodon* species hardly migrate. According to them, lack of migration is caused by the phytophagous feeding strategy of their larvae: if the adults remain in the same area to reproduce, they can be sure to find food plants for the next generation (the same explanation is provided by Aubert et al. (1976) who found a very low frequency of *Merodon* species in their traps). Rotheray (1993) provided an extensive list of plant genera attacked by *M. equestris*; these genera belong to the Amaryllidaceae, Liliaceae and Zingiberaceae. He also figured and described the larva of this species.

Following Hurkmans (1993) who published the first part of a monograph of this genus, many species of *Merodon* are incorrectly regarded xerophilic and thermophilous; they should be considered only xerotolerant. Species of *Merodon* have often been represented as being 'xerophilic', e.g. by Bankowska 1980. Moreover many species actually occur mainly in areas with a cold climate such as eastern Anatolia, the coldest region of Turkey, and mountain areas in Turkmenistan, Kazakhstan and Kirghizia; Hurkmans (1993) figured the distribution of 61 species and two subspecies of *Merodon*. Gilbert et al. (1994) analyzed the evolution of larval feeding strategies of the Syrphidae, arriving at the conclusion that *Merodon* is one of the most plesiomorphic genera of this family. Dirickx (1994) figured the distribution of syrphid flies occurring in the Mediterranean region, including 47 species of *Merodon*. Dirickx (1994) data on *Merodon* includes incorrect citations from literature, as he himself noted. Vujic et al. (1995) discussed the habitat preference of *M. desuturinus* Vujic, Simic & Radenkovic. Hurkmans & De Goffau (1995) described the rearing of *M. eques* and *M. constans* from *Narcissus tazetta* L. and *Galanthus nivalis* L. (both Amaryllidaceae) respectively and discussed the preferred habitats of these and several other *Merodon* species. Vujic et al. (1996) discussed the preferred habitat of *M. albonigrum*

Vujic, Radenkovic & Simic, and a possible cause for this preference. Hurkmans & Freidberg (pers. comm.) found that in Israel species of *Merodon* prefer relatively cool and moist habitats and occur especially in mountain regions at high altitudes, or alternately very early in the season when temperatures are moderate and the summer drought has not yet set in. Hurkmans et al. (pers. comm.) found 11 species of *Merodon* occurring together in a marshland habitat in eastern Anatolia, which once more confirms the preference of *Merodon* species for moist biotopes. The present paper presents new data on *Merodon* behaviour and biotopes and hopes to answer some questions raised by previous research. The number of species for which data have become available has been substantially increased. Most data were obtained during a fieldtrip to eastern Anatolia, Turkey, in June and July of 1996.

Material and Methods

Most of the material and observations on 16 *Merodon* species discussed here were obtained by R. Hayat (RH), E. Yildirim (EY), G. Tozlu (GT) and W. Hurkmans (WH) during a field trip in eastern Anatolia, Turkey, organized by the present authors and workers of Bitki Koruma Bölümü.

Observations began early, at Erzurum before 07.00, and at the other localities between 08.00 and 09.30. Observing and collecting was continued until about 16.30 to 17.30, depending on site, when flies became inactive. Males were captured, marked and again released to test territory attachment. Marking was done on the wing(s) with black marker at the capture spot. Behaviour was timed with stopwatches. To test competition for territories, males were removed from their territory, and the time that it took until the territory was re-occupied was recorded. Following observations, many individuals were captured and pinned; specimens captured in copula were placed on the same pin. They are stored in the collections of the Zoologisch Museum, Amsterdam (ZMAN) and at Bitki Koruma Bölümü, Erzurum (BKB).

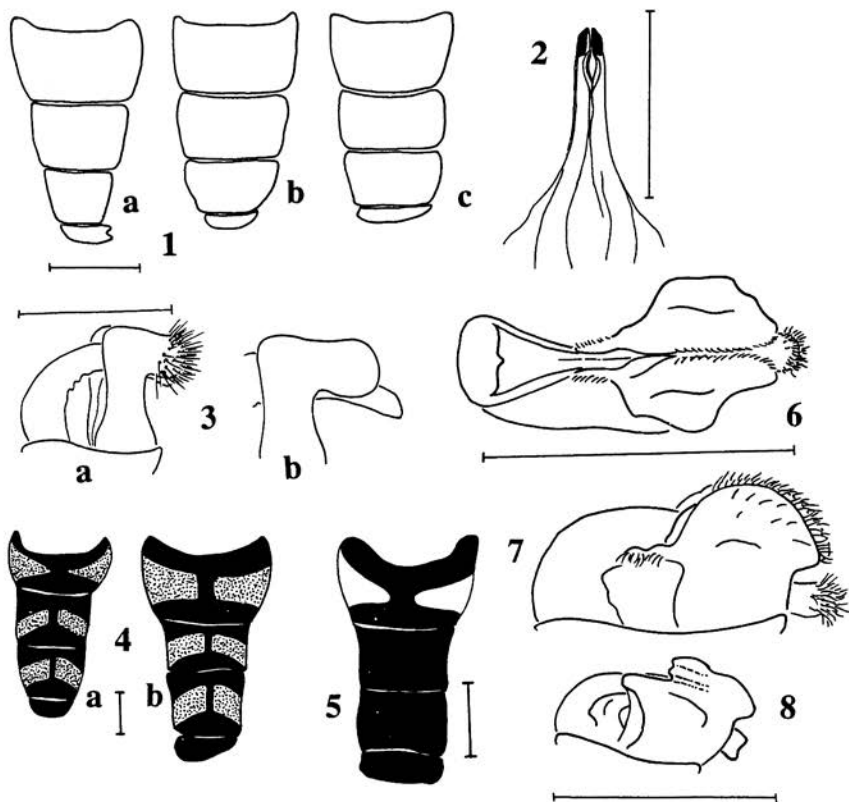
Data on the 8 localities visited (Figs. 9-10) is given below.

- (1) Küçükgeçit (KG), 45 km. west of Erzurum, on the main Erzurum - Erzincan road; visited 16 (RH, WH) and 17.vi.1996 (WH). KG is a marsh with very diverse vegetation, rich in Orchidaceae and *Gladiolus atraviolaceus* Boiss. This locality is of high natural value (Hurkmans, Hayat & Özbek, unpublished data).
- (2) Kösk Köyü (KK), 31 km northeast of Erzurum, 4 km southeast of the Erzurum - Tortum road (this locality was subdivided into Kösk Köyü 1, 2 and 3); visited 20.vi, 2-3.vii.1996 (all RH & WH). KK 1 is a dry hillside with yellow Umbelliferae and *Euphorbia* species and adjacent marshy meadow in the valley bottom; KK 2 is a marsh rich in *Pimpinella saxifraga* L. and yellow Umbelliferae, partially overshadowed by trees; KK 3 is a mosaic of shrubs and meadow along a stream dominated by Umbelliferae.
- (3) Sütkans (SK), 14 km southwest of Oltu and 2 km west from the Oltu - Tortum road (this locality was subdivided into Sütkans 1 and 2); visited 25 and 26.vi.1996 (RH & WH). SK 1 is a stony, rather steep but wide valley side with a vegetation of mainly *Euphorbia* species; SK 2 is the steep bank of the deeply cut bed of a stream just below a small waterfall, with a vegetation of *Euphorbia* and Labiatae.
- (4) Erzurum (ER), (this locality was subdivided into Erzurum 1 and 2); visited 13-17, 19, 22-23 (all WH), 24-25, 28.vi (both RH & WH) and 3.vii.1996 (WH). ER 1 and 2 are sections of the banks of a dry channel behind the university campus, differing in direction

of exposure: 1 to the west, 2 to the north.

(5) Palandöken mountains directly south of Erzurum (PD) (subdivided into Palandöken 1 and 2; visited 14, 24 and 28.vi (all RH & WH) and 1.7 (EY). PD 1 is alpine meadow at 2800 m; PD 2 is the (partially ruderal) banks of a torrent valley at 2300 m.

(6) Sarikamiş (SR), directly west from railway station; visited 27.vi.1996 (GT). SR is a



Figs. 1-8 *Merodon* from Turkey. 1, Abdominal outline in males of a) *M. hayati* sp. n.; b) *M. caerulescens* Loew; c) *M. cinereus* Fabricius, scale line 1 mm. 2, *M. hayati* male, aedeagus in ventral view, scale line 0.5 mm. 3a, Lateral view of genitalia in *M. hayati* male; 3b, lateral view of surstylus in *M. caerulescens* (note protruding aedeagus), scale line 0.5 mm. 4a, Abdomen of *M. distinctus* Palma; 4b, Abdomen of *M. biarcuatus* Curran, scale line 2 mm. 5, Abdomen of male *M. hikmeti*, note absence of pruinose bands; scale line 2 mm. 6, *M. hikmeti*, ventral view of male genitalia, scale line 1 mm. 7, *M. hikmeti*, lateral view of male genitalia, scale line 1 mm. 8, *M. biarcuatus*, lateral view of male genitalia, scale line 1.5 mm.

wet subalpine meadow.

(7) 18 km east of Horasan (HS), along the Horasan - Agri road; visited 22.vi.1996 (GT & WH). HS is rather dry meadows in the winter bed of the Aras river, rich in *Euphorbia* species.

(8) Kargapazari Dagi (KP), 35 km northeast of Erzurum, on the Tortum-Erzurum road; visited 27.vi.1996 (RH & WH). This is a slightly peaty marsh dominated by *G. atraviolaceus*.

Results

(i) Description of new species

Merodon hayati Hurkmans, (Figs. 1-3)

Male

Head: antennae brown, antennal ratio (cf. Hurkmans 1993) 1.4; 3rd antennal article with convex upper margin, well rounded; touchline of compound eyes incomplete (cf. Hurkmans 1993); frons large; ocellar angle 55 degrees; oral margin well protruding; pubescence rather sparse, greyish yellow throughout, but whitish grey and of conspicuously even length on compound eyes.

Thorax : Conspicuous bluish lustre on dorsum and sides, with rather uniform yellowish grey pubescence (black around wing insertions); wings clear, halteres, squama and antisquama (upper and lower calypter) pale yellow, fringed with long pale pubescence.

Legs: all femora and tibiae dark brown, joints paler; coxae 3 with conspicuous metallic lustre; trochanters 3 blackish brown with weak lustre, bearing a large spade-shaped projection; femora 3 somewhat swollen, the triangular process rather low but with serrate distal margin bearing 6 - 9 bristles; tibiae and tarsi 3 normally shaped, with rather dense golden brown pubescence on lower face.

Abdomen: stout, regularly tapering caudad (Fig. 1a); all tergites and sternites with considerable slate grey metallic lustre; pubescence rather sparse, pale yellowish grey; pruinose or pubescent bands absent.

Genitalia: surstyle without sulcus, only posterior lobe present; this lobe broad, rounded, with some long yellow apical pubescence; cercus well protruding, elongate, with same pubescence; aedeagus rather long, smooth on outer face, fringed plates on thecal apex just suberect; apical shaft part short (Figs. 2 - 3a).

Body length 7.5 - 8.5 mm.

Female

Similar to the male but differing as follows:

Head: dichoptic, wide frons strongly metallic lustrous, with sparse pale pubescence.

Thorax: pubescence yellow, metallic lustre weaker than in male.

Abdomen: less lustrous than in male, nearly bald.

Body length 7.5 - 9.5 mm.

Diagnosis

M. hayati externally resembles *M. caeruleus* Loew (abdomen: Fig. 1b) because of the

strong metallic lustre. It can be distinguished by the denser pubescence, different lustre colour and shorter aedeagus in the male (*hayati*: Fig. 3a; *caerulescens*: Fig. 3b), and the lack of pubescence bands in the female. Moreover *M. caerulescens* occurs in spring at sea level in mediterranean habitats while *M. hayati* occurs in high altitude in summer. *Merodon hayati* is much narrower than, for example *M. cinereus* (abdomen: Fig. 1c).

Merodon hayati is known from eastern Turkey where it occurs in alpine regions from June through August. This species is dedicated to my co-author Dr. Rüstem Hayat, who collected the holotype.

Type material

Holotype male: [Turkey, Erzurum] 'Turnali, Senkaya, 3.vii.1990 R. Hayat' (ZMAN). Paratypes: 1 male, same data (BKB); 1 male, 3 females 'Kafkasör, Artvin, 16.viii.1990, 1750 m R. Hayat' (BKB); 2 females 'Anzer Yaylasi Rize, 5.viii.1995 E. Ergün (BKB); 2 males 'Turkey, Erzurum, (Oltu) Sütkans 14 km SW Oltu, 25.vi.1996 W. Hurkmans leg.' (ZMAN); 1 male ' Turkey: Rize, Pas İkizdere-Ispir 2500 m 31.vii.1983 leg. J. A. W. Lucas' (J.A.W. Lucas Collection, Rotterdam, the Netherlands).

The type material is preserved at ZMAN and BKB, and in the collection of J. A. W. Lucas, Rotterdam (JAWL).

Merodon hikmeti Hurkmans & Hayat (Figs. 5 - 7)

Male

Head: antennal ratio 1.8; 3rd antennal article rounded-subacute, upper margin convex; tl - v ratio (cf. Hurkmans 1993) 0.4; ocellar angle 50 degrees, vertex angle 40 degrees; pubescence yellow, rather dense on metallic lustrous face with moderate oral margin.

Thorax: dark, moderately steel blue lustrous on sides, with rather sparse, even yellow pubescence; wings clear, halteres, squamae and antisquamae (upper and lower calypters) pale, with fringe of pale pubescence.

Legs: tarsi of fore and mid leg slightly widened; trochanters 3 acuminate, femora 3 moderately swollen, with triangular process bearing 10 bristles on the serrate distal margin.

Abdomen: rather stout, with some purplish lustre (Fig. 5); T II clearly tapering caudad and showing paired orange lateral spots; pubescence rather sparse, golden brown to deep yellow; pruinose bands lacking, but corresponding hairless (or nearly) zones present. S IV narrowly, deeply emarginate posteriorly.

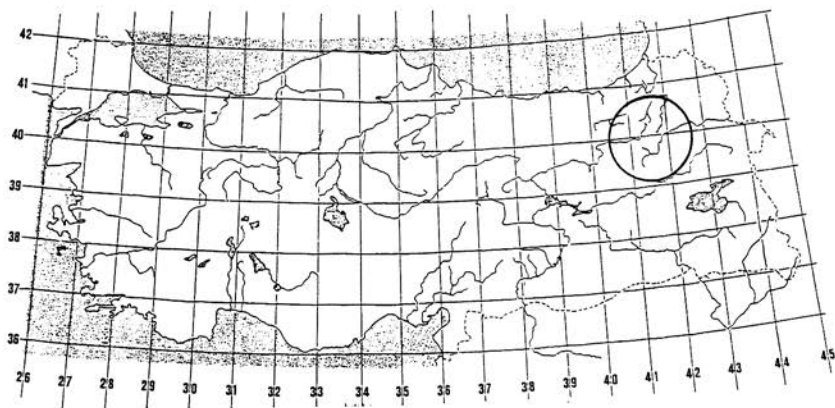
Genitalia: anterior surstyle lobe small, bearing tubercles with long, yellow pubescence, separated from the posterior lobe by a small sulcus; posterior lobe relatively very large, semicircular in outline, with overall short, sparse pubescence but some long pale hairs along the distal-dorsal margin and a straight inner antero-ventral ridge bearing yellow pubescence; cercus small, with moderately dense yellow pubescence. Aedeagus rather stout, with basal heavily sclerotized, crenate part; apical shaft part short, fringed plates on thecal apex recumbent (Figs. 6-7).

Body length 10.5 - 11 mm

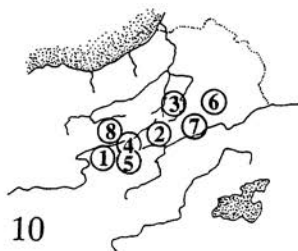
Female Unknown.

Diagnosis

Merodon hikmeti can easily be distinguished by its relatively narrow shape and lack of abdominal pruinose bands. In view of the structure of its genitalia it is assigned to the *distinctus* group. This species is known from the province of Erzurum, Turkey where it occurs in June. It is dedicated to Dr. Hikmet Özbek, Professor of Entomology, Atatürk



9



10

Figs. 9-10. Study sites. 9, Map of Turkey showing the position of NE Anatolia where the work was carried out; 10, Map of NE Anatolia showing localities: 1. Küçükgeçit; 2. Köşk Köyü; 3. Sütkans; 4. Erzurum; 5. Palandöken; 6. Sarikamis; 7. 15 km E of Horasan; 8. Kargapazari Dagı.

Üniversitesi, Ziraat Fakültesi, Bitki Koruma Bölümü, Erzurum, Turkey, who kindly provided facilities for this study.

Type material

Holotype: male 'Turkey (Erzurum) Küçükgeçit, 45 km W. of Erzurum (1650 m) 17.vi.1996 leg. W. Hurkmans' (ZMAN). Paratype: male 'Turkey (Erzurum), Köşk Köyü, 32 km NE of Erzurum (1800 m), 20.vi.1996 leg. Hurkmans & Hayat' (BKB).

Merodon biarcuatus Curran, 1939, male (Figs. 4b, 8)

The male of this species has not been described. A single male of this species was collected along with a female *biarcuatus* from 'Türkiye, Tunceli, 15 - 20 km NW Tunceli, 1000 - 1200 m, 13. vii.1992, leg. J. A. W. Lucas' (JAWL). It conforms to the characters of the *distinctus* group to which the female *biarcuatus* had already been preliminarily assigned. The *M. biarcuatus* male externally resembles *M. distinctus* (cf. Hurkmans 1993, Fig. 23d). This species is slightly larger and narrower than *M. biarcuatus*, especially in the abdomen (Fig. 4a,b)

Head: pubescence white, not yellow; no dark tuft in ocellar region.

Thorax: pubescence more extremely short, pale greenish-greyish. no traces of dark interalar band.

Legs: tibiae and tarsi 3 predominantly dark.

Abdomen: lateral spots and pruinose bands pale orange to creamy coloured, not yellow; especially T III - IV narrower than in *distinctus*, T IV much swollen.

Genitalia: similar to that of *distinctus*, but the posterior part of the posterior surstyle lobe abruptly rising from the distal margin (Fig. 8).

(ii) Behaviour

Merodon aberrans

Males of this species were defending territories by chasing at KG on 16.vi (6 obs.), alternating with "display-sitting" i.e., sitting in a conspicuous place in the territory with wings slightly spread (8 obs.) lasting from 11 to 18 sec., mean 15.5 sec. One display-sitting ended because a female approached and copulation ensued, lasting 35 sec. This took place on a grass leaf just above ground level, and looked like an attack. The male was on top and slightly behind the female. No buzzing was heard. At PD 2 on 24.vi and 28.vi., males were frequently chasing one another (31 obs.). This was alternated with display-sitting (49 obs.) lasting 3-37 sec. mean 14.7 sec.) and was usually ended by intruding conspecific males. Sometimes the cause of ending display-sitting was unclear; three copulae, all on *Urtica* leaves, were timed at 38, 51 and 67 sec. This species has a strict preference for Umbelliferae and has not been seen to visit *Ornithogalum*. It is one of the first *Merodon* species to become active during the day. The females fly low, through the vegetation.

Merodon alagoezicus

Males were seen at KK 3 on 2.vii and 3.vii chasing conspecific and other *Merodon* males (9 obs.), other Syrphidae (5 obs.) and Tabanidae (6 obs.), up to the size of *Palumbia flavipes*. Display-sitting in sunny spots on *P. saxifraga* also occurred (6 obs.) This species prefers half-shadow and is found on the lee side of shrubs. They were only visiting *P. saxifraga*. They also patrol the borders of these shrubs, flying into the wind (7 obs.). Females of the *alagoezicus* group also engage in patrolling in this way (4 obs.). In the field *M. alagoezicus* seems large, rather short and fat and strongly grey-green metallic lustrous, with conspicuously large genitalia. Apart from their conspicuously different colour pattern, they resemble *M. nigritarsis* in the field.

Merodon alexeji

Males were track flying along the border of a stand of yellow Umbelliferae at KK 2 on 20.vi. (7 obs.), flying into the wind. They frequently alighted on the umbels of these plants (11 obs.), but for less than 5 sec. In the field *M. alexeji* males seem small and dark, with the abdomen tapering to an almost acute tip (the genitalia are small). The females look like small *M. avidus* specimens. This species is new for the Turkish Fauna.

Merodon avidus

Several modes of territorial defense were observed: display- sitting at KG on 16.vi and 17.vi (32 obs.), patrolling at KG on 16.vi and 17.vi and at PD 2 on 24.vi (18 obs.), and chasing at KK 2 on 20.vi. where males chased *Xanthogramma citrofasciatum* and *Palumbia flavipes*. This species becomes active after *M. aberrans* and it could often be observed on (and collected from) flowers of *Ornithogalum*. It also visited *P. saxifraga*, other Umbelliferae and a range of Compositae.

Merodon avidus was present at ER 1 and 2, at SK 1 and KK 2 and 3. It seemed to be very widespread in the region, possibly because it is less restricted by foodplant. Some *M. avidus* males engaged in display-sitting on stones lying in a stream; this has been seen before, e.g. by WH at St. Marie de Campan, Htes- Pyrenees, France (alt. 1250 m) in 1993. Seven copulations were observed, the male being on top of, and slightly behind the female, with durations of 17 to 41 sec. mean 30 sec. When disturbed the mated pairs usually separated, although they are capable of flight in copula. This species shows considerable colour and size variation. The specimens observed at KG, KK 2 and PD all show a bluish lustre that is unusual in this species. The lustre is so conspicuous that these specimens resemble *M. aberrans* in the field.

Merodon biarcuatus

Females of this large, slender species were found at KG on 17.vi where they were patrolling over, not through, the vegetation, in the same way as *M. velox* females. In the field this species resembles *M. clavipes* females in size and colour. The flight pattern is similar to that of asilids: a short, somewhat erratic flight, interrupted by seemingly random landings among the vegetation. They were not seen on flowers. The *M. biarcuatus* females were flying along the bottom of an embankment bordering the valley bottom on the west side. One presumed *biarcuatus* male that was patrolling the same zone could not be collected.

Merodon hayati

This species is conspicuous in the field by its strong blue-grey lustre, almost as strong as *Lucilia* (Diptera: Calliphoridae) species. The two males collected were found at SK 1 on 25.vi in stony terrain with scant vegetation when flying up the almost dry bed of a torrent with many boulders and scree on a well-wooded hillside without visiting flowers or drinking water.

Merodon hikmeti

At KG on 17.6 and KK 2 on 20.6, one male each was observed. The male is conspicuous in the field for its dark colour and strong lustre (abdominal pruinosity is virtually absent, abdominal pubescence is very sparse). Both specimens were captured late in the day, display-sitting on umbels of *P. saxifraga*.

Merodon kaloceros

Males of this species are conspicuously grey, to even white, in the field. At KG on 16.vi. they were patrolling (7 obs.) and chasing (2 obs.). At KK 3 on 2.vii males were also patrolling (4 obs.). The males flew through the top layer of the vegetation at the level of the umbels of *P. saxifraga*. At PD 2 a female was flying in the stony bed of a small stream just above the water on 28.vi. (*M. aberrans* females also do this occasionally: in Anogeia, Crete, (alt. 1700 m), WH collected several in May 1985 in the stony and almost dry bed of a stream without any vegetation). In the field the female looks conspicuously red and does not at all resemble the male.

Merodon loewi

At PD 1 on 14.vi, at KG on 16 and 17.vi and at KK 2 on 20.vi males were chasing one another (19 obs.), display-sitting (11 obs.) and frequently buzzing (over 40 obs.). Many females were present at all localities but copulae (4 obs., all at PD) were rare in view of the abundance of the species. Copulation was observed on leaves of *Rumex crispus* L. in all cases with the male atop and slightly behind the female, but when disturbed the mated pair proved capable of flight in copula. At KK 2 on 20.vi the males were flying low through the marsh vegetation, following zones of lower plants. They frequently visit *Ornithogalum* and have hardly been collected from Umbelliferae.

Merodon lucasi

This species is not easy to distinguish from *M. alagozicus*. Although nearly the same size, *M. lucasi* seems distinctly smaller and less lustrous than *M. alagozicus* in the field. It also has a different site preference. All specimens captured were flying in the shadow, inside the small copses at KK 3 on 2.vii and 3.vii; they were visiting *P. saxifraga* umbels and *Ranunculus* sp. and clearly not patrolling.

Merodon nanus

This is best distinguished from *M. spinitarsis* Paramonov, *M. telmateia* and *M. syriacus* Paramonov by its silvery (vs. golden or coppery) appearance, but in the field it is difficult to separate these species. *Merodon nanus* visits *Ornithogalum* sp., various Compositae and Umbelliferae. At SK 1 on 25.vi one female was found very high up the slope in a small marsh. At KP on 27.vi this species was flying very close to the soil through the vegetation in the wettest parts of the marsh, adjacent to the small river running through it, and display-sitting on *Ornithogalum* sp. (6 obs.).

Merodon nigratarsis

In the field this species shows a warm orange colour and seems large and stout. When sitting its large genitalia are conspicuous. Males were chasing at SK 1 on 25.vi and 26.vi, at KG on 17.vi and at KK 3 on 2 and 3.vii (17 obs.). Display-sitting was seen at KK 3 on 2 and 3.vii (7 obs.) on umbels of *P. saxifraga*.

Merodon ottomanus

Males of this species show a strong coppery lustre in the field. At KK 2 on 20.vi they were continuously engaged in track flying along a stand of yellow Umbelliferae (over 25 obs.). The females did exactly the same (over 25 obs.); males and females rarely visited the

umbels; once when this happened copulation directly ensued, with the male atop and slightly behind the female. This mated pair was quickly netted to investigate the characters of the female. Several other mated pairs were netted, but not in copula. Females were much more numerous than males, and display a more grey lustre in the field. Outside the zone where the track flying took place, both sexes could be seen visiting *Ornithogalum* sp.

Merodon planiceps

This species appeared to be less common than *M. loewi*, contrary to what was found during a previous fieldtrip (Hurkmans 1988). At SK on 26.vi some males were visiting *Euphorbia* sp.

Merodon telmateia

Males were observed by GT on 27.vi at SR, where they were found by the sound of their buzzing. They defended territories centred on flowers of an *Ornithogalum* sp. (over 5 obs.) in a marshy meadow.

Merodon velox

In the field both sexes are easy to identify and can be well seen up to great distances. The males are very large, dark and strongly lustrous. Their brown to orange abdominal pubescence is not visible in the field, except when the male is seen sitting at close range. The females are very dark and resemble small species of *Xylocopa* (Hymenoptera, Xylocopidae) in flight. They resemble Tabanidae when sitting. This species prefers rather drier habitats than all other *Merodon* species studied thus far (Hurkmans 1985, 1988, 1993) including *M. clavipes* (Fabr.) and *M. pruni* (Rossi). Both sexes prefer yellow Umbelliferae and stands of *Euphorbia* on stony ground, preferably with low soil cover by the vegetation. They are late to become active during the day and are best observed in the late morning or late afternoon, depending on sun exposure. They remain active at an air temperature above 35 centigrade when most other syrphid flies seek shelter, but during the midday period they have not been seen defending territories.

Territorial behaviour of this species was studied at ER 1 and 2, KG, SK 1 and 2 and KK 1. At ER 2, a relatively very warm and stony site. Initially several males were seen track flying along the area in general (12 obs.) but from 15.vi, territories were maintained by their occupants. The males greatly outnumbered females and displayed various behaviours. They were display-sitting inside the territory (47 obs. with duration from 7 to 86 sec. mean 22 sec. They patrolled the territory, as far as could be seen, mainly clockwise (81 obs. with duration from 7 to 135 sec. mean 30 sec. The sat on the embankment overlooking the territories (31 obs. with duration from 4 to 30 sec. mean 16 sec.) and were lookout-sitting on high plants that marked territory borders (44 obs. with duration 3 to 33 sec. mean 18 sec.). They rarely engaged in chasing since the other species of syrphids at ER, mainly *Eristalis tenax* L. were actually seen to avoid confrontation (6 obs.). The females flew very fast through and above the vegetation. Copulae usually took place atop umbels or on *Euphorbia* plants (11 obs. with duration from 17 to 86 sec. mean 41 sec.) and were only begun when a patrolling male saw a female landing on flowers in its territory. The male then jumped at the female, sometimes so roughly that both flies tumbled off the plant and separated before hitting the ground. When disturbed a mated pair can fly away in copula. Attachment of occupying males was tested by capture and marking. At ER on 15.vi

3 marked males did not return, but on 22 and 23.vi attachment proved strong, captured and marked males returning in 15 to 30 secs (4 obs. mean 21 sec.).

To test the competition for, and eligibility of territories, males were captured, and the time elapsing before the territory was again occupied was recorded (8 obs., duration 70 to 165 sec. mean 115 sec.). Of two males marked in the afternoon of 22.vi that had not returned, one was captured the next day, but defending a different territory to the one it was captured in the previous day. On 23.vi four males were captured, marked and released. The next morning one was recaptured, again in a different territory.

At KG, SK 1 and 2 and KK 1 the strong preference of this species for stony ground was again apparent. Some patrolling (7 obs. total) and chasing (4 obs. total) was found. At SK 2, males defended territories by patrolling (7 obs.), chasing (12 obs.) and display sitting (11 obs.). Females seemed to outnumber males here and were flying up and down the slope in a very visible way.

As soon as the sun disappeared behind a hill ridge, activity ceased in about 10 minutes.

At KG population density was very low. *Merodon velox* was found only near the stony embankments bordering on this marsh, where the few specimens visited *Euphorbia* stands. At KK 1 the males seemed to defend very large territories on a dry stony hillside with *Ferula communis* L. (Umbelliferae) and some *Euphorbia* stands. Lookout sitting (8 obs. with duration from 12 to 45 sec. mean 29 sec.) and probable patrolling (11 obs. duration from 9 to over 60 sec.) were infrequent and no chasing or display sitting was seen. The visit at KK 1 occurred at a time of low population density. Some females were present at KK 1, but no copulations were observed.

Xanthogramma citrofasciatum

This species was found at KK 2 on 20.vi. It preferred to fly in the shadow and visit white and yellow Umbelliferae. Its flight is quiet and somewhat heavy, much less nimble than observed in *X. pedissequum* Harris. As soon as the sun disappears, if only for a minute, it ceases flight and shelters.

Chrysotoxum festivum

At ER, this is the hoverfly that became active earliest, at about 06.45. Somewhat later, *C. octomaculatum* Curtis and *C. parmense* Rondani also were flying. These species and *C. vernale* Loew all prefer shadow interspersed with sunlight. Therefore they are found under thinned stands of trees and flying through high grass and reeds. They almost disappeared after 10.30, but some specimens were seen at midday flying several metres above ground. Moreover the *Chrysotoxum* species are very fast flyers and can blend in very well with the background in full sunshine. Flies of this genus were by far the most common Syrphidae during the fieldtrip.

Volucella zonaria

This large species prefers flying in the shadow, under small trees and alongside shrubs but curiously enough it disappears when the sun is blocked by clouds, even if the temperature is suitable. Its flight is slow and laborious over short distances (such as when it manoeuvres through tall grass), but once going it can fly very fast. It visits unusual flowers for a syrphid, e.g. *Rosa canina* L., *Clematis* sp., *Acer* sp. (KK 2) and *Tilia* sp. (SK).

Palumbia flavipes

This rare hoverfly can actually be common, as at KK 2 on 20.vi and at KK 3 on 2 and 3.vii. It is a slow flier that often settles on umbels of *P. saxifraga*. It flies mainly over short distances from one umbel to another, even when disturbed, and has been collected by hand. When still, the wings are folded over the abdomen. From a distance it resembles an orange wasp but at close range it resembles large species of *Merodon*. Its behaviour is however much less vivid, even in very hot weather. It prefers flying in the shade (in the same biotope as *V. zonaria*) during the midday period, but flies in the sun in the late afternoon. Both males and females were present, but they seemed uninterested in one another. They cannot be separated in the field except at very close range when their eyes can be examined (this is possible in the field, since this species is so sluggish). Apart from KK 2 and 3 a few single specimens of this fly have been found in other marshy habitats that include tree stands.

Eoseristalis arbustorum and *Eristalis tenax*

At some localities, these common species share the biotope of *M. avidus* and *M. velox*. Although *E. arbustorum* and *E. tenax* have an active way of defending territories, they seem unable to maintain territories in spots selected by *M. avidus* or *M. velox*. They even avoid confrontations with these species. When at ER on 15 and 17.vi *E. tenax* showed its hovering display to mark its territory, chasing by *M. velox* (7 obs.) and *M. avidus* (5 obs.) followed. *Eoseristalis arbustorum* was not seen to display by hovering at this locality, while it did so in many other places.

Discussion

In many species of *Merodon*, several modes of territorial defense can be distinguished. Patrolling and chasing intruders in flight usually alternated with display-sitting. Display-sitting was only recorded if the sitting post was not at the border of a territory on a high plant. Most display-sitting was very close to the ground. At KG preferred display-sitting sites of *M. aberrans* and *M. avidus* males were places where the grass had been trodden down. Hurkmans (1988) suggested that in *M. planiceps* patrolling flight paths along the contour of the slope might be a precursor to territorial activity. At ER 1 and 2, track flying in *M. velox* was shown to precede genuine territorial defense. In view of the copulations of *M. ottomanus* at KK 2, it is possible that this species does not engage in territorial behaviour since both sexes were track flying at the same place. This behaviour may have replaced territory maintenance in *M. ottomanus* and possibly other species as well. Apparently track flying does not exclude territorial activity (at the same time, but possibly by different individuals), as observations of *M. alagozicus* at KK 3 have shown.

At KK 2 and 3, large trees and moderately large shrubs cast shadows over the ground. Few territories were found in the zones affected by shadow; most territories were found where the shadow was only cast in early morning or very late afternoon. At ER 1 and 2 and SK 2 it soon became apparent that to *Merodon* insolation is an important factor: as long as the sun shines on the site the flies are active from about 0800 until about 1700, but if the sun is blocked by clouds or terrain, they quickly cease activity. Even at the ideally situated SK 2 where conditions were crowded for *M. velox* and territorial defense fierce, shadow ended all activity within 10 minutes. This seems to hold true for all species

encountered. The dip in activity during the midday period is most marked in *M. velox*, which is not surprising since it occupied the driest and arguably hottest habitats (stony and with little vegetation).

Curiously, the presence of females does not provoke the same behaviour in different species of *Merodon*. When females of *M. velox* became more frequent at ER after 15.vi, the behaviour of the male markedly changed from track flying to territorial activities. At KK 2 the *M. ottomanus* females outnumbered the males at least 2:1, but there was no sign of territorial activity in this species. At KK 3, territorial defense by *M. aberrans*, *M. alagozicus* and *M. avidus* was fierce and many females were present. At KG, PD 1 and KK 2, many females of *M. loewi* and *M. kaloceros* were also present, but territorial defense by the males of these species was not a feature of their behaviour. In all these observations, weather conditions were almost identical. The question why male response to the presence of females varies among *Merodon* species is not understood.

The phenomenon of sneaking i.e. presence in a territory to mate or feed without exhibiting territorial behaviour and avoiding confrontation with the occupant (e.g. Alcock et al., 1978, Severinghaus et al., 1981, Tsubaki & Ono, 1986) may be present in *Merodon*: at KK 3 track flying males of *M. alagozicus* apparently were not chased by males of the same species maintaining a territory. In places where densities of territories are high, sneaking into a territory, as seen in *M. alexeji* and *M. ottomanus*, may be an alternative method of obtaining mating opportunities. The sneaking behaviour described by Tsubaki & Ono (1987) is very similar to lookout sitting; it is possible that under very crowded conditions when territories are hard to establish by males arriving late, this behaviour may lead to direct copulation without territorial defense. Copulation without territorial activity is possible, as the observations of *M. ottomanus* at KK 2 have shown. Conditions were certainly crowded at KK 2 and 3, to judge by the violent territorial defense of the *M. aberrans* and *M. avidus* males. It is noteworthy that the territorial defense by *M. avidus* and *M. velox* is fierce enough to expel *E. tenax*, which is known for its aggressive territorial behaviour (Wellington & Fitzpatrick 1981). The way in which the track flying males avoid expulsion by territorial males is unknown.

The effect of crowding on territory size was obvious at ER 1 and 2: when the number of *M. velox* males increased after 15.vi, the number of territories increased from 4 to 7 in the same area, while clearly less eligible sites were incorporated in existing territories after this date. The three fresh territories (all on the less sunny western bank of the channel) were the last to be occupied during the activity period of *M. velox* and the first to be vacated in the late afternoon. The end of the activity period was signalled by a) the disappearance of the females and b) males flying up and down the whole area, becoming more or less detached from their territories.

The fact that recaptured males of *M. velox* were in different territories indicates that territories are established all over again each day. This means that the first males to become active during the day have the best territories to choose from. It is even possible that this phenomenon happens again in the afternoon when *M. velox* resumes its activity after the absence of activity during the midday heat. This also explains why the least eligible territories are occupied last and vacated first, and means there is evolutionary pressure toward becoming active over a wide temperature range.

If it is correct that *M. velox* initiates new territories in every activity period this probably means *M. velox* does not require feeding/drinking sites inside the territory. Since

territories are ephemeral, the occupants can feed and drink during periods when the territories are not defended. The large size of *M. velox*, together with its excellent flying abilities would enable this species both to travel from the territory to obtain food and return to defend the site from other species such as *Eristalis tenax*. Other species of *Merodon* would be expelled by aggressive *M. velox*, if they occurred in the same habitat. The few *M. avidus* present at ER 2 had not established territories. Most species however occur in moister habitats, where there is no midday activity dip (due to e.g., cooling by evaporation and available shadow in the lower layers of the vegetation). Therefore they need establish their territories only once a day; and one day may be sufficient for a high number of copulations to take place. No difference in habitat preference between track flying species such as *M. alexeji* and *M. ottomanus*, and species that defended territories, was recorded.

Apart from the species discussed in this paper, other *Merodon* species about which something is known of the life cycle, ecology and behaviour are: *M. aeneus* Megerle (Verlinden & Decler 1987, Verlinden 1994, Hurkmans & De Goffau 1995), *M. albonigrum* (Vujic et al., 1996), *M. amaryllidis* (Villeneuve 1934), *M. bombiformis* (Stuckenberg 1956: Afrotropical region), *M. clavipes* (Hurkmans 1985), *M. constans* (Hurkmans & De Goffau 1995), *M. desaturinus* (Vujic et al., 1995), *M. elegans* (Van der Goot 1964), *M. equestris* Fabr. (Hurkmans & De Goffau 1995), *M. equestris* (Heiss 1938, Lindner 1949, Šuster 1959, Conn 1976, 1978, Wellington & Fitzpatrick 1981, Fitzpatrick & Wellington 1983, Rotheray 1993, Hurkmans & De Goffau 1995), *M. pruni* (Hurkmans 1988), *M. ruficornis* (Verlinden & Decler 1987) and *M. rufus* (Treiber 1987).

Most of these species share a general preference for a climate with a warm (but not hot) summer and for mountainous terrain where food plants are abundant. The general climate and geography of the Mediterranean region appears to be particularly suitable, as reflected by the large number of *Merodon* species in this area (Hurkmans 1993, Dirickx 1994). The reason why Greece, Turkey and to some extent Israel are so rich may be explained by three reasons. First, the flora of these countries include a very large number of Amaryllidaceae and Liliaceae growing at high altitudes. These localities are subject to a severe winter, but the soil is covered by deep snow. In spring and summer these localities remain in general well watered by melting snow and reduced evaporation because temperatures are lower in high altitudes. Second, Greece and Turkey are at the centre of the natural distribution range of *Merodon* as a genus. These countries include many species groups, some of them endemic, especially in Turkey. It is interesting that the most apomorphic species groups all occur in the eastern part of the distribution range of *Merodon*. Third, Greece and Turkey are rich in mountains and mountain ranges surrounded by large plains. Often these mountain ranges have a lush vegetation up to the end of summer, while the plains below dry out, isolating the areas that long remain green. Under such isolated conditions the probability of speciation is higher than in more continuous mountain areas or plains such as those in southern Russia.

The high diversity in altitude in Greece, Turkey and Israel may also have permitted variation in flight periods. Adults of several Mediterranean species occur extremely early in the season, from January-April. As the season proceeds, the adults of species at higher altitudes become active. This factor also contributes to species richness and again is absent from the south Russian plains. Israel is less rich in *Merodon* species than Greece and Turkey, but relatively it is very rich: *Merodon* species contribute over 25% of the known Syrphidae of Israel (about half of the country is extremely dry and nearly devoid of any

Syrphidae). Currently more *Merodon* species from Israel are known than from for example, Spain, which is about 25 times larger. The mountain habitats visited by WH in Mediterranean countries have one additional advantage: since agriculture is often impossible on account of the rocky nature and/ or inaccessibility of the terrain, the flora often is less impoverished by human action. In Turkey and Greece, yellow and white Umbelliferae are very important food plants for adult *Merodon*, many species of which visit *P. saxifraga* or *F. communis* (see also Hurkmans 1988). These plants are widespread in Turkey (Baytop, 1994) and seem to play an important role in the biology of several *Merodon* species and other hoverflies.

We may summarise what is known of *Merodon* in the following way:

Merodon larvae develop in underground parts of plants, mainly bulbs, of the families Amaryllidaceae, Liliaceae and Zingiberaceae.

Although several species are thermophilous (but not xerophilous) most species with a known habitat preference occur in cooler (mountain), often really moist habitats. Some species ensure the presence of moisture by occurring very early in the season.

Many species show a distinct (often aggressive) territorial behaviour. Frequent modes of territorial defense are:

patrolling the boundary - *M. aberrans*, *M. alagoezicus*, *M. avidus*, *M. biarcuatus*, *M. clavipes*, *M. equestris*, *M. kaloceros*, *M. loewi*, *M. pruni*, *M. velox*
chasing - *M. aberrans*, *M. alagoezicus*, *M. avidus*, *M. kaloceros*, *M. loewi*, *M. nigritarsis* and *M. velox*

display-sitting - *M. aberrans*, *M. alagoezicus*, *M. avidus*, *M. clavipes*, *M. equestris*, *M. hikmeti*, *M. loewi*, *M. nanus*, *M. nigritarsis*, *M. planiceps*, *M. pruni*, *M. telmateia* and *M. velox*

buzzing i.e. producing a piping or buzzing sound, believed to be used by the occupant of a territory in keeping out intruders (see Hurkmans, 1988) - *M. loewi*, *M. rufus* Meigen and *M. telmateia*.

Under crowded conditions, territories become smaller and territorial defense fiercer. Alternate mating tactics are track flying (*M. alexei*, *M. ottomanus*, *M. planiceps* and *M. velox*) and lookout sitting (*M. velox*) which are possibly forms of sneaking, or behaviour developed from it. Lookout sitting may be incorporated in territorial defense.

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The status of *Melanostoma dubium* (Diptera, Syrphidae)

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The validity of the putative species *dubium* Zetterstedt has been a difficult problem for some time. Verrall (1901) first introduced this taxon to the British list but states, '*Melanostoma dubium* is still a very dubious species'. He based this introduction on two females, one from approximately 915m on top of Grey Fell in Perthshire and the other from Rannoch. Both specimens were taken by Colonel J.W. Yerbury in 1898. Verrall (1901) described these females and described the male from an Austrian specimen, but as Speight (1978) points out, this probably refers to a male *Platycheirus*. Verrall (1901) found it disconcerting that a male specimen also taken by Col. Yerbury on Grey Fell on the same day as the *dubium* female, was, in his opinion, only an obscurely marked, very dark-legged *Melanostoma mellinum* (L.).

In his major work on the British Syrphidae, Coe (1953) regarded *dubium* as a variety of *M. mellinum*. In his view, specimens referable to *dubium* were no more than a dark, more dusted form found in northern England and Scotland.

Speight (1978) re-examined the status of *dubium* in the British Isles with reference to the work of Andersson (1970) and Kanervo (1938). Comparing Verrall's (1901) descriptions to those of these authors and to material which he had collected himself, Speight (1978) considered *dubium* a valid species and re-introduced it to the British list on the basis of 9 specimens. Speight (1978) also provided a revised key to the British *Melanostoma* species.

Stubbs and Falk (1983) followed Speight (1978) in recognising *mellinum* and *dubium* as distinct species. They did, however, state that, 'there remain considerable problems since some specimens are neither ideal *M. dubium* nor *M. mellinum*'. In response to this predicament they defined a provisional new taxon, Form A, which covered the range of variation present between *dubium* and *mellinum*. This form is close to *dubium* but its inclusion in that taxon would extend its definition to a point where key characters break down. They hoped that the definition of *Melanostoma* Form A would be a step towards solving some of the taxonomic problems but recognised that the scarcity of material was a major drawback.

Morphological basis of *dubium*

Andersson (1970) examined Zetterstedt's (1838) type material. The nominate form, var. a, was described from 3 females collected in northern Sweden. A second form, var. b, was also described from northern Sweden and Norway. Andersson designated a female of var. a as the lectotype. This specimen has all the femora darkened, narrow dark bands on all the tibiae and abdomen is black with hardly any dusting (Andersson, 1970). The other two var. a females were *Platycheirus* species. Andersson states that the male genitalia of *dubium* are of the *Melanostoma* type but gives no details on differences with other *Melanostoma* species. With regard to the separation of female *dubium* from the not infrequent melanic form of *mellinum*, Andersson gives the character of a divided tergite 8 in the former whilst in *mellinum* this tergite is in one piece. This was considered to represent a definite character to distinguish the two taxa.

The genitalia of putative *dubium* and *mellinum* are very similar and are of no assistance in distinguishing these taxa (Speight 1978). These taxa, including Form A, are separated on a combination of characters involving body colouration and dusting, colour of pubescence and length of antennal segments (Table 1).

Table 1. Differences between *M. mellinum*, *M. dubium* and Form A according to Andersson (1970), Speight (1978) and Stubbs and Falk (1983).

character	<i>M. mellinum</i>	<i>M. dubium</i>	Form A
Males			
arista	long & narrow	short & thick	short and thick
antennal-segment 3	long &	short &	short &
face	yellow below	black	black
frons angle	narrow	narrow	wide
thoracic-dorsum	< 90	> 100	intermediate?
abdomen	black	black	greenish black
tergite-pubescence	widening	parallel	parallel
tergite-colour	black	pale	intermediate
sternites	pairs yellow spots T2-T4	dark	markings reduced
	usually pale	usually dark	usually dark
Females			
face	narrow	v. wide	wide
frontal			
dust spots	small	extensive	extensive
antennal-segment 3	long &	short &	short &
thorax	yellow below	black	black
abdomen	black	black	greenish black
tergite-pubescence	long & narrow	short & wide	intermediate?
tergite-colour	dark	pale	intermediate
sternites	pairs yellow spots T2-T5	dark	reduced
tergite 8	complete	divided	spots not scored

New material from Scotland

As Stubbs and Falk (1983) point out, one of the difficulties in assessing the status of *dubium* has been lack of material. As part of an investigation into the montane Diptera of Scotland, extensive pitfall trapping and hand collecting resulted in approximately 130 *Melanostoma* specimens from various altitudes being available for study (Horsfield and MacGowan, 1997). These specimens plus others from lower levels throughout Scotland (28 males and 30 females, Table 2) were used for a detailed analysis of the morphological basis for recognising *dubium*.

On trying to identify these specimens, some from higher altitudes, at over or about 700m in males and 500m in females, fitted the description of *dubium*. Intermediate forms

referrable to Form A occurred at lower altitudes followed by *mellinum* specimens only below 150m. The altitudinal difference between the males and females of specimens identified as *dubium* was a particular feature (Fig. 1).

The *dubium* records given by Speight (1978) would seem to agree with the altitudinal separation of the *dubium* sexes suggested by Fig. 1. Speight (1978) records two males and two females at 760m on Beinn a' Chuallaich, but only females at lower altitudes, two at 460m on Schiehallion and one near Camghouran, Rannoch (estimated altitude 250m).

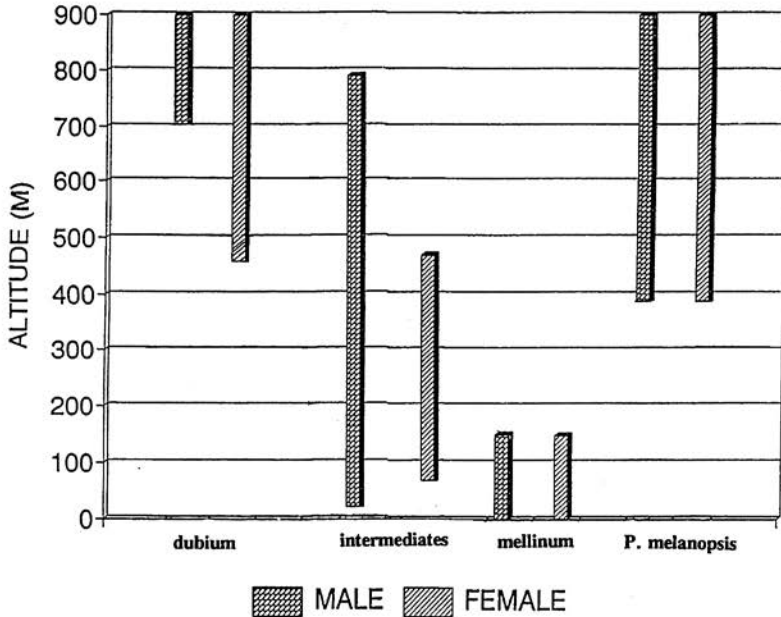


Fig. 1. Distribution in relation to altitude on Scottish mountains of sexes of *Melanostoma dubium*, *M. mellinum* and morphological intermediates (Form A) and *Platycheirus melanopsis*

Critical examination of key characters

The existence of intermediate Form A specimens in our material confirms the problem identified by Stubbs and Falk (1983): that morphological variation is greater than can be accounted for in the *dubium* concept. To investigate this variation, a detailed examination of the key characters used to distinguish *dubium*, Form A and *mellinum* was undertaken.

(a) Colour of abdominal hairs

Speight (1978) uses the presence of white hairs over all the abdominal tergites apart from a few on the tip of t4 as one of his key points in distinguishing male *dubium*. Stubbs

and Falk (1983) also use this character for male *dubium*, but state that this condition can occur in Form A where the abdominal hairs can be all white or transitional to the black haired state of *mellinum*. In specimens we examined, the white haired tergites are not restricted to the high altitude *dubium* form, but also occur occasionally in specimens from intermediate altitudes. For example, on Beinn Eighe one male from 250m, two males from 350m and one male from 650m had white and black hairs on the abdomen (Table 2).

(b) Antennal length

Speight (1978) states that in both sexes of *dubium* the depth of antennal segment 3 (A3) is 75% or more of length. Stubbs and Falk (1983) also state that in males of *dubium* and Form A this segment is shorter than long. Our specimens seem to show continuous variation with altitude in this character with no grouping of data points (Fig. 3a,b).

(c) Aristal length

Stubbs and Falk (1983) state that in males of *dubium* and Form A the arista is short and thickened at the base. Measurements of the arista on our specimens suggest that the variation in this character not is consistent with altitude or taxon (Fig. 3c).

(d) Face width

Speight (1978) states that for *dubium* males 'the face is wider than the maximum width of the eye'. Stubbs and Falk (1983) use as their key character the angle of the eyes where they meet at the top of the frons. Where this angle is less than 90° the specimen is *mellinum*, when more than 90° the specimen is either Form A or *dubium*. Measurements of our males and females suggest continuous variation between face width and altitude with little sign of groups of data points (Fig. 3d,e).

(e) Antennal colour

Speight (1978) states that in both sexes of *dubium* antennal segment 3 is nearly always black. Stubbs and Falk (1983) state that both sexes have entirely black antennae, or at most, some yellow on the base of the female third segment. They also state that Form A has the antennae black in both sexes. Examination of our material shows that antennal darkening gradually increases with altitude (Table 2).

(f) Colouration of the thorax

Stubbs and Falk (1983) use as the feature to separate Form A the fact that the colouration of the thoracic dorsum differs from that of the tergites. In Form A the thorax has brassy reflections which contrast with the black reflections from the tergites. We would certainly agree that in specimens from intermediate altitudes there are often strong brassy or iridescent reflections on the thoracic dorsum and more especially on the pleurae. This feature does, however, vary in intensity between individuals throughout the Highlands irrespective of altitude and is not a consistent character.

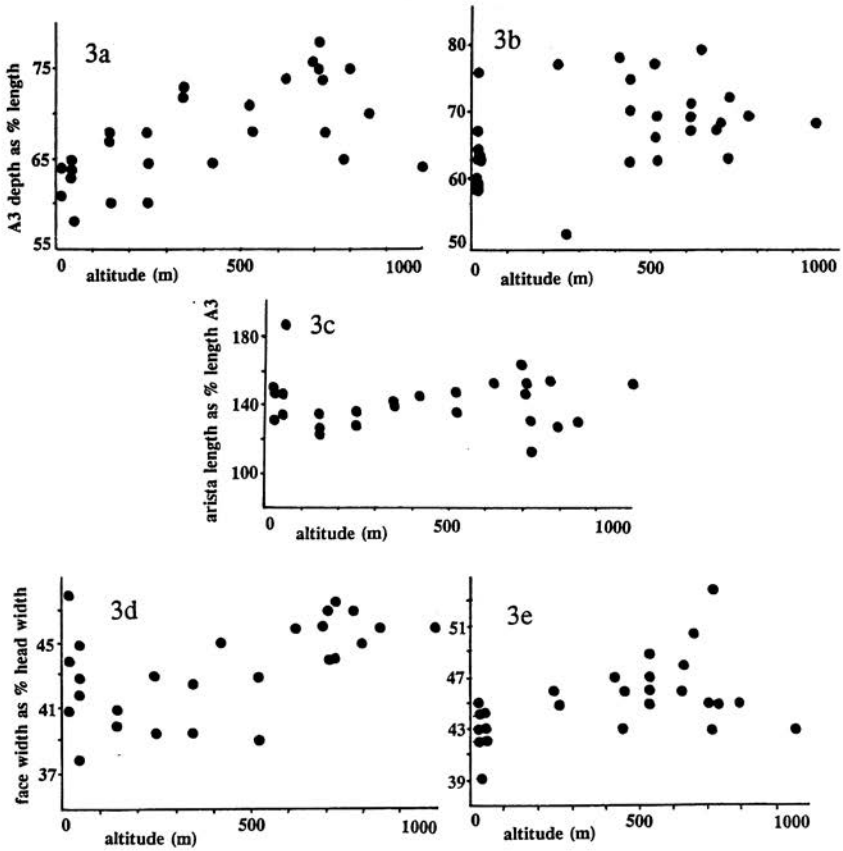


Fig. 3. Altitudinal variation in characters of *Melanostoma*, depth of antennal segment 3 (A3) as % of its length in (a) males, (b) females; (c) length of arisia as % of the length of A3 in males; width of face as % of width of head in (d) males, (e) females.

(g) Female tergite 8

Andersson (1970) first introduced this character as a means of separating melanic *mellinum* females from those of *dubium*. This feature has been presented as one of the few clear cut morphological differences between female *mellinum* and *dubium*. As with many apparently distinguishing characters, it would appear that Andersson (1970) only examined specimens which were at the edge of the range of variation of *mellinum*. Detailed study of this feature revealed the presence of intermediates and gradually increasing excision and separation of tergite 8 with altitude (Fig 2).

Variation with altitude

In order to determine whether morphology varies continuously with altitude, morphological features were measured on males and females taken at three different altitudinal ranges. Ten males and ten females were measured from low, medium and high altitudes. Only 8 male specimens were available from the mid altitudes. Low altitude specimens were captured at between 0m and 250m, mid altitude specimens between 250m and 500m and high altitude specimens at over 500m.

The characters measured were in males, face width, angle of eyes where they meet above the antennae, width, depth and colour of antennal segment 3, presence or absence of abdominal spots, colour of abdominal hairs and colour of legs. Similar measurements were made on females but instead of eye angle, face width was measured (Table 2).

Discriminant Function Analysis was performed on the males and females separately. For the male data, the first axis showed highly significant discrimination ($x = 55$, $df=18$, $p < 0.001$), and is negatively correlated with the colour of abdominal hairs and the depth of the 3rd antennal segment. It is positively correlated with the colour and length of the 3rd antennal segment. For females, the first axis is likewise highly significant ($x = 48$, $df=14$, $p < 0.001$), reflecting a positive correlation with antennal colour and a negative correlation with the presence of abdominal spots and leg colour. In both cases, the low altitude samples have the most negative scores and high altitudes the most positive scores.

A Principal Components Analysis was then run to find the direction of maximum variation between individuals ignoring any *a priori* groupings. If there are really two or more groups this should show up as two distinct clusters of points. The first two principal axes accounted for 77% (females) and 93% (males) of the variation with no sign of any clustering into groups.

Discussion

Melanostoma dubium has been considered a valid concept by some authors (Speight, 1978; Stubbs and Falk, 1983) but invalid or doubtful by others (Coe, 1953; Verrall, 1901). This study analyses a wider range of material than previously studied. It included forms referable to *dubium*, *mellinum* and Form A and was obtained from a range of altitudes in the Scottish Highlands. All of the characters suggested as separating *dubium* from the closely related *mellinum* (Table 1) showed intermediate states at intermediate altitudes. A principal components analysis revealed no clusters in this material and showed that, of the characters examined, variation is continuous. The main directions of morphological change include a darkening of body colouration and an increase in facial width.

These results suggest that *dubium* represents no more than the extreme end of a

Table 2. Morphometric data and source of *Melanostoma* material used for multi-variate analysis males, 1 = face width as % head width; 2 = A3 depth as % length; 3 = arista length as % length A3; 4 = abdominal spots: 1 normal, 2 reduced, 3 melanic/silver; 5 = A3 colour: 1 black, 2 <15% yellow, >15% yellow; 6 = leg score (all x6): 1 yellow, 2 ringed, 3 yellow/black, 4 black; 7 = eye angle on frons 1 <90°, 2 90°, 3 >90°; 8 = abdominal hairs: 1 all black, 2 some white, 3 all white; 9 = A3 length as % head width; females, 1 = face width as % head width; 2 = face height as % width; 3 = A3 depth as % length; 4 = abdominal spots: 1 normal, 2 reduced, 3 melanic; 5 = A3 colour: 1 black, 2 <15% yellow, >15% yellow; 6 = leg score (all x6): 1 yellow, 2 ringed, 3 yellow/black, 4 black; 7 = A3 length as % head width

Males													
No	Site	Grid ref	Altitude	1	2	3	4	5	6	7	8	9	
1	Benn Eglie	NH0162	20	44	61	148	1	2	20	3	1	29	
2	Benn Eglie	NH0162	50	45	63	147	1	2	20	3	1	37	
3	Benn Eglie	NH0162	50	43	58	135	1	3	20	3	1	36	
4	Benn Eglie	NH0162	50	42	65	135	1	1	20	2	1	30	
5	Benn Eglie	NH0162	150	41	67	123	1	3	18	3	1	32	
6	Benn Eglie	NH0162	150	41	60	127	1	2	20	2	1	34	
7	Laggan Fen	NH5515	150	40	68	135	1	3	18	3	1	34	
8	Benn Eglie	NH0162	20	48	64	150	1	1	15	3	1	32	
9	Laggan	NH2895	50	38	64	187	1	3	13	1	1	34	
10	Benn Eglie	NH0162	20	41	64	132	1	1	17	1	1	40	
only 8 specimens in this group													
11	Benn Eglie	NG9962	350	39	5	72	140	1	1	20	3	2	29
12	Benn Eglie	NG9962	350	42	5	73	142	1	1	20	2	30	
13	Benn Eglie	NH0062	250	43	68	128	1	1	20	1	2	34	
14	Benn Eglie	NH0062	250	39	5	60	136	1	3	20	2	31	
15	Benn Eglie	NG9963	525	39	68	136	1	2	16	1	1	35	
16	Benn Eglie	NG9963	525	43	71	148	1	1	20	3	3	29	
17	Friondra	NG3300	425	45	64	5	145	1	1	18	3	30	
18	Benn Eglie	NH0062	250	43	64	5	129	1	2	20	2	33	
only 8 specimens in this group													
19	Am Faachagach	NH1177	730	47	5	74	130	3	1	24	3	34	
20	Am Faachagach	NH1177	730	44	68	113	2	1	20	3	3	32	
21	Meall a Bhruith	NH2550	1000	46	64	153	2	2	20	3	3	29	
22	Aonach Beag	NH1870	850	46	70	130	1	1	20	2	3	34	
23	Spurr na Ruadh	NH3042	715	47	75	146	2	1	24	3	3	29	
24	Am Faachagach	NH1177	780	47	65	154	3	1	20	3	3	28	
25	Spurr na Ruadh	NH3042	715	44	78	152	1	1	18	2	3	28	
26	Benn Eglie	NG7841	700	46	76	164	2	1	22	3	3	31	
27	Spurr na Ruadh	NH3042	800	45	75	128	3	1	24	3	3	30	
28	Benn Eglie	NG9962	625	46	74	152	1	1	20	3	2	27	
Females													
No	Site	Grid ref	altitude (m)	1	2	3	4	5	6	7			
1	Tillicoultry	NS9296	20	43	79	5	63	1	3	7	37		
2	Tillicoultry	NS9296	20	39	84	62	5	2	3	7	33		
3	Tuamast	NB2645	10	43	79	60	2	2	18	30			
4	Loch Sheppit	NF8238	15	42	94	58	1	3	8	36			
5	Loch Sheppit	NG4930	10	44	97	63	1	2	16	42			
6	Loch Sheppit	NG9963	5	42	83	59	2	3	9	34			
7	Knockmole	NH1172	20	44	87	76	1	1	11	33			
8	Ullapool	NH1294	20	43	87	59	1	3	8	36			
9	Loch Sheppit	NG4930	10	45	88	64	2	2	10	30			
10	Col Sands	NB4337	10	43	88	67	1	3	8	34			
11	Benn Eglie	NH0062	250	46	78	77	2	2	18	31			
12	Benn Eglie	NG9963	525	45	84	69	3	1	20	33			
13	Benn Eglie	NG9963	525	49	81	62	5	3	1	24	37		
14	Benn Eglie	NG9963	525	47	71	66	3	1	22	33			
15	Benn Eglie	NG9963	525	46	79	77	3	1	22	33			
16	Friondra	NG3300	425	47	71	78	2	2	20	28			
17	Creag Mhor	NC7021	450	46	82	75	3	1	24	34			
18	Creag Mhor	NC7021	450	43	86	70	3	1	22	31			
19	Creag Mhor	NC7021	450	48	80	62	5	3	1	22	33		
20	Glen Orchy	NH2841	260	45	83	51	5	2	2	18	35		
21	Benn Eglie	NG9962	625	48	72	67	3	1	24	36			
22	Benn Eglie	NG9962	625	48	80	71	2	1	20	30			
23	Benn Eglie	NG7841	700	45	83	67	3	1	18	33			
24	Spurr na Ruadh	NH3042	710	43	85	68	3	1	24	33			
25	Meall a Bhruith	NH2550	960	43	72	68	3	2	22	34			
26	Am Faachagach	NH1177	655	50	5	84	79	3	1	20	33		
27	Benn Eglie	NH4438	730	45	81	72	3	1	22	34			
28	Benn Eglie	NG9962	625	46	73	69	3	1	24	32			
29	Spurr na Ruadh	NH3042	790	45	76	69	3	1	24	35			
30	Spurr na Ruadh	NH3042	715	54	84	62	5	3	1	24	30		

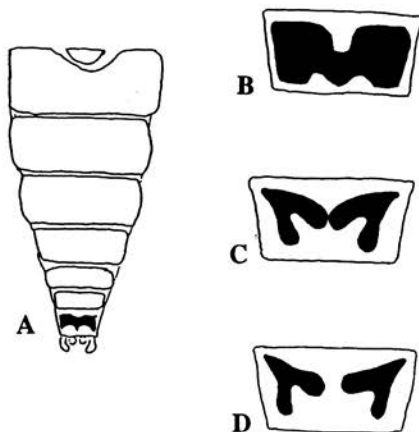


Fig. 2. Abdominal tergite 8 in female *Melanostoma* A, ventral view abdomen, shaded area = tergite 8; B, *M. mellinum* Tillicoultry, 31.vii.1980, altitude 15m; C, *M. dubium* Beinn Eighe, 12.vi.1990, altitude 250m; D, *M. dubium* Beinn Eighe, 12.vi.1990, altitude 625m.

morphological cline along an altitudinal axis. We therefore find no grounds within the characters examined, to support *dubium* as a valid species.

Some of the problems experienced by previous authors are undoubtedly due to lack of material. To anyone familiar with the forms of *M. mellinum* found in lowland Britain, high altitude specimens are strikingly different and raise the question of whether they truly belong to the same taxon. However, with the advantage of material from various altitudes the nature of this variation, with its extremes, can be better understood.

Vockeroth (1990) considers *Melanostoma* to be an Old World genus with one very variable New World species. If *Melanostoma* is as variable in the Old World as it seems to be in the New World, then clinal variation of the kind we have encountered on Scottish mountains is to be expected.

If *dubium* is a valid concept then differences appear to exist in the altitudinal distribution of males and females (Fig. 1). However, it is always difficult to accurately assign specimens to a known altitude in the mountains. High winds which are common even in summer can quickly transport an individual from one location to another several hundred metres higher or lower. In general altitudinal zoning of forms is evident, especially in early summer soon after the emergence of the adults. Nonetheless, the distribution on Creag Meagaidh of the montane syrphid *Platycheirus melanopsis* Loew show that both sexes are

evenly distributed throughout the altitudinal range of the species (Fig. 1). The difference in altitude between males and females of *dubium* raises all sorts of problems in understanding the ecology and dispersal behaviour of this taxon, but they disappear if a morphological cline of a single species is involved.

Temperature on Scottish mountains is negatively correlated to altitude and falls by around one degree centigrade for every 150m rise. Windspeed, rainfall and cloud cover all increase so that mountains are cold, wet and windy (Rotheray and Horsfield, 1995). The adult colours of some hoverflies become darker with decreasing temperatures experienced during pupal development (Dušek and Láška, 1974). This could be the physiological mechanism underlying the morphological cline of *M. mellinum*.

Our data show that females exhibit signs of melanism at lower altitudes than males (Table 2). At low altitude temperatures, bright colours may not be precluded, but a mechanism to become dark might be advantageous. Females need to spend more time feeding and maturing eggs. Dark females may be able to remain active for longer than bright coloured individuals. Males, however, are not faced with the same demands and possibly require bright colours to maintain a territory or attract a mate and do not possess such a mechanism.

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