

**Larval stages of 17 rare and poorly known British hoverflies  
(Diptera: Syrphidae)**

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Third stage larvae of three species of phytophagous (*Portevina maculata*, *Cheilosia albitarsis* and *C. antiqua*), thirteen species of saprophagous (*Callicera aurata*, *Brachyopa bicolor*, *B. insensilis*, *B. pilosa*, *Hammerschmidtia ferruginea*, *Myolepta potens*, *Brachypalpus laphriformis*, *Caliprobola speciosa*, *Criorhina berberina*, *C. floccosa*, *C. ranunculi*, *Pocota personata* and *Xylota tarda*) and one possibly predatory species (*Microdon devius*) of Syrphidae are described. Most of the saprophagous species breed in dead wood and many are European rarities. Nine of the 17 species described are included in the British Red Data Books: 2. Insects (Shirt, 1987). For the larva of each species, recognition features and breeding sites are described.

KEYWORDS: Syrphid, larva, description, breeding site, dead wood.

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**Introduction**

Morphologically and biologically Syrphidae stand out among insect families in having highly diverse larval stages (Metcalf, 1916; Stubbs and Falk, 1983; Vockeroth and Thompson, 1987). Such high levels of diversity are probably only rivalled in the related family, Phoridae (R. H. L. Disney, pers. comm.) and suggest that larvae could be a useful source of characters for systematic analysis.

Consequently, attempts to understand the systematics of Syrphidae need larval stages to be taken into account. This need is supported in a recent study of just one group of syrphid larvae, the predators (Rotheray and Gilbert, 1989). Larval characters showed that predatory species form a distinctive monophyletic taxon within which various morphological and biological trends were identified. However, in many insect families, larval characters are rarely studied.

Despite the desirability of involving larval stages in systematics, their inclusion is often severely limited by lack of knowledge. Even within the British fauna, many species have yet to be reared. Collecting, rearing and describing larvae is therefore an important first step to ensuring that larval characters are available for analysis. In this paper, the third stage larvae of 17 poorly known and rare species are described and comparisons made with other known syrphid larvae. Of these 17 species, larval stages of 11 have been described previously to varying degrees. However almost all previous descriptions lack sufficient detail to make comparisons possible. Thus, they are re-described here. For each species data on breeding sites is also given.

### Materials and methods

Larvae of all 17 species were field-collected. Larvae of *Cheilosia albitarsis* Meigen, were also obtained by rearing from field-collected eggs.

Many of the larvae described here breed in vulnerable habitats such as dead wood. When examining these habitats care was taken to minimise damage. For example, when searching rot-holes the first step was to look for live puparia attached to its sides or in the upper layers of a rot-hole. Such puparia are often firmly attached and, to prevent damage, were removed on surrounding pieces of material. Other measures included replacing contents of rot-holes and the underground parts of stumps after examination. Care was taken to minimise the amount of bark removed on sap runs, fallen branches and dead trees. This was particularly important at sap runs because more extensive accumulations of decaying sap often occur under the bark rather than on its surface.

Live plants were usually examined non-destructively by searching for signs of larval presence such as entry holes, feeding damage, etc. Following examination, uninfested bulbs and rootstocks were replaced in the ground.

When larvae were found, the numbers present were estimated and only a few (usually <10) were retained for study. In most cases it was necessary to confirm identification by rearing and identifying the adult stage. Larvae were reared individually in 75 × 25 cm, corked, glass tubes or in groups of approximately 10 individuals in litre-sized plastic cups about half full of the material in which they were found. Tubes and cups were stored in an outdoor insectary or in a cool, dark cellar. They were checked at weekly intervals and food supplied as necessary until pupariation. Puparia were wrapped in moist tissue paper and placed individually in 75 × 25, corked, glass tubes and checked daily until emergence. Some larvae of each species were preserved. Larvae selected for preservation were those with patches of differentiated cuticle between sensilla one and two on the first abdominal segment. This feature signifies that the larva is close to pupariation and therefore fully developed (Hartley, 1961). For permanent preservation, larvae were fixed by gentle boiling in water for about three minutes and transferred to 70% alcohol in plastic capped tubes. All material is in the collections of the National Museums of Scotland.

Descriptions are based on preserved specimens with many characters checked against living material to minimise errors due to preservation. Few such errors were found. Measurements were made using a measuring eyepiece fixed to a binocular microscope. Body length was measured mid-dorsally from the anterior margin of the prothorax to the tip of the posterior respiratory process or, in larvae with a retractile anal segment, to the base of the third (posterior) pair of lappets. Width is maximum abdominal width excluding lateral projections. Unless otherwise stated, larval terms follow Hartley (1961) and Rotheray (1990). However, the method used to number sensilla differed from Hartley (1961). Sensilla can be used to specify particular sites on the integument because they tend to be uniform in position. Hartley (1961) divided the body into longitudinal regions (dorsal, ventrolateral, etc.) and numbered each sensilla sequentially within each region for each segment. These regions are not always easy to recognize and in this paper, sensilla positions are simply numbered sequentially from the dorsal to the ventral surface for each segment (Fig. 1). Species are presented according to the checklist in Stubbs and Falk (1983).

**Descriptions of third (= final) stage larva**

*Callicera aurata* (Rossi) (= *aenea* (Fabricius) of authors,  
a misidentification, see Speight, 1991)

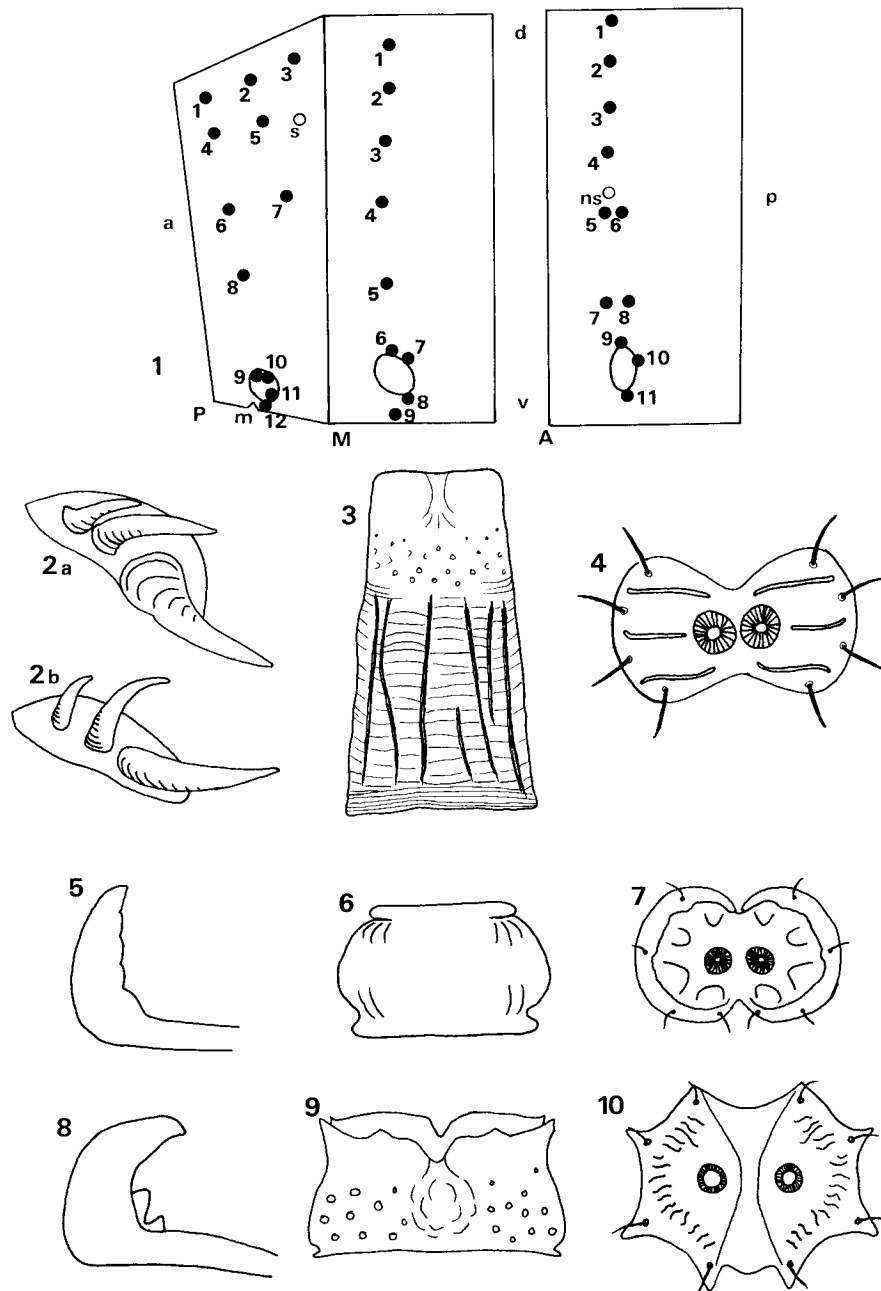
(Figs 2–4)

*Overall appearance.* Larva with internal mouthparts and a short 'tail' bearing a conspicuous pair of fleshy lappets just before the tip, partially fused prolegs and two groups of three or four hooks on a common base just posterior to the anterior spiracles.

*Length.* 20–22 mm; width: 5 mm; subcylindrical in cross-section, truncate anteriorly, tapering posteriorly; mandibles and mandibular lobes internal (mouthparts of the saprophagous type, Roberts (1970)); lateral lips well developed, i.e. in profile they project forward of the anterior part of the prothorax and are delineated by integumental folds from the rest of the prothorax; base of lateral lips with broad setae at base and fine setae at tip; body coated in short (up to 0.06 mm long), mostly backwardly directed pubescence which is shorter (up to 0.01 mm long) on the thorax and the ventral surface except for the anal segment, aggregations of longer setae (up to 0.14 mm long) surrounding sensilla groups 7 and 8; anterior fold of the prothorax with a narrow (<50% of the anterior fold) band of densely-aggregated, backwardly directed, sclerotized spicules which become progressively shorter posteriorly (0.24 mm to 0.04 mm); thorax broader than abdomen and somewhat dorso-ventrally flattened with integumental folds bearing sensilla 4–5 and 6–7 dorsal rather than lateral in position; lateral margins of the thorax with longitudinal furrows; anterior spiracles on the dorsal surface of the prothorax; dorsum of mesothorax rectangular; sensilla 2 of mesothorax posterior and lateral to sensilla 1; two groups of three or rarely four strong black hooks on a common base, each group anterior to mesothoracic sensilla 3 and 4 and posterior to prothoracic fold bearing sensilla 6 and 7 (Fig. 2a); hooks becoming progressively larger towards the outer lateral hook: length of inner hook 0.26 mm, middle hook 0.44 mm, outer hook 0.62 mm; prolegs present on mesothorax and first six abdominal segments; crochets multi-serial, i.e. with up to six rows of progressively smaller crochets from tip to base; each pair of prolegs fused medially; on each proleg crochets arranged in a lateral penellipse, i.e. break in ring of crochets on inner margin; anterior margin of each pair of prolegs with a break in crochets becoming progressively reduced but still present on abdominal segments 1–6; abdominal segment 7 extended dorsally so that, in profile, sensilla 2 and 4 lie posterior to anal opening and sensilla 3 above anal opening; base of anal segment to lappets at tip about twice as long as segment six; posterior respiratory process (prp) (Fig. 3): length: 1.3 mm, width: at base 0.9 mm, at tip 0.62 mm; shiny with faint nodulations just below tip and matt with broad longitudinal folds below to base; tip with three pairs of transverse spiracular slits (Fig. 4).

*Material examined.* Wood Crates, New Forest, Hampshire, 16 March 1990, two larvae in a rot-hole approximately 18 m high in a recently fallen *Fagus*, collected by A. E. Stubbs and bred by GER; 28 March 1990, one larva in a rot-hole about 1.75 m high in a live *Fagus*.

All three *Callicera* species occurring in the British Isles are considered rare (Stubbs and Falk, 1983). *Callicera aurata* = *aenea* (see Speight, 1991) is classified as vulnerable and is known mainly from southern England (Shirt, 1987). Within *Callicera* only the larva of *rufa* Schummel has been described previously (Coe,



Figs. 1-10. Fig. 1: Map showing sensilla group positions on P=prothorax, M=mesothorax and A=abdominal segment 2 of third stage syrphid larva, 1-12=numbered sensilla groups, a=anterior, p=posterior, d=dorsal, v=ventral, m=mouth, s=anterior functional spiracle, ns=nonfunctional spiracle, oval on ventral surface of prothorax with sensilla groups 9-11 shows position of a lateral lip, ovals on other segment maps are prolegs; Fig. 2a: *Callicera aurata*, thoracic hooks, dorsal view; Fig. 2b: *Callicera rufa*, thoracic hooks, dorsal view; Figs 3-4: *Callicera aurata*; Fig. 3: prp, anterior view; Fig. 4: prp, dorsal view; Figs. 5-7: *Portevinia maculata*; Fig. 5: mouth-hooks, lateral view; Fig. 6: prp, anterior view; Fig. 7: prp, dorsal view; Figs 8-10: *Cheilosia albitarsis*; Fig. 8: mouth-hooks, lateral view; Fig. 9: prp, anterior view; Fig. 10: prp, dorsal view.

1938; Zimina, 1986). Both *C. aurata* and *C. rufa* breed in rot-holes as does apparently *Callicera spinolae* Rondani (Zimina, 1986). *Callicera* larvae are very distinctive. They can be recognized by the partially fused prolegs, the position and arrangement of hooks on the thorax and the transverse spiracular slits. These characters can also be used to identify puparia. *C. rufa* and *C. aurata* are separated from each other by the following characters: in *C. aurata* the large, outer hook on the thorax is anterior in relation to the other smaller hooks, whereas in *C. rufa* the outer hook is aligned with the others (Fig. 2); the tip of the prp in *C. aurata* is smooth and faintly nodulate just below the tip but in *C. rufa* this region is nodulate; in *C. rufa* crochets are continuous on the anterior margin of prolegs on abdominal segment 6, in *C. aurata* the crochets are interrupted.

### *Cheilosia albitarsis* Meigen

(Figs 8–10, 45)

*Overall appearance.* Larva with external mouth-hooks; body ends in a flat disc with the prp in its centre; prp with four pairs of apical projections and anal opening transverse (Fig. 45).

*Length.* 8–11 mm; width: 3–4 mm (Fig. 45); subcylindrical, slightly tapering anteriorly and truncate posteriorly; dorsal lip without setae; a large pair of mouth-hooks 0.06 mm long and a pair of smaller hooks (0.03 mm) on the inner margin of the large pair (Fig. 8); mandibular lobes external and sclerotized; lateral lips without setae and weakly developed, i.e. not projecting forward of the anterior part of the prothorax and poorly delineated by integumental folds; body coated in pointed spicules up to 0.02 mm long; anterior fold of prothorax without sclerotized spicules but with a pair of deep, antero-dorsal, longitudinal impressions between folds bearing sensilla 4–5 and 6–7 so that the mid section of the anterior fold projects forward; dorsal plate present consisting of a triangular-shaped, lightly sclerotized region encompassing both folds bearing sensilla pairs 1–3 and extending to posterior margin of the prothorax; mesothorax also bearing a lightly sclerotized region between the first sensilla; antenno-maxillary complex not borne on papillae; dorsal lip with setal fringe; prolegs absent; dorsal part of abdominal segment 7 and dorsal part of anal segment coalesced to form a flat disc at the end of the body; margin of disc with groups of broad spicules and sensilla 1–3 of segment 7 and sensilla 1–6 of anal segment which are not on lappets; anal opening transverse; chaetotaxy: abdominal sensilla 8 absent; prp (Fig. 9): length: 0.32 mm, width: at base 0.6 mm, at tip 0.5 mm; basal third with deep punctures and matt then a deep groove and the apical part of the prp shining red-brown; tip with four pairs of spiny projections and groove separating the two spiracular plates; up to 17 short radially arranged spiracular slits (Fig. 10).

*Material examined.* Newbattle Abbey, Dalkeith, Midlothian, 5 June 1990, five larvae reared from eggs collected on the lower part of stems of *Ranunculus* and fed on *Ranunculus* rootstock; 17 July 1990, three larvae ex rootstock of *Ranunculus* growing in shade.

*C. albitarsis* is a common species in the British Isles (Stubbs and Falk, 1983). The larva of *C. albitarsis* does not seem to have been described previously. It can be separated from other syrphid larvae possessing mouth-hooks in that it has a flat disc with the prp in its centre at the end of the body and the margin of each spiracular plate bearing four spine-like projections. The larva of *Cheilosia variabilis* (Panzer)

has similar spine-like projections but, in this case, three pairs are present and there is no flat disc at the end of the body (Rotheray, 1990).

*Cheilisia antiqua* Meigen

(Figs 11–13)

*Overall appearance.* Larva with external mouth-hooks, body ending in a flat disc with the prp at its ventral margin and the anal opening is transverse.

*Length.* 6–9 mm; width: 2.5–3.5 mm; subcylindrical, slightly tapering anteriorly and truncate posteriorly; four pairs of mouth-hooks—one large (0.08 mm long) anterior pair with two intermediate sized (0.06 mm) pairs behind and a small (0.04 mm) pair on the inner margin of the first large hook (not visible in lateral view) (Fig. 11); mandibular lobes external and sclerotized; dorsal lip coated in fine setae; lateral lips lacking setae and weakly developed, i.e. not projecting forward of the anterior part of the prothorax and poorly delineated by integumental folds; body coated in broad blunt-tipped spicules up to 0.03 mm long, spicules becoming nodulate on abdominal segments 6–8; anterior fold of prothorax without sclerotized spicules but with a pair of deep, antero-dorsal, longitudinal impressions between folds bearing sensilla 4–5 and 6–7 so that the mid section of the anterior fold projects forward; dorsal plate present consisting of a triangular-shaped lightly sclerotized region encompassing both folds bearing sensilla groups 1–3 and extending to posterior margin of the prothorax; antenno-maxillary complex not borne on papillae; prolegs absent; dorsal part of abdominal segment 7 and dorsal part of anal segment coalesced to form a flat disc at the end of the body, sensilla 1 and 2, 3, 4–6 of anal segment on short (up to 0.18 mm) lappets; the prp is sited at the lower margin of this disc; anal opening transverse; sensilla 8 apparently absent; prp (Fig. 12): length: 0.60 mm, width: at base 0.50 mm, at tip 0.30 mm; prp tapering from base to tip; nodulate to just below tip, matt to tip; 3 pairs of spiracular slits (Fig. 13).

*Material examined.* Odiham Common, Hampshire, 20 May 1990, two larvae, one per plant tunnelling down into the rootstock of *Primula* growing in damp, shaded deciduous woodland. Infested plants were easily recognized from the mass of pale brown plant fragments at the tip of the rootstock.

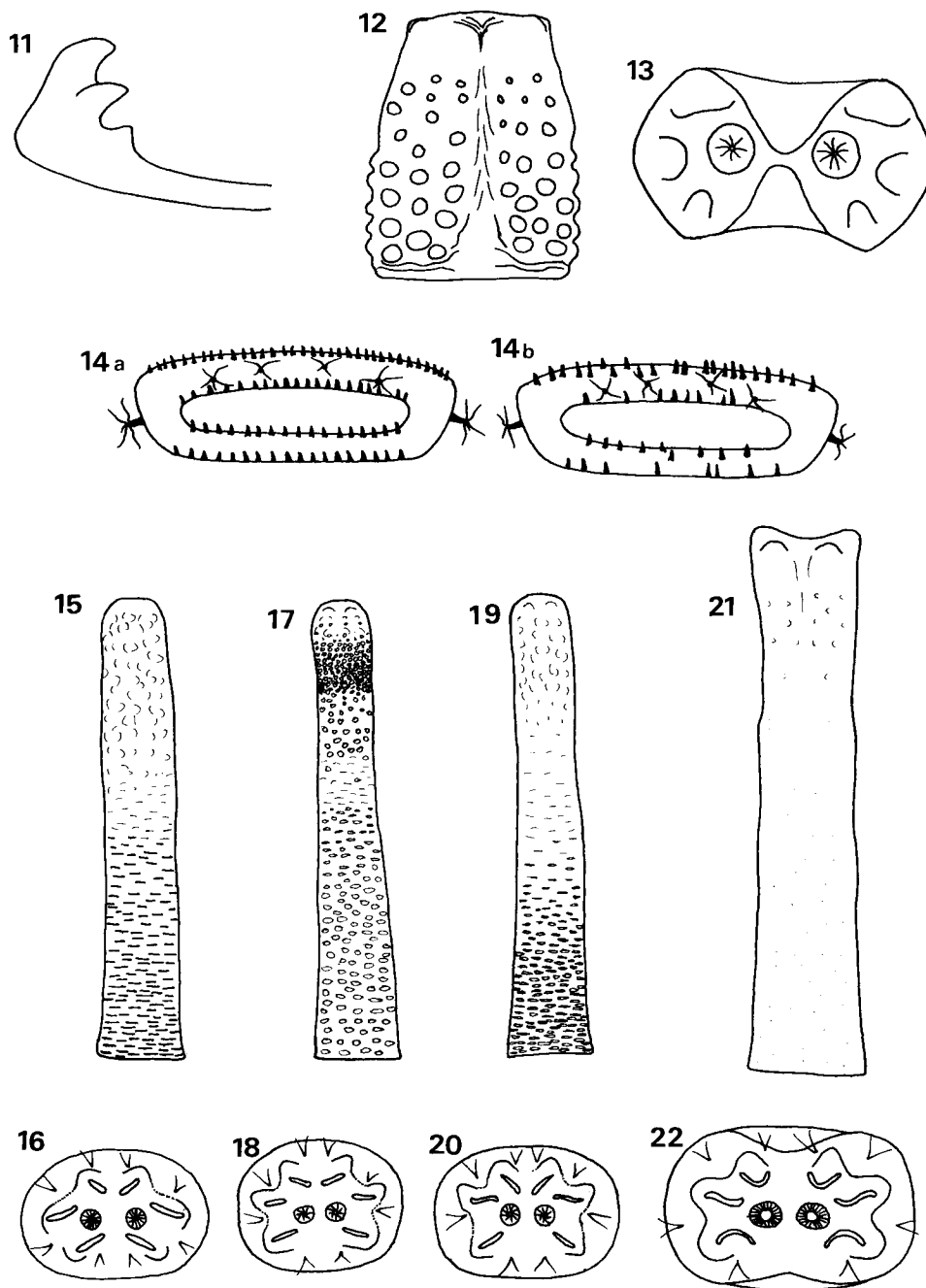
*C. antiqua* is widespread but localized and scarce over most of the British Isles (Stubbs and Falk, 1983). This species is known previously from *Primula* but few descriptive details were given (Carpenter, 1913). The larva of *C. antiqua* can be distinguished from other syrphid larvae possessing mouth-hooks by the flat disc at the end of the body with the prp sited on its ventral margin.

*Portevinia maculata* (Fallén)

(Figs 5–7)

*Overall appearance.* Larva with external mouth-hooks, body ends with a flat disc with the prp at its centre and the anal opening parallel to the longitudinal axis of the body.

*Length.* 9–12 mm; width: 3–4 mm; subcylindrical, slightly tapering anteriorly and truncate posteriorly; one pair of mouth-hooks 0.1 mm long (Fig. 5); mandibular lobes external and sclerotized; dorsal lip without setae; lateral lips without setae



FIGS. 11–22. Figs 11–13: *Cheilosia antiqua*; Fig. 11: mouth-hooks, lateral view; Fig. 12: prp, anterior view; Fig. 13: prp, dorsal view; Fig. 14a: *Brachyopa bicolor*, dorsum of abdominal segment 3; Fig. 14b: *Brachyopa pilosa*, dorsum of abdominal segment 3; Figs 15–16: *Brachyopa bicolor*; Fig. 15: prp, anterior view; Fig. 16: prp, dorsal view; Figs 17–18: *Brachyopa insensilis*; Fig. 17: prp anterior view; Fig. 18: prp, dorsal view; Figs 19–20: *Brachyopa pilosa*; Fig. 19: prp, anterior view; Fig. 20: prp, dorsal view; Figs 21–22: *Hammerschmidia ferruginea*; Fig. 21: prp, anterior view; Fig. 22: prp, dorsal view.

and weakly developed, i.e. not projecting forward of the anterior part of the prothorax and poorly delineated by integumental folds; body coated in blunt-tipped spicules up to 0.01 mm long except for disc at end of abdomen; anterior fold of prothorax without sclerotized spicules but with a pair of conspicuous, anterodorsal, longitudinal impressions between folds bearing sensilla 4–5 and 6–7 so that the mid-section of the anterior fold projects forward; anterior spiracles present; antenno-maxillary complex not borne on papillae; dorsal lip with longitudinal striations and no setae; prolegs absent; dorsal part of abdominal segment 7 and dorsal part of anal segment coalesced to form a flat disc at the end of the body; prp sited in the centre of this disc; disc with blunt-tipped spicules between sensilla on margin of disc except where segment 7 meets anal segment; margin of disc with sensilla groups 1–4 of abdominal segment 7 in dorsal half and ventrally with three sensilla groups bearing sensilla 1 and 2, 3, 4 and 5 (sensilla 6 apparently absent) of anal segment; anal opening parallel to longitudinal axis of the body; chaetotaxy: abdominal segments apparently lacking sensilla 8 and 11; prp (Fig. 6): length: 0.1 mm, width: at base 0.4 mm, at tip 0.36 mm; matt with constriction just below tip; 4 pairs of spiracular slits (Fig. 7).

*Material examined.* Newbattle Abbey, Dalkeith, Midlothian, from deciduous woodland south side of River South Esk: 30 January 1990, four larvae from bulbs of *Allium ursinum* L.; 7 February 1990, three larvae from bulbs of *A. ursinum*.

*P. maculata* is a widespread species in the British Isles (Stubbs and Falk, 1983). The only previous description of the larva of *P. maculata* is by Speight (1986). The larva of *P. maculata* may be distinguished from other syrphid larvae possessing mouth-hooks by the anal opening which is parallel to the longitudinal axis of the body.

### ***Brachyopa bicolor* (Fallén)**

(Figs 14a, 15–16)

*Overall appearance.* A dorso-ventrally flattened larva having internal mouth-parts and a coating of brown blotches and straight rows of transverse setae with a tapering anal segment, a long prp and gradually elongating projections along the lateral margins.

*Length.* 7–9 mm; width: 2.5–3.5 mm; flattened dorso-ventrally (about twice as broad as high), slightly tapering anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; lateral lips well developed (i.e. bulge forward and delineated by integumental folds from the rest of the prothorax); base of lateral lips coated in spicules and tip coated in fine setae; dorsal and lateral margins of thorax and abdomen coated in brown blotches; abdominal segments 1–7 each with four transverse rows of setae, one row anterior and one row posterior to sensilla 1–3 and two rows, in close proximity, on the integumental fold posterior to that bearing sensilla 1–3; all of the setae comprising these rows are in strict linear sequence so that each row appears straight (Fig. 14a); lateral margins with groups of setae surrounding sensilla 4–8; ventral surface coated with backwardly directed spicules, less so on the mesothorax and anal segment; anterior fold of the prothorax with a broad (>75% of space coated) spicule band reaching to sensilla 1 and comprising >5 rows; anterior spiracles present; prolegs, as weakly produced transverse ridges, present on abdominal segments 1–6 and mesothorax, with up to five crochets per proleg, crochets absent or reduced in number on abdominal segment 6; sensilla 1–7



on each abdominal segment on projecting basal papillae up to 0.6 mm long; each sensilla with up to three surrounding setae; anal segment about twice as long as abdominal segment 6; dorsally anal segment consisting of two tapering folds, the first with two pairs of lappets and the second with a single pair; prp (Fig. 15): length: 1.1 mm, width: at base 0.3 mm, at tip 0.16 mm; basal two-thirds finely ridged then nodulate to just below the smooth and shining tip; three pairs of spiracular slits (Fig. 16).

*Material examined.* Pamper Forest, Hampshire, 25 April 1989, one puparium (adult bred) ex sap run on *Quercus*, M. Oates; Denny Wood, New Forest, Hampshire, 12 March 1990, three larva ex sap runs on *Quercus* (M. Oates, GER); Wood Crates, New Forest, Hampshire, 28 March 1990, three larvae ex sap run at base of *Fagus*.

*B. bicolor* is classified as vulnerable and is known only from a few sites in southern England (Shirt, 1987; Stubbs and Falk, 1983).

### ***Brachyopa insensilis* Collin**

(Figs 17–18)

*Overall appearance.* A dorso-ventrally flattened larva having internal mouth-parts a coating of brown blotches without rows of transverse setae with a tapering anal segment, a long prp and gradually elongating projections along the lateral margins.

*Length.* 7–9 mm; width: 2.5–3.5 mm; flattened dorso-ventrally (about twice as broad as high), slightly tapering anteriorly, tapering posteriorly; mouth-hooks and mandibular lobes internal; lateral lips with base coated in spicules and tip coated in fine setae; dorsal and lateral margins of thorax and abdomen coated in conspicuous dark brown blotches; abdominal segments 1–7 without conspicuous rows of setae although a few stunted setae are present; lateral margins with groups of setae surrounding sensilla 4–8; ventral surface coated with backwardly directed spicules, less so on the mesothorax and anal segment; anterior fold of the prothorax with a narrow (about 50% of space coated) spicule band reaching to sensilla 1 and comprising <5 rows; anterior spiracles present; prolegs, as weakly produced transverse ridges, present on abdominal segments 1–6 and the mesothorax, with up to five crochets per proleg, crochets absent or reduced in number on abdominal segment 6; sensilla 1–7 on each abdominal segment on projecting basal papillae up to 0.6 mm long; each sensilla with up to five surrounding setae; anal segment about twice as long as sixth abdominal segment; dorsally anal segment consisting of two tapering folds, the first with two pairs of lappets and the second with a single pair; prp (Fig. 17): length: 1.1 mm, width: at base 0.24 mm, at tip 0.12 mm, basal two-thirds matt and coated in blotches then shining and nodulate to tip, which is usually slightly upturned about a constriction of the prp below the tip; 3 pairs of spiracular slits (Fig. 18).

*Material examined.* Wollaton Park, Nottingham, 17 May 1985, seven larvae, five puparia (bred) ex sap run on *Aesculus*, F. Gilbert; Odiham Common, Hampshire, 20 May 1990, two larvae ex sap run on *Quercus*; Newbattle Abbey, Dalkeith, Midlothian, 16 March 1990, six larvae ex sap run on *Aesculus*.

*B. insensilis* is considered rare but widespread in the British Isles (Stubbs and Falk, 1983).

***Brachyopa pilosa* Collin**

(Figs 14b, 19–20)

*Overall appearance.* A dorso-ventrally flattened larva having internal mouthparts, a coating of brown blotches, rows of transverse setae which are not regularly aligned, a tapering anal segment, a long prp and gradually elongating projections along the lateral margins.

*Length.* 7–9 mm; width: 2.5–3.5 mm; flattened dorso-ventrally (about twice as broad as high), slightly tapering anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; lateral lips with base coated in spicules and tip coated in fine setae; dorsal and lateral margins of thorax and abdomen coated in pale brown blotches; abdominal segments 1–7 each with four transverse rows of setae, one row anterior and one row posterior to sensilla 1–3 and two rows in close proximity on the integumental fold posterior to that bearing sensilla 1–3; some of the setae comprising these rows are slightly anterior and posterior to each other so that they are not in straight lines (Fig. 14b); lateral margins with groups of setae surrounding sensilla 4–8; ventral surface coated with backwardly directed spicules, less so on the mesothorax and anal segment; anterior fold of the prothorax with a broad (>75% of anterior fold) spicule band comprising >5 rows and reaching to sensilla 1; prolegs, as weakly produced transverse ridges, present on abdominal segments 1–6 and the mesothorax, with up to five crochets per proleg, crochets absent or reduced in number on abdominal segment 6; sensilla 1–7 on each abdominal segment on long basal papillae; each sensilla with up to five surrounding setae; anal segment about twice as long as sixth abdominal segment; dorsally anal segment consisting of two tapering folds, the first with two pairs of lappets and the second with a single pair; prp (Fig. 19): length: 1.1 mm, width: at base 0.3 mm, at tip 0.24 mm; basal two-thirds matt with blotches, apical third dorsal surface shining and nodulate, ventrally shining without nodules; 3 pairs of spiracular slits (Fig. 20).

*Material examined.* Ranmore Common, Surrey, 4 February 1967, one puparium (bred) under thin outer flake of bark of a large fallen *Fagus*, A. Stubbs; Denny Wood, New Forest, Hampshire, 12 March 1990, three larvae, 12 puparia (bred) in sap under exposed bark of recently cut *Quercus*; Inverfarigaig, nr. Inverness, 6 September 1990, four larvae in sap under bark of recently dead *Populus tremula* L.; Achany Glen, Sutherland, 8 September 1990, one larva in sap run on *P. tremula*.

*B. pilosa* is classified as rare with an apparent disjunct distribution being known only from a few sites in southern England and north-east Scotland (Shirt, 1987; Stubbs and Falk, 1983).

*Brachyopa* larvae are poorly known. Lundbeck (1916) summarizing from earlier sources states that the larvae are associated with decaying sap. A recent description of an unidentified *Brachyopa* larva is given by Hartley (1961). This material is now in the collections of the National Museums of Scotland and is most similar to *B. insensilis*. Hartley (1961) states that larvae are found in exudates of various trees especially *Ulmus*. Krivosheina and Mamaev (1967) provide rather generalized descriptions of all three species considered here and of *B. conica* Panzer.

*Brachyopa* larvae are easily separated from other syrphid larvae having internal mouthparts by their dorso-ventrally flattened shape, body coated in blotches and a narrow, elongate prp which is longer than the width of the body. The three *Brachyopa* species described here are easily distinguished from each other. *B.*

*insensilis* lacks transverse rows of setae on the abdominal segments that are conspicuous features of *B. bicolor* and *B. pilosa*. These latter two species can be separated from each other by the setae comprising the rows which are in strict alignment in *B. bicolor*, but are not so in *B. pilosa*. In addition the ventral surface of the prp of *B. bicolor* is nodulate, but in *B. pilosa* the ventral surface is smooth without nodules.

***Hammerschmidtia ferruginea* (Fallén)**

(Figs 21–22, 46)

*Overall appearance.* A dorso-ventrally flattened larva lacking blotches and coated in setae with a tapering anal segment, an elongate prp and gradually elongating projections along the lateral margins (Fig. 46).

*Length.* 9–12 mm; width: 4–5 mm (Fig. 46); flattened dorso-ventrally (about twice as broad as high), slightly tapering anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; lateral lips with base coated in spicules and tip coated in fine setae; blotches absent on abdominal segments; abdominal segments 1–7 coated in setae up to 0.24 mm long; ventral surface coated with backwardly directed spicules, less so on the mesothorax and anal segment; anterior fold of the prothorax with a broad (>75% of space coated) spicule band reaching to sensilla 1 and comprising >5 rows; anterior spiracles present; prolegs, as weakly produced transverse ridges, present on abdominal segments 1–6 and the mesothorax with up to five short and indistinct crochets per proleg, crochets absent or reduced in number on abdominal segment 6; sensilla 1–7 on each abdominal segment on projecting basal papillae up to 0.36 mm long; integumental fold separating sensilla 1 from 2 so that sensilla 1 lies anterior to 2; each sensilla with up to five surrounding setae; anal segment about twice as long as sixth abdominal segment; dorsally anal segment consisting of two tapering folds, the first with two pairs of lappets and the second with a single pair; prp (Fig. 21): length: 1.8 mm; width: at base 0.44 mm, at tip 0.36 mm; basal two-thirds matt with fine ridges, apical third smooth and shining; three pairs of spiracular slits (Fig. 22).

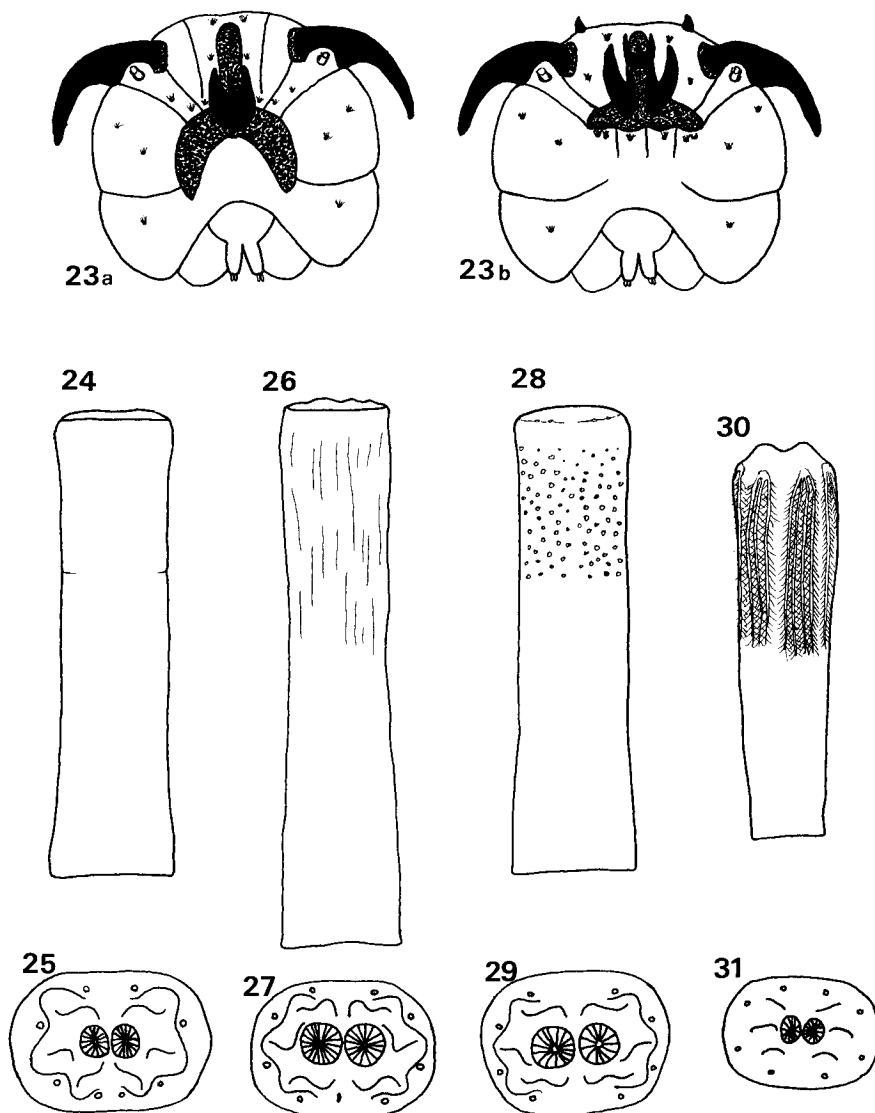
*Material examined.* Grantown, Strathspey, Inverness-shire, 14 June 1989, two larvae, two puparia (bred) under bark of recently fallen *P. tremula*; Ord Ban, Strathspey, 25 May 1990, two larvae, two puparia (bred) under bark of recently fallen *P. tremula*.

*H. ferruginea* is classified as endangered and is known only from one or two sites in Scotland (Shirt, 1987). The only previous description of the larva of *H. ferruginea* appears to be that of Krivosheina and Mamaev (1967). The larva of *H. ferruginea* can be separated from those of *Brachyopa* species which it closely resembles by its coating of setae, absence of blotches and on abdominal segments 1–6 sensilla 1 is separated from sensilla 2 by an integumental fold such that sensilla 1 is anterior to sensilla 2.

***Myolepta potens* (Harris)**

(Figs 36–37)

*Overall appearance.* Short-tailed larva with internal mouthparts, lacking hooks and a band of spicules on the thorax and with dorsal surface of the end of the body coated with papillae bearing setae.



FIGS. 23-31. Fig. 23a: *Criorhina floccosa*, prothorax, anterior view; Fig. 23b: *Criorhina berberina*, prothorax, anterior view; Figs 24-25: *Criorhina berberina*; Fig. 24: prp, anterior view; Fig. 25: prp dorsal view; Figs 26-27: *Criorhina floccosa*; Fig. 26: prp, anterior view; Fig. 27: prp, dorsal view; Figs 28-29: *Criorhina ranunculi*; Fig. 28: prp, anterior view; Fig. 29: prp, dorsal view; Figs 30-31: *Caliprobola speciosa*; Fig. 30: prp, anterior view; Fig. 31: prp, dorsal view.

*Length.* 12-15 mm; width: 3 mm; subcylindrical, truncate anteriorly, elongate and tapering posteriorly; mandibles and mandibular lobes internal; lateral lips with fine setae; vestiture of fine setae up to 0.16 mm long; dorsal surface of abdominal segment 7 and anal segment coated in papillae up to twice as long as broad and tipped with setae about twice as long as basal papilla; lateral margins of anal segment with long (up to 0.3 mm) fine setae between the lappets and extending to the base of the segment, mid-dorsal row of similar but shorter (0.16 mm) setae also

present; anterior fold of prothorax without spicule band; anterior spiracles present; prolegs present on mesothorax and first six abdominal segments; crochets multi-serial, six–eight large primary crochets; crochet arrangement gradually changing from posterior penellipse (i.e. crochets complete around posterior margin of the proleg) on abdominal segment one to lateral penellipse (i.e. crochets complete laterally) on abdominal segment 6; dorsal section abdominal segment 7 extending over anal segment with sensilla 2, 3 and 4 posterior to anal opening; anal segment extended to nearly half of length of thorax and first seven abdominal segments; three pairs of equidistant lappets; at tip of anal segment, third pair of lappets about half as long as first two pairs; sensilla 2, 3 and 4 of abdominal segment 7 on projecting papillae up to three times as long as basal width; prp (Fig. 36): length: 1.5 mm; width: at base and tip, 0.2 mm; pale brown and shining; 3 pairs of spiracular slits (Fig. 37).

*Material examined.* Avon Court, Bristol, one larva, five puparia (bred), ex rot-holes at base of *Fagus* trees, J.C. Hartley.

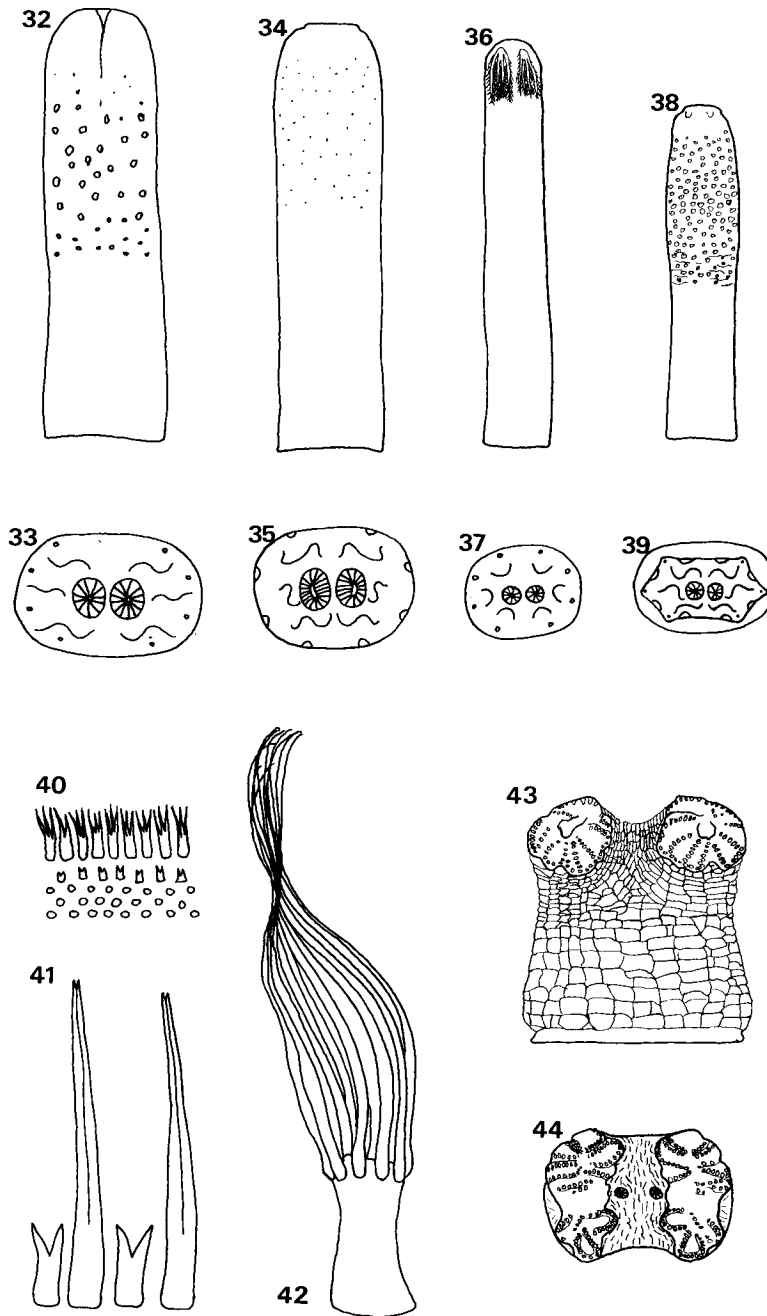
*M. potens* is classified as endangered and is known only from a few sites in Gloucestershire and Somerset (Shirt, 1987). *Myolepta* larvae are separated from other syrphid larvae with internal mouthparts by the lack of a spicule band on the anterior fold of the prothorax, the coating of papillae on abdominal segments 7 and 8 and the 3 pairs of lappets on the anal segment which is extended to about half body length. The larva of *Myolepta luteola* Gmelin has been described by Hartley (1961) from material found in a rot-hole of a *Fagus*. The larva of *M. potens* can be easily separated from that of *M. luteola* by the rows of long setae (longer than length of third lappet) along the lateral margins of the anal segment. In *M. luteola* a few inconspicuous setae are present about as long as or shorter than the third lappet.

#### ***Brachypalpus laphriformis* (Fallén)**

(Figs 32–33)

*Overall appearance.* A short-tailed larva with internal mouthparts, a narrow spicule band and two pairs of thoracic hooks.

*Length.* 15–17 mm; width: 3–5 mm; subcylindrical, truncate anteriorly, tapering anteriorly; mandibles and mandibular lobes internal; base of lateral lips with broad setae, tip with fine setae; vestiture of short (up to 0.06 mm) fine setae; anterior fold of prothorax with a narrow (<50% of anterior fold) spicule band comprising four rows, upper-most, posterior row completely sclerotized and dark coloured contrasting with the paler bases of spicules in other rows; mesothorax and metathorax without spicule bands; one large (length: 0.24 mm) laterally directed hook anterior to sensilla 4 on mesothorax and a smaller (0.20 mm) hook anterior to sensilla 5 on mesothorax; prolegs present on mesothorax and first six abdominal segments; crochets biserial on abdominal prolegs, multiserial on mesothorax; six–eight large primary crochets; crochet arrangement gradually changing from posterior penellipse (i.e. crochets complete around posterior margin of the proleg) on abdominal segment one to lateral penellipse (i.e. crochets complete on the outer margin) on abdominal segment 6; dorsal section of abdominal segment 7 extended over anal segment with sensilla 2, 3 and 4 above anal opening; anal segment about twice as long as sixth abdominal segment; three pairs of lappets with equidistant sections between them; third pair of lappets about three times as long as first two pairs (0.42 mm); sensilla 5, 6, 7–8 on fleshy projections; prp (Fig. 32): length: 1.4 mm;



FIGS. 32-44. Figs 32-33: *Brachypalpus laprifformis*; Fig. 32: prp, anterior view; Fig. 33: prp, dorsal view; Figs 34-35: *Pocota personata*; Fig. 34: prp, anterior view; Fig. 35: prp, dorsal view; Figs 36-37: *Myolepta potens*; Fig. 36: prp, anterior view; Fig. 37: prp, dorsal view; Figs 38-39: *Xylota devius*; Fig. 38: prp, anterior view; Fig. 39: prp, dorsal view; Figs 40-44: *Microdon devius*; Fig. 40: dorsal setae and nodules of marginal band, anterior view; Fig. 41: ventral setae of marginal band, anterior view; Fig. 42: papilla with terminal setae from dorsal surface of the abdomen, anterior view; Fig. 43: prp, anterior view; Fig. 44: prp, dorsal view.

width: at base 0.58 mm, at tip 0.48 mm; shining pale brown; apical half coated in punctures about as wide apart as width across; three pairs of spiracular slits (Fig. 33).

*Material examined.* Leigh Wood near Bristol, Avon, April 1961, one larva ex rot-hole/exudate in *Taxus*, J.C. Hartley; Wood Crates, New Forest, Hampshire, 28 March 1990, one larva from a water and sap filled cavity under fractured bark about 2 m up a live *Quercus*.

*B. laphriformis* is classified as rare and is known mostly from woodlands in southern England (Shirt, 1987). The larva has apparently not been described previously. Although larvae are known only from rot-holes, male *B. laphriformis* were observed patrolling dead *Fagus* stumps in which there were no rot-holes suggesting that wet, decaying roots may also be a breeding site. The short-tailed larva of *B. laphriformis* can be separated from other syrphid larvae having internal mouthparts by the two pairs of hooks and the narrow spicule band of the prothorax.

### *Calprobola speciosa* (Rossi)

(Figs 30–31, 48)

*Overall appearance.* Larva with internal mouthparts, lacking hooks on the thorax and having an anal segment with a non-retractile section between lappet pairs 2 and 3 of about 75% of the length of the thorax and abdomen minus the anal segment.

*Length.* 20 mm + 14 mm for anal segment (Fig. 48); width: 4.5 mm; subcylindrical, truncate anteriorly, elongate and tapering posteriorly; mandibles and mandibular lobes internal; base of lateral lips with broad setae, tip with fine setae; vestiture of short (up to 0.06 mm) fine setae, setae becoming longer (0.08 mm) towards posterior of larva; long setae (0.2 mm) in two dorso-lateral rows encompassing sensilla 7–8; anterior fold of prothorax with broad (>75% of anterior fold) spicule band comprising >5 rows; spicules extending posteriorly onto folds between sensilla 4–5, 6–7 and 8; mesothorax with two groups of spicules anterior to sensilla 4 and 5, anterior spiracles present, antero-ventral margin of metathorax with two groups of spicules; prolegs present on mesothorax and first six abdominal segments; crochets multiserial, six–eight large primary crochets; crochet arrangement gradually changing from posterior penellipse (i.e. crochets complete around posterior margin of the proleg) on abdominal segment one to lateral penellipse (i.e. crochets complete on the outer margin) on abdominal segment 6; dorsal section abdominal segment 7 extending over anal segment with sensilla 2, 3 and 4 above anal opening; anal segment extended to about 75% length of thorax and first seven abdominal segments; three pairs of lappets with section between lappet 3 and 2 longest (about six times as long as section between lappets one and two; third pair of lappets about twice as long as first two pairs (0.24 mm); prp (Fig. 30): length: 0.76 mm; width: at base 0.16 mm, at tip, 0.22 mm; pale brown and shining; three pairs of spiracular slits (Fig. 31).

*Material examined.* Denny Wood, New Forest, Hampshire: 16 May 1989, two puparia (bred); 18 May 1989, four larvae; 10 March 1990, six puparia (bred), all collected as larvae from wet, decaying roots of *Fagus* stumps.

*C. speciosa* is classified as endangered and is known from a few sites in southern England (Shirt, 1987). The larva of *C. speciosa* has apparently not been described previously. However, Girschner (1884) briefly described the puparium from larvae collected in the rotten wood of a *Fagus* stump. Like the *Criorhina* larvae described

here, the larva of *C. speciosa* was also found underground in wet, decaying roots of *Fagus* stumps around which males frequently patrolled and on which females were seen to alight. The larva of *C. speciosa* can be separated from other syrphid larvae having internal mouthparts, by the absence of hooks on the prothorax and the long extension between lappet pairs 2 and 3 on the anal segment.

***Criorhina berberina* (Fabricius)**

(Figs 23b, 24–25)

*Overall appearance.* A short-tailed larva with internal mouthparts and four pairs of hooks on the thorax including two pairs mounted mid-dorsally on a black triangular base.

*Length.* 17–27 mm; width: 4–6 mm; subcylindrical, truncate anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; lateral lips with base coated in spicules and tip coated in fine setae; vestiture of short (up to 0.06 mm) fine setae, setae very short or absent on ventral surface; anterior fold of prothorax with a narrow (<50% of anterior fold) spicule band comprising >5 rows; mesothorax and metathorax with antero-ventral band of spicules; prothorax with black, sclerotized, triangular-shaped region bearing conspicuous hooks between folds bearing sensilla 2 and 3 with sensilla 2 lateral to 3, sensilla 1 anterior to the triangular-shaped region (Fig. 23b); triangular-shaped region bearing two pairs of closely set but diverging backwardly directed hooks, length of anterior hooks 0.4 mm, length of posterior hooks 0.2 mm; sensilla 1, 4 and 5 in close proximity so that no fold exists between them; behind each anterior spiracle is a large laterally directed hook, length in dorsal view 0.8 mm; mesothorax with sensilla 2 posterior to 1; a small (0.12 mm) hook present on the anterior margin of the mesothorax between sensilla 2 and 3; prolegs present on mesothorax and abdominal segments 1–6; crochets multi-serial, primary crochets largest; crochets arranged in a posterior penellipse i.e. crochets complete around posterior margin of the proleg; abdominal segment 7 with dorso-lateral margins extended over anal segment so that sensilla 2, 3 and 4 above the anal opening; dorsally anal segment about 9.5 mm long and about 3.8 times as long as abdominal segment six with three pairs of equally spaced lappets; prp (Fig. 24): length: 1.6 mm; width: at base 0.48 mm, at tip 0.32 mm, pale brown and shining from base to tip, three pairs of spiracular slits (Fig. 25).

*Material examined.* Failand, Somerset, 16 April 1958, one puparium (bred) ex base of *Betula* tree, J. C. Hartley; Denny Wood, New Forest, Hampshire, 16–19 May 1989, two larvae ex wet, decaying roots of *Fagus* stumps.

*C. berberina* is considered a scarce woodland species in the British Isles (Stubbs and Falk, 1983).

***Criorhina floccosa* (Meigen)**

(Figs 23a, 26–27, 47)

*Overall appearance.* A short-tailed larva with internal mouthparts and two pairs of hooks on the thorax including one pair mounted mid-dorsally on a Y-shaped triangular base.

*Length.* 17–27 mm; width: 4–6 mm (Fig. 47); subcylindrical, truncate anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; lateral lips with base coated in spicules and tip coated in fine setae; vestiture of short (up to 0.06 mm long) fine setae, setae very short or absent on ventral surface; anterior fold



of prothorax with a broad (>75% of anterior fold) spicule band comprising >5 rows; mesothorax and metathorax with antero-ventral band of spicules; prothorax with black, sclerotized, Y-shaped region bearing hooks (Fig. 23a); stem of Y-shape between folds bearing sensilla 1–3 and arms of Y-shape extending over the anterior fold; spicules between arms longer than those elsewhere on the spicule band; at the junction of the stem and arms of the Y-shaped region are a pair of large (0.44 mm long) closely set but diverging backwardly directed hooks; fold bearing sensilla 4 and 5 narrow and almost transverse with sensilla 4 and 5 approximated and close to sensilla 1; behind each anterior spiracle is a large laterally directed hook, length in dorsal view 1.2 mm; prolegs present on mesothorax and abdominal segments 1–6; crochets multi-serial, primary crochets largest; crochets arranged in a posterior penellipse i.e. crochets complete around posterior margin of the proleg; abdominal segment 7 with dorso-lateral margins extended over anal segment so that sensilla 2, 3 and 4 lie above the anal opening; dorsally anal segment about 9.5 mm long and about 3.8 times as long as abdominal segment six with three pairs of equally spaced lappets; prp (Fig. 26): length: 1.6 mm; width: at base 0.48 mm, at tip 0.46 mm, pale brown, shining and without punctures from base to tip, three pairs of spiracular slits (Fig. 27).

*Material examined.* Attenborough, Nottingham, May 1963, three larvae, one puparium (bred) ex rot-hole about 0.75 m high in a *Ulmus* tree, J. C. Hartley; Denny Wood, New Forest, Hampshire, 16–19 May 1989, two larvae ex wet, decaying roots of *Fagus* stumps.

*C. floccosa* is considered a scarce woodland species in the British Isles (Stubbs and Falk, 1983).

### ***Criorhina ranunculi* (Panzer)**

(Figs 28–29)

*Overall appearance.* A short-tailed larva with internal mouthparts and two pairs of hooks on the thorax including one pair mounted mid-dorsally on a Y-shaped triangular base.

*Length.* 17–27 mm; width: 4–6 mm; subcylindrical, truncate anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; lateral lips with base coated in spicules and tip coated in fine setae; vestiture of short (up to 0.06 mm long) fine setae, setae very short or absent on ventral surface; anterior fold of prothorax with a broad (>75% of anterior fold) spicule band comprising >5 rows; mesothorax and metathorax with antero-ventral band of spicules; prothorax with black, sclerotized, Y-shaped region bearing hooks; stem of Y-shape between folds bearing sensilla 1–3 and arms of Y-shape extending over the anterior fold; spicules between arms longer than those elsewhere on the spicule band; at the junction of the stem and arms of the Y-shaped region are a pair of large (0.52 mm long) closely set but diverging backwardly directed hooks; fold bearing sensilla 4 and 5 narrow and almost transverse with sensilla 4 and 5 close and very close to sensilla 1; behind each anterior spiracle is a large laterally directed hook, length in dorsal view 0.9 mm; prolegs present on mesothorax and abdominal segments 1–6; crochets multi-serial, primary crochets largest; crochets arranged in a posterior penellipse i.e. crochets complete around posterior margin of the proleg; abdominal segment 7 with dorso-lateral margins extended over anal segment so that sensilla 2, 3 and 4 above the anal opening; dorsally anal segment about 9.5 mm long and about 3.8 times as long

as abdominal segment six with three pairs of equally spaced lappets; prp (Fig. 28): length: 2.0 mm; width: at base 0.50 mm, at tip 0.6 mm, basal two-thirds matt, apical third shining with numerous punctures; three pairs of spiracular slits (Fig. 29).

*Material examined.* One puparium (bred), ex *Fagus* stump, Selborne Common, Hampshire collected 29 December 1988 by M. Oates. Adult emerged 27 February 1989.

*C. ranunculi* is considered a scarce woodland species in the British Isles (Stubbs and Falk, 1983).

*Criorhina* larvae are poorly known. According to Lundbeck (1916), van Roser, in 1834, found the larva of *Criorhina oxyacanthae* (Meigen) in flood refuse. Verrall (1901) states that larvae are associated with decaying sap. However, various authors (Lundbeck, 1916; Hartley, 1961; Allen, 1964; Schuhmacher, 1968) report finding *Criorhina* puparia in association with tree stumps.

*Criorhina* larvae are separated from other syrphid larvae having internal mouthparts by their backwardly directed, mid-dorsal hooks on the prothorax. The larva of *C. berberina* can be separated from *C. floccosa* and *C. ranunculi* by the triangular-shaped base which bears two pairs of mid-dorsal hooks on the prothorax. In the latter two species the base is Y-shaped and only bears one pair of hooks. *C. ranunculi* differs from *C. floccosa* in that it has a prp about 3.5 times as long as wide at the tip and the apical third has numerous punctures. The prp of *C. floccosa* is about five times as long as wide at the tip and lacks punctures.

### ***Pocota personata* (Harris)**

(Figs 34–35)

*Overall appearance.* A short-tailed larva with internal mouthparts, a broad spicule band on the prothorax, no thoracic hooks and a broad anal segment.

*Length.* 18–20 mm; width: 4 mm; subcylindrical, truncate anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; base of lateral lips with broad setae, tip with fine setae; vestiture of short (up to 0.04 mm long) fine setae, these setae denser on thorax than on the abdomen; dorso-lateral margin of abdomen and anal segment with long (0.08 mm) setae surrounding sensilla 7 and 8; ventral surface of abdominal segment 7 with longer (0.14 mm) setae; anterior fold of prothorax with a broad (>50% of anterior fold) spicule band comprising up to eight rows; mesothorax anterior to sensilla 4 and 5 with a few spicules; prolegs present on mesothorax and first six abdominal segments; crochets multiserial; six–eight large primary crochets; crochet arrangement gradually changing from posterior penellipse (i.e. crochets complete around posterior margin of the proleg) on abdominal segment one to lateral penellipse (i.e. crochets complete on outer margin) on abdominal segment 6; dorsal section of abdominal segment 7 extended over anal segment with sensilla 2, 3 and 4 above anal opening; anal segment about three times as long as sixth abdominal segment; one pair of lappets (up to 1 mm long); distance between sensilla 1/2, 3 and 4–6 of anal segment about equal; extension of anal segment characteristically broad and fleshy (>0.5 basal width); prp (Fig. 34): length: 1.8 mm; width: at base 0.64 mm, at tip 0.44 mm; shining pale brown with fine punctures in the apical half; three pairs of spiracular slits (Fig. 35).

*Material examined.* Bristol, 1960–3, ten larvae, two puparia ex rot-hole on *Fagus* J. C. Hartley; Wandlebury Common, Cambridge, 18 May 1990, two larvae, three puparia ex rot-hole about 1.75 m up a live *Fagus*.

*P. personata* is classified as vulnerable and is known only from southern England (Shirt, 1987). The larva of *P. pocota* was briefly described by Aubertin (1928) and Dixon (1960). Lundbeck (1916) gives a brief description of the puparium. Larvae are known only from rot-holes especially in *Fagus* and *Popula* (Lundbeck, 1916; Donisthorpe, 1928; Shillito, 1947). The short-tailed larva of *P. personata* can be separated from other syrphid larvae having internal mouthparts by the absence of hooks on the thorax and the extension of the anal segment which, at the tip, is more than half as broad as at the base.

***Xylota tarda* (Meigen)**

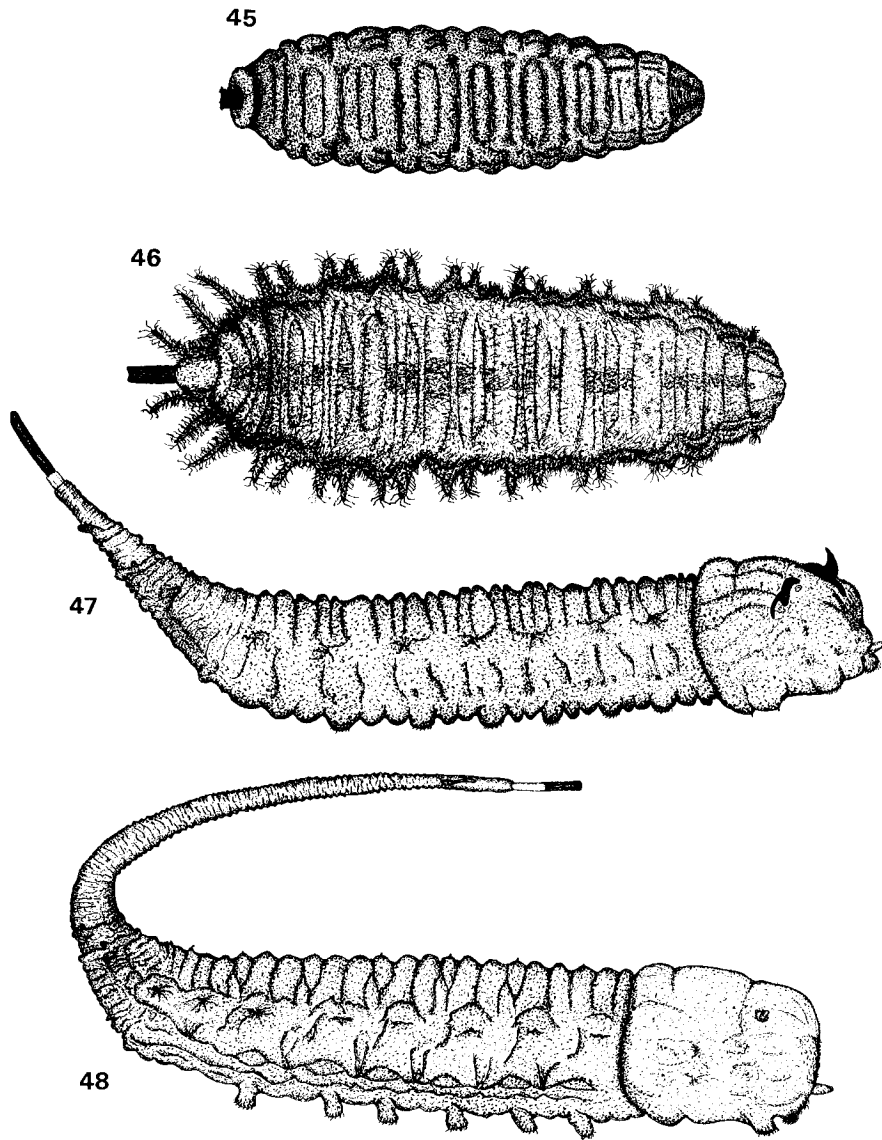
(Figs 38–39)

*Overall appearance.* A short-tailed larva with internal mouthparts, lacking hooks but having spicules reaching sensilla 2 on the prothorax, some spicules longer than the anterior spiracles and a parallel-sided prp with punctures in the apical half.

*Length.* 13–16 mm; width: 2–3 mm; subcylindrical, truncate anteriorly, tapering posteriorly; mandibles and mandibular lobes internal; base of lateral lips with broad setae, tip with fine setae; vestiture of short (up to 0.04 mm) fine setae; setae longer on anal segment (0.06 mm); anterior fold of prothorax with broad (>75% of space coated) spicule band comprising <5 rows; longest spicules of this band longer than length of anterior spiracles; spicules extending posteriorly up to sensilla 2 and a few spicules on folds bearing sensilla 5, 6 and 7; posterior to these spicules and close to margin between prothorax and mesothorax are two isolated groups of spicules; antero-ventral margin of metathorax with a few spicules anterior to sensilla 6; postero-ventral margin of abdominal segment 7 with a row of setae; prolegs present on mesothorax and first six abdominal segments; crochets multi-serial, 6–8 large primary crochets; crochet arrangement gradually changing from posterior penellipse (i.e. crochets complete around posterior margin of the proleg) on abdominal segment 1 to lateral penellipse (i.e. crochets complete laterally) on abdominal segment 6; dorsal section abdominal segment 7 extending over anal segment with sensilla 2, 3 and 4 above anal opening; anal segment extended to nearly a quarter of the length of thorax and first seven abdominal segments; three pairs of equidistant lappets; at tip of anal segment third pair of lappets about 1.5 times as long as first two pairs; abdominal segments with sensilla 1–6 mounted on triangular-shaped papillae as high as basally broad (0.2 mm); prp (Fig. 38): length: 0.95 mm; width: at base and tip, 0.24 mm; pale brown; basal half matt and finely ridged, apical half shining and punctured, punctures separated by about their own diameter; three pairs of spiracular slits (Fig. 39).

*Material examined.* Inverton, nr. Kingussie, Strathspey, Inverness-shire, 22 July 1990, four larvae, two puparia ex sap run at base of *P. tremula*.

*X. tarda* is a scarce and local species in the British Isles with an apparent disjunct distribution in Scotland and southern England (Stubbs and Falk, 1983). The larva of *X. tarda* has not been described previously. Hartley (1961) describes the larval stages of four *Xylota* species. Lundbeck (1916) refers to earlier descriptions of *Xylota* species. Most species are associated with dead wood, although *Xylota segnis* has been reared from decaying non-woody plant material (Hartley, 1961; Blackith and Blackith, 1989). *X. tarda* can be separated from other short-tailed larvae having internal mouthparts by the spicules on the prothorax reaching to sensilla 2 and by the parallel-sided prp which has a punctured apical half.



FIGS. 45-48. Whole third stage syrphid larvae. Fig. 45: *Cheilosia albitarsis*, dorsal view; Fig. 46: *Hammerschmidia ferruginea*, dorsal view; Fig. 47: *Criorhina floccosa*, lateral view; Fig. 48: *Caliprobola speciosa*, lateral view.

***Microdon devius* (L.)**

(Figs 40-44)

*Overall appearance.* A dome-shaped larva with internal mouthparts and a flattened ventral surface coated almost completely in fine setae, dorsally with a reticulate pattern of longer than basally broad papillae bearing terminal setae and a marginal band of two rows of setae.

*Length.* 8-11 mm; width: 5-6 mm; pale grey; nearly semicircular in cross-section, rounded anteriorly and posteriorly with a flattened ventral surface;

prothorax and mesothorax subcylindrical and retracted under metathorax so that, when retracted, they lie flat with the ventral surface; ventral surface flattened to level of sensilla 5 and 6 of abdominal segments 1–7; two rows of setae borne on projecting papillae and a row of nodules forming a nearly continuous dorso-lateral margin at level of sensilla 5 and 6 of abdominal segments 1–7 and reaching round metathorax and anal segment broken only anteriorly; dorsal row in this marginal band up to 0.08 mm long consisting of basal papillae with up to five terminal setae each (Fig. 40), below this an alternating row of papillae with two short terminal setae (0.02 mm) and papillae with a single long seta (0.08 mm) (Fig. 41); body surface above the marginal band with a reticulate pattern of long brown papillae (0.1 mm) bearing up to 12 terminal setae (up to 0.2 mm long) (Fig. 42); ventral surface almost completely coated in fine setae up to 0.05 mm long; spicule band on prothorax absent; prothorax and mesothorax divided mid-dorsally in the same manner as the metathorax; prolegs absent; lappets absent; anal segment not extended; prp (Fig. 43): length: 0.8 mm; width: at base 0.7 mm, at tip 0.65 mm; base cream coloured with coating of brown slit-shaped punctures, these punctures extending into the groove separating the spiracular plates at the tip of the prp; spiracular openings numerous on raised arms arranged in a stellate pattern over the lateral margins of the tip of the prp (Fig. 44).

*Material examined.* Noar Hill Hanger, nr. Selborne, Hampshire, 29 March 1990, three larvae, two puparia (one bred, one empty in nest) ex nest of *Lasius flavus* (Fabricius) (Hym. Formicidae).

*M. devius* is classified as vulnerable and is known only from a few chalk grassland sites in southern England (Shirt, 1987). The larva of *M. devius* is briefly described by Vimmer (1925) and a generalized description based on a puparium without data is given by Dixon (1960). Speight *et al.* (1975) state that *M. devius* is associated with *L. flavus* although Stubbs and Falk (1983) say this requires verification. The records presented here support the assumption of an association between *M. devius* and *L. flavus*. *Microdon* species occurring in the British Isles are very distinctive and easy to separate from other syrphid larvae with their dome-like appearance, prothorax and mesothorax concealed under the metathorax and a marginal band of setae. *M. devius* most closely resembles *Microdon eggeri* Mik in having a reticulate pattern of papillae on the dorsal surface. The larva of *Microdon mutabilis* (L.) differs in that it has a smooth dorsal surface with the reticulate pattern confined to a narrow region above the marginal band. *M. devius* can be separated from *M. eggeri* by the almost complete coating of fine setae on the ventral surface, the reticulate pattern consisting of cells as large as, or larger, than the diameter of the prp and the papillae on the dorsal surface being longer than basally broad.

## Discussion

This small sample of syrphid larvae are diverse morphologically (Figs 45–48). Three structures account for most of the variation: the anal segment in its degree of extension and the variable way this occurs as shown by the relative positions of the lappets and sensilla, the thorax in its variable shapes and arrangements of spines and hooks and the locomotory organs in their variable sizes, shapes and arrangements of crochets.

Variation appears to be consistent within genera such as *Brachyopa* and *Criorhina* with individual species varying only in fine detail suggesting that these

genera represent monophyletic taxa. However, within *Cheilisia* greater levels of variation exist. The few described larvae have suites of characters exclusively associated with particular feeding modes such as leaf-mining, tunnelling and mycophagy, etc. (Rotheray, 1990). The larvae of *C. albitarsis* and *C. antiqua* described here, are similar to other tunnelling *Cheilisia* larvae in sharing the following characters: one large and up to three pairs of smaller mouth-hooks; spicules concentrated at the anterior end; a dorsal plate on the prothorax. This arrangement of mouth-hooks is probably effective for tunnelling in the relatively compact tissues of stems and roots. The concentration of spicules at the anterior end probably enable the larva to grip the sides of the tunnel and the dorsal plate may help prevent wear (Rotheray, 1990). Except for the dorsal plate, the tunnelling larva of *P. maculata* also has these characters. However, in possessing a flat disc at the end of the body, *P. maculata*, *C. albitarsis* and *C. antiqua* possess an additional character not seen in other tunnelling *Cheilisia* larvae. A flat disc at the end of the body also occurs in larvae of the syrphid genus *Temnostoma* Lapeletier and Serville which tunnel in moist decaying sapwood (Stammer, 1933). Such a disc may help protect the spiracular slits from being blocked by excavated material which tends to accumulate behind a tunnelling larva. Other species of *Cheilisia* that have tunnelling larvae but lack a flat disc often have ornamented prolegs: *C. albipila* Meigen has a mid-dorsal projection; *C. grossa* (Fallén) has lateral extensions; *C. variabilis* has spines (Rotheray, 1988, 1990). These structures may also help protect the spiracular slits.

The large, black hooks on the larval thorax of species of *Callicera*, *Criorhina* and *Brachypalpus* are variable in shape, number and form (Figs 2 and 23). *Criorhina* larvae differ from other hook-bearing species in having altered positions for sensilla groups 1–3 on the prothorax which appear to result from the development of the large mid-dorsal hook base (Fig. 23). The unusual positions of these sensilla provide an exception to the high level of uniformity usually occurring in sensilla positions.

Hartley (1961) suggested that the function of the hooks was rasping. I did not observe rasping, but hooks may be advantageous for locomotion in wet decaying wood. This material usually contains numerous, solid fragments of varying sizes. In *Criorhina* larvae, these fragments were pushed out of the way by the hooks during the first stage of locomotion when the thorax was extended into the material and tilted up. *Xylota sylvarum* L. and *C. speciosa* also inhabit wet decaying wood but lack hooks. However, they possess a spicule band on the anterior fold of the prothorax.

Species with hooks may preferentially inhabit firmer areas of decaying wood. This was suggested by larval distributions within *Fagus* stumps. *Criorhina* larvae were often located in places where firm wood was present. *C. speciosa* and *X. sylvarum* were present in more fluid parts of the decay. Despite hooks and spicules numerous integumental scars, indicated by small, black, irregular-shaped blotches were present on *Criorhina* larvae showing that injuries are common.

That decaying roots are a major breeding site for *Criorhina* species was confirmed at Denny Wood in the New Forest, Hampshire during 16–19 May 1989. Female *C. berberina* were observed repeatedly ovipositing in bark crevices around the base of *Fagus* stumps and on the undersides of leaves of plants growing on, or next to these stumps and male *C. berberina* patrolled stumps throughout the day. In addition, empty puparia of *C. berberina* and *C. floccosa* were found in the leaf litter

around these stumps where both small (<0.5 cm) and large (2–3 cm) larvae were found in the decaying roots.

*Criorhina* females were also seen entering holes in the bases of live *Fagus* trees and in Scotland, in June 1989, larvae of *C. berberina* were obtained from wet decaying heartwood at the base of a recently fallen (green leaves present), hollow *Fagus* tree. *Criorhina* species probably breed in live trees with heartrot and gain entry to areas of decay from holes at the base of the trees.

Wet, decaying roots of *Fagus* stumps are breeding sites for a number of species. Apart from larvae of *Criorhina*, *Caliprobola* and *X. sylvarum*, larvae of other species found in decaying roots were *Xylota abiens* Meigen and *Myathropa florea* (L.). The abundance of larvae in certain stumps was high with 50+ larvae frequently encountered and in some stumps 100+ larvae were found.

The fungi responsible for heartrot in roots and rot-holes are predominantly Basidiomycetes, such as the Honey fungus, *Armillaria mellea* (Vahl.) (Peace, 1962). These fungi gain entry to the tree through dead and broken branches, damaged roots and exposed sap/heartwood and infestations may persist for many years without the tree dying or showing external signs of decay (Peace, 1962). Although moisture is often associated with fungal growth, the wet decaying heartwood found in *Fagus* stumps and rot-holes is probably not due solely to these fungi. Moisture may accumulate from rainfall, translocation from healthy tissue and secondary decay from bacteria and other micro-organisms. The distribution of larvae in wet decaying wood suggests that many feed on the micro-organisms and breakdown products of this secondary decay rather than on active heart-rot fungi. However, the role of these larvae in retarding or accelerating primary or secondary decay is unclear, but they may play a crucial role in this respect.

A pattern in oviposition heights appears to be present among heartrot-breeding syrphids. Larvae of certain genera (*Brachypalpus*, *Callicera*, *Myolepta* and *Pocota*) have only been found in rot-holes above ground level. Others, like *C. speciosa* and *C. ranunculi* are currently only known below ground in decaying roots. While *C. berberina*, *C. floccosa*, *M. florea* and some *Xylota* species are recorded both from rot-holes and decaying roots.

The feeding habits of the larva of *M. devius* are not known. Reports that larvae of *M. eggeri* and *M. mutabilis* feed on solid pellets ejected from the hypopharyngeal pockets of ants in whose nests they live (Donisthorpe, 1927; Syms, 1935) require confirmation. The larvae of several nearctic *Microdon* species are predators of ant cocoons (Duffield, 1981; Garnett *et al.*, 1985).

Fourteen of the species considered here are British or European rarities (Stubbs and Falk, 1983; Torp, 1984) including nine red data book species (Shirt, 1987). It should now be possible to make detailed investigations of the status and biology of these and related species using larval stages similar to that made recently for *Callicera rufa*. This is a red data book species classified as endangered and possibly close to extinction (Shirt, 1987). Using larvae and puparia to sample this syrphid, rather than the elusive adult stage, it was found in pinewoods all over northern Scotland showing that its status was previously underestimated and that, in this case, the appropriate stage to sample is the larva (Rotheray and MacGowan, 1990).

Other species may be similar, particularly where adults are similarly elusive and occur only for short periods in the year. Larvae, however, can be sampled throughout the year and are sometimes abundant. Furthermore, if hoverflies are to be conserved, the investigation of breeding sites is essential, particularly when

breeding sites are in habitats that are themselves under threat such as saproxylic species in primary woodlands (Speight, 1989).

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