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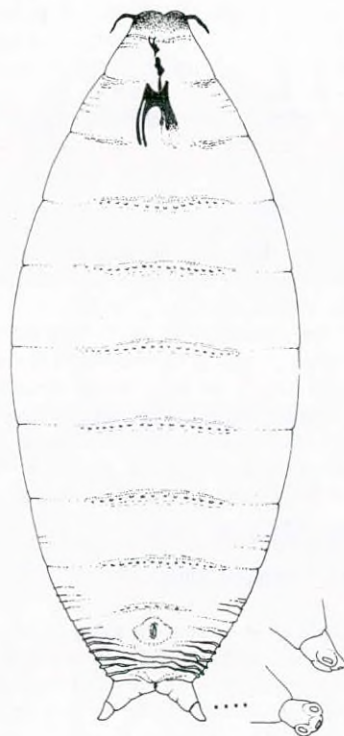
Guest Editor : Phil Withers

Observations of the behaviour and immature stages of *Dixella graeca* Pandazis
(Diptera: Dixidae)

E. Kathleen Goldie-Smith

Dixella graeca in Britain

Among the hundreds of dixid specimens sent to the author by Andrew Foster from the N.C.C invertebrate survey in East Anglia, 1988-91, were six adults (4 male and 2 female) which could not be identified using Disney's (1975) key. They had all been collected at the same site at Walberswick in East Suffolk during August 1989. Slide mounts were identified as *Dixella graeca* Pandazis by Dr. Disney, who had already commented on the confusion in the literature concerning this species and *Dixella obscura* Loew (1974). He has now established *D. graeca* as the fifteenth species on the list of British Dixidae, illustrating the salient differences of various stages between *graeca, obscura and filicornis* (Edwards) (Disney, 1992). A brief note was inserted by the present author in a paper which reviewed the three types of egg in Dixidae, and their sculpturing as revealed by SEM photography (Goldie-Smith & Thorpe, 1991).

From drawings sent by Dr. Disney to the author it was also clear that a species of *Dixella* first found in Rye, East Sussex in May 1988, and identified and mapped as *D. filicornis,* is *graeca* (Goldie-Smith, 1989d, map 11). The site on this map near Cranbrook, Kent does support *filicornis*, but the site at Oare in north Kent has not recently yielded either species. The Rye *graeca* exhibited a peak in October 1991 during which it was possible to obtain and study all stages, but subsequent searches for larvae have indicated a rapid decline with the onset of colder weather. A third known site for *graeca* is at Chippenham Fen in Cambridgeshire, where one larva was found in August 1991. It is hoped that dipterists will have an added incentive to collect dixids and increase the number of records of this interesting addition; a new distribution map for *graeca* and a corrected map for *filicornis* are planned for the near future.

"Semaphore" behaviour of graeca adults

In laboratory culture, adult *graeca* perform a sort of "semaphore"; this has not been seen in any of the ten other species of dixid observed in culture by the author. Brief wing flexes may be carried out alternately by a pair, or more or less in rotation by a number of adults up to six inches apart (the width of the container). Sometimes the wings are flexed continuously for longer periods. Occasionally this "semaphore" has been seen as a definite preliminary to mating, but it has also been observed in cultures of five or more females in the absence of a male. Laboratory observations to date suggest that males appear early in the peak period, but may be lacking in later cultures. With present knowledge, therefore, obtaining the eggs of this species necessitates careful timing and observation of the seasons.
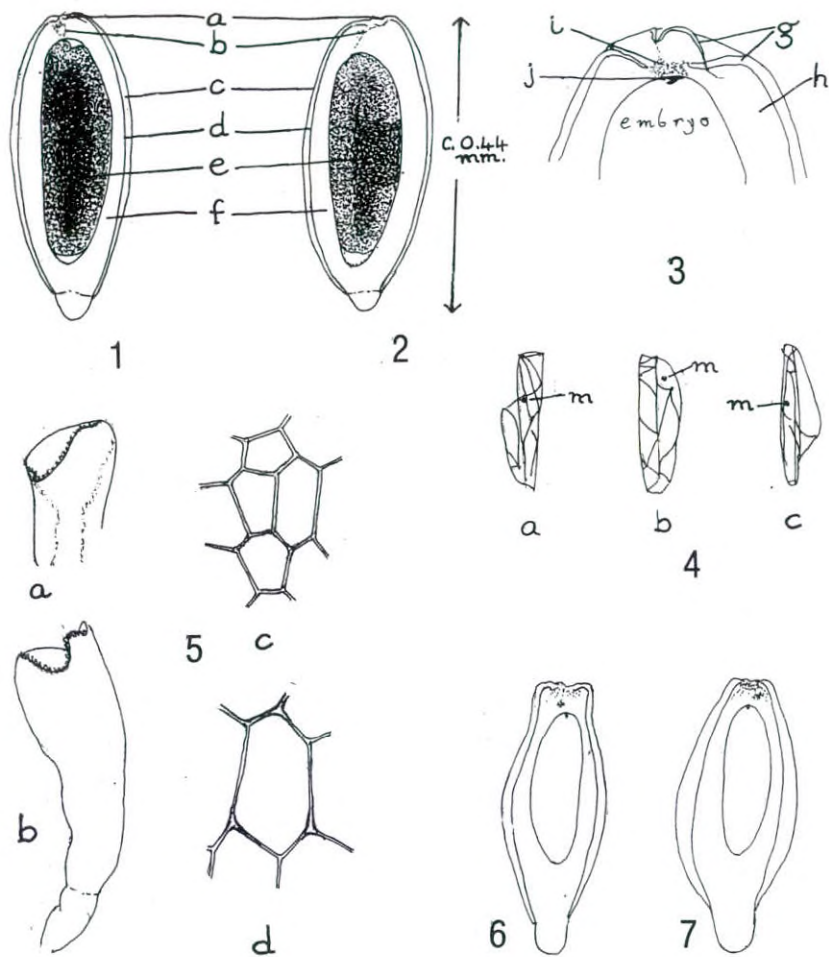
The egg of Dixella graeca

Dixid eggs can be classed in three types (Goldie-Smith & Thorpe, *op. cit*). Those of *filicornis* and *amphibia* Degeer constitute Type II, to which *graeca* may now be added. They are streamlined, comparatively smooth, and generally in looser clutches than Type I

or III eggs (Figs.1,2,6,7). The egg of *filicornis* (Fig. 6) is outstanding in having a "neck" and a flattened, though irregular, apex. In outline, the *graeca* egg (Figs. 1,2) is more like that of *amphibia* (Fig. 7) but its capsule does not protrude so prominently at the posterior end. Also, there is a greater distance between the capsule and the outer coat in the *amphibia* egg; in all three species this distance is usually greatest in the middle third of the egg. The refractive ring in the micropylar cup, so characteristic of *amphibia* eggs (Goldie-Smith, 1989a) has not been observed in the eggs of the other two species.

Most *graeca* clutches seen so far have contained 30-40 eggs, but one contained 60 and another 83. The clutches are loose, in a very soft jelly matrix; they are sometimes free-floating, but more often intertwined with a plant at the water surface. Decaying *Phragmites* is a useful substratum, but in this study, clumps of the aquatic moss *Fontinalis* were deliberately placed against the side of the container, partly submerged, the emergent portions holding a film of water among the leaves and stems. As with *filicornis*, ovipositing female *graeca* repeatedly selected these clumps as suitable nurseries. Because the clutches are so loose, and a few eggs may be deposited separately, the eggs are harder to find than those of Type I species. In structure, however, they follow the basic pattern characteristic of Dixidae: the embryo is always orientated with the bluntly rounded anterior end under the micropylar cup at the top of the egg; its ventral side is slightly flattened; it is surrounded by a transparent jelly contained within a capsule with a thin refractive wall which is often minutely ridged or denticulated on its inner side. The capsule projects beyond the outer sheath posteriorly and joins it anteriorly in a small number of rounded bumps and thickenings around a shallow micropylar cup; fine refractive lines, delicate folds or thickenings may sometimes be seen radiating down a short distance from the micropylar cup. A tiny mass of seminiferous residue lies between the cup and the top of the embryo; in *graeca* the dark micropylar spot on the top of the embryo frequently bears a tiny, inwardly directed, curved knob (Fig. 3). The transparent jelly seems to be made up of blocks which can sometimes be clearly distinguished along the lower edge, and may give the impression, albeit extremely faint, of reticulation over parts of the egg. However, no reticulation of the outer coat, such as characterises Type I eggs, has been observed in these Type II eggs. The consistency and durability of the jelly becomes apparent four or five days after the eggs are laid, when the clear space left in it by the hatched larva can often be seen. The developmental stages of the embryo, which can be watched through the transparent coverings, are similar in *graeca* to those described and illustrated for other species of *Dixella* (Goldie-Smith, 1989a,b,c; 1991). The membrane which is usually left within the egg by the hatching larva, still bearing a recognisable micropylar spot (Figs. 4 a-c) is closely folded and crumpled, much more so than in, for instance, *obscura* (Goldie-Smith 1989c figs. 6a-c).

Reticulation of the pupal trumpet of graeca

In view of the absence from Type II eggs of the reticulation of the outer coat which is such a conspicuous feature of Type I eggs, the strong reticulation of the respiratory trumpets of the *graeca* pupa is of particular interest. These are shallow-cupped (Fig. 5a) but so long-stalked (Fig. 5b) that on an undisturbed pupa in a natural position just above the water surface, they stick out like two pins on a pin cushion. The meshes in the cup region are smaller than those further down the stalk (Fig. 4 c,d). The significance of such meshes on

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Fig. 1-5 *Dixella graeca.* **1 & 2** Eggs, with embryos in early stages of differentiation. a, shallow micropylar cup, b, seminiferous residue, c, outer coat, d, capsule, e, embryo, f, transparent jelly. **3** Apex of an egg. g, irregular thickenings of apical wall (outer coat + capsule), h, transparent jelly, i, seminiferous residue, j, micropylar spot. **4** a-c, collapsed membranes left behind by hatching larvae, m, micropylar spot. **5** Respiratory trumpet. a, shallow cup, b, entire trumpet, c, mesh of the reticulated covering layer in the cup region (smaller), d, mesh of the reticulated covering layer over the "stalk" (larger, with conspicuous thickenings). **6** Diagrammatic view of the egg of *Dixella filicornis.* **7** Diagrammatic view of the egg of *Dixella amphibia.*

respiratory surfaces of insects, acting as a "plastron", was pointed out by Hinton (1981) and related to Type I eggs by the present author (Goldie-Smith, 1991).

Acknowledgements

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Notes on the taxonomy of the puparia of British Sphaeroceridae

Peter Skidmore

In the course of studying dipterous material from archaeological sites in Greenland, Iceland and various parts of the British Isles, the author has examined some 15,000 sphaerocerid puparia. The importance of this family in this field of research was noted by Smith (1989), but I have found that in total, members of this family, and especially those belonging to the subfamily Limosininae, have massively outnumbered all other Cyclorrhapha combined. Clearly the identification of this material is of paramount importance in the interpretation of these deposits but the existing literature is inadequate for this purpose and a reappraisal of the taxonomy of sphaerocerid puparia is essential.

Pitkin (1988) provides references for the puparia of Sphaeroceridae described in the literature, and Okely (1974) gives keys for the identification of those which were then known. Whilst some may have been based upon misidentifications, the main problems were that some important features had been overlooked and that descriptions traditionally included trivial details emanating from the process of pupariation, and of structures common to most cyclorrhaphous puparia. The present paper aims to highlight characters which appear to be of taxonomic importance with a view to producing improved keys.

"Subfossil" puparia such as occur in postglacial deposits are, perhaps surprisingly, of great potential taxonomic value. Traditionally, the identification of emerged adults has been regarded as an essential prerequisite for the production of descriptions of puparia and dipterists have often discarded unhatched puparia. In "subfossil" material of course one is forced to rely upon the examination of unhatched flies for positive identification. The author has found that in deposits he has studied, puparia have occurred in huge numbers, and that between 1 and 10 percent have contained unhatched adults, often in a remarkably good state of preservation. In limosinine puparia such vital diagnostic features as male genitalia and pregenital combs, female spermathecae and cerci, and almost all important chaetotactic details may be clearly visible through the puparial integument. Obviously when identifications are based on the adult within the puparium, errors so easily resulting from incorrect correlation of puparia and emerged adults are inapplicable. Dipterists only interested in modern material should also bear this in mind: before throwing out those unhatched puparia, closely examine them for signs of the unhatched adult inside (see fig. 14).

Some of the excavations in which the writer has been involved in this study have yet to be published, even in outline. For those which have, the reader is referred to the following papers covering the respective sites - Baker & Higham 1982 (Hen Domen, Montgomery), Buckland 1983 and McGovern et al 1983 (Western Settlement, Greenland), Greig 1981 (Barrel Latrine, Worcester), Leach 1984 (Taunton) and Sveinbjarnardóttir 1981 (Stóraborg).

The terminology for morphological features of the puparium follows Skidmore (1985) and nomenclature that of Pitkin (op. cit.).
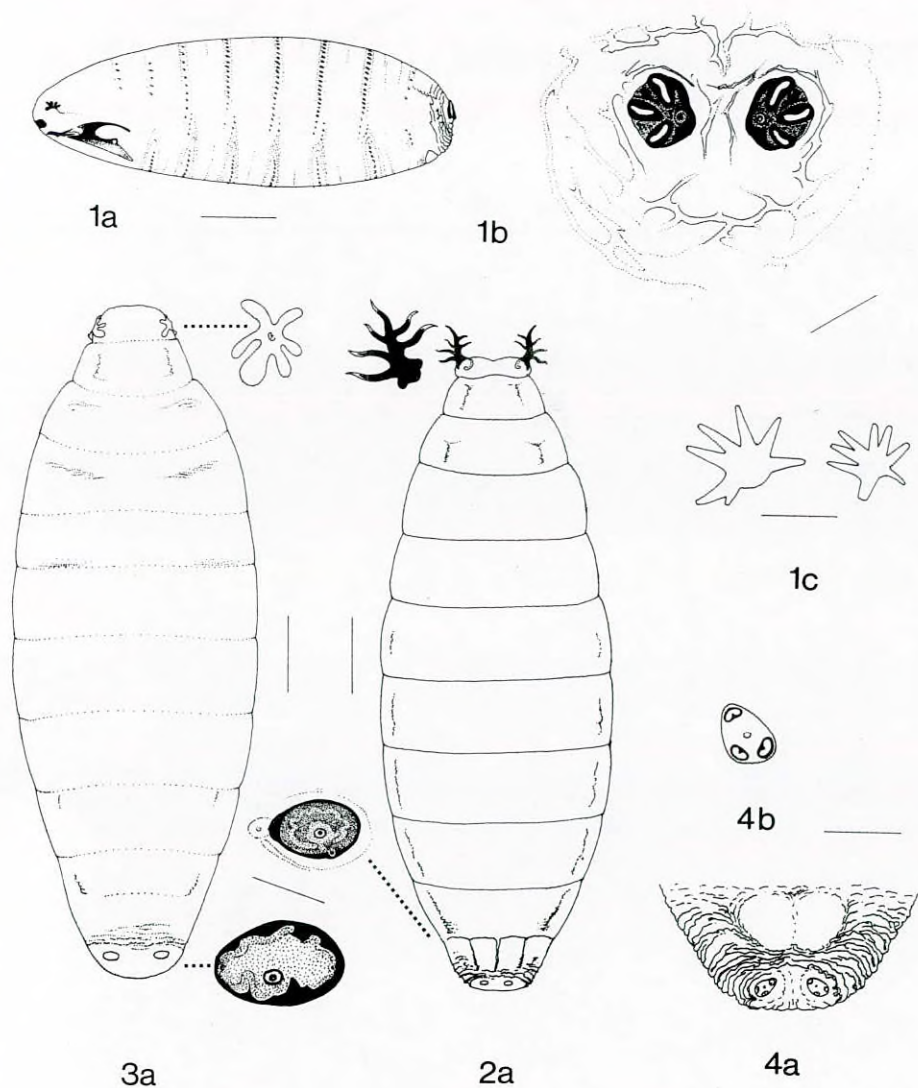
Fig. 1-4. 1 *Copromyza (s.str.) similis*, a, puparium (lateral), b, anal spiracles (posterior), c, prospiracular processes showing two variants. **2a** *Ischiolepta denticulata*, puparium (dorsal) showing details of prospiracular process and right anal spiracle. **3a**, *I. pusilla*, puparium (dorsal) showing details of prospiracular process and right anal spiracle. **4** *Sphaerocera curvipes*, a, caudal segment of puparium (dorsal), b, right anal spiracle. (Scales: 1a, 0.6mm; 1b,1c, 0.12mm; 2a,3a,4a,4b 0.24mm) (Orig.)

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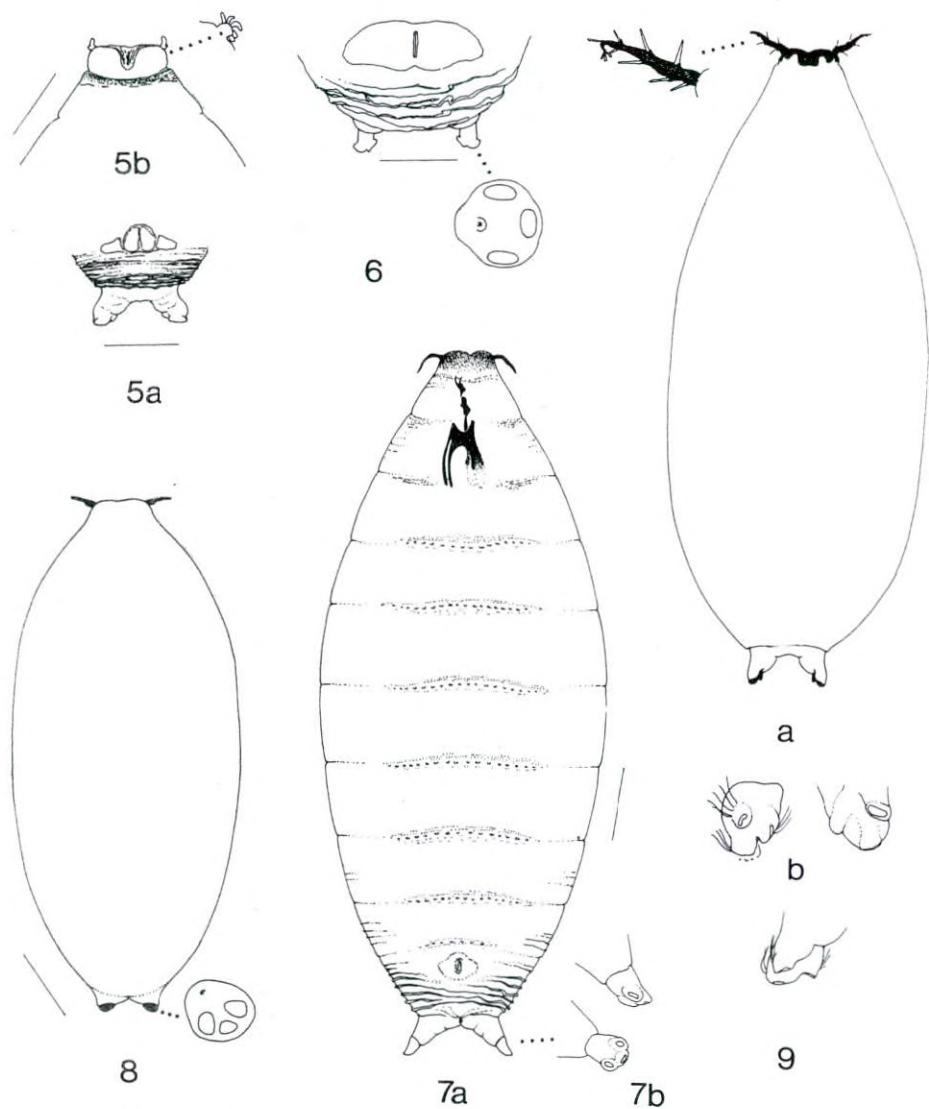
Fig. 5-9. 5 *Herniosina bequaerti,* a, caudal segment of puparium (dorsal), b, thoracic segments showing detail of prospiracular process. **6** *Leptocera (s.str.) fontinalis,* caudal segment of puparium (ventral) showing detail of left anal spiracle. **7** *Opalimosina (Pappiella) liliputana,* a, puparium (ventral), b, anal spiracle in dorsal and frontal view. **8** *Pullimosina heteroneura,* puparium (dorsal) showing detail of right anal spiracle. **9** *Spelobia (s.str.) rufilabris,* a, puparium (dorsal) showing detail of prospiracular process, b, anal spiracle in various aspects. (Scales: 0.12mm) (Orig.)

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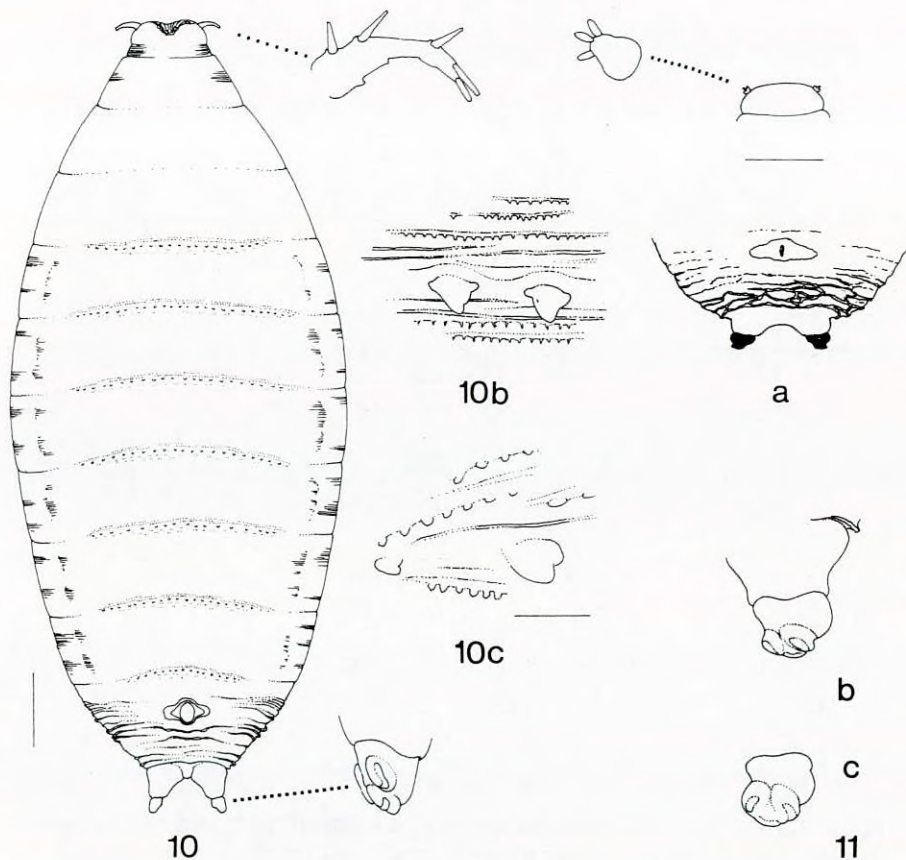
Fig. 10-11. 10 *Telomerina flavipes*, a, puparium (ventral) showing details of prospiracular lobes and anal spiracle, b and c, median and lateral section respectively of ventral ambulatory welt on abdominal segment 4. **11** *Terrilimosina racovitzai*, a, prothoracic and caudal segments of puparium in dorsal and ventral aspect respectively, showing detail of prospiracular process, b and c, two views of anal spiracle. (Scales: 10a and 11a, 0.12mm; 10b,c, 0.03mm) (Orig.)
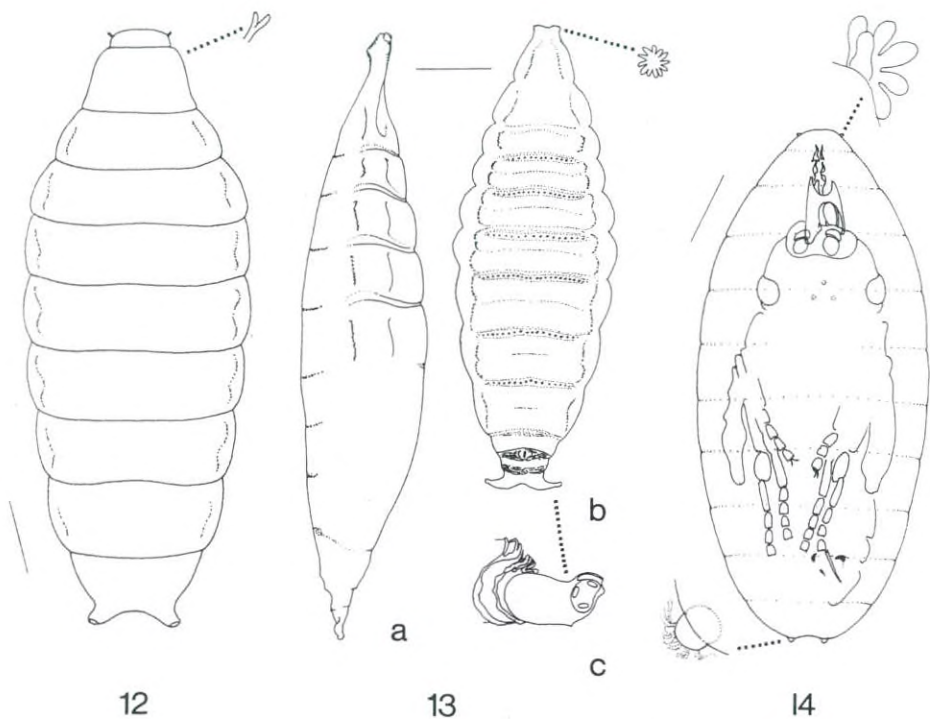
Fig. 12-14. 12 *Thoracochaeta brachystoma*, puparium (dorsal). **13** *T. zosterae*, a, puparium (lateral), b, same (ventral), showing details of prospiracular process, c, detail of anal spiracle. **14** *Trachyopella (s.str) coprina*, puparium with outline of adult inside, showing details of prospiracular process and anal spiracle. (Scales: 0.12mm) (Orig.)

Apart from the superb works of Rohácek (1982-5) and Marshall & Rohácek (1984), which have set the very highest standards in taxonomic work in this family, most workers have omitted biometric details for adults, invoking an argument of extreme variability. Although most sphaerocerids vary in size intraspecifically, there are nevertheless considerable interspecific differences within the family. Rohácek & Marshall not only give the adult size range for each sex, but state the number of specimens examined. In puparial descriptions a single figure has usually been given but the number of specimens studied is rarely stated. The author has found some evidence to suggest that the ratio of adult to puparial length (A/P ratio) is not constant and there may be differences in this ratio between certain genera. Clearly these ratios can only be calculated from a large amount of biometric data. The details for puparia provided in this paper result mainly from material from archaeological excavations. The A/P ratio in the species studied lies mainly in the range 0.61-0.78:1. The puparial length given by Okely for *Opalimosina (s. str.) mirabilis* appears wildly excessive, especially when compared with the available details for *O. (Pappiella) liliputana* (Rondani) (see table 1). Also the bent form of the puparium of *O. mirabilis* figured by him is not a specific character but a malformation seen very commonly in many limosinines.

Table 1   **Calculated Adult/Puparium Ratios for certain British species of Limosininae.** Mean dimensions for adults calculated from the size-ranges given in Rohácek. Puparial lengths marked with an * from Okely, the remainder calculated from specimens examined by the current author.

Species	L. (Adult) mm	L. (Puparium) mm	A/P ratio
O. liliputana	1.45	2.28	.64
O. mirabilis	1.34	2.9*	.46
P. heteroneura	1.25	1.74	.70
P. moesta	1.50	2.1*	.71
P. pullula	1.39	2.0*	.70
S. rufilabris	1.64	2.16	.76
T. flavipes	1.41	2.31	.61
T. zosterae	2.34	3.5	.67

Prospiracular processes

These structures are clearly of great taxonomic significance as has been recognised by previous students of the group. Goddard (1938) and Okely rely almost wholly on these in

their keys to puparia. They range from short stellate or palmate structures to very long dendriform ones adorned with lateral, usually translucent linear papillae (see figs. 14, 1c and 9 for stellate, palmate and elongate dendriform types respectively). In the dendriform type the length of the processes relative to the space separating them provides a useful character (the P/P ratio). The British Limosininae are broadly categorised below on the calculated P/P ratios of their puparia. Whilst the papillae arising from the dendriform types are brittle and prone to loss, their points of attachment remain as distinct alveoli. As noted by Ferrar (1987) the pupal spiracles are internal.

Prospiracular process very short (P/P = up to 0.3:1):

> *Apteromyia claviventris; Chaetopodella scutellaris; Coproica (hirtula, ?lugubris); Herniosina bequaerti; Leptocera (s. str.) (caenosa, fontinalis, oldenbergi); L. (sg. Rachispoda) (fuscipennis); Limosina silvatica; Minilimosina (fungicola); Pteremis fenestralis; Thoracochaeta (brachystoma, zosterae); Trachyopella (s.str.) (coprina, lineafrons).*

Prospiracular process medium to very long (P/P = 0.5-1.5:1):

> *Coproica (pusio, vagans); Elachisoma aterrima; Halidayina spinipennis; Opalimosina (s.g Pappiella) liliputana; O. (s.str.) (mirabilis); Pullimosina (heteroneura, moesta, pullula); Spelobia (Bifronsina) bifrons; S.(s.str.) (*all known puparia including *rufilabris); Spinilimosina brevicostata; Telomerina (flavipes); Terrilimosina (racovitzai); Trachyopella (Nudopella) leucoptera.*

Anal spiracles

The taxonomic importance of these structures has been largely overlooked. Although the clear differences between the forms found in the three subfamilies has been long recognised, in the Limosininae they appear to have been ignored. It will be clear from the descriptions given below that they provide very promising characters.

Lateral muscle scars

The grooves along the sides of sphaerocerid puparia have been used as features of taxonomic importance but their utility in this regard is highly dubious as they result from differentials in cuticular tensions during pupariation. The parallel dorsal muscle scars on the caudal segment are similarly unlikely to be of major taxonomic significance.

Ventral ambulatory welts

These appear to be remarkably uniform throughout the family, consisting of a median row of 12-20 large rounded spicules with 3-5 rows of minute serrations before and 2-5 rows behind; laterally the large median spicules may diminish in size and the serrations increase so that all spicules become more nearly uniform in size (see fig. 10b,c).

Key to subfamilies   The key in Okely requires some amendment as follows.

1. Anal spiracles on dorsal surface of caudal segment and hence invisible from ventral view (fig. 2a,3a,4a); anal spiracular slits encircling the scar which is central (fig. 4b) or inferior (fig. 2a,3a). Prospiracular process stellate (fig. 3a) or dendriform (fig. 2a)..*Sphaerocerinae*

- Anal spiracles on posterior surface of caudal segment, so visible from ventral and dorsal view...2

2. Anal spiracle large, usually barely exserted, the peritreme usually in contact with the posterior face of caudal segment (fig. 1a); anal spiracular slits convergent upon median scar (fig. 1b). Prospiracular processes very short dendriform, stellate or palmate (fig. 1c), never elongate..*Copromyzinae*

- Anal spiracles usually on tubercles exserted from posterior surface of caudal segment (figs. 5-14); respiratory slits peripheral, scar median. Prospiracular horns often very elongate, with lateral papillae (figs. 9a, 10), but sometimes stellate (fig. 13b) or palmate (fig.11a) ....*Limosininae*

Copromyzinae

The puparia of this family are surprisingly little known considering the extreme abundance of many of the species and the fact that our largest sphaerocerids belong here. *Alloborborus* is undescribed in the puparial state and only one *Borborillus* (i.e *sordidus* (Zett.)) is known. It is not yet possible to distinguish the described puparia of *Copromyza, Crumomyia* or *Lotophila*. The anal spiracles may sometimes appear to be slightly exserted (c.f *C. pedestris*) but their large size and convergent slits are diagnostic.

Copromyza (s.str.) similis (fig. 1) typifies the known puparia found in this subfamily. Prospiracular process palmate or very short dendriform with 5 to 7 dark lobes. Ventral ambulatory welts usually indiscernible apart from the row of large spicules. Intersegmental margins, dorsally and laterally with a conspicuous series of cuticular knots which, on the sides delimit the pleural sclerites. Anal spiracular plates large with very conspicuous convergent slits. Length, puparia 3.60-4.38mm (n=9); adults 3.12-3.78mm (n=9); A/P = .86. [Material studied, 6 puparia *ex* cow dung, Bentley Common, Doncaster (England), em. April 1974 and May 1976 (PS); 3 puparia *ex* dung Salterforth, Yorks., (England), em. 2 April 1949 (A. Brindle, coll. Manchester Museum). Many puparia from archaeological excavations at Hen Domen, Montgomery (Wales), Tuquoy, Westray (Orkney) and Stóraborg (Iceland) also examined, but these probably include *C. (s.str.) equina*.]

Dimensions given in the literature for puparia of other copromyzines are:

Copromyza (s.str.) equina, 3.5-3.8mm (n = 6, Goddard)
C. stercoraria, 3.64mm (n = 1, Goddard)
C. fimetaria, 3.3mm (Okely)
Crumomyia (s.str.) nigra, 4.5mm (Okely)
C. notabilis, 3.4mm (Goddard, *sub nom. glacialis*)

C. *(Apterina) pedestris*, 3.5mm (Deeming & Knutson, 1966)
Ferrar (1987) figures the third instar larva, showing details of anal spiracles and
cephalopharyngeal skeleton, of *Borborillus sordidus*.

Sphaerocerinae

The described sphaerocerine puparia (i.e *Ischiolepta pusilla* and *scabricula*, and
Sphaerocera curvipes and *monilis*) are unlikely to be confused with those of the other
subfamilies. The unusual position of the anal spiracles, on the dorsal surface of the caudal
segment, with their central or inferior scar and the arrangement of their slits (when visible)
are characteristic of this subfamily. Prospiracular processes often of aberrant form (figs.
2a,3a). *S. curvipes* is the largest species, exceeding 3mm in length, shiny black in colour
with small, stellate 8-lobed prospiracular processes. *I. scabricula* is the smallest at about
1.8mm. Okely separates *S. monilis* and *I. pusilla* on the number, colour and shape of
prospiracular processes. In *I. pusilla* the form is of an aberrant stellate type and the lobes
(up to 5) are remarkably broad, leaf-like and pale in colour (fig. 3a). Okely's figure of *I.
scabricula* shows that this structure is similar in that species. In stark contrast are the
processes seen in *S. monilis* and *I. denticulata* (fig. 2a) which are truly dendriform with
long stout black spiniform papillae.

The details for the specimens figured here are as follows:
> *Ischiolepta denticulata* (fig. 2), Length, puparium 2.20mm; adult 1.85mm *ex* old cow-
> dung, Bentley Common, Doncaster (England) em. May 1976 (PS)
> *I. pusilla* (fig. 3), Length, puparium 2.22mm; adult 1.95mm Victoria Park,
> Manchester (England), em. 10 June 1924 (L.W. Grensted; Manchester Museum)
> *Sphaerocera curvipes* (fig. 4), Length, puparia 3.36-3.85mm (n = 7) (Goddard); adults
> 3.05-4.20mm (n = 9) [Material studied, 7 incomplete puparia from Tuquoy excavation
> on Westray (Orkney).]

Limosininae

The puparia of six genera are unknown (i.e *Gigalimosina, Kimosina, Opacifrons,
Philocoprella, Paralimosina* and *Puncticorpus*). Goddard and Okely emphasised the
taxonomic significance of the prospiracular processes and the P/P ratios, but unfortunately
their descriptions and figures gave little information on the anal spiracles. In all species
examined by the author however, and in the better published figures, the slits appear to be
peripheral, the median one lying parallel with the edge of the peritreme. Furthermore, the
slits are often on raised bosses, separated from each other by deep fissures. In *Spelobia*
these bosses are peculiarly angulate giving a very distinctive uneven hoof-like silhouette to
the spiracular plate (fig. 9b).

Most authors have commented upon the whitish or very pale colour of some limosinine
puparia. This is particularly the case in *Pullimosina* (perhaps all species), but is also noted
by Okely in *Coproica pusio* and *Spelobia (Bifronsina) bifrons*.

In the treatment below dimensions for adults are mostly from Roháček.

Genus *Apteromyia* Vimmer

Okely and Rohácek figure the puparium of the single species *A. claviventris*, pointing out that the figure in Richards (1930) was drawn from a damaged specimen. Prospiracular processes elongate dendriform (P/P = 0.3:1) with 4 short lobes. Anal spiracles on short, thick tubercles, their slits on low rounded protuberances and apparently peripheral. Ventral ambulatory welts with usual transverse row of large rounded spicules, preceded and succeeded by 3 rows of much smaller ones. Length, puparium (not stated by Okely); adults (male) 1.49-2.08mm (n = 171), (female) 1.47-2.50mm (n = 157).

Genus *Chaetopodella* Duda

Rohácek figures details of all three larval instars and the prospiracular horns and anal spiracles of the mature larva of the single species *C. scutellaris,* but the puparium remains undescribed. Prospiracular horns short dendriform with 9 lobes. Anal spiracles with the typical peripheral alignment of the slits. Length of adults (male) 1.43-1.85mm (n = 243), (female) 1.51-1.87mm (n = 380).

Genus *Coproica* Rondani

Okely figures the puparia of two species (i.e. *C. hirtula* and *pusio*), whilst Goddard figures *C. vagans*. Anal spiracular slits clearly peripheral but the species differ in the length of the prospiracular horns (see below). Also, Okely says that whilst *C. hirtula* is black, *pusio* is white. Goddard does not give the colour of *C. vagans.*

    P/P = over 1:1. Length 2.1mm *C. pusio* (= *pseudolugubris* (Duda))
    P/P = c.0.5:1. Length 2.4-2.62mm *C. vagans*
    P/P = c. 0.25:1. Length 1.5-1.75mm *C. hirtula.*

Ferrar gives spiracular details of *C. lugubris*; prospiracular horns long dendriform with 12 close-set lobes and anal spiracular slits again peripheral. P/P not calculable from his figure.

Genus *Elachisoma* Rondani

Okely figures *E. aterrima* stating that it is very like *Halidayina spinipennis* but smaller. Prospiracular horns extremely long (P/P = c. 1.5:1) with 7 short pale papillae. Length, puparium 1.6mm (Okely); adults 0.6-1.2mm (Rohácek).

Genus *Halidayina* Duda

According to Okely this differs from the previous one only in the larger size. His figures suggest a very strong resemblance to *Spelobia s. str.* with a P/P about 1:1 and anal spiracles similarly exserted. Length, puparium 1.95mm (Okely); adults (male) 1.01-1.28mm (n = 982), (female) 1.03-1.63mm (n = 1252).

Genus *Herniosina* Roháček

H. bequaerti, the only species, is one of the larger limosinines. Prospiracular process subpalmate with 6 lobes; anal spiracles rather inflated and situated on broad tubercles (fig. 5). Length, puparia 2.54-3.51mm (n = 14) (Goddard gives 3mm); adults (male) 2.26-2.72mm (n = 32); (female) 2.22-3.05mm (n = 34). [Material studied - 13 puparia, Stóraborg farm excavation (Iceland); 1 puparium Buiston Crannog excavation, Kilmarnock (Scotland). Males were dissected from unhatched puparia from both sites.]

Genus *Leptocera* Olivier

Four species are known in the puparial state (i.e *L. (s. str.) caenosa, fontinalis* and *oldenbergi*, and *L. (Rachispoda) fuscipennis*. In *L. fontinalis* (fig. 6), which is a rather large species, prospiracular lobes extremely short, simple (?palmate), with very short lobes; anal spiracles shiny black, abruptly contracted below peritremes but swollen basally and situated on prominent, widely separated tubercles. Length, puparia 3.19-3.78mm (n = 18) (Okely gives 3-3.3mm); adults 2.40-3.48mm (n = 4). [Material studied - 8 puparia 4 Bessastaðir and Stóraborg excavations (Iceland); 7 puparia from Tuquoy, Westray (Orkney); 3 puparia Papa Stour (Shetland).]

L. oldenbergi is according to Okely smaller than *fontinalis* with similarly extremely short prospiracular processes. Length 2.85mm. Ferrar figures *L. (Rachispoda) fuscipennis*, again showing very short prospiracular horns.

Genus *Limosina* Macquart

L. silvatica, the only species, reaches a rather larger size than any other limosinine. Prospiracular horns very short, subpalmate with 7 lobes. Goddard says that the anal spiracular discs are flattened and directed inwards. Length, puparia 3.42-3.82mm (n = 5, Goddard); adults (male) 2.86-3.61mm (n = 144); (female) 3.02-3.73mm (n = 157). [Material examined, 9 incomplete puparia from Tuquoy, Westray (Orkney); 4 from Bessastaðir (Iceland); 1 from Stóraborg (Iceland).]

> NB. *Gigalimosina flaviceps* is only slightly smaller than *silvatica* so should have a large puparium. Length, adults 2.66-3.50mm (n = 236).

Genus *Minilimosina* Roháček

The only species known in the puparial stage is *M. (s. str.) fungicola*, in which the prospiracular processes are very small, palmate, and 3-lobed. Anal spiracles minute, on distinct though short tubercles. Length, puparia 1.68-1.86mm (n = 3) (Goddard gives 1.8mm); adults (male) 1.03-1.35mm (n = 93); (female) 1.14-1.61mm (n = 113). [Material studied, 3 puparia from Tuquoy excavation, Westray (Orkney) tentatively referred to this species on the form of the female spermathecae and cerci.]

16

Genus *Opalimosina* Roháček

Puparia of two species are known although Okely's description of *O (s. str.) mirabilis* is based on a deformed specimen and there is clearly some mistake with the dimensions given. $P/P = c.0.6:1$ with up to 4 elongate lobes. It appears likely that the species is extremely similar to the next one. Length, puparium "2.9mm" (Okely); adults (male) 1.04-1.45mm (n = 142); (female) 1.05-1.65mm (n = 127).

O. (Pappiella) liliputana (fig. 7) has elongate dendriform prospiracular horns curved backwards, with 6 long pale lobes; $P/P = c.$ 0.5:1. Anal spiracles noticeably slender triangular in dorsal view, on long, distally narrowed tubercles (very similar to *Telomerina flavipes* but slits relatively smaller). Length, puparia 2.16-2.40mm (n = 48); adults (male) 1.23-1.58mm (n = 83), (female) 1.34-1.81mm (n = 102). [Material studied, 48 puparia, including unhatched males showing genital characters perfectly, Tuquoy excavation, Westray (Orkney).]

Genus *Pteremis* Rondani

The puparium of *P. fenestralis* is figured and described by Okely. Prospiracular horns palmate, with up to 3 lobes. Anal spiracles clearly exserted, but more detailed structure indiscernible from his figures. Length, puparium 2.6mm (Okely). Roháček regards this as a subgenus of *Leptocera*.

Genus *Pullimosina* Roháček

The puparia of three species have been described and figured (i.e *P. heteroneura, moesta* and *pullula*). The writer has also examined puparia of *P. heteroneura*. Okely says puparia of *heteroneura* are white, a fact which my experience confirms, whilst in *moesta* they are pale yellow. Goddard gives the colour of *heteroneura* as light yellowish brown, but possibly some discolouration may emanate from their environment. In all three species the prospiracular processes are elongate dendriform (P/P up to 0.6:1). Goddard's figure for *heteroneura* differs from mine (fig. 8) in the degree of exsertion of the anal spiracles but the disparity is inconclusive. Roháček gives electroscan photographs of the anal spiracles of *pullula*; here the slits appear to be on slightly raised prominences and peripherally arranged. Okely details his laboratory rearing of *pullula*, stressing the parthenogenesis found in this species. Lengths for the three species are as follows.

P. heteroneura, puparia, 1.56-1.92mm (n = 75)(Goddard gives 2-2.1mm, n = 8); adults (male) 0.95-1.44mm (n = 220), (female) 1.04-1.56mm (n = 252). [Material studied, 75 puparia, some containing male adults, from excavation at Tuquoy, Westray (Orkney).]

P. moesta, puparia, 2.1mm (Okely); adults (male) 1.14-1.52mm (n = 137), (female) 1.26-1.87mm (n = 155).

P. pullula, puparia, 2.0mm (Okely); adults (male) 1.11-1.23mm (n = 2), (female) 1.07-1.71mm (n = 294).

Genus *Spelobia* Spuler

Puparia of 9 species are known, the most aberrant being *S. (Bifronsina) bifrons*, the smallest member of the genus and the only one in the subgenus. In this species the puparium is white (Okely). The dimensions for this species are given below.

Puparia of *Spelobia s.str.* are exceedingly similar and probably indistinguishable on external characters. In all known puparia the prospiracular horns are elongate dendriform with a P/P ratio about 1:1 (except *S. pseudosetaria* at 0.6:1 (Richards) and *parapusio* at 0.8:1 (Roháček); all have conspicuous lateral translucent papillae. Anal spiracles strongly exserted, on conspicuous basal tubercles. Figure 9 shows the puparium of *S. rufilabris* and attention is drawn to the peculiar shape of the anal spiracles in which the slits are arranged on sharply raised bosses separated by very deep fissures. *Spelobia (s.str.) luteilabris* has an identical anal spiracle and the electroscan photograph of *S. parapusio* in Roháček shows the same structure. It is impossible to conclude anything from the figures in Okely and Goddard in this feature but it is most likely that all members of this subgenus will be identical in the form of the anal spiracles. Dimensions for members of the genus are as follows.

> *S. (Bifronsina) bifrons*, puparia 1.6mm (Okely); adults (male) 1.07-1.26mm (n = 51), (female) 1.19-1.56mm (n = 81)
>
> *S. (s.str.) clunipes*, puparia 2.16-2.55mm (Goddard and Okely *sub nom. crassimana* and *manicata*); adults (male) 1.51-2.58mm (n = 1007), (female) 1.59-2.50mm (n = 1136)
>
> *S. luteilabris*, puparia 2.58(PS)-2.6mm(Okely); adults (male) 1.55-2.08mm (n = 115), (female) 1.59-2.30mm (n = 140). [Material studied, 1 puparium with unhatched male adult, Tuquoy excavations, Westray (Orkney).]
>
> *S. palmata*, puparium 2.66mm (Goddard); adults (male) 1.70-2.18mm (n = 122), (female) 1.69-2.62mm (n = 146)
>
> *S. parapusio*, puparia 2.2mm (Okely); adults (male) 1.67-1.81mm (n = 2), (female) 1.58-2.22mm (n = 259). A parthenogenetic species.
>
> *S. pseudonivalis*, puparia 2.6mm (Okely); adults (male) 1.98-2.78mm (n = 7), (female) 1.82-2.58mm (n = 17)
>
> *S. rufilabris*, puparia 1.92-2.40mm (n = 959); adults (male) 1.50-1.79mm (n = 25), (female) 1.70-2.06mm (n = 21). [Material studied, 959 puparia, many with unhatched male adults, Tuquoy excavation, Westray (Orkney)]. NB. It is highly likely that some of the hatched puparia from Tuquoy belonged to *S. luteilabris* although in such localities the present species appears much commoner. Some wings from the same site were more like *S. clunipes* in the broad alula so puparia of that species too may have been present.
>
> *S. talparum*, puparia 2.35mm (Goddard); adults (male) 1.52-2.10mm (n = 112); (female) 1.61-2.24mm (n = 215)

Genus *Spinilimosina* Roháček

Ferrar figures the prospiracular horns of *S. rufifrons* (Duda), showing them to be elongate dendriform (P/P = 1.5:1).

Genus *Telomerina* Rohácek

The puparium of *T. flavipes* (fig. 10) is very like that of *Opalimosina liliputana* but of a rather larger average size and with anal spiracular slits relatively larger. Length, puparia 1.74-2.88mm (n = 1536); adults (male) 1.15-1.43mm (n = 32), (female) 1.31-1.67mm (n = 54). [Material studied, 1119 puparia from various farmstead sites in the Western Settlement at the head of Godthaabsfjord (West Greenland); 28 puparia from Stóraborg excavation and 13 from that at Bessastaðir (Iceland); 360 puparia from Pluscarden Priory, Nairn (Scotland); 1 puparium from Hen Domen, Montgomery (Wales); 6 puparia from Buiston Crannog, Kilmarnock (Scotland); 3 from "Barrel Latrine", Worcester (England); 4 from Taunton excavation, Somerset (England). Unhatched males were dissected from puparia from all of the above sites]

NB. This fly appears to have been the commonest limosinine eusynanthrope of the Viking settlements in Iceland and probably the only one to reach West Greenland. The species is unknown in Greenland today (Henrikson, 1937) and it presumably shared the demise of the early nordic settlers who took it there from Iceland.

Genus *Terrilimosina* Rohácek

The puparium of *T. racovitzai* is figured here (fig. 11) for the first time and no other species has been described in the literature. Prospiracular processes very short palmate with 3 lobes (fig. 11a). Anal spiracles bulbous basally and constricted below peritreme (fig. 11a,b,c), shiny black in colour, on short broad tubercles. Length of puparia 2.19-2.68mm (n = 43); adults (male) 1.35-1.79mm (n = 26), (female) 1.63-2.22mm (n = 41). [Material studied, 43 puparia, 3 containing unhatched males, Pluscarden Priory, Nairn (Scotland).]

Genus *Thoracochaeta* Duda

Puparia of two British species have been described and figured and are treated here. Confusion between them is unlikely due to their great disparity in size and morphology. *T. brachystoma* (fig. 12)) is a very small species with simple bilobed prospiracular processes (fig. 12b); anal spiracles on rather long processes which are directed outwards distally. *T. zosterae* is much larger and has been figured by many authors (eg. Richards 1930, Egglishaw 1961, Pitkin 1988, Smith 1989, Belshaw 1989 etc.), being a very familiar and easily recognised inhabitant of littoral wrack beds. The integument is thick and often opaque blackish in colour whilst the long outwardly directed anal spiracular processes and generally flattened form with "crimped margins" give a highly distinctive appearance (fig. 13a,b). Prospiracular processes stellate with up to 12 radially arranged lobes (fig. 13b). Anal spiracular slits peripheral (fig. 13d). Dimensions are as follows.

T. brachystoma, puparia 1.73-2.17mm (n = 17); adults 1.32-1.68mm (n = 3).[Material studied, 17 puparia, some with unhatched adults, collected from decaying seaweed on foreshore at Howbeg, South Uist (Scotland).]

NB. According to Tenorio (in Ferrar, *op. cit.*) the larvae of the two species dealt with here are very alike but in this one there are 6 prospiracular lobes and in the next one 9.

T. zosterae, puparia 3.02-4.2mm (n = 362); adults (male) 1.74-2.40mm (n = 10); (female) 2.04-2.94mm (n = 5). [Material studied, 27 puparia from rotting seaweed on Howbeg foreshore, South Uist (Scotland); 27 from Tuquoy excavation, Westray (Orkney); 302 from Taunton excavation, Somerset (England); 4 from "Barrel Latrine" excavation, Worcester (England); 2 from Bessastaðir palace excavation (Iceland).]

NB. Despite the highly distinctive appearance of the puparium of this fly it has been the cause of much confusion in an archaeological context. Belshaw (*op. cit.*) noted that records of the Urinal fly *Teichomyza fusca* Macquart from archaeological sites in Britain had proved to belong to *T. zosterae*. This discovery has provoked considerable consternation amongst historians. Why was this fly, which is only known to breed in seaweed, so common around human habitations in medieval England ? Had there been a widespread trade in seaweed throughout the country, or has the biology of the fly undergone some major change ? Pitkin draws attention to modern inland records of this fly, but these are very rare and probably the result of casual importations.

Genus *Trachyopella* Duda

Descriptions of the puparia of three species occur in the literature and one of these is here figured (fig. 14). Okely figures and describes *T. (Nudopella) leucoptera* in which the prospiracular horns are elongate dendriform (P/P = *c*.0.6:1), with 4 pale lobes. Anal spiracles on very long, broad-based processes, similar to *T. zosterae* in relative length. Length 2.1mm (Okely).

The other two described puparia belong to *Trachyopella s.str.* Like the previous one they are translucent, pale yellowish brown. In *T. lineafrons* according to Okely the prospiracular processes are very small, palmate with up to 4 lobes, whilst the anal spiracles are strongly exserted on large tubercles. Tenorio (in Ferrar, *op. cit.*) showed that the larval mouth-hooks are strongly serrate; an unique feature amongst known sphaerocerids and usually regarded as indicating a phytophagous mode of life. Length 1.8mm (Okely).

Assuming the reliability of Okely's figure for the last species, *T. coprina* differs very strikingly in the absence of anal spiracular tubercles, for here the spiracles are hardly exserted at all (fig. 14). Goddard's figure for this species agrees perfectly with specimens seen by the present writer in this regard, but he states that the prospiracular processes are only 3 lobed. The number clearly varies and often reaches 6 (fig. 14), arranged in a stellate fashion. Length of puparia 1.32-1.74mm (n = 9313). [Material studied, 9313 puparia, many containing adults (both sexes), Tuquoy excavation, Westray (Orkney).]

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A Guide to the Rearing of Shoot Flies

John C. Deeming

Introduction

The shoot flies are those species of cyclorrhaphous Diptera having larvae that develop in the shoots of grasses and more rarely sedges. Some are significant pests of cereal crops. Those Old World families containing shoot fly species are:-

1) Muscidae: Phaoniinae: Atherigonini: genus *Atherigona*
2) Anthomyiidae: some *Phorbia* and *Delia* spp.
3) Diopsidae: *Diopsis* spp. especially, but other genera also
4) Ephydridae: *Hydrellia* spp.
5) Opomyzidae: *Opomyza* and *Geomyza* spp.
6) Chloropidae: numerous genera

Certain other families, such as Lonchaeidae and Milichiidae, have species which can be reared from shoots. However, their larvae are saprophytic, utilising damaged shoots without being responsible for initial attack. The same is so of some chloropid genera, but within that family are species which will utilise shoots already damaged, but can also initiate damage. The frit fly of oats, *Oscinella frit* (Linnaeus), has an autumn generation which can develop in the forming seeds of oats when these are at the "milky dough" stage of development in much the same way as do the larvae of the related chloropid genus *Dicraeus*.

The best introductory literature to shoot flies and their biology is that of Balachowsky & Mesnil (1935: 910-1075) and Nye (1958). These papers include neither the genus *Atherigona* nor the Diopsidae, for which see Skidmore (1985) and Deschamps (1957) respectively. The most exhaustive treatment of *Hydrellia* and its biology is that of the Nearctic species by Deonier (1971), but Collin (1966) gives keys to and excellent male genitalia figures of most of the Palaearctic species.

We have now reached a stage of knowledge where most of the species which attack cereal crops are known, as also, but to a lesser extent, are their alternative wild hostplants. It is necessary that we continue to collect adults in order to recognise undescribed sexes of known species, to appreciate the degree of morphological variation that exists within species and to form a more complete picture of their distribution, both spatial and temporal. However, immature stages are only described for a small fraction of shoot fly species, and these descriptions are all too often incomplete. Nye (*op. cit.*:450-455) has shown that larvae of what we call *Oscinella frit* are morphologically distinct between oats and two other grass species, indicating a possible species complex. Also, as it is in the Agromyzidae, a study of the larval or puparial morphology may well be of use in the separation of genera and the placing of species within these. Lastly, by rearing from pupae of known identity, one can establish firm relationships between hosts and hymenopterous parasites.

Having over a period of many years received large quantities of reared shoot fly material from a variety of sources, I have very often been disappointed by its condition and the information that accompanied it. This has been due either to the entomologist undertaking

such investigations being ignorant of correct procedures or of his passing the responsibility for rearing to assistants who had little idea of how it should be done. For this reason I saw the need for a simple guide that could be used by anyone.

The mechanism and recognition of shoot fly attack

Young shoots, whether they be shoots, seedlings or tillers, are more prone to attack than are older shoots. Although there is evidence of ovovipary in two species of the chloropid genus *Pachylophus* (Moyal 1982: 298; Spencer 1985: 179), as far as is known shoot fly females deposit eggs onto the leaves of shoots. In *Atherigona* the female first inspects the shoot to determine that no eggs are already there before ovipositing. On hatching, the larva works its way down into the shoot, penetrating the growing point just above the node. Using its mouth-hooks it severs the base of the growing point and then feeds in the decaying substance of the shoot's core. Thus it cannot be said to be truly phytophagous, since it feeds on decaying matter and the microorganisms that develop in it. Sometimes the larva does not succeed in completely severing the growing point, which leads to a deformed and ragged emergence of the shoot. When the severing is complete the central shoot wilts while the outer leaves remain healthy (fig. 1). This condition is known as "dead-heart". Shoot fly damage and that of lepidopterous stem borers can be very similar. Some of the latter lay their eggs on the side of the shoot and the caterpillars, upon hatching, chew into the shoot. When in doubt one can look for these tiny entry holes on the side of the shoot, but their absence is not conclusive evidence that the attack is by shoot flies. Often one can pull out the core of the shoot and inspect its basal part for maggots feeding there. Sometimes one finds both caterpillars and maggots within the same shoots. Shoots that are collected at the first sign of wilt are likely to contain those larvae causing primary damage, whereas those that are strongly discoloured may contain both the causal agent of the damage and a later invasion of saprophytic larvae. Sometimes only the saprophytic larvae are found, that which caused the initial damage either having died or completed its development and vacated the shoot. Dependant upon species and also the condition of the plant and its environment, larvae may pupate in the shoot or vacate it when fully fed. It is interesting that in swamp rice, which is subject to inundation, shoot fly larvae adopt different strategies for survival. *Hydrellia* larvae vacate the shoot and burrow into floating vegetation, where they pupate. The larvae of certain *Pachylophus* species (Deeming 1973: 157), when they come to pupate, plug their anterior spiracles into the aerenchyma of the adjacent living leaf. If the shoot is then submerged the pupae can survive using the plant's air supply. Attack by shoot flies to young seedlings often results in the death of the plant, but older seedlings will produce tillers, which in turn may be attacked. Heavy or prolonged infestation results in plants being stunted and with reduced yield of both seed and vegetative material for animal fodder. Grazing of pasture inspires the development of new shoots and shoot fly populations increase accordingly.

Host plant identification

To identify young grass plants can be very difficult, especially if they are seedlings. Local botanists are often an invaluable source of help in such matters, as often they can recognise immature plants by drawing upon their knowledge of the habitat. When no such help is available it is necessary to take samples of the plant material for future identification. If convenient one can take the whole plant, pot it, and allow it to mature, but when far from

home this is often impossible. Rather than use a host plant name of which one is uncertain, it is better to label the specimens reared as being from a grass of unknown identity. Where shoots or tillers of a mature plant are infested it is wise to take and press a sample of the heads, stems and leaves. If cross-referenced to specimens reared, such herbarium samples can always be checked if doubt is cast upon the identification of the host plant.
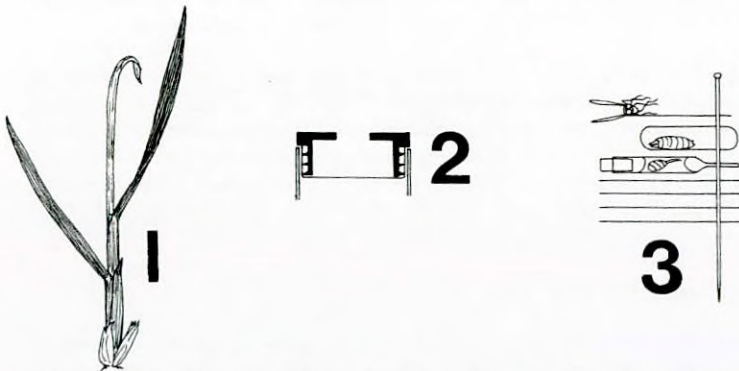
Fig. 1 Wheat seedling exhibiting the condition of "dead heart". Fig.2 Cross section of polythene and cotton ventilation cap on rearing tube Fig. 3 Mounted reared specimen with

Treatment of Infested Shoots

Should adequate material be available in an abundance of infested shoots from the same plant or group of plants at the same time and place, then it is wise to preserve a larval sample. This can be done either by splitting shoots, removing mature larvae and dropping them into boiling water, or by isolating the part of the shoot containing the causal agent of the damage by cutting it off with scissors below the node, trimming off free leaves and plunging the shoots into boiling water. The killing of larvae in boiling water leaves them in a fully extended position, whereby by electron microscopy the highly diagnostic facial mask will be exposed to examination. Once killed, larvae can be preserved in 70% alcohol. If many wet shoots are packed together in a container of alcohol, it must be borne in mind that the concentration of alcohol will be considerably diminished, necessitating a change of alcohol. The remainder of the shoots can be similarly trimmed and put individually into tubes to await the emergence of the flies. Care must be taken in collecting and trimming not to crush between the fingers the part of the shoot containing the larva or pupa. Tubes used should not be closed by using a bung of cotton lint or cotton wool, since emerging adults will attempt to burrow through the material and die so entangled in it that their removal from it in an undamaged state is impossible. Glass tubes of dimensions 3" x 1" with push-in (not push-on) polythene caps are ideal. To allow for ventilation and to prevent condensation from forming, these caps can have a hole punched in their centre using cork-borers and a disc of thin cotton material trapped between tube and cap (fig. 2). Such tubes allow for diffusion of the gases of decomposition. In very dry conditions water lost by evaporation from the shoot can be replaced by simply dropping water onto the cotton material using a pipette. In the same way, flies that emerge can be killed by placing a drop or two of ethyl acetate or carbon tetrachloride onto the cotton. However, flies that emerge should be kept alive in their tubes for 3-4 days if possible to allow them to mature. Those that die shortly

after emergence tend to shrivel upon drying; so they should be transferred to alcohol or glycerine. Feeding of the flies can be done by placing a drop or two of honey solution onto the cotton.

In order to prevent adult flies in alcohol from becoming rigid some persons add lactophenol or other chemicals to the alcohol. This causes darkening of specimens. Since colour characters are often diagnostic, any change of colour can lead to misidentification.

Once the emerged flies are dead, the procedure to follow depends on the quantity of material to be dealt with and the time available. Ideally the flies can be mounted straight away, or the tubes frozen until mounting can be done. Alternatively, whatever emerges, be it flies or parasitic Hymenoptera, can be transferred into gelatin capsules with a small loose bung of cellulose wadding or soft toilet tissue to prevent it being shaken up and, once the tubes and shoots are thoroughly dry, the capsules returned to the individual tubes from which they came.

The collection of puparia from shoots

Some larvae, especially those of *Hydrellia* and *Diopsis*, tend to vacate shoots when ready to pupate. In tubes having cotton-covered caps *Diopsis* larvae will invariably pupate on the cotton and firmly attach to it by adhesive. It is then necessary, once the flies have emerged, to cut out the piece of cotton to which the puparium is attached, as any attempt to remove it will result in it being broken. When puparia are found with their spiracles implanted in a leaf, these can only be removed undamaged after maceration in KOH or NaOH solution. Initially the section of leaf bearing the puparium must be cut out. Puparia in shoots must be carefully removed, bearing in mind that the two anterior caps (one in *Atherigona*) may have become separated from it. These caps bear the anterior spiracles and cephalopharyngeal skeleton and so are of great diagnostic value. When shoots are still damp and pliable the leaves can be stripped away from the outside in turn to expose the damaged core. In large shoots it may be necessary to strip back a single leaf in longitudinal sections. When the puparium is discovered it is removed with its caps in place or detached to a gelatin capsule. If the puparium is filthy it can be cleaned in alcohol, the decayed plant fragments being teased off its surface with a fine artist's paint brush. If it is to be put into a gelatin capsule it must first be thoroughly dried, otherwise it may adhere to it. Alternatively it may be put into a Durham or van Doesburg vial containing glycerine. Dry shoots of a delicate nature may be rendered pliable by "relaxing" them overnight in a saturated atmosphere. To attempt to dissect them when thoroughly dry can result in puparia (or bits of them) being flicked away on account of the springy nature of the leaves. If one has to dissect shoots in such dry conditions it is as well to do so on a large flat white surface where any flicked bits can be seen and retrieved. Heavy shoots, such as those of bamboo, may need to be soaked in warm water for some hours before being able to be manipulated. The disadvantage of soaking shoots is that pupal caps tend to float off. If more than a single puparium is present in the same shoot it can be impossible to determine which caps belong to which puparium. If more than a single fly emerges from a shoot it is unwise, unless there is considerable difference in size, to attribute a particular fly to a particular puparium. In such cases it is better to keep both flies mounted on a single stage and both puparia with them in a single capsule. At a later date it may be possible to identify the puparia once the identities of the adults are known.

The mounting of shoot flies and their puparia

When, as sometimes happens, a particularly substantial shoot has leaked the products of decomposition into the tube in which it has been put, emerging flies can become entrapped in the ooze and stick to the tube. To secure these specimens undamaged they must be soaked off the glass and transferred to alcohol. If cleaning them without damaging chaetotaxy appears impossible, then they are best kept in alcohol or glycerine. Should they be suitable for dry-mounting, it should be borne in mind that they will have died while still in a teneral state and will need to be hardened off before drying. This is done by passing them through absolute alcohol to ethyl acetate, where they should remain for 24 hours before being dried. Emphasis must be placed on the alcohol used being absolute. Unless dehydration is complete the ethyl acetate will not permeate the specimen. Dry adults are best mounted (fig. 3) on points of stiff card, on their sides and affixed to the point by adhesive that is soluble in water, alcohol or acetone. Care should be taken to confine the area of adhesion to the thoracic pleura. Any head or appendage that breaks off may be stuck to a rectangle of card pinned beneath the point. This will allow easy removal of the abdomen for maceration and the examination of diagnostic postabdominal structures. Any head or appendage that breaks off may be stuck to a rectangle of card pinned beneath the point Full length (continental) steel pins are advised for mounts, as these have the height to accomodate the specimen on its point, the rectangle bearing detatched parts, the gelatin capsule containing the puparium, the van Doesburg or Durham vial containing the abdomen in glycerine and also the various data, determination and museum acession labels. The mounting pin should pass through the overlap of both halves of the gelatin capsule. Pupae that fail to emerge are useful in that they may be able to be identified, especially if they contain pharate adults. Such pupae may need to be dissected onto a series of slides and permanently mounted, in which case the slides should be labelled "slide 1 of 6", "slide 2 of 6" etc. in addition to other data.

Data presentation

When conducting field trials involving large numbers of samples it is usual to keep a log book in which each sample is identified by a code number and information is added to it as it becomes available. Such information might include columns for (a) locality, (b) plant species, (c) cultivar, (d) degree of maturity (might be indicated by sowing date), (e) date of collection, (f) date of pupation (if known), (g) date of emergence of adult, (h) notes (to include multiple larvae present in shoot and whether or not of obviously different species), (i) identification and (j) whether specimen retained for reference or not. Such notes are very useful to those making them and analysing information. Those persons should think of their reference collection specimens as being the evidence supporting their research and label their specimens accordingly. The code numbers used mean nothing to anyone other than the person doing the research, especially if the log book has been lost or discarded. Thus a fully documented specimen might be labelled "N. NIGERIA: Zaria, Samaru, em. 14.iii.1979, ex irrigated "Maiwa" millet shoot coll. 10.iii., pup. ?, with 2 ex. *Oscinella* sp., M. Chori". This quantity of information can be distributed amongst a number of labels if necessary. Labels to be placed in fluid are best written in pencil and for those on dry specimens in indian ink. Alternatively a printing machine with 5 point type can be used or a word-processor and printer that can reduce to that size. Labels should never be written with a

ballpoint pen, as its ink will run in alcohol or if subjected to the fumes of benzene-based fumigants.

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New rearing records of fungus gnats (Diptera: Mycetophilidae and allied families)

Peter J. Chandler

Many batches of fungus gnats reared over the past twenty years have been referred to me by Mr. R.E. Evans. As he is an experienced mycologist, these records have the advantage of precise determination of the fungus concerned and most of the fungi involved had not previously been the subject of rearing studies. Although the commoner species of gnat have predominated, altogether 59 species have been reared, 51 of them from named fungi, the others from rotten wood or decayed fungi. Earlier rearings were from sites in Warwickshire but from 1975 onwards most were from Norfolk. Several species reared mainly in East Anglia by Mr. P. Withers are also included.

Some of the more notable rearings have already been published : *Keroplatus testaceus* Dalman, from cocoons on rotten wood (Chandler, 1977b and in press), *Anatella flavomaculata* Edwards and *Mycetophila lunata* Meigen (Chandler, 1977a) and *Sciophila nonnisilva* Hutson (Chandler, 1987). The three latter and five other species had not been reared previously. Stubbs & Chandler (1978) also incorporated some records in the list of food plants provided. Other rearings such as those of *Brachycampta* species have been useful in providing associated females where these were not previously distinguished.

Here full details are given of the species reared on one or a few occasions; only the fungus hosts are listed for other species. New host records additional to those listed (or summarised in the case of the less often reared species) by Stubbs & Chandler are marked * except in the case of genera known to be attacked by polyphagous species.

Bolitophilidae

Bolitophila cinerea Meigen - **Panaeolus campanulatus* (Bull.) Quél., several MF, 26.vii.88, Thompson Common, Norfolk

B. hybrida (Meigen) - **Lyophyllum decastes* (Fr.) Sing., M emerged 14.x.80, collected ix., Frosts Wood, Norfolk

B. pseudohybrida Landrock - *Clitocybe cerussata* (Fr.) Kummer, F, xi.76, Warren Wood, Honingham, Norfolk; * *Physisporinus sanguinolentus* (Alb & Schw.: Fr.) Pilát, F, v.77, Honingham Fen, Norfolk

B. saundersi (Curtis) - * *Panaeolus campanulatus* (Bull.) Quél., M, reared with *B. cinerea*

Diadocidiidae

Diadocidia ferruginosa (Meigen) - on *Peniophora* species, M, ix.74, Wellesbourne Wood, Warwicks.

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Ditomyiidae

Symmerus annulatus (Meigen) - **Hypoxylon rubiginosum* (Pers.) Fr., 2.xi.85, Honingham Fen, Norfolk (this fungus grows on tree bark and previous rearing records of this species have been from decaying wood).

Ditomyia fasciata (Meigen) - *Bjerkandera adusta* (Willd.) Karst., x.84, Narford Hall, Norfolk; **Hydnellum spongiosipes* (Peck) Pouzar, ix.81, emerged x.81, Felthorpe Woods, Norfolk

Keroplatidae

Orfelia unicolor (Staeger) - ex pupa suspended in threads on *Trametes versicolor* (L.) Pil., emerged 4.vi.73, Bubbenhall Wood, Warwicks. (first rearing record).

Mycetophilidae

Mycomya marginata (Meigen) - *Trametes versicolor* (L.) Pil., **Naucoria* species, *Tremella mesenterica* Retz. ex Hock.

M. winnertzi (Dziedzicki) - *Phellinus ferruginosus* (Schrad. ex Fr.) Pat., x.75, Edgbaston N.R., Warwicks; indet. resupinate fungus, x.76, Foxley Wood, Norfolk

Leptomorphus walkeri Curtis - pink resupinate fungus, probably **Corticium roseum* Pers., 7.vi.85, Honingham Fen, Norfolk

Sciophila buxtoni Freeman - [**Laetiporus sulphureus* (Fr.) Murr., M emerged 23.ix.86, West Harling Common, Norfolk (P. Withers)]

S. nonnisilva Hutson - **Auricularia auricula-judae* (L.) Schroet., emerged 14.x.80, collected 11.ix, Lenwade Pits, Norfolk (first rearing record).

S. lutea Macquart - **Morchella elata* Fr., 5M, 5F, 25.v.91, Alderford Common, Norfolk; **M. esculenta* (L.) Pers., 2M, 17.v.84, Honingham Fen, Norfolk; **Russula cyanoxantha* (Sch.) Fr., M, 28.vii.80, Wells, Norfolk; **R. fellea* (Fr.) Fr., F, emerged 30.viii.78, collected 10.viii., Warren Wood, Honingham, Norfolk. (Also from *Gymnopilus junonius* (Fr.) P.D. Orton, 30.x-7.xi.88 by P. Withers)

Grzegorzekia collaris (Meigen) - surface of damp rotten wood or often suspended in web, communal, but individual webs, pupate on wood without cocoon, emerged iv-v and 18.viii;69, Oversley Wood, Warwicks. (this record was the basis of the comments on biology by Hutson, Ackland & Kidd, 1980)

Leia bimaculata (Meigen) - [**Russula krombholzii* Shaffer, F, collected 26.ix.86, emerged 23.x.86, Wheatfen Broad, Norfolk (P. Withers)]

Docosia gilvipes (Haliday) - **Morchella elata* Fr., **Tremella mesenterica* Retz. ex Hock., **Peziza vesiculosa* Bull., **Bolbitius vitellinus* (Pers.) Fr. [also reared from stipe of *Amanita muscaria* (L.) Hook. by P. Withers]

Anatella flavomaculata Edwards - *Cudoniella aciculare* (Bull.) Schroet., on rotten oak stump, 2M, 1F, Oversley Wood, Warwicks. (only known rearing record)

Tarnania fenestralis (Meigen) - **Melanoleuca grammopodia* (Bull.) Pat., 5M, 16.x.88, East Wretham, Norfolk; **Lactarius quietus* (Fr.) Fr., emerged 13.i.90, collected 21.xi.89, Foxley Wood, Norfolk

Synplasta excogitata (Dziedzicki) - **Pleurotus dryinus* (Pers.) Kummer, emerged 25.xi., collected 19.x.80, Daffy Wood, Norfolk; **Mycoacia uda* (Fr.) Donk, MF emerged 8.xi., collected 27.x.80, Warren Wood, Norfolk (first rearing records)

Allodiopsis domestica (Meigen) - *Calocybe gambosa* (Fr.) Donk, M, 2F, 30.iv.75, Bannams Wood, Warwicks.; *Marasmius oreades* (Bolt) Fr., MF, 1.x.84, Belstead House, Ipswich, Suffolk; 2M 3F, emerged 6-12.viii.88, East Wretham Heath, Norfolk; **Clitocybe odora* (Bull.) Kumm., F, viii.88, Felthorpe Woods, Norfolk

A. rustica (Edwards) - **Hygrophoropsis aurantiaca* (Wulf.) Maire, emerged 22.x, collected ix.80, Ringland Wood, Norfolk; **Clitocybe nebularis* (Batsch) Kumm., 15.x.84, Lenwade Pits, Norfolk

Pseudexechia trisignata (Edwards) - **Naucoria pseudoamarescens* (K. & R.) K. & R., F, iii.90, Holt Country Park, Norfolk [also reared from **Galerina mutabilis* (Schaeff. ex Fr.) P.D. Orton 23.x-3.xi.89, West Harling Common, Norfolk by P. Withers] (not previously reared)

P. trivittata (Staeger) - **Panaeolus sphinctrinus* (Fr.) Quél., MF, emerged vii.88, Denver, Norfolk; **P. campanulatus* (Bull.) Quél., 5M, emerged 26.vii.88, Thompson Common, Norfolk; **Psathyrella candolleana* (Fr.) Maire, 4M, 11F, 17.viii.88, emerged 28.viii.88, Foulden Common, Norfolk

Allodia (sensu stricto) lugens (Wiedemann) - **Psathyrella microrhiza* (Lasch) Fr., **P. candolleana* (Fr.) Maire, **Panaeolus papillionaceus* (Bull. ex Fr.) Quél., *Mycena galericulata* (Scop.) S.F. Gray (twice), **Lepiota rhacodes* (Vitt.) Sing., **Meripilus giganteus* (Pers.) Karst.

A. (sensu stricto) ornaticollis (Meigen) - *Inocybe geophylla* (Bull.) Karst., *I. griseolilacina* J. Lange, *I. lucifuga* Kummer, *I. asterospora* Quél., *I. rimosa* (Bull.) Kumm., *Hygrocybe nigrescens* (Quél.) Kühn, **Agrocybe semiorbicularis* (Bull.) Fayod, **Melanoleuca melaleuca* (Pers. ex Fr.), **Tricholoma leucocephalum* (Fr.) Quél., **Pluteus cervinus* (Batsch) Fayod, *Collybia butyracea* (Bull.) Kummer, *Hebeloma crustuliniforme* (Bull.) Quél., **Panaeolus papillionaceus* (Bull. ex Fr.) Quél., **P. campanulatus* (Bull. ex Fr.) Quél., **Laccaria laccata* (Scop.) Bk. & Br., *Russula nitida* (Pers.) Fr., *R. fragilis* (Pers.) Fr., *R. pectinata* Fr., *Suillus granulatus* (L.) O. Kuntze, *Xerocomus subtomentosus* (Bull.) Quél.

A. (sensu stricto) truncata Edwards - *Inocybe lacera* (Fr.) Kummer, 3M, 4F, collected 1.vii.88, emerged 13.vii.88, Holt Country Park, Norfolk

A. (Brachycampta) barbata Lundström - *Peziza vesiculosa* Bull., 6M, 4F, emerged viii.87, Quidenham, Norfolk

A. (Brachycampta) czernyi Landrock - *Cortinarius semisanguineus* (Fr.) Gill., collected 16.ix.87, 3M,1F, emerged ix.87, Corsican and Scots pine plantation, Holkham N.R., Norfolk (first rearing record: only 6 other British records known to me, all from Scottish Highlands)

A. (Brachycampta) grata (Meigen) - *Pluteus cervinus* (Batsch) Fayod (3 rearings, 1 with *A. ornaticollis*); *P. salicinus* (Pers.) Kummer; *Xerocomus chrysenteron* (Bull.) Quél.

A. (Brachycampta) silvatica Landrock - *Aleuria aurantia* (Pers.) Fuckel, 19M,11F, emerged 3.vii.88, Beetley, Norfolk; *Peziza varia* (Hedw.) Fr., M, 2F, emerged 14.viii.80, collected 23.vii.80, Warren Wood, Norfolk

Exechia bicincta (Staeger) - *Pluteus salicinus* (Pers.) Kummer, 2M, 2F, emerged 3.ix.88, collected 24.viii., Pentney Common, Norfolk

E. dorsalis (Staeger) - *Hebeloma strophosum* (Fr.) Sacc., *Collybia maculata* (Alb. & Schw.) Kummer [also reared from *Inocybe* species, *Tricholoma columbetta* (Fr.) Kummer and *Amanita muscaria* (L.) Hook. by P. Withers]

E. fusca (Meigen) - *Collybia dryophila* (Bull.) Kummer, *C. confluens* (Pers.) Kummer, *Naucoria pseudoamarescens* (K. & R.) K. & R., *Psathyrella* species, *Conocybe tenera* (Schaeff.) Fayod, *Inocybe cervicolor* (Pers.) Quél., *Psathyrella lachrymabunda* (Bull.) Moser, *Mycena pura* (Pers.) Kummer, *Panaeolus sphinctrinus* (Fr.) Quél., *Pluteus cervinus* (Batsch) Fayod, *Lepiota clypeolaria* (Bull.) Kummer, *L. alba* (Bres.) Sacc., *Lactarius tabidus* Fr., *Stropharia aurantiaca* (Cooke) P.D. Orton, *S. cyanea* (Bolt. ex Secr.) Tuomikoski, *Russula ionochlora* Romagn., *R. cyanoxantha* (Schaeff.) Fr., *R. grisea* (Pers. ex Secr.) Fr., *R. fellea* (Fr.) Fr., *R. alutacea* (Pers.) Fr.

E. separata Lundström - *Chroogomphus rutilus* (Sch.) O.K. Miller, 2M, 3F, emerged 12.xi.80, collected 30.x., Welborne, Norfolk [also from *Suillus bovinus* (L.) O. Kuntze, M, 4F, 20.ix.86, West Harling Woods, Norfolk by P. Withers]

E. spinuligera Lundström - *Panaeolus sphinctrinus* (Fr.) Quél., M, emerged vii.88, Denver, Norfolk; M emerged 12.vi.90, collected 1.vi.90, Rush Meadow, Dereham, Norfolk

Cordyla brevicornis (Staeger) - *Russula ionochlora* Romagn., MF, emerged 4.ix.88, collected 26.viii., Honingham, Norfolk; old *Boletus* species, emerged 21.ix.80, Bawdeswell Heath, Norfolk. [also from *Amanita muscaria* (L.) Hook. stipe by P. Withers]

C. fusca Meigen - [*Russula krombholzii* Shaffer, 3M, emerged 23.x.86, Wheatfen Broad, Norfolk (P. Withers)]

Trichonta terminalis (Walker) - *Peniophora incarnata* (Fr.) Karst., M 10F, 3.iii.89, Hockering Wood, Norfolk

T. vitta (Meigen) - *Schizophora paradoxa* (Schrad.: Fr.) Donk., iii.73, Dumble Wood, Warwicks

Phronia braueri Dziedzicki - *Pluteus salicinus* (Pers.) Kummer, 2M F, emerged 3.vii.80, Lenwade Pits, Norfolk

Dynatosoma fuscicorne (Meigen) - *Daedalopsis confragosa* (Bolt) Schröt., 2M 4F, iv.84, Lenwade Pits, Norfolk [also from *Grifola frondosa* (Dicks.) Gray, 6M, 4F, collected 26.ix.86, emerged 21.x.86, Wheatfen Broad, Norfolk by P. Withers]

Mycetophila britannica Lastovka & Kidd - *Entoloma clypeatum* (L.) Kummer, *Russula fellea* (Fr.) Fr. (3 times)

M. cingulum Meigen - [*Polyporus squamosus* FR., many MF, 27.vii.85, near Jervaulx Abbey, N. Yorks., by P. Withers]. This species has been considered specific to *P. squamosus*, but I observed it assembling in numbers on *Grifola frondosa* (Dicks.) Gray at Padley Gorge, Derbyshire, 11.x.91.

M. fraterna Winnertz - *Physisporinus vitreus* (Pers. : Fr.) Donk, MF, emerged 2.xi.80, collected 30.x., Warren Wood, Norfolk (first rearing)

M. fungorum (DeGeer) - *Entoloma clypeatum* (L.) Kummer, *Armillaria mellea* (Vahl.) Kummer, *Inocybe godeyi* Gill., *Russula claroflava* Grove, *R. vesca* Fr., *R. pectinata* Fr., *R. alutacea* (Pers.) Fr. [also reared from *Suillus bovinus* (L.) O. Kuntze and *Chamaemyces fracidus* (Fr.) Donk by P. Withers]

M. sp. near fungorum (a common species recently recognised as distinct from *fungorum*) - *Xerocomus chrysenteron* (Bull.) Quél.

M. fungorum group (not determined to species) - from the following genera: *Lyophyllum, Russula, Pluteus, Boletus, Leccinum, *Stropharia, *Psathyrella, Amanita, Lactarius, Hebeloma, *Lepiota, *Exidia* and *Clavaria*

M. ichneumonea Say - *Lactarius tabidus* Fr., MF, 20.ix.88, Hockering Wood, Norfolk; *Mycena pelianthina* (Fr.) Quél., 2M, 3F, 17.vi.87, emerged 29.vi; rotten *Pleurotus* species, 12.vii.88, Abington, Cambs. [also from * *Gymnopilus junonius* (Fr.) P.D. Orton by P. Withers]

M. luctuosa Meigen - decaying agaric on beech trunk, x.83, West Harling Woods, Norfolk; *Lactarius rufus* (Scop.) Fr., 14.ix.87, MF emerged 19.ix.87, Holkham N.R., Norfolk; *Sebacina incrustans* (Pers. ex Fr.) Tul., 17.vi.85, Santon Downham, Norfolk

M. lunata Meigen - **Coniophora puteana* (Schum.) Karst., M 3F, emerged 19.xi.75, Dumble Wood, Warwicks. (first rearing record)

M. marginata Winnertz - *Trametes versicolor* (L.) Pil., *Fistulina hepatica* (Schaeff.), **Russula vesca* Fr., *Pleurotus ostreatus* (Jacq.) Kumm., **Hebeloma crustuliniforme* (Bull.) Quél.

M. ocellus Walker - *Coniophora puteana* (Schum.) Karst., **Bjerkandera adusta* (Willd.) Karst., **Stereum sanguinolentum* (Alb. & Schw.) Fr., **Mycoacia uda* (Fr.) Donk, wood bearing **Hypocrea rufa* (Pers.) Fr., **Chroogomphus rutilus* (Schaeff.) O.K. Miller, **Psathyrella candolleana* (Fr.) Maire, **Amanita rubescens* Pers.

M. ornata Stephens - **Chondrostereum purpureum* (Pers.) Pouzar, **Polyporus squamosus* (Huds.) Fr., *Pleurotus* species

M. signatoides Dziedzicki - deformed *Lactarius* species, probably **quietus* (Fr.) Fr., **Paxillus atromentosus* (Batsch.) Fr., **Boletus luridus* Schaeff.

M. tridentata Lundström - [**Laetiporus sulphureus* (Bull.) Murr., numerous MF, emerged 23.ix onwards, collected 20.ix.86, West Harling Common, Norfolk and *Inonotus cuticularis* (Bull. ex Fr.) Karst., 16.iv.89, Hickling Broad, Norfolk (P. Withers).I have also reared large numbers, emerging i-ii.92, from *L. sulphureus* collected at Windsor Great Park, Berks., 28.xii.91; cocoons were embedded within the dry fungus and adults had evidently already developed within some of these cocoons]

Platurocypta testata (Edwards) - *Lycogala epidendrum* L., *Tubifera ferruginosa* (Batsch.) J. Gmel.

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Two undescribed larvae of the genus *Jungiella* Vaillant (Diptera, Psychodidae) with a key to the known larvae

Rüdiger Wagner

Introduction

Jungiella Vaillant is one of the easiest to recognise genera of palaearctic Psychodidae. Adult males are as well characterised as the larvae. The basic features of males apparently are found in the genitalia. The dorsal apodemes of the gonocoxites form a "dorsal bridge". A Y-shaped, movable furca connects this "dorsal bridge" and the aedeagus apodeme. The apodeme is dorsoventrally flattened and also Y-shaped. Often, two movable and specifically shaped appendages are articulated to this apodeme. During opening and closing of the aedeagus, furca, apodeme and appendages change their positions and therefore may appear in a different shape or seemingly disappear when viewed dorsoventrally.

The small adults are mainly caught in the vicinity of streams (alder brook) and springs in early summer. Some taxa, however, apparently prefer moist places in damp peaty biotopes. In this special environment, the water is standing or flowing only slowly. The presence of decaying organic material, preferably packs of alder and willow leaves is necessary in localities where the *Jungiella* larvae are assumed to live. Hundreds of larvae may be extracted from half a square metre of organic material layer, coexisting with larvae of *Peripsychoda* Enderlein and *Panimerus* Eaton. Extracted *Jungiella* larvae can be separated from other genera by naked eye. They are comparatively small, dark and the setae are remarkably short, so that the larvae appear "naked" (i.e without bristles) compared with

other "setose" taxa from the same environment. (e.g *Panimerus, Satchelliella, Clytocerus*) but still black.

The basic larval feature is the reduction of the size of most tergites. This seems to be an autapomorphy of the genus, and not simply a reaction to the ecological conditions in the larval environment. Several bristles are no longer placed on sclerotised plates (tergites/sternites), but stand in a certain position solely on the body surface. Furthermore, most setae are reduced in size or completely absent. However, the numerous sclerotised small hooks on the body surface may help to keep the larvae in place. All species known so far have a one year life cycle. Concerning the environmental conditions, eggs probably can survive the dry summer season, with little or no moisture in the substratum.

Summarising the above, *Jungiella* Vaillant is one of the easiest of telmatoscopoid Psychodid genera to recognise. Although all such genera require revision, *Jungiella* species are very characteristic as larvae, as well as adults, and both are clearly distinguished from all other European telmatoscopoid genera. Evidently there is no need to regard this remarkably diverse and widespread genus as a subgenus or species group of *Telmatoscopus* as proposed by Duckhouse (1978) - it is clearly well defined as a genus of its own.

Methods

Larvae were extracted from the wet substratum by drying leaf packets over a pan of water. Single extracted larvae were kept individually in small petri dishes until the emergence of the adult. Larval and pupal skin and adult were put together into individual vials with ethanol(80%). Slides were prepared clearing skins and adults (without wings) in hot KOH (10%), transferring them into acetic acid, then into a mixture of clove oil/acetic acid and finally into pure clove oil. All parts (larval and pupal skin, head thorax, wings, genitalia) were arranged on a slide and mounted in Canada balsam. Species distinction under a microscope was then easy. Drawings were made with a drawing mirror on a Leitz Dialux 20EB.

Descriptions of larvae

Jungiella danica (Nielsen), IVth instar larva (Figs 1-4)

Head narrow, nearly as long as wide. Mesotergite of the prothorax with a complete set of setae. Seta 4 is approximately 3 times longer than setae 1-3, seta 7 twice as long as setae 1-3. Metatergite with setae 14-19, and seta 17, in particular, longer than setae 14 and 15. Front spiraculum comparatively short. Mesothorax with mesotergal plate less than half as wide/long as the metatergites of segment 1. Seta 1 small, on the mesotergal plate, seta 2 small as well, situated at a distance equal to a longitudinal diameter laterally of the plate. Seta 3 missing, setae 4-7 at the lateral margin. Setae of metathorax as those of the mesothorax.

Abdomen with protergites missing on all segments. Mesotergites small with simple seta 2 at fronto-lateral margin. Seta 3 simple, lateral of the mesotergite at a distance of more than 3 diameters of a mesotergite width. Seta 4 feathery, near the laterodorsal margin of the annulus. Metatergal plate more than twice as long and broad as the mesotergal plate. Setae
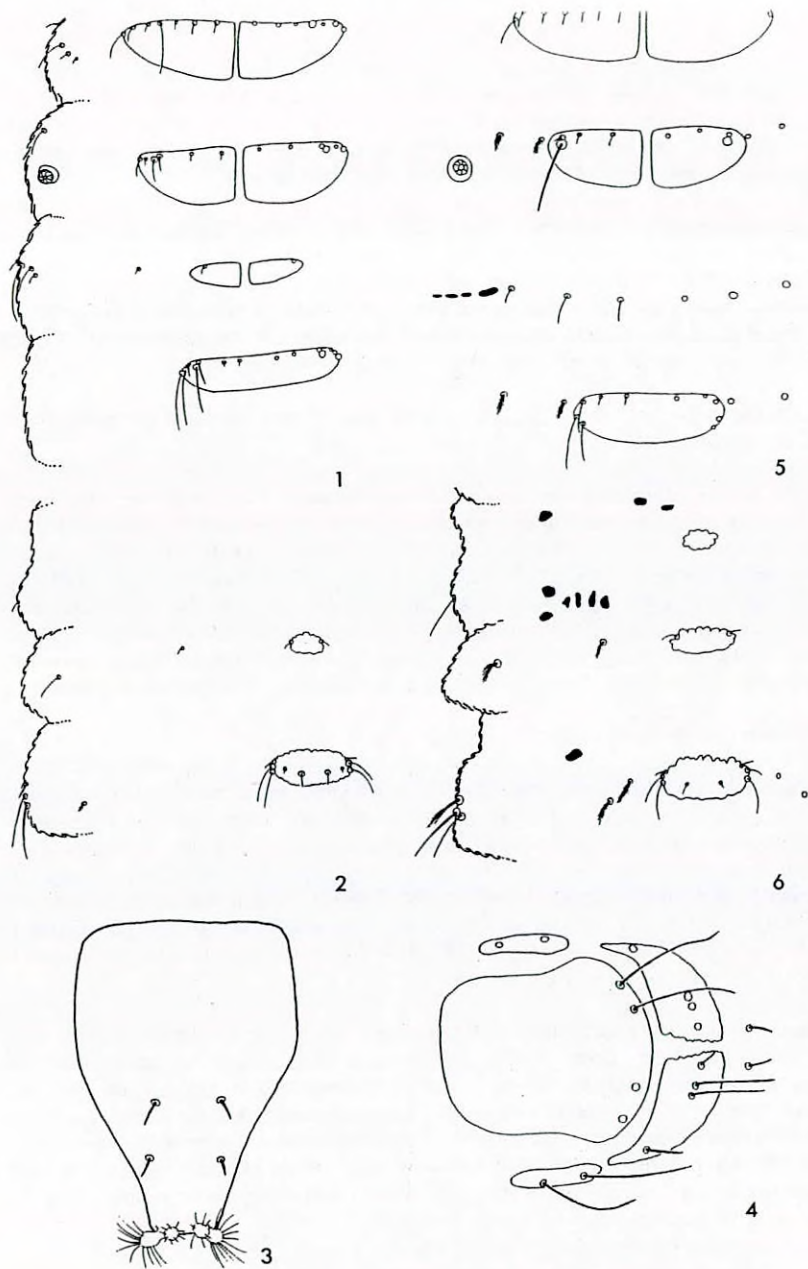
Fig 1-4. *Jungiella danica* (Nielsen), IVth instar larva. **1** pro- and mesothorax. **2** V[th] abdominal segment. **3** siphonal plate. **4** preanal, lateroanal and adanal plates with setae.

Fig 5-6. *Jungiella interna* (Nielsen), IVth instar larva. **5** pro- and mesothorax. **6** V[th] abdominal segment. (Fig 4 ventral view, others dorsal view)

7-11 on the plate, simple, 7th stronger and twice as long as 8th. Setae 9-11 along the frontolateral margin of the metatergite, 9th only half the length of the following setae. Seta 12 small, feathery, near the lateral margin of the annulus. Setae 13-15 at the lateral margin of the annulus, simple, seta 13 half the length of the following setae.

Siphonal plate approximately 2/3 of the total length of the siphonal segment, with 2 pairs of setae. Lateroanal plates elongate, with 2 setae. Adanal plates with 4 setae, one near the lateral margin, 3 near the inner margin, both inner setae 3 times longer than the laterals. Preanal plate with 2 pairs of setae, approximately 3/4 of the longitudinal diameter of the plate. There are 2 single setae situated between the sipho and the adanal plate. No seta remarkably long or hook-shaped. Total length of larva 3.9-4.4mm.

Relations: The larva of *J. danica* is distinguished from all other larvae of the genus by the lack of abdominal tergites.

Ecology: Larvae of *J. danica* were collected from in between leaf packs in an alder brook. The entire biotope is kept wet throughout the year by springs, opening at the slope of a hill into the small alder brook. Adults have been bred from larvae to confirm the determination. Larvae of other congeneric taxa found belonged to *Jungiella soleata* (Walker), which was more abundant in this locality. Larvae of the following other Psychodidae were found to be present: *Panimerus albifacies* Tonnoir, *Peripsychoda auriculata* (Curtis), *Ulomyia fuliginosa* (Meigen), *Satchelliella trivialis* (Eaton), *Sycorax silacea* (Curtis) and *S. feuerborni* Jung. The *Sycorax* larvae preferred the moss carpets between the alder roots.

Jungiella interna (Nielsen) IVth instar larva (Figs 5-6)

Head slightly longer than wide. Prothorax with a complete set of setae. Setae 1-7 on the mesotergite, seta 7 at the lateral tip of the tergite, slightly longer than the other setae. Metatergite with setae 14-17 on the tergite all simple, but seta 17 definitely stronger and 4-5 times longer than the others. Setae 18-19 feathery, very short, close to the lateral margin of the tergite. Spiracular opening short, circular. Mesothorax without mesotergites, setae 1-3 simple, not located on a sclerotised tergite. Metatergite half the size of the mesotergite of prothorax. Setae 10-14 on the metatergite, 12th-14th 2-3 times longer than the 10th or 11th. Setae 15-16 feathery, lateral of the metatergite.

Abdomen with small circular protergites. Mesotergites small with simple seta 2 at the front margin. Seta 3 feathery, lateral from the mesotergite at a distance of approximately a mesotergite diameter. Seta 4 feathery, near the laterodorsal margin of the annulus. Metatergal plate twice as wide as long, and 1.5 times broader than the mesotergal plate. Setae 7-10 on the plate simple; setae 8-10 along the fronto-lateral margin of the metatergite, 7th and 8th only half the length of the following setae. Setae 11 and 12 small, feathery, both near the lateral margin of the metatergite. Setae 13-15 along the lateral margin of the annulus, seta 13 feathery, slightly shorter than setae 14 and 15. Setae 1 and 18 of every pedichaet are very long and distally bent like a hook.

Siphonal plate ovoid with normal set of setae. There is a pair of remarkably long setae, distally shaped like a hook, situated on each of the adanal plates, very similar to those described for *Jungiella valachica* (Vaillant). Total length of larva 3.8-4.0 mm.

Relations: The larva of *J. interna* is morphologically very similar to that of *J. valachica*, especially by virtue of the hook-shaped setae of the adanal plates. However, the larvae of both species may be distinguished by the localisation of setae 11 and 12 of the abdominal segments, situated very close to the metatergite in *J. valachica* but at a distance of at least the diameter of the metatergite in *J. interna*.

Ecology: Larvae of *J. interna* were collected by Dr. M. Droste (Marburg) from in between leaf packs in the Schweinsberger Moor, near Marburg, Germany. Adults have been bred to confirm the determination, hatching 2 June 1980. Larvae of other congeneric taxa found belonged to *J. soleata* (Walker), which were normally more abundant in this environment, along with several species of *Psychoda*.

Key to the described larvae of the genus Jungiella Vaillant

1. Protergites of abdominal segments strongly reduced or missing.........*J. danica* (Nielsen)
-   Protergites of abdominal segments a distinctive plate...2

2. Mesotergites of meso- and metathorax missing..3
-   Mesotergites of meso- and metathorax present..4

3. Setae 12 and 13 of the abdominal segments close to the metatergite (less than a longitudinal diameter of a tergite)..*J. interna* (Nielsen)
-   Setae 12 and 13 of the abdominal segments at a distance of more than a metatergite diameter lateral of the metatergite.......................................*J. valachica* (Vaillant)

4. Mesotergites of meso- and metathorax very small and circular....*J. longicornis* (Tonnoir)
-   Mesotergites of meso- and metathorax distinct plates...5

5. Mesotergites of meso- and metathorax with only 5 pairs of setae.....*J. parvula* (Vaillant)
-   Mesotergites of meso- and metathorax with 7 pairs of setae................................6

6. Setae of meso- and metathorax lateral from the plate at a distance of less than diameter of plate...*J. soleata* (Walker)
-   Setae of meso- and metathorax lateral from the plate at a distance of at least 1.5 times diameter of plate...7

7. Setae 6 and 7 of the prothorax one behind the other...................*J. acuminata* (Szabó)
-   Setae 6 and 7 of the prothorax one beside the other......................*J. revelica* Vaillant

Summary

The hitherto unknown larvae of *Jungiella danica* (Nielsen) and *Jungiella interna* (Nielsen) are described and figured. A key for the known larvae of the genus is provided. The genus *Jungiella* Vaillant is well differentiated as adults and as larvae, and should be treated as a distinct genus.

Acknowledgement

I sincerely thank Dr. M. Droste for the larvae, and P. Withers for linguistic help and helpful comments on the manuscript.

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EDITORIAL POSTSCRIPT

A rare but distinct pleasure for an editor is to be sent manuscripts for consideration which are of such quality as to require minimal intervention. All of the papers presented here are of this nature - I feel fraudulent in being named as Guest Editor, but delighted to have had such a flawless introduction to the job. Any criticisms should be attributed to the fact that this is issue number 13 !

I confess to not having a particular liking for larvae - for me, they refuse to pupate or they turn into the exact opposite of what you were expecting. I have, however, spent a great deal of time with people who do care about preadult stages of flies, and they have progressively convinced me that this is an area of study both underrated and immensely neglected. The contents of this issue are thus without apology.

I wish I had the patience of Dr. Goldie-Smith, and was as in love with some of my studies as she clearly is with hers. I know I do not have the staying power of Peter Skidmore - anyone who has looked at 15,000 subfossil puparia commands my respect and, I hope, yours too. If there is any justice, this work should achieve classic status rather quickly. John Deeming vents his spleen about inattention to detail when breeding - he is right, readable and there are lessons for all in his pithy presentation. If, like myself, you have ever been tempted to breed flies from fungi, you will appreciate two of the problems this presents. Identifying the flies may well not be easy, but identifying the fungi is well nigh impossible - and you can't have another go tomorrow. (I can assure British dipterists that it is much worse here in France). Peter Chandler has found the perfect partner. No issue of Dipterists Digest should be considered perfect without something on moth flies, so Rüdiger Wagners careful descriptions of psychodid larvae were tailor-made.

Having read this far, and mindful of the back cover looming, I now suggest you go back to page one and read them all over again.

PHIL WITHERS

Provisional atlas of the long-palped craneflies (Diptera: Tipulinae) of Britain and Ireland

by
Alan E Stubbs

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