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The larva of *Brachyopa scutellaris* Robineau-Desvoidy (Diptera: Syrphidae), with a key to and notes on the larvae of British *Brachyopa* species

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Adult *Brachyopa* are unusual hoverflies. In general appearance they resemble Anthomyiidae or Muscidae (Diptera) and adults are infrequent at flowers. None of the four British species is considered common (Stubbs & Falk, 1983) and three are accorded red data book categories by Falk (1991). Speight (1989) includes one British species, *Brachyopa bicolor* (Fallén), in a list of insects useful in identifying woodlands of international importance to conservation. However, the rarity of some *Brachyopa* species is possibly over-stated. Adults could be under-recorded due to their habit of staying close to breeding sites.

Lundbeck (1916), summarizing from various sources, states that the breeding site is decaying tree sap. This is confirmed by Hartley (1961), Krivosheina & Mamaev (1967), McLean & Stubbs (1990) and Rotheray (1991). The larva of the related species, *Hammerschmidtia ferruginea* (Fallén), also breeds in decaying tree sap (Krivosheina & Mamaev, 1967; Rotheray, 1991).

Adult European *Brachyopa* are keyed by Thompson (1980) and Thompson & Torp (1982). The only key to larvae is that of Krivosheina & Mamaev (1967) which includes only 4 of the 12 European species. Recently, however, the larva of a fifth species, *Brachyopa scutellaris* Robineau-Desvoidy, was obtained from Scotland. It is described in this paper and keyed with larvae of the other British species: *B. bicolor, B. insensilis* Collin and *B. pilosa* Collin and the larva of the related species, *H. ferruginea*. The larvae of these latter four species are described by Krivosheina & Mamaev (1967) and Rotheray (1991). The larva described by Krivosheina & Mamaev (1967) not considered further here is the non-British *Brachyopa panzeri* Goffe [= *conica* Panzer].

Description of the third (= final) stage larva of *Brachyopa scutellaris*

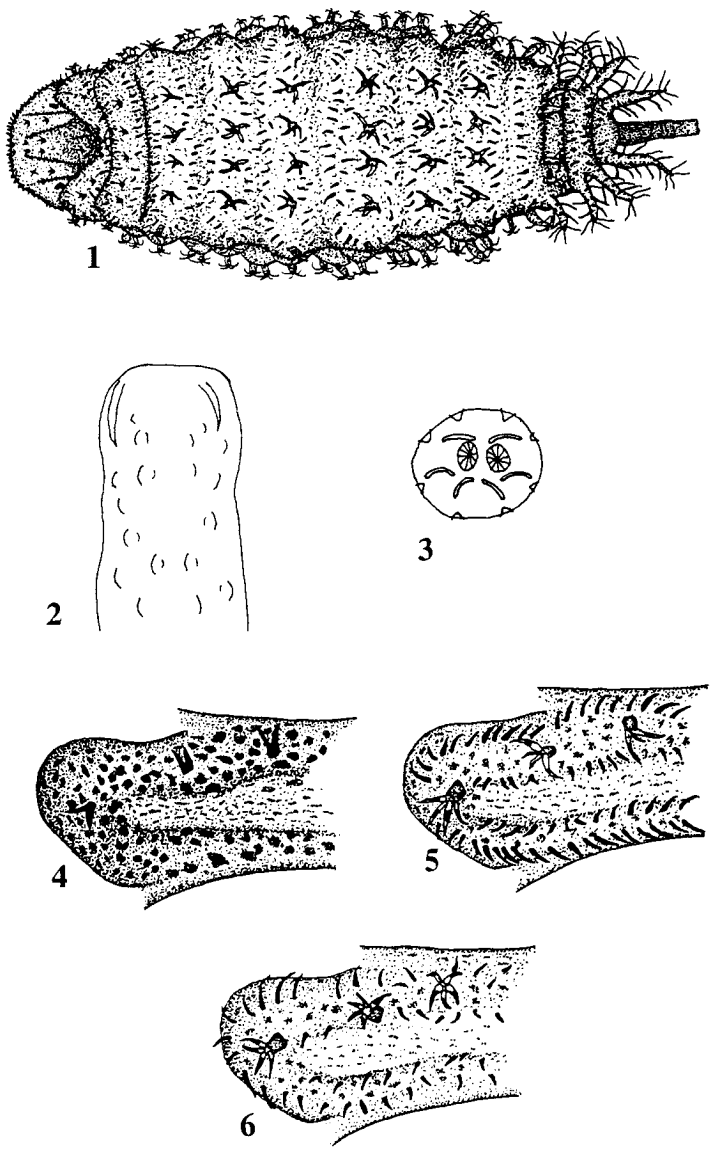
Unless otherwise stated larval terms follow Hartley (1961) and Rotheray (1991).

Overall appearance

A dorso-ventrally flattened larva with mandibles reduced and not protruding from the mouth (Roberts, 1970), dorsal surface with rows of transverse setae, a long posterior breathing tube and fleshy projections along the lateral margins which are longer posteriorly (Fig. 1).

Description

Length 6–8 mm; width 2–3 mm; flattened dorso-ventrally (about twice as broad as high), tapering anteriorly, slightly 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,



Figs 1–6. Third stage larva of *Brachyopa* species. 1–3, *B. scutellaris*; (1) whole larva, dorsal view, length 6 mm; (2) tip of posterior respiratory process, ventral view; (3) tip of posterior respiratory process, apical view. 4–6, left-hand side dorsal views of abdominal segment 2 of (4) *B. insensilis*, (5) *B. bicolor*, (6) *B. pilosa*.

inconspicuous, oval blotches of varying sizes; abdominal segments 1–7 each with four transverse rows of setae: one row anterior and one row posterior to the transverse row of 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; lateral margins with groups of setae surrounding sensilla 4–8; ventral surface coated in backwardly directed spicules, less so on the mesothorax and anal segment; anterior fold of prothorax with a broad (more than 75% of anterior fold) spicule band comprising more than 5 rows and reaching to sensilla 1; dorsum of prothorax with a heavily blotched section such that the blotches run together; prolegs, as weakly developed transverse ridges, present on abdominal segments 1–6 and the mesothorax with up to five crochet-like spicules per proleg becoming less developed on posterior prolegs; sensilla 1–7 on each abdominal segment on a long basal papilla; each sensilla with up to seven 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; posterior respiratory process (prp) (Fig. 2): length 0.9 mm, width at base 0.3 mm, at tip 0.2 mm; basal third with blotches, apical two-thirds with pits; 3 pairs of spiracular slits (Fig. 3).

Material examined

15 larvae from sap-runs at the base of large *Fraxinus excelsior* L. trees, Rassal Ashwood, Wester Ross, Scotland, 27 May 1993; 2 larvae from a sap-run low down (about 30 cm high) on a *Taxus baccata* L. tree, Newbattle Abbey, Midlothian, Scotland, 7 June 1993; 7 larvae from a sap-run at the base of an *Ulmus* coppice stool, Little Sorn Wood, Ayrshire, Scotland, 26 June 1993; 2 larvae from sap-run at the base of *Fraxinus excelsior* L. tree, Myreton Wood, Stirlingshire, Scotland, 26 February 1995, 1 ♂, 1 ♀ emerged April 1995; 1 larva from a sap-run at the base of a *Populus tremula* L. tree, Speybank, Strathspey, Scotland, 23 October 1995.

Key to the third stage larvae of British *Brachyopa* and *Hammerschmidtia* species

1 Dorso-ventrally flattened larva with gradually elongating projections along lateral margins (Fig. 1); posterior respiratory process (prp) dark, longer than broad and marked with pits and striations; four groups of sensilla behind anal opening ..... (***Brachyopa*** and ***Hammerschmidtia***) 2

– Not like this ..... **other syrphid larvae**

2 Dorsal surface of larva evenly coated in setae; abdominal segments 2–6 with sensilla 1 (i.e. the mid-dorsal pair of sensilla) separated from sensilla 2 by an inclined integumental groove such that sensilla 1 is anterior to sensilla 2 .... ***Hammerschmidtia ferruginea***
Under bark of and in sap-runs of Populus tremula L.

– Dorsal surface either lacking setae and instead, body coated in blotch-like markings (Fig. 4), or setae arranged into distinct transverse rows (Figs 5, 6); sensilla 1 not separated from sensilla 2 by a groove and both pairs of sensilla are aligned 3

3 Larva lacking transverse rows of setae, although a few isolated stump-like setae may be present; body coated in dark coloured blotches of various sizes (Fig. 4) ..... ***Brachyopa insensilis***
In sap-runs of various deciduous trees, particularly Aesculus, Quercus, Ulmus
– Larva with rows of setae; body with blotches inconspicuous and pale, or blotches absent 4

4 Rows of setae strictly aligned (Fig. 5); sensilla pairs 1 and 2 of abdominal segments 1–6 with 2 large and 2 small setae ..... ***Brachyopa bicolor***
In sap-runs on Aesculus, Fagus *and* Quercus
– Rows of setae not aligned (Fig. 6); sensilla pairs 1 and 2 usually with more than 2 large setae 5

5 prp >1 mm long, as long as or longer than body width; ventral surface of prp smooth just below tip ..... ***Brachyopa pilosa***
In sap-runs and under bark of Fagus *and* Quercus *(England) and* Populus *(Scotland)*
– prp <1 mm long, shorter than body width; ventral surface of prp with pits just below tip (fig. 2) ..... ***Brachyopa scutellaris***
In sap-runs at base of Fraxinus, Populus, Taxus *and* Ulmus *and probably other deciduous trees*

Discussion

Larvae of the four British *Brachyopa* species are similar in behaviour and ecology. Of the two sites where decaying sap occurs, sap-runs and under bark, all of them occur in sap-runs. If they occur under bark, it is usually loose bark associated with a sap-run. However, McLean & Stubbs (1990) report an instance of *B. pilosa* being found under bark of a *Fagus* log without reference to a sap-run. This is similar to *H. ferruginea* which, although it may occur in sap-runs, is usually found in decaying sap under bark. At many breeding sites small and large *Brachyopa* larvae occur together, even during winter. This suggests larval development takes more than a year.

The larvae of all four *Brachyopa* species are dorso-ventrally flattened and, in the second and third stages, can lift up the prp. These are presumably adaptations to life in a layer of decaying sap and under flaps of bark. When the prp is raised, only the tip protrudes from the sap enabling the larva to respire without exposing itself. First stage larvae overcome this problem in a different way. They can extend the prp sufficiently so that it trails loosely at the surface of the sap, held there by water-repellent setae. This is like the similar-sized third stage larva of the common sap-run breeding acalyptrate, *Aulacigaster leucopeza* (Meigen) (Diptera: Aulacigasteridae) (Robinson, 1953).

All *Brachyopa* larvae and the larva of *H. ferruginea* are, in relation to other syrphid larvae, slow-moving. Other syrphid larvae that live in sap-runs, such as those of *Ferdinandea* Rondani and *Sphegina* Meigen, move at relatively faster rates. Slow movement may be a defence against detection by predators such as the larva of the muscid, *Phaonia subventa* (Harris) (Diptera) (Keilin, 1917) and the dolichopodid, *Systenus pallipes* (von Roser) (Diptera), both of which live in sap-runs, and visiting predators like birds and carabids. As a defence, slow movement may be enhanced in *Brachyopa* larvae by disguise. Parts of the

integument are often coated thickly in dried sap, particularly the basal region of the prp and the fleshy projections at the end of the body. These projections not only break up the body outline but are points of attachment for sap. Dried sap on the body not only makes them difficult to see, but makes them difficult to detect by gustatory or tactile cues.

A further development is seen in the larva of a Nearctic species, *Brachyopa vacua* Osten-Sacken. The posterior end is usually obscured completely by a tangled mass of what seems to be actively growing lichen attached to the depressed region of the 7th abdominal and anal segments, just in front of the prp.

Based on larvae, *B. insensilis* is the most common and widespread British species in the genus. It can sometimes be very numerous with hundreds of larvae present at individual sap-runs. In relation to other *Brachyopa* species it may have an enhanced ability to tolerate desiccation which could help explain its abundance. Coping with desiccation is important as sap-runs frequently dry up. In one comparison, 96% (n=26) of shrivelled *B. insensilis* larvae found in dried-up sap-runs on *Aesculus* recovered completely when given moisture. In contrast, only 65% (n=15) of artificially desiccated larvae of *B. pilosa* recovered when given moisture. The larva of *B. insensilis* differs from other *Brachyopa* larvae in the development of oval-shaped blotches that coat the body and make the integument thick (Fig. 4). These blotches may be important in protecting larvae from desiccation.

The following records are for *B. insensilis* in sap-runs additional to those on *Quercus* and *Aesculus* in Rotheray (1991) and are my own except where stated: 7 larvae from sap-run on *Betula*, Treborth Botanic Garden, Gwynedd, Wales, 18 March 1993, collected by Mike and Liz Howe; Newbattle Abbey, Midlothian: 2 larvae from sap-run at base of an *Acer pseudoplatanus* L. tree, 23 September 1989; 5 larvae from sap-run on *Ulmus*, 3 October 1992; 3 larvae from a sap-run on *Fagus*, 7 July 1993.

The rarest British species is *B. bicolor* which only occurs in southern Britain, particularly in the New Forest and Windsor Forest (Stubbs & Falk, 1983; Falk, 1991). Previous breeding records are for sap-runs on *Ulmus* and in sap-filled borings of caterpillars of *Cossus cossus* (L.) (Lepidoptera: Cossidae) in *Populus* (Lundbeck, 1916). In the New Forest larvae have been found in sap-runs on *Fagus* and *Quercus* (Rotheray, 1991). In addition I collected two larvae from a sap-run on *Aesculus* at Selborne, Hampshire, on 27 March 1990. However, one was parasitized by the eulophid, *Tetrastichus brachyopae* Graham (Hymenoptera), a species known previously only from Czechoslovakia (Graham, 1991). One male *T. brachyopae* and 7 females emerged 7–9.vi.1990.

Based on adults, *B. scutellaris* is the commonest British species in the genus (Stubbs & Falk, 1983). However, during the past four years sap-runs were sampled on *Acer, Aesculus, Betula, Fagus, Quercus, Taxus* and *Ulmus* in many places from southern England to northern Scotland but the larva of *B. scutellaris* was never encountered, even at sites where the adult was known to be common. Nevertheless, few sap-runs at the base of trees were examined, except in the grounds of Chatsworth House, Derbyshire, on 17 May 1990, where I encountered a teneral adult *B. scutellaris* within a mass of accumulated sap at the

base of a *Taxus* tree. All the larvae of *B. scutellaris* found to date have been in sap-runs at the base of trees. Unlike other species in the genus, which seem to utilize sap-runs at whatever height they occur, *Brachyopa scutellaris* females appear to have a preference for oviposition at the base of trees. However, adult *B. scutellaris* certainly occur at sap-runs above ground, possibly feeding and mating rather than breeding there.

In Britain *Brachyopa pilosa* appears to have a disjunct distribution. It is scarce but fairly widespread in southern England with records as far north as Northamptonshire and Coventry (Falk, 1991 and pers. comm.). The only populations north of these points seem to be in the Moray and Cromarty Firth areas of north-east Scotland. Moreover, breeding sites differ between northern and southern populations. In the south McLean & Stubbs (1990) record it from *Fagus* and I also recorded it from that tree and *Quercus* (Rotheray, 1991). In the north, however, it is only known from *Populus tremula* L. (Rotheray, 1991). For example in Glen Shin, Sutherland, on 8 September 1990, sap-runs on *Aesculus, Quercus, Ulmus* and *P. tremula* were found within a few hundred metres of each other but only on the latter species were larvae of *B. pilosa* found. Different breeding sites are far from unusual in Scottish insects (Crowson, 1966; Shaw, 1984).

In Europe, *Brachyopa pilosa* may have become disjunctly distributed and confined to *P. tremula* as it accompanied the northern advance of the latter during the retreat of the ice at the end of the last period of glaciation (O'Sullivan, 1974). Moreover, *B. pilosa* is not the only species involved. A group of five red data book flies from various families are also found only in north-east Scotland on *P. tremula* (MacGowan, 1993). In Norway *B. pilosa* is known from similar habitats as in Scotland, i.e. rich deciduous forests as well as *Betula-Salix* communities (Nielsen, 1992), suggesting similar isolated populations exist there as well. Unfortunately, the breeding sites of Norwegian populations are unknown. However, to the south, in Germany, *B. pilosa* has been found in sap-runs on *Fagus* (C. Kasserbeer, pers. comm.).

Evaluations of the status of *Brachyopa* species have previously relied on adults. There is no doubt, however, that hoverflies breeding in well-defined microhabitats like sap-runs are easier to record in the larval than the adult stage (Rotheray & MacGowan, 1990; Rotheray, 1990). *Brachyopa* larvae are present in sap-runs all year round, so recording is not limited to the short flight period of the adult. Unlike the adults, which tend to be elusive, larvae are generally easy to find within wet sap and particularly under flaps of loose bark over which the sap is flowing (Rotheray, 1993). The key should enable most second and all third stage larvae of the four British species to be identified and so enables their use in future assessments of status and distribution.

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