Chapter 3
Key Parasitoids of the Pests of Oilseed Rape in Europe: A Guide to Their Identification

Andrew W. Ferguson, Ingrid H. Williams, Lynda M. Castle, and Matthew Skellern

Abstract The six major pests of oilseed rape, namely the cabbage stem flea beetle, the cabbage stem weevil, the rape stem weevil, the pollen beetle, the cabbage seed weevil and the brassica pod midge, are reported to host at least 80 species of hymenopteran parasitoids. Of these, 12 key species are widespread and abundant on oilseed rape crops throughout Europe; these species are important for conservation biocontrol of the pests on winter rape. This guide aims to help in their identification. It collates information from previously published keys, other literature and recent extensive examination of specimens and highlights selected key features of relevant taxa from superfamily to species. It is liberally illustrated with figures, newly-drafted and redrawn and/or modified from published literature. A glossary of terms is provided.

3.1 Introduction

This illustrated guide is intended as an aid to the identification of the species of hymenopteran parasitoid most important for conservation biocontrol of the pests of oilseed rape in Europe.

The six major pests of oilseed rape, namely the cabbage stem flea beetle, the cabbage stem weevil, the rape stem weevil, the pollen beetle, the cabbage seed weevil and the brassica pod midge (Table 3.1) are host to at least 80 species of hymenopteran parasitoid from 15 different families. A systematic list and classification of all species is given in Ulber et al. (Chapter 2 this volume); their life-histories, status, and importance are reviewed in Alford (2003). The majority belong to six hymenopteran families: the Ichneumonidae (12 species), the Braconidae (14 species), the Pteromalidae (11 species), the Eulophidae (10 species), the Platygastridae (17 species) and the Proctotrupidae (1 species).

A.W. Ferguson (✉)
Plant and Invertebrate Ecology Department, Rothamsted Research, Harpenden, AL5 2JQ, Hertfordshire, UK
e-mail: andrew.ferguson@bbsrc.ac.uk

I.H. Williams (ed.), *Biocontrol-Based Integrated Management of Oilseed Rape Pests*,
DOI 10.1007/978-90-481-3983-5_3,

Table 3.1 Key parasitoids of the six major pests of oilseed rape in Europe

Host	Parasitoid	Family
Cabbage stem flea beetle, *Psylliodes chrysocephala* (Linnaeus)	*Tersilochus microgaster* (Szépligeti)	Ichneumonidae
Cabbage stem weevil, *Ceutorhynchus pallidactylus* (Marsham)	*Tersilochus obscurator* Aubert	Ichneumonidae
Rape stem weevil, *Ceutorhynchus napi* Gyllenhal	*Tersilochus fulvipes* (Gravenhorst)	Ichneumonidae
Pollen beetle, *Meligethes aeneus* (Fabricius)	*Phradis interstitialis* (Thomson)	Ichneumonidae
	Phradis morionellus (Holmgren)	Ichneumonidae
	Tersilochus heterocerus Thomson	Ichneumonidae
	Diospilus capito (Nees)	Ichneumonidae
Cabbage seed weevil, *Ceutorhynchus obstrictus* (Marsham) syn. *C. assimilis* (Paykull)	*Trichomalus perfectus* (Walker)	Pteromalidae
	Stenomalina gracilis (Walker)	Pteromalidae
	Mesopolobus morys (Walker)	Pteromalidae
Brassica pod midge, *Dasineura brassicae* (Winnertz)	*Platygaster subuliformis* (Kieffer)	Platygastridae
	Omphale clypealis (Thomson)	Eulophidae

Twelve species of parasitoid are sufficiently widespread and abundant on oilseed rape crops throughout Europe to be of key economic importance for conservation biocontrol of pests (Ulber et al. Chapter 2 thisvolume, Table 3.1). They vary in importance with country and season but frequently exceed 50% host parasitism. All are larval endoparasitoids, except those of the cabbage seed weevil, which are larval ectoparasitic.

Hymenopteran parasitoids are difficult to identify to species. Taxonomic literature is widely dispersed, few voucher specimens are readily available and several genera have been recently revised. Consequently, many species records, particularly those in the older literature, are suspect due to possible erroneous identification (Alford 2003).

This guide collates selected information from many different sources, but in particular from the published keys and other publications by Delucci and Graham (1956), Graham (1959, 1963, 1969), Rosen (1964), Askew (1968), Horstmann (1971, 1981), Medvedev (1978), Vlug (1985), Tobias et al. (1986), Bouček and Rasplus (1991), Achterberg (1993), Achterberg and Quicke (2000), Goulet and Huber (1993), Murchie et al. (1999), Noyes (2000), Noyes et al. (2000), Fitton et al. (2000), Vidal (2003), Barari et al. (2005), and Gibson et al. (2005). Additional expertise and information was obtained by examination of specimens (over 39,000) of the key parasitoid species collected from crops of oilseed rape during 2001–2005 in Estonia, Germany, Sweden, Poland and the UK, during the course of the EU-funded project MASTER (QLK5-CT-2001-01447) and through consultation with taxonomic authorities (see Acknowledgements). Voucher specimens of the key species are deposited in collections of partner organisations of the MASTER project (see www.rothamsted.bbsrc.ac.uk/pie/master/master.htm). The guide is liberally

Table 3.2 Systematic list and classification of species of the family Ichneumonidae reported to be parasitic on pests of oilseed rape in Europe

	Host(s)
ORDER HYMENOPTERA	
Superfamily ICHNEUMONOIDEA	
Family ICHNEUMONIDAE	
Subfamily Phygadeuontinae	
Stibeutes Förster	
– *curvispina* (Thomson)	Rape stem weevil
Subfamily Tersilochinae	
Aneuclis Förster	
– *incidens* (Thomson)†	Pollen beetle
– *melanaria* (Holmgren)† (= *diversus* Szépligeti) (= *petiolaris* Szépligeti)	Cabbage stem flea beetle; cabbage seed weevil
Phradis Holmgren	
– *interstitialis* (Thomson)*,†	Pollen beetle
– *morionellus* (Holmgren)*,†	Pollen beetle
Tersilochus Holmgren (= *Tersilochus* Holmgren) (= *Thersilochus* Holmgren)	
– *fulvipes* (Gravenhorst)[a],*,† (= *gibbus* Holmgren)	Rape stem weevil
– *heterocerus* Thomson*,†	Pollen beetle
– *microgaster* (Szépligeti)[b],*,†	Cabbage stem flea beetle
– *obscurator* Aubert[c],*,†	Cabbage stem weevil
– *stenocari* (Gregor)†	Rape winter stem weevil (*Ceutorhynchus picitarsis*)
– *triangularis* (Gravenhorst)†	[not parasitic on rape pests]
– *tripartitus* Brischke[d],†	Cabbage stem flea beetle

Key species are marked*. Species included in this guide are marked†.
[a]Also cited in the literature as *Porizon fulvipes* (Gravenhorst) and as *Thersilochus fulvipes* (Gravenhorst) ssp. *gallicator* Aubert.
[b]Also cited in the literature as *Isurgus microgaster* Szépligeti.
[c]Also cited in the literature as *Thersilochus tripartitus* Brischke spp. *obscurator* Aubert.
[d]Possibly a misidentification of *Tersilochus microgaster* (Szépligeti)†.

illustrated with figures, many new and, where indicated, redrawn and/or modified from the above-listed keys. Examination of vouched specimens of species in conjunction with this guide will aid correct identification. Additional characters to aid identification will be found in the above-mentioned keys.

The guide is arranged in order of the families: Ichneumonidae and Braconidae, the Pteromalidae, the Eulophidae, the Platygastridae and the Proctotrupidae. It lists the key species that are associated with rape pests in each of these families and presents the key characters of the main taxa to which the key species belong, from superfamily to genus (Tables 3.2, 3.3, 3.4, 3.5, and 3.6). The guide is not intended to be a comprehensive taxonomic key but seeks to highlight features that will help to distinguish the key species from others that may be reared from the pests or may be found in oilseed rape crops.

Table 3.3 Systematic list and classification of species of the family Braconidae reported to be parasitic on pests of oilseed rape in Europe

	Host(s)
ORDER HYMENOPTERA	
Superfamily ICHNEUMONOIDEA	
Family BRACONIDAE	
Subfamily Cheloninae	
Sigalphus Latreille	
– *obscurellus* Nees	Rape winter stem weevil; cabbage seed weevil
Subfamily Doryctinae	
Bracon Fabricius	
– *fulvipes* Nees	Cabbage seed weevil
– *variator* Nees	Cabbage seed weevil
(= *discoideus* Wesmael)	
(= *maculiger* Wesmael)	
Subfamily Euphorinae	
Microctonus Wesmael	
– *areolatus* Thomson	Cabbage flea beetle (*Phyllotreta nemorum*)
– cf. *deceptor* Wesmael	Cabbage seed weevil
– *melanopus* Ruthe[a]	Cabbage stem flea beetle; rape winter stem weevil; cabbage seed weevil
– *vittatae* Muesbeck	Cabbage flea beetle (*Phyllotreta nemorum*)
Townesilitus Haeselbarth and Loan	
– *bicolor* (Wesmael)	Cabbage flea beetle (*Phyllotreta nemorum*)
Subfamily Helconinae	
Blacus Nees	
– *nigricornis* Haeselbarth[†]	Pollen beetle
Diospilus Haliday	
– *capito* (Nees)[*,†]	Pollen beetle
– *morosus* Reinhardt[†]	Cabbage stem flea beetle; cabbage seed weevil
– *oleraceus* Haliday[†]	Cabbage stem flea beetle; rape winter stem weevil; cabbage seed weevil
Eubazus Nees (= *Calyptus* Haliday)	
– *sigalphoides* (Marshall)	Pollen beetle
Taphaeus Wesmael	
– *affinis* Wesmael	Cabbage seed weevil
– *tidius* (Walker)	Cabbage seed weevil

Key species are marked*. Species included in this guide are marked[†].
[a]Also cited in the literature as *Perilitus melanopus* Ruthe.

3.2 Key Characters of the Order Hymenoptera, Suborder Apocrita and Superfamilies Ichneumonoidea, the Chalcidoidea, the Platygastroidea and the Proctotrupoidea

The most distinctive and constant feature of the order Hymenoptera is the fusion of the first abdominal segment (the propodeum) with the thorax to form the mesosoma. All other abdominal segments form the metasoma (Fig. 3.1).

Table 3.4 Systematic list and classification of species of the family Pteromalidae reported to be parasitic on pests of oilseed rape in Europe

	Host(s)
ORDER HYMENOPTERA	
Superfamily CHALCIDOIDEA	
Family PTEROMALIDAE	
Subfamily Pteromalinae	
Anisopteromalus Ruschka	
– *calandrae* (Howard)	Cabbage seed weevil
Chlorocytus Graham	
– *diversus* (Walker)	Cabbage seed weevil
Habrocytus Thomson	
– *dispar* (Curtis)	Cabbage seed weevil
– *semotus* (Walker)	Cabbage seed weevil
Mesopolobus Westwood (= *Amblymerus* Walker) (= *Eutelus* Walker) (= *Xenocrepis* Förster)	
– *morys* (Walker)*,† (= *pura* Mayr)	Cabbage seed weevil
Stenomalina Ghesquière	
– *gracilis* (Walker)[a,*,†]	Cabbage seed weevil Rape stem weevil
Trichomalus Thomson	
– *lucidus* (Walker)†	Cabbage stem weevil
– *perfectus* (Walker)*,† (= *decisus* Walker) (= *decorus* (Walker)) (= *laevinucha* (Thomson))	Cabbage seed weevil
Zatropis Crawford	
– sp.	Cabbage seed weevil

Key species are marked*. Species included in this guide are marked†.
[a]Misidentified as *S. muscarum*.

The Hymenoptera are divided into two suborders, the Symphyta (sawflies) and the Apocrita, which comprises the majority of species. In the Apocrita, the first (sometimes the first and second) segment(s) of the metasoma are constricted to form the petiole, a narrow 'waist' or stalk joining the gaster (remaining segments of the metasoma) with the propodeum (Fig. 3.1).

The Apocrita are divided into two main groups, the Aculeata (ants, bees and wasps) and the Parasitica, small wasps whose larvae are usually ecto- or endoparasitic on other insects. The species of Parasitica which are parasitoids of the larvae of the major pests of oilseed rape belong to the four superfamilies: the Ichneumonoidea, the Chalcidoidea, the Platygastroidea and the Proctotrupoidea.

3.2.1 Key Characters of the Superfamily Ichneumonoidea

The superfamily Ichneumonoidea comprises two families: the Ichneumonidae and the Braconidae.

Table 3.5 Systematic list and classification of species of the family Eulophidae reported to be parasitic on pests of oilseed rape in Europe

	Host(s)
ORDER HYMENOPTERA	
Superfamily CHALCIDOIDEA	
Family EULOPHIDAE	
Subfamily Entodoninae	
Neochrysocharis Kurdjumov	
– sp.†	Brassica pod midge
Omphale Haliday (= Secodes Förster)	
– *clypealis* (Thomson)*,†	Brassica pod midge
– *coilus* (Walker)	Brassica pod midge
Subfamily Eulophinae	
Eulophus Müller	
– sp.	Cabbage seed weevil
Subfamily Tetrastichinae	
Aprostocetus Westwood	
– *epicharmus* (Walker)† (= *variegatus* Szelényi)	Brassica pod midge
Necremnus Thomson	
– *tidius* (Walker) (= *duplicatus* Gahan)	Cabbage seed weevil
– *leucarthros* (Nees)	Brassica pod midge
Sigmophora Rondan	
– *brevicornis* (Panzer)	Brassica pod midge
Tetrastichus Haliday	
– *galectobus* (Ratzeburg)	Cabbage seed weevil

Key species is marked*. Species included in this guide are marked†.

1. Basal (head) end of metasoma constricted to form the petiole (Fig. 3.1).
2. Forewing with no costal cell and at least one closed cell which may be open at its basal end or very narrow (Fig. 3.2, not Fig. 3.3).
3. Antennae with 14 or more segments (including scape, pedicel and flagellum) (as in Fig. 3.14).

3.2.2 Key Characters of the Superfamily Chalcidoidea

The superfamily Chalcidoidea is a diverse group with a wide range of hosts. It is the most important group of parasitic Hymenoptera in applied biocontrol (Noyes 1985). It comprises 20 families, including the Pteromalidae and the Eulophidae.

1. Body commonly metallic, often strongly so.
2. Length usually $\leq$ 5 mm, but some > 20 mm.
3. Forewings with no cells enclosed by tubular veins (as in Fig. 3.26).
4. Antennae almost always < 15 segments (including scape, pedicel and flagellum), rarely > 13. Scape elongate and elbowed in appearance, as in ants. Flagellum, especially in females, differentiated into funicle and clava. Clava conspicuously larger than any preceding segment and composed of two or more fused segments. Longitudinal sensilla present on at least one flagellar segment, with

their distal apices free, separated from the cuticle (unique to Chalcidoidea) (as in Fig. 3.27).
5. Prepectus present and separating tegula and pronotum so that they do not touch (as in Fig. 3.28a).

Table 3.6 Systematic list and classification of species of the family Platygastridae reported to be parasitic on pests of oilseed rape in Europe

ORDER HYMENOPTERA
Superfamily PLATYGASTROIDEA
Family PLATYGASTRIDAE
Amblyaspis Förster
– sp.
Inostemma Haliday
– *boscii* (Jurine)
– *walkeri* Kieffer
– nr. *reticulatum* (Szelényi)
Isocybus Förster
– *thomsoni* Kieffer
Piestopleura Förster
– sp.
Platygaster Latreille (= *Prosactogaster* Kieffer)
– *boscii* Nees
– *gladiator* Zetterstedt
– *iolas* Walker†
– *munita* Walker
– *niger* Nees
– *nitida* (Thomson)
– *oebalus* Walker†
– *subuliformis* (Kieffer)*,†
– *tisias* Walker†
Synopeas Förster
– nr. *lugubris* Thomson
– sp.

All are parasitoids of brassica pod midge. Key species is marked*. Species included in this guide are marked†.

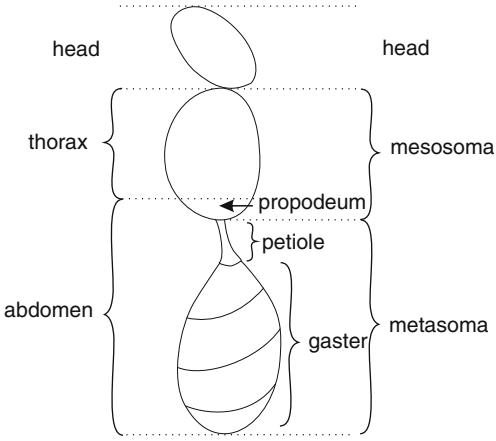

Fig. 3.1 Morphological divisions of the body of the suborder Apocrita (order Hymenoptera)

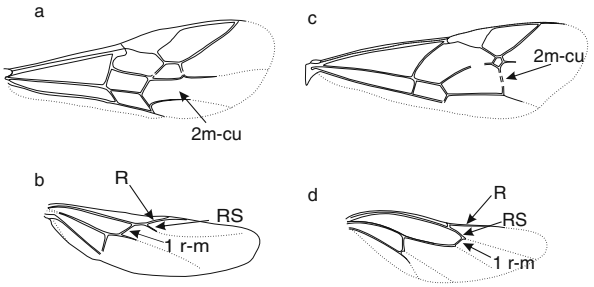

Fig. 3.2 Forewings and hindwings of (**a**) and (**b**) Braconidae, and (**c**) and (**d**) Ichneumonidae (redrawn after van Achterberg and Quicke 2000). Letters indicate the names of veins. Vein 2m-cu is absent in the forewing of Braconidae

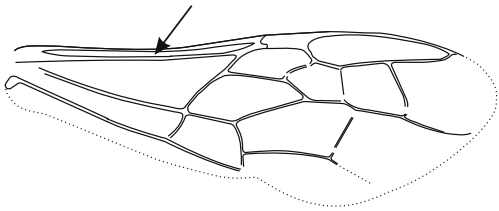

Fig. 3.3 A hymenopteran forewing with costal cell (*arrowed*) (redrawn after Goulet and Huber 1993)

3.2.3 Key Characters of the Superfamily Platygastroidea

The superfamily Platygastroidea comprises two families, the Scelionidae and the Platygastridae.

1. Body rarely metallic
2. Small (forewings 0.5–6.0 mm)
3. Forewing without cells enclosed by tubular veins, many species with no wing veins (as in Fig. 3.49).
4. Ovipositor weakly sclerotised and completely retracted within the metasoma when not in use.
5. Gaster <seven visible tergites. Moderately well sclerotised and dorso-ventrally compressed, sometimes with morphological adaptations (horns, sacks, humps, elongation) to accommodate the length of the ovipositor.
6. Antennae $\leq$12 segments.

3.2.4 Key Characters of the Superfamily Proctotrupoidea

The superfamily Proctotrupoidea is a diverse group including nine families. Most species belong to the families Diapriidae and Proctotrupidae.

1. Non-metallic.
2. Morphologically diverse.

3. Forewing usually with a closed costal cell (as in Fig. 3.54).
4. Strongly sclerotised.

3.3 Parasitoids of the Families Ichneumonidae and Braconidae

The family Ichneumonidae has 39 subfamilies, two of which include parasitoids of rape pests: the Phygadeuontinae and the Tersilochinae. The Phygadeuontinae is a little studied group and there are no good keys to their identification (Horstmann *pers. comm*); it includes only one species reported to attack rape pests. The Tersilochinae includes 12 species (of which six are key species) reported to attack rape pests, all in the genera *Aneuclis*, *Phradis* and *Tersilochus.* They are all small, univoltine, koinobiont larval endoparasitoids of Coleoptera (Table 3.2).

The family Braconidae also includes several species reported to attack oilseed rape pests (Table 3.3). Only one, *D. capito*, is sufficiently widespread and abundant to be considered a key species for biocontrol.

3.3.1 Key Characters of the Family Braconidae

1. Forewing vein 2m-cu absent (Fig. 3.2a). Hindwing vein 1 r-m (also known as rs-m) branches before veins R and RS divide (Fig. 3.2b).
2. Second and third metasomal tergites fused, with two pairs of spiracles (Fig. 3.4a).

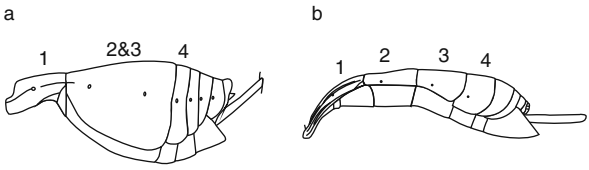

Fig. 3.4 Metasoma of (**a**) Braconidae, and (**b**) Ichneumonidae (redrawn after Goulet and Huber 1993)

Key characters of *Blacus nigricornis*

1. General appearance as in Fig. 3.5.
2. Antennae with 17 (sometimes 18 in males) segments. First two segments (scape and pedicel) rounded and bulbous. Segments after ninth or tenth abruptly shorter (Fig. 3.5).
3. Wing venation with forewing cell 2cu open (Fig. 3.5).
4. Ovipositor long (ca. as long as the hind wing), and gently curved downwards, curve more pronounced towards the tip (Fig. 3.5).
5. Maxillary palps with 6 segments, the fourth longer than the rest; labial palps with three segments.
6. Mesosoma and first metasomal tergite coarsely granulated.

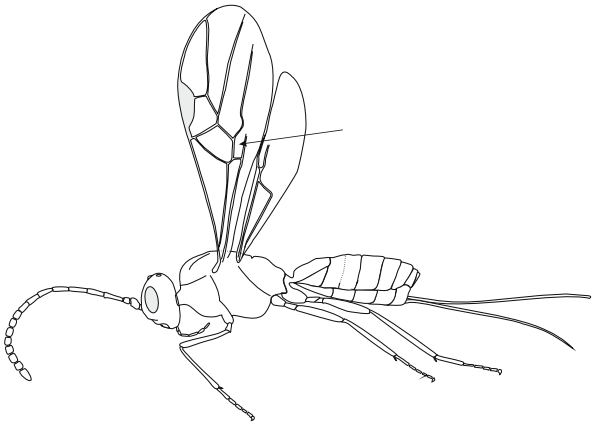

Fig. 3.5 *Blacus nigricornis* ♀. Forewing cell 2cu *arrowed*

Key to *Diospilus spp.*

1. General appearance as in Fig. 3.6.
2. First metasomal tergite slender, subparallel in basal half, largely smooth, may be sculptured at edges (Fig. 3.7a and b). Marginal cell of forewing normal (Fig. 3.8a), not short (Fig. 3.8b)..... *D. capito*

Fig. 3.6 *Diospilus capito* ♀

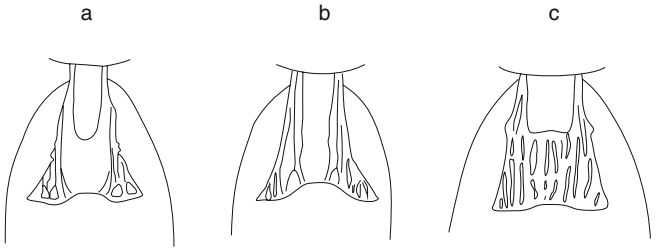

Fig. 3.7 First metasomal tergites of (**a**) and (**b**) two specimens of *Diospilus capito*, (**c**) *Diospilus oleraceus* and *Diospilus morosus*

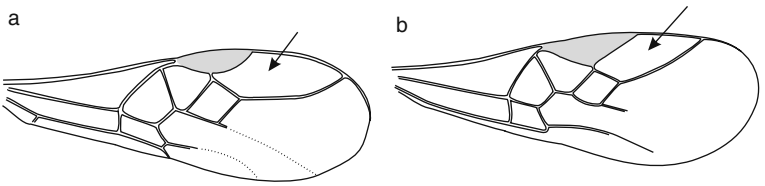

Fig. 3.8 Forewings of (**a**) *Diospilus capito* and *Diospilus oleraceus* and (**b**) *Diospilus morosus* (redrawn after Tobias et al. 1986). Marginal cell *arrowed*

– First metasomal tergite distinctly sculptured, robust and gradually widening towards the apex (Fig. 3.7c).....3

3. Marginal cell of forewing normal (Fig. 3.8a)..... *D. oleraceus*

– Marginal cell of forewing short (Fig. 3.8b)..... *D. morosus*

3.3.2 Key Characters of the Family Ichneumonidae

1. Forewing vein 2m-cu present (Fig. 3.2c). Hindwing vein 1 r-m (also known as rs-m) joins vein RS apically to the division of veins R and RS (Fig. 3.3d).
2. Second and third metasomal tergites usually separate and articulated, as indicated by the single pair of spiracles on each tergite (Fig. 3.4b).

3.3.2.1 Key Characters of the Subfamily Tersilochinae

1. General appearance as Fig. 3.9b.
2. First metasomal tergite (on petiole) with spiracles on its posterior half in most genera, including all species parasitic on rape pests (Fig. 3.10a, b), not at, or in front of, the mid-point (not Fig. 3.10c, d).
3. Forewing vein 2m-cu with single fenestra, not two separate fenestra. Pterostigma short and broad. Forewing areolet open (Fig. 3.11a, not b).

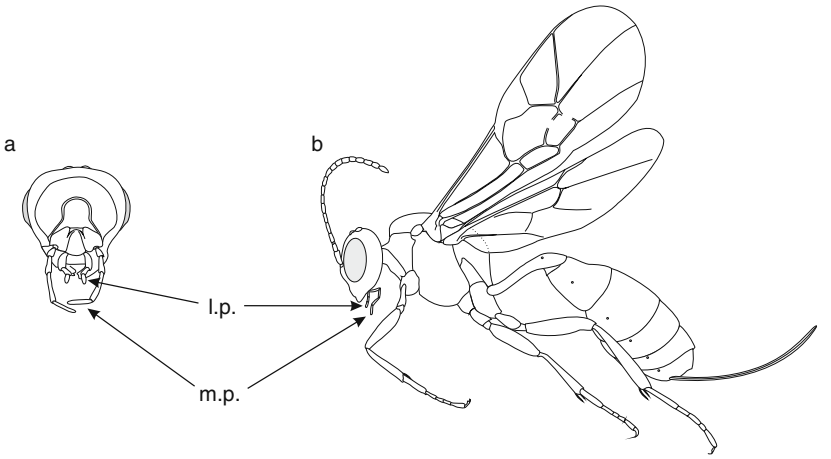

Fig. 3.9 Maxillary (m.p.) and labial palps (l.p.) on (**a**) head, rear view, (**b**) a tersilochine (redrawn after Goulet and Huber 1993)

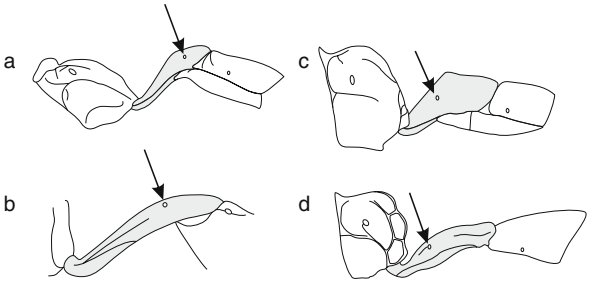

Fig. 3.10 First metasomal tergites (in *grey*): (**a**) and (**b**) as in Tersilochinae; (**c**) and (**d**) not as Tersilochinae (redrawn after Goulet and Huber 1993). *Arrows* indicate spiracles

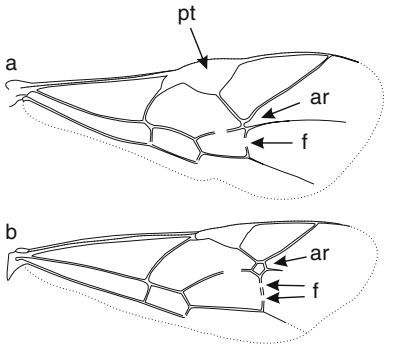

Fig. 3.11 Forewings of Ichneumonidae: (**a**) Tersilochinae, (**b**) not Tersilochinae (redrawn after Goulet and Huber 1993). ar = areolet. f = fenestra. pt = pterostigma

4. Maxillary palps (outer pair around mouth) with four segments, labial palps (inner pair around mouth) with three segments (Fig. 3.9).
5. Lower margin of clypeus with a single comb-like row of regularly-spaced and parallel setae (Fig. 3.12a, not b).

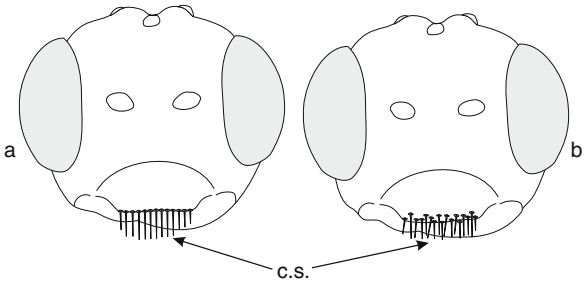

Fig. 3.12 Clypeal setae (c.s.) of (**a**) Tersilochinae, (**b**) other subfamilies (redrawn after Fitton et al. 2000)

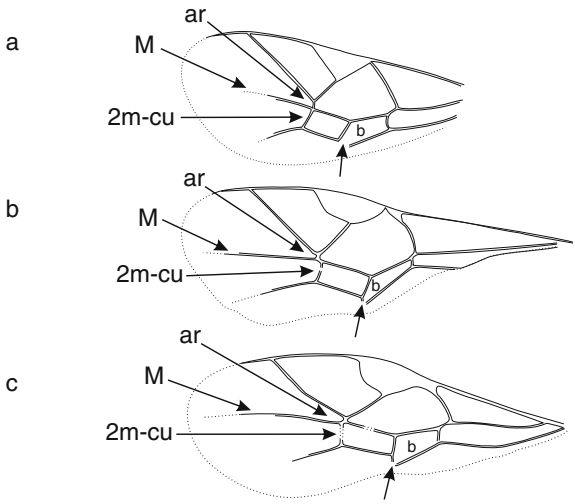

Fig. 3.13 Forewings in (**a**) *Aneuclis* (redrawn after Horstmann 1971), (**b**) *Phradis*, and (**c**) *Tersilochus*. *Arrows* to brachial cells (**b**) indicate their openings. ar = areolet

Key to the Genera *Aneuclis*, *Phradis* and *Tersilochus*

1. Forewing brachial cell wide open (Fig. 3.13a). Forewing vein 2m-cu at least partly pigmented. Ovipositor with a simple curve, not sinuous apically. Head usually granulated.....genus *Aneuclis*

   – Forewing brachial cell closed or nearly so (Fig. 3.13b, c). Maxillary palps clearly shorter than height of head (Fig. 3.9b). Forewing vein 2m-cu joins vein M at or after junction of veins forming the areolet, at most only slightly before it (Fig. 3.13b, c).....2

2. Forewing vein 2m-cu leaves vein M at or slightly before (slightly basal to) the junction of veins forming the areolet (Fig. 3.13b).....genus *Phradis*

   – Forewing vein 2m-cu joins vein M after (apical to) the junction of veins forming the areolet (Fig. 3.13c). Surface of head and thorax completely, or almost

completely, dull and granulated. Path of the sternaulus across the mesopleuron (see Fig. 3.24) is indicated by a series of pits or wrinkles, or by more coarse granulation than the surrounding surface..... genus *Tersilochus*

NB see Horstmann (1981) for more key characters separating the genus *Tersilochus* from 11 other genera.

Key to *Aneuclis* spp.

The five species of the genus *Aneuclis* are difficult to separate. This key separates only *A. incidens* and *A. melanaria*, the two species that parasitise rape pests.

Key characters of *Aneuclis incidens* ♀♀

1. Antennae with 16 segments.
2. Forewing vein 2m-cu usually joins vein M at the junction of veins forming the areolet (Fig. 3.13a), but rarely it joins vein M before (basal to) or after (apical to) this junction.
3. Sternaulus (see Fig. 3.24) not clearly defined or indicated only by coarser granulation along its path across the mesopleuron.

Key characters of *Aneuclis melanaria* ♀♀

1. Antennae with 18 segments.
2. Forewing vein 2m-cu always joins vein M clearly after (apical to) the junction of veins forming the areolet.
3. Path of sternaulus across the mesopleuron (see Fig. 3.24) delineated by wrinkles

Key to *Phradis* spp.

There are 12 species in the genus *Phradis* but this key separates only *P. morionellus* and *P. interstitialis*, both key parasitoids of the pollen beetle.

Key characters of *Phradis morionellus* ♀♂ (see Fig. 2.1).

1. Antennae with 15–16 (sometimes 17) segments; basal segments of flagellum elongate (Fig. 3.14).
2. Ovipositor incised (notched) dorsally just before tip (Fig. 3.15).
3. Thyridiae approximately triangular and not longer than wide (Figs. 3.16 and 3.17).

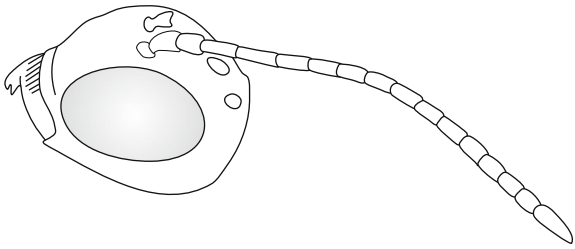

Fig. 3.14 Antenna of *Phradis morionellus*

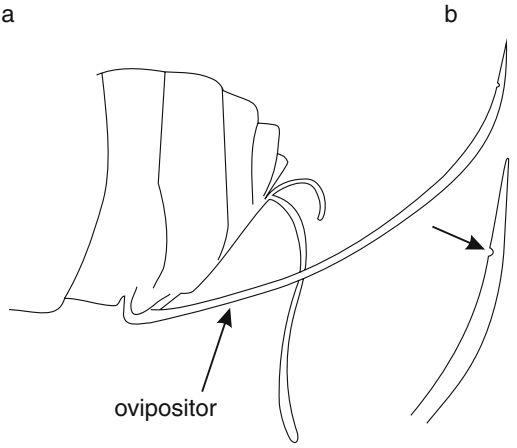

Fig. 3.15 *Phradis morionellus* (**a**) tip of abdomen, and (**b**) tip of ovipositor. Incision *arrowed*

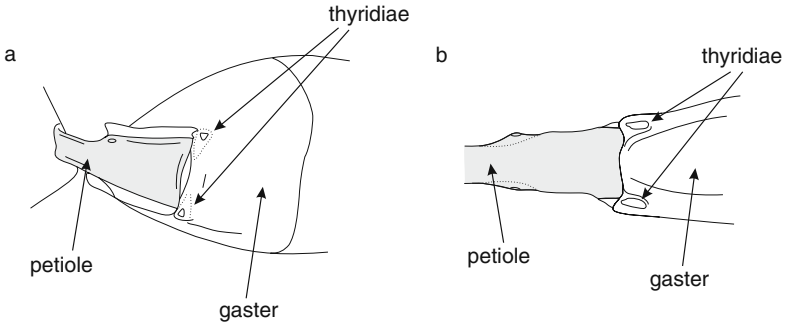

Fig. 3.16 Petiole and gaster of (**a**) *Phradis morionellus*, and (**b**) *Phradis interstitialis*, indicating thyridiae

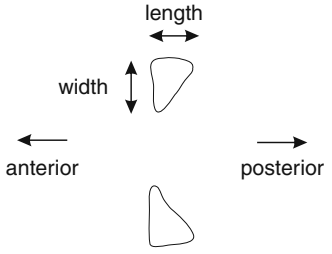

Fig. 3.17 Shape of the thyridiae in *Phradis morionellus*, indicating their length and width

Key characters of *Phradis interstitialis* ♀♂

1. Antennae with 17–18 segments (up to 20 in males).
2. Ovipositor slender, with an upward curve that increases towards the tip and not incised dorsally just before tip (Fig. 3.18, not Fig. 3.15)
3. Thyridiae oval and 1.5–2 times as long as wide (Fig. 3.16b)

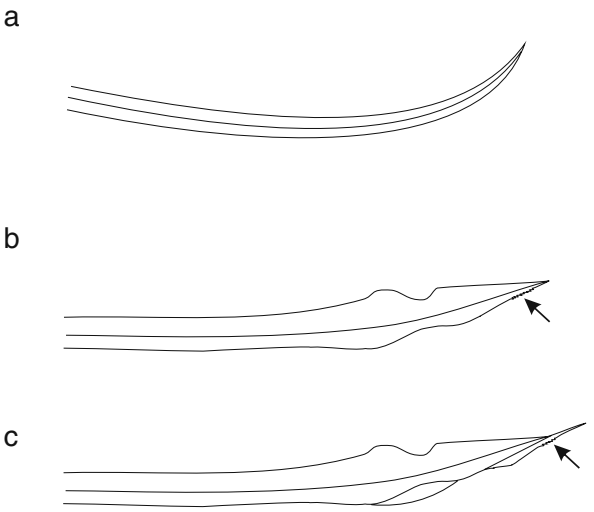

Fig. 3.18 Ovipositor tips of (**a**) *Phradis interstitialis*, and (**b**) and (**c**) *Tersilochus heterocerus*. In (**c**) one ventral component of the ovipositor is extended as when sawing through host cuticle. *Arrows* indicate finely serrated areas

Key to *Tersilochus* spp.

Eight species of the genus *Tersilochus* are reported to attack coleopteran pests of rape; four are key species. Species can be hard to separate. Males of groups *jocator* or *obliquus* cannot be determined to group or to species. Tersilochines of the group *obliquus* are not known to be parasitoids of oilseed rape pests.

1. Ovipositor tip evenly incised dorsally and lacking fine teeth ventrally. Antennae with 24 segments.....*Tersilochus stenocari* ♀

   – Ovipositor tip toothed dorsally and with fine or shallow teeth ventrally..... 2

2. Fourth antennal segment shorter than third and fifth segments (Fig. 3.19). Antennae with 16 (sometimes 15 or 17) segments. Ovipositor slightly and smoothly curved upwards, dorsally clearly toothed, ventrally shallowly toothed

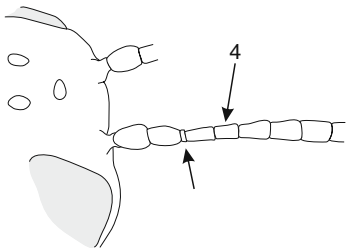

Fig. 3.19 Antenna (proximal segments) of *Tersilochus heterocerus* indicating segment 4. *Arrowed* annulus is not a segment

Fig. 3.20 Ovipositor tips of (**a**) *Tersilochus* spp. group *jocator*, and (**b**) *Tersilochus* spp. group *obliquus* (redrawn after Horstmann 1971)

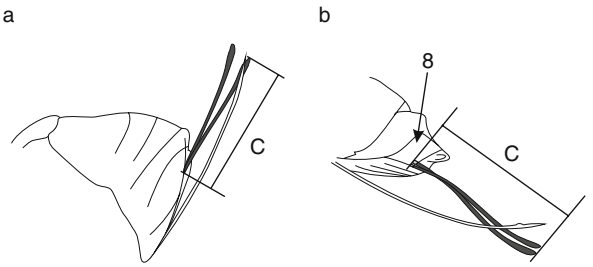

Fig. 3.21 (**a**) and (**b**) ovipositor sheaths of *Tersilochus obscurator* indicating measurement of their length, C. Proximal end of the sheath may be concealed behind the eighth metasomal tergite (*arrowed*) as in (**b**)

and finely serrated close to tip (Fig. 3.18b, c)..... *Tersilochus heterocerus* ♀♂ (see also Fig. 2.2).

– Length of antennal segments decreasing from the third segment onwards..... 3

3. Ovipositor tip with two dorsal teeth and fine teeth ventrally (Fig. 3.20a). Antennae with 21–27 segments ..... *Tersilochus* spp. group *jocator* ♀.... 4

– Ovipositor tip convex dorsally; ovipositor variably and shallowly incised distally, both dorsally and sometimes ventrally (Fig. 3.20b). Antennae 19–24 segments ..... *Tersilochus* spp. group *obliquus* ♀

4. Length of ovipositor sheaths ≤ length of first metasomal tergite (Figs. 3.21 and 3.22) ..... *Tersilochus triangularis* ♀
NB *Tersilochus triangularis* is not known as a parasitoid of rape pests.

– Length of ovipositor sheaths > length of first metasomal tergite 5

5. Ovipositor sheath: first metasomal tergite ratio ('sheath ratio') ≥ 2.0 (Figs. 3.21 and 3.22). Sternaulus weakly defined by a line of pits spanning 25–50% of the mesopleuron (Figs. 3.23 and 3.24), centrally or forward of its centre, and not

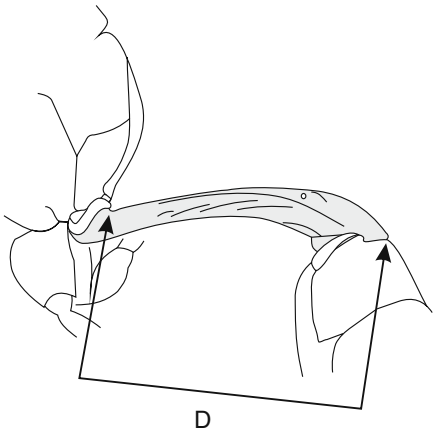

Fig. 3.22 First metasomal segment (= petiole; in *grey*) of *Tersilochus obscurator* indicating measurement of the length, D, of its tergite

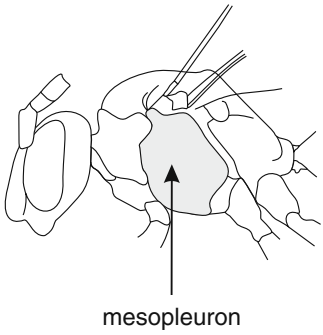

Fig. 3.23 Head and thorax of an hymenopteran indicating the mesopleuron (redrawn after Goulet and Huber 1993)

reaching its anterior nor posterior margins. Antennae with 25 or 26 segments ..... *Tersilochus fulvipes* ♀

– Ovipositor sheath: first metasomal tergite ratio ('sheath ratio') ≤ 1.9 (Figs. 3.21 and 3.22)..... 6

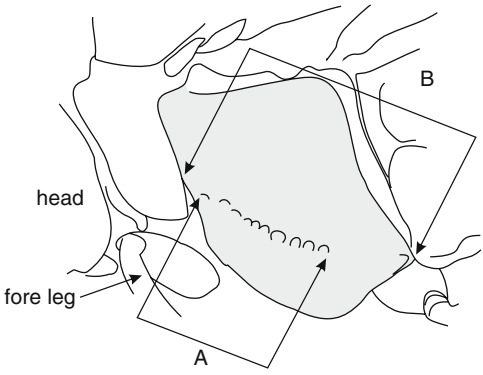

Fig. 3.24 Mesopleuron (in *grey*) of *Tersilochus microgaster* indicating measurement of sternaulus (*B*) and of the line of pits along it (*A*)

6. Ovipositor sheath: first metasomal tergite ratio 1.1–1.5 (Figs. 3.22 and 3.23). Sternaulus clearly defined by a line of pits spanning ≥50% of its path across the mesopleuron (Fig. 3.24).....7

   – Ovipositor sheath: first metasomal tergite ratio 1.4–1.9 (average 1.6) (Figs. 3.21 and 3.22). Sternaulus usually only weakly defined by a line of pits spanning 0–70% (average 40%) of its path across the mesopleuron as measured in Fig. 3.24, the pits often not reaching the anterior margin of the mesopleuron, never reaching its posterior margin. Antennae with 21–26 segments, commonly 23..... *Tersilochus obscurator* ♀

7. Ovipositor sheath: first metasomal tergite ratio 1.1–1.5 (average 1.3) (Figs. 3.21 and 3.22). Sternaulus clearly defined by a line of pits spanning 50–85% (average 70%) of its path across the mesopleuron, sometimes reaching its anterior margin, never reaching its posterior margin (Fig. 3.24). Petiole, measured in the last third of the distance from the mesosoma to the spiracles (Fig. 3.25a, b), broader than high in transverse section, flattened dorsally and with longitudinal ridges (carinae) laterally (Fig. 3.25c). Antennae with 21–23 segments..... *Tersilochus microgaster* ♀

   – Sternaulus with line of pits almost across entire mesopleuron Petiole, measured in the last third of the distance from the mesosoma to the spiracles (Fig. 3.25a, b), round in cross-section with only weak longitudinal ridges (carinae) laterally (Fig. 3.25d). Antennae ≤ 24 segments..... *Tersilochus tripartitus* ♀

NB Reports in the literature that *Tersilochus tripartitus* is a parasitoid of the cabbage stem flea beetle may have resulted from erroneous identification of *T. microgaster* (Ulber et al. Chapter 2 this volume).

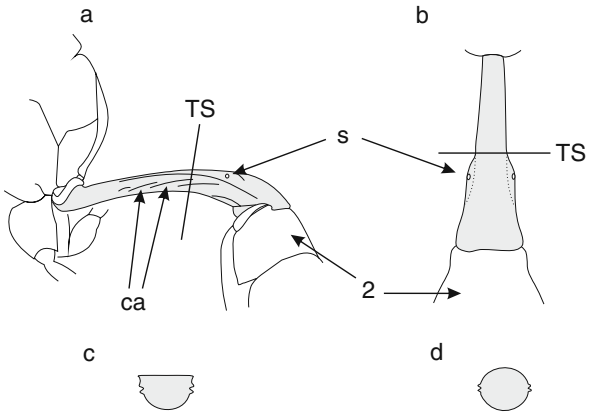

Fig. 3.25 Petioles (in *grey*) of a tersilochine in (**a**) lateral view, and (**b**) dorsal view, to indicate location (TS) of (**c**) and (**d**), transverse sections of (**c**) *Tersilochus microgaster*, and (**d**) *Tersilochus tripartitus*. ca = carinae. s = spiracle. 2 = second metasomal tergite

3.4 Parasitoids of the Family Pteromalidae

The family Pteromalidae is large and varied and species can be hard to separate. It includes nine species known to attack rape pests, including the three key species *Mesopolobus morys*, *Stenomalina gracilis* and *Trichomalus perfectus* (Table 3.4). All three are larval ectoparasitoids of weevils.

3.4.1 Key Characters of the Pteromalidae

1. Head and body metallic colour.
2. Head + body length 2.5–4 mm.
3. Forewings with no cells enclosed by tubular veins, veins represented by creases or lines of hairs. Forewing membrane clear ('hyaline'), not shaded or reticulate. Anterior margin of forewing without conspicuous long dark bristles. Hind-wing normal, not long and stalked (Fig. 3.26b, not c).
4. Antennae with 13 segments, differentiated into scape, pedicel and flagellum. Scape elongate, giving an elbowed appearance as in ants. Flagellar segments differentiated into two or three small anelli, five or six segments in the funicle and three distal segments fused to form the clava. Longitudinal sensilla present on at least one flagellar segment of the antennae with their distal apices free, separated from the cuticle (Fig. 3.27).
5. Mesosoma with prepectus present and clearly defined, separating tegula and pronotum so they do not touch. Prepectus not obviously smaller than tegula in side view. Mesopleuron divided into two parts, the mesepisternum and mesepimeron. Scutellum not conspicuously hairy (Fig. 3.28).

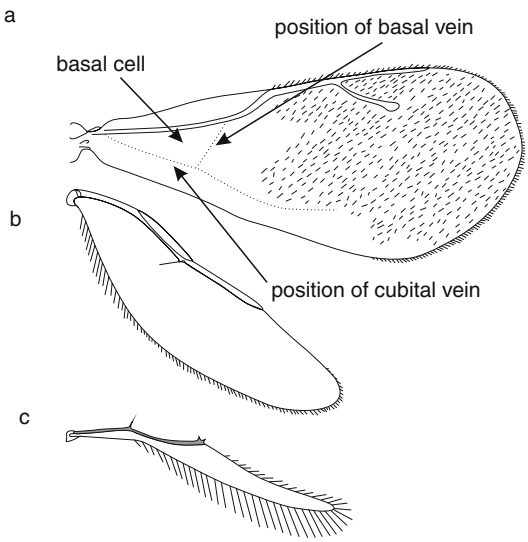

Fig. 3.26 (**a**) Forewing, and (**b**) hind wing of Pteromalidae (modified after Bouček and Rasplus 1991). (**c**) stalked hind wing not found in Pteromalidae (redrawn after Goulet and Huber 1993)

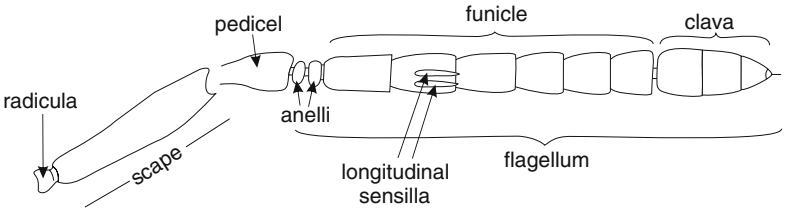

Fig. 3.27 Antenna of Pteromalidae (redrawn after Graham 1969)

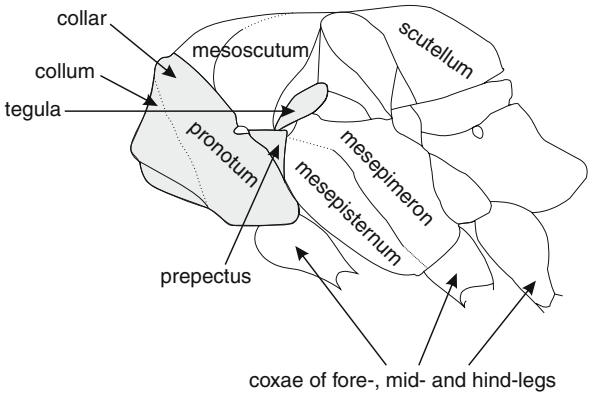

Fig. 3.28 Mesosoma (lateral view) of Pteromalidae (redrawn after Bouček and Rasplus 1991)

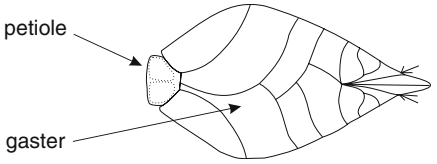

Fig. 3.29 Metasoma (ventral view) of Pteromalidae (redrawn after Bouček and Rasplus 1991)

6. Gaster constricted at its junction with the petiole. Petiole small (Fig. 3.29).
7. Legs all with five tarsal segments.

3.4.2 Key to Mesopolobus morys, Stenomalina gracilis, Trichomalus perfectus *and* Trichomalus lucidus

1. Antennae with three anelli and five funicular segments (Fig. 3.30).
   ..... could be *Mesopolobus morys*
   ..... see key characters of *M. morys* below.

   – Antennae with two anelli and six funicular segments (Fig. 3.30b, c)
   2

2. Anterior margin of clypeus with a central tooth flanked by two slightly shorter teeth (Fig. 3.31b). Base of central tooth forms a slight vertical ridge in the clypeus.
   .....could be *Stenomalina gracilis*
   ..... see key characters of *S. gracilis* below.

   – Anterior margin of clypeus with no central tooth but is shallowly notched, giving a wavy appearance with two shallow teeth (Fig. 3.31c)..... could be *Trichomalus* spp.
   ..... see key characters of *Trichomalus perfectus* and *T. lucidus* below.

Key characters of *Mesopolobus morys*

1. Antennae with three anelli and five funicular segments (as in Fig. 3.30a)
2. Mesoscutum not conspicuously or densely hairy (Fig. 3.28).
3. Clypeal anterior margin with no teeth but truncate with small notches either side. Sculpture on clypeus granulated (with faint striations radiating from anterior margin) and virtually indistinguishable from sculpture on frons (Fig. 3.31a).
4. Dorsal anterior margin of pronotal collar (Fig. 3.28) rounded, its edge not sharply defined and angular, so separation between pronotal collar and collum less distinct than in *T. perfectus* and *S. gracilis* (Fig. 3.32a, not b or c).
5. Basal cell of forewing (Fig. 3.26) bare, with no hairs within it and few or none outlining it (Fig. 3.33a, not b or c).

Description of *Mesopolobus morys*

Overall rather squat in appearance. Colour when fresh: head and all body strongly iridescent metallic black/green; legs pale yellow except for the proximal 75% of femora and final tarsi, which are very dark brown. Antennae rather club-like, i.e., flagellum gets wider up to the clava. The first segment of the clava is the widest antennal segment. Funicular segments not longer than broad (Fig. 3.30a) (see also Fig. 2.7).

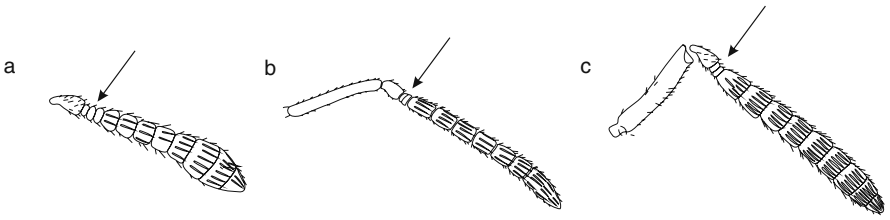

Fig. 3.30 Antennae of (**a**) *Mesopolobus teliformis* (redrawn after Graham 1969), (**b**) *Stenomalina gracilis* and (**c**) *Trichomalus perfectus* (redrawn after Graham 1969). Anelli *arrowed*

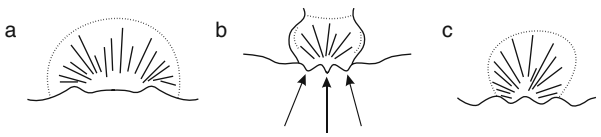

Fig. 3.31 Clypeal margin of (**a**) *Mesopolobus morys*, (**b**) *Stenomalina gracilis* (modified after Bouček and Rasplus 1991), and (**c**) *Trichomalus perfectus.* Teeth *arrowed*

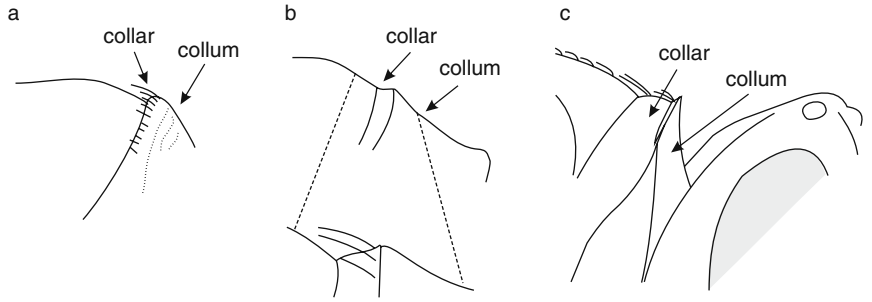

Fig. 3.32 Pronotal collar of (**a**) *Mesopolobus morys*, (**b**) *Stenomalina gracilis*, and (**c**) *Trichomalus perfectus*

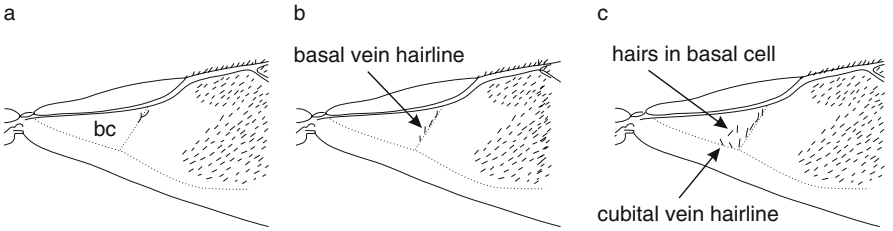

Fig. 3.33 Forewing basal cell (bc) hairs as in (**a**) *Mesopolobus morys*, (**b**) *Stenomalina gracilis*, and *Trichomalus perfectus* (redrawn after Bouček and Rasplus 1991)

Key characters of *Stenomalina gracilis*

1. Antennae slender with two anelli and six funicular segments (Fig. 3.30b).
2. Clypeus with central tooth flanked by two slightly shorter teeth on anterior margin (Fig. 3.31b). Base of central tooth forms a slight vertical ridge on clypeus. Sculpture of clypeus merges with reticulate sculpture of frons with clear striations radiating from anterior margin of clypeus.
3. Pronotal collum (Fig. 3.28) dorsally concave in profile and forward-extended. Dorsal anterior margin of pronotal collar upwardly produced and angular but less so than in *T. perfectus* (Fig. 3.32b, not c).
4. Basal cell of forewing (Fig. 3.26a) with hairs on basal hairline but no hairs within cell or on cubital vein (Fig. 3.33b, not c).

Description of *Stenomalina gracilis*

Overall long and slender in appearance. Colour when fresh: head and mesosoma metallic colour ranging from bronze-red with a green iridescence to black-green with a strong green iridescence, the abdomen being less iridescent and more bronze. Wet specimens appear less green. Tibiae, fibiae and tarsi all straw-yellow except for final tarsal segment which is dark brown. Antennae slender, basally barely wider than scape, at least the first two funicular segments longer than broad (see also Fig. 2.6).

Key characters shared by *Trichomalus perfectus* and *T. lucidus*

1. Antennae with two anelli and six funicular segments (Fig. 3.30c)
2. Anterior margin of clypeus with a wavy appearance comprised of two shallow teeth, one each side of a central shallow notch (Fig. 3.31c)
3. Pronotal collar smooth at its dorsal anterior margin with a raised and sharply-defined angular edge (Fig. 3.32c, not b).
4. Basal cell of forewing (Fig. 3.26a) with no hairs or few hairs (ca. one to three) within it. Basal hairline with hairs throughout its length. Variable numbers (usually none to four) of hairs on cubital vein, sometimes cubital vein hairy throughout (Fig. 3.33c).
5. Gaster first tergite conspicuously hairy laterally (not with only a few hairs as in *Pteromalus* spp.) (Fig. 3.34a, b).
6. Hind coxa (dorsal surface) hairy basally (nearest body) (Fig. 3.34). Dorsal hairs not restricted to distal (far) end of hind coxa as in *Pteromalus* spp.

Key characters distinguishing *Trichomalus perfectus* and *T. lucidus*

– Hind coxa basally with dorsal hairs curved and dense giving a ‘furry’ appearance (Fig. 3.34). Forewing marginal vein: stigmal vein ratio 1.4–1.6 (for vein nomenclature see Fig. 3.36). Propodeum with hairs arising from an area lateral to the plical carina leaving a bare area on the lateral surface of the propodeum distinctly anterior to the nucha and approximately square (Fig. 3.35a)
..... *Trichomalus perfectus*

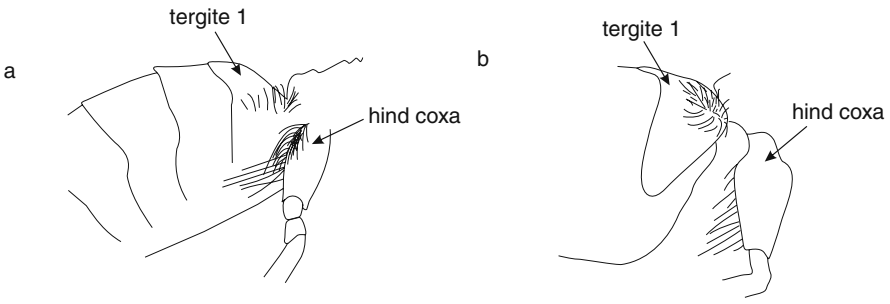

Fig. 3.34 Gaster and hind coxa of (**a**) *Trichomalus perfectus*, and (**b**) *Trichomalus lucidus*

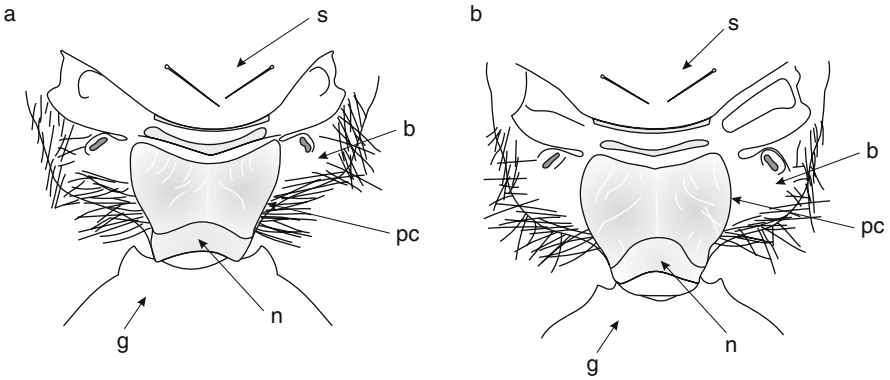

Fig. 3.35 Propodeum of (**a**) *Trichomalus perfectus*, and (**b**) *Trichomalus lucidus* (drawn after Gibson et al. 2005). b = bare area. g = gaster. n = nucha. pc = plical carina. s = scutellum

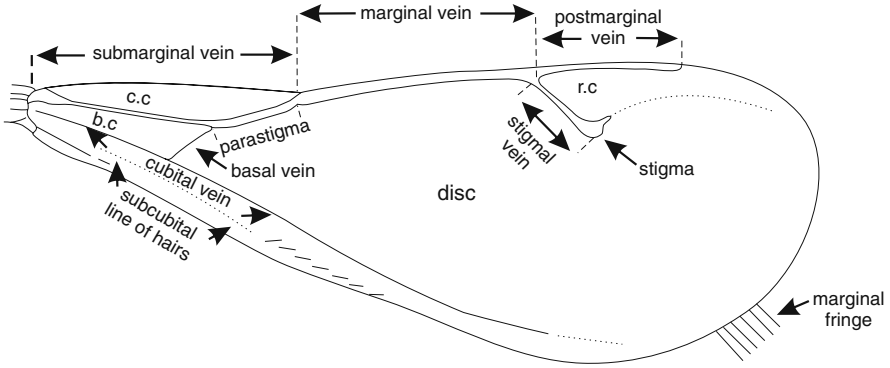

Fig. 3.36 Forewing of Eulophidae (redrawn after Graham 1959). b.c. = basal cell. c.c. = costal cell. r.c. = radial cell

– Hind coxae with dorsal proximal hairs spiny and sparse. Forewing marginal vein: stigmal vein ratio 1.65–1.85 (for vein nomenclature see Fig. 3.36). Propodeum with hairs arising from an area extending laterally and diagonally forwards from a point on the plical carina close to the nucha, leaving a bare area on the lateral surface of the propodeum that extends backwards in an acute angle towards the plical carina – nuchal juncture (Fig. 3.35b)..... *Trichomalus lucidus*

Description of *Trichomalus perfectus*

Overall appearance stocky and powerful. Head and body metallic bronze-red with some green iridescence, most obvious on head and mesosoma. Legs pale brown to pale yellow. Hind coxa (dorsal surface) densely hairy proximally. Clypeus with strong striations radiating from its anterior margin and radiating striations continue in the reticulate sculpture of the frons (Fig. 3.31c) (See also Fig. 2.5).

Description of *Trichomalus lucidus*

Overall appearance similar to *T. perfectus*. Head and body iridescent dark copper-green. Legs yellow to orange. Hind coxa (dorsal surface) clearly but sparsely hairy proximally.

3.5 Parasitoids of the Family Eulophidae

The Eulophidae comprises four subfamilies: the Entodoninae, the Tetrastichinae, the Eulophinae and the Euderinae, the first three of which include species reported to attack brassica pod midge and cabbage seed weevil on oilseed rape (Table 3.5). The Entodoninae includes *Omphale clypealis*, a key parasitoid of brassica pod midge. The Tetrastichinae are mostly endoparasitoids of the eggs, larvae and pupae of Diptera, Hymenoptera or Lepidoptera, although some are ectoparasitoids or hyperparasitoids. This is a guide to females only.

3.5.1 Key Characters of the Family Eulophidae

1. Body almost always at least partly metallic-coloured.
2. Forewing with typical chalcid forewing venation. Forewing membrane not reticulate. Marginal vein distinct and several times longer than broad (Fig. 3.36).
3. Hindwing not long and stalk-like (not Fig. 3.26c).
4. Mesosoma with prepectus as big, or bigger, than the tegula in side view (Fig. 3.37). Mesoscotum with notauli distinctly curved when complete (Fig. 3.38a).

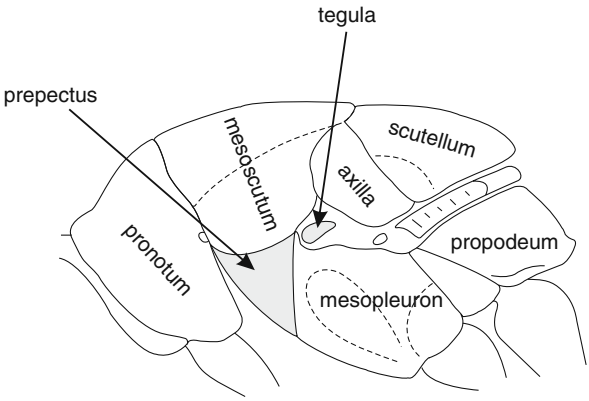

Fig. 3.37 Mesosoma (lateral view) of Eulophidae (redrawn after Graham 1959)

5. Forelegs and middle legs similar in size. Coxae of hind legs approximately cylindrical not flattened (Fig. 3.39, not Fig. 3.40). Hind femurs not swollen (not Fig. 3.41). Hind tibia without darker bristles arranged in a conspicuous pattern. Foretibial spur straight. Tarsi of all legs with four segments (Fig. 3.42).
6. Gaster distinctly constricted at junction with propodeum.
7. Antennae with five or fewer funicle segments (Fig. 3.43a, b).

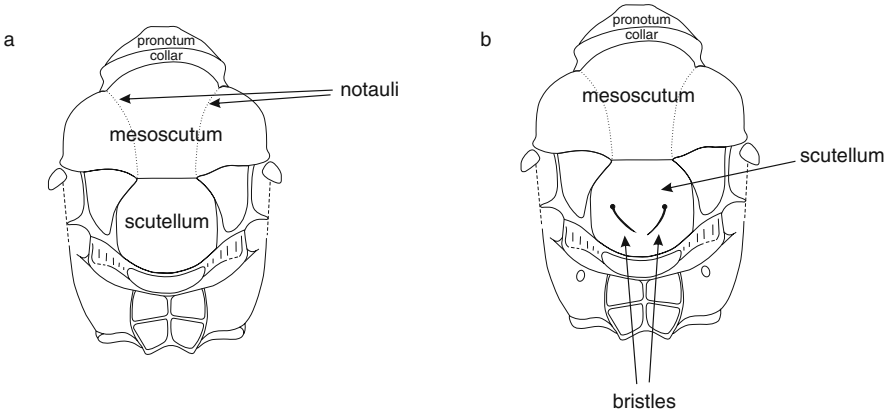

Fig. 3.38 Mesosoma (dorsal views) of (**a**) Eulophidae, and (**b**) Entedoninae (modified after Graham 1959)

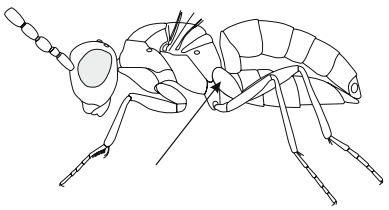

Fig. 3.39 Chalcidoid with cylindrical hind coxa (*arrowed*) (redrawn after Goulet and Huber 1993)

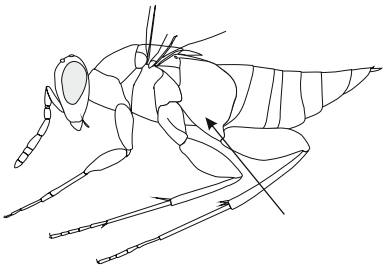

Fig. 3.40 Chalcidoid with flattened hind coxa (*arrowed*) (redrawn after Goulet and Huber 1993)

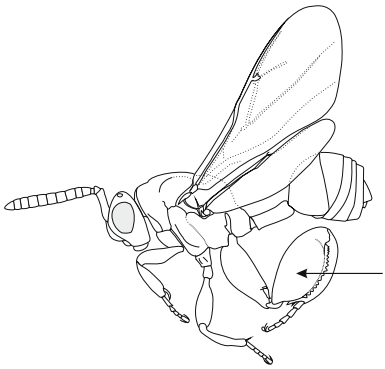

Fig. 3.41 Chalcidoid with swollen hind femur (*arrowed*) (redrawn after Goulet and Huber 1993)

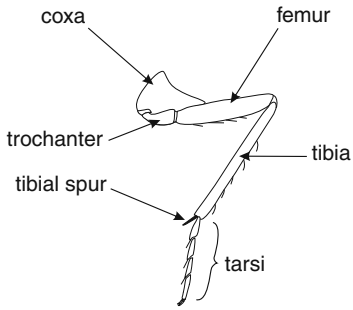

Fig. 3.42 Mid leg of *Omphale clypealis*

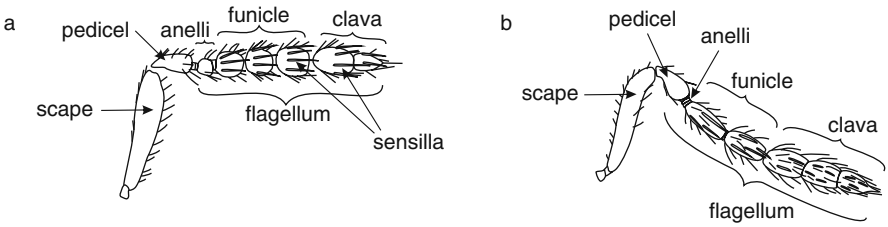

Fig. 3.43 Antenna of (**a**) Eulophidae (redrawn after Graham 1959), and (**b**) *Omphale clypealis*

3.5.1.1 Key Characters of Subfamilies Entodoninae and Tetrastichinae

1. Wing size normal.
2. Scutellum with two bristles near its middle and without a pair of longitudinal grooved lines either side of midline (Fig. 3.38b) ..... Entedoninae

– Scutellum with four bristles and a pair of longitudinal grooved lines either side of midline. Postmarginal vein of forewing (Fig. 3.36) absent or rudimentary..... Tetrastichinae

Entedoninae: Characters distinguishing *Neochrysocharis* spp. and *Omphale clypealis*

1. Clypeus same colour as rest of head. Antennae clearly with two funicle segments and three closely-fused clava segments..... *Neochrysocharis* sp.

– Clypeus (Fig. 3.44) pale lemon-yellow. Antenna with two funicle segments (Fig. 3.43b) and first of the three claval segments less tightly fused to second segment than the second is to the third..... *Omphale clypealis*

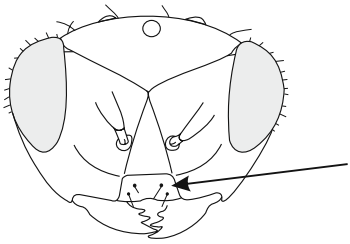

Fig. 3.44 Head of *Omphale clypealis*. Clypeus *arrowed*

Description of Omphale clypealis (after Graham 1963)

Body mainly green to blue-green (less so when wet). Gaster ovate, as long or slightly longer than head plus thorax. Clypeus entirely yellow, almost flat, shape as Fig. 3.44. Lower part of face with reticulate sculpture. Antennal flagellum black with two-segmented funicle and well-defined, three-segmented clava that is slightly broader than the funicle. Forewing with few, if any, hairs in the radial cell, the stigma rhomboidal and with the post-marginal vein slightly shorter than the stigmal vein (See also Fig. 2.10).

Tetrastichinae: Characters distinguishing *Aprostocetus epicharmus* from other Tetrastichinae attacking rape pests

1. Top of head with no ridge behind the lateral ocelli.
2. Mesosoma and metasoma weakly tinted with olive-blue and sometimes with much yellow (NB other species of Tetrastichinae are also strongly yellow-coloured).

3.6 Parasitoids of the Family Platygastridae

The family Platygastridae comprises about 1,000 known species, all endoparasitoids, mostly of Diptera, particularly the Cecidomyiidae. More than a third belong to the genus *Platygaster* (Vlug 1995) which includes *Platygaster subuliformis*, a key parasitoid of the brassica pod midge (Table 3.6). This is a guide to females only.

3.6.1 Key Characters of the Genus Platygaster

1. General appearance (of ♂) as in Fig. 3.45.
2. Forewings and hindwings with no veins (Fig. 3.45).
3. Antenna with 10 segments: scape, pedicel and eight flagellar segments (Fig. 3.46).
4. Petiole simple, not with a forward-extending cornutus as in *Inostemma* spp (Fig. 3.47).
5. Scutellum dome-shaped with a rounded posterior edge (Figs. 3.45 and 3.48a), not elongated into a backward-directed spine as in *Synopeas* spp (Fig. 3.48b).

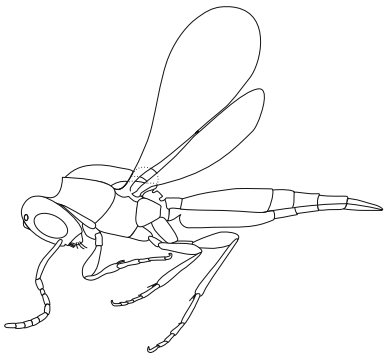

Fig. 3.45 Typical platygastrid (redrawn after Goulet and Huber 1993)

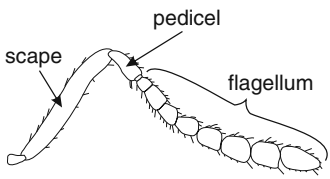

Fig. 3.46 Antenna of *Platygaster subuliformis* ♀ (redrawn after Murchie et al. 1999)

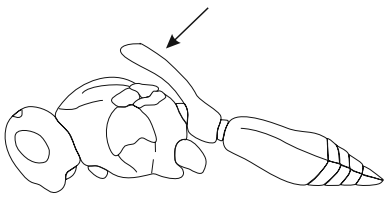

Fig. 3.47 *Inostemma boscii* (redrawn after Medvedev 1978). Cornutus *arrowed*

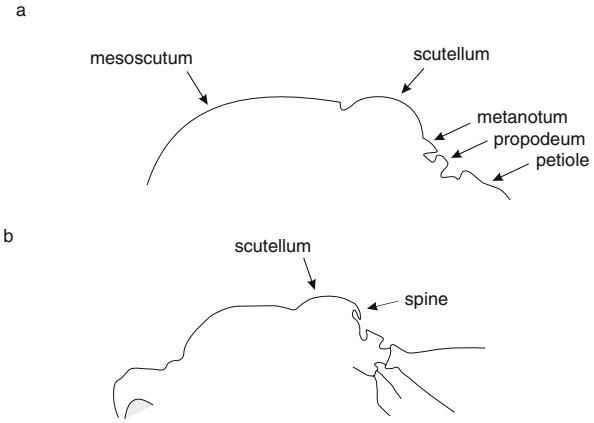

Fig. 3.48 Mesosoma (dorsal profiles) of (**a**) *Platygaster subuliformis* ♀ with dome-shaped scutellum and no spine, (**b**) a platygastrid with a backward-directed spine

Four other species of *Platygaster* could be confused with *Platygaster subuliformis*: *P. oebalus* (especially close), *P. tisias, P. iolas* and *P. munita.* The first three are reported to parasitise the brassica pod midge and hence may be found in oilseed rape. *Platygaster munita*, although a closely-related species, has not been associated with the brassica pod midge. It is therefore unlikely to be found in rape crops and is not considered further here.

Key characters of *Platygaster subuliformis* ♀♀ (See also Fig. 2.9).

1. General appearance as in Fig. 3.45.
2. Length 1.7–1.9 mm.
3. Colour black except for tarsi and extremities of femora and tibiae, which are brown.
4. Wings transparent (hyaline) and colourless, not smoky grey-brown ('infuscated') as in *P. munita* and *P. tisias*. Surface of both wings covered with fine evenly-spaced hairs except for a bare patch near base of forewing (chalcid speculum). Forewing edge with short fringe of marginal hairs, a little longer distally and towards the trailing edge (posterior margin), but not markedly so (Fig. 3.49a, not b).
5. Scutellum domed and rounded (Fig. 3.48a).
6. Gaster with a forward-projecting protrusion of first sternite (Fig. 3.50a, not b). Gaster elongated (Fig. 3.51a), not like *P. iolas* (Fig. 3.51b). Gaster with third tergite wider than long (Fig. 3.51a) but less markedly so than in *P oebalus* (Fig. 3.51c) and *P. tisias* (Fig. 3.51d).
7. Antennae with 10 flagellar segments, only segments four and 10 longer than wide (Fig. 3.52a, not b, c, d).
8. Vertex (top of head) with fine reticulate (network-like) sculpture which looks more transverse (cross-ways to length of insect) behind the lateral ocelli. Vertex not with the strongly transverse and coarse sculpture that is present in *P. oebalus.*

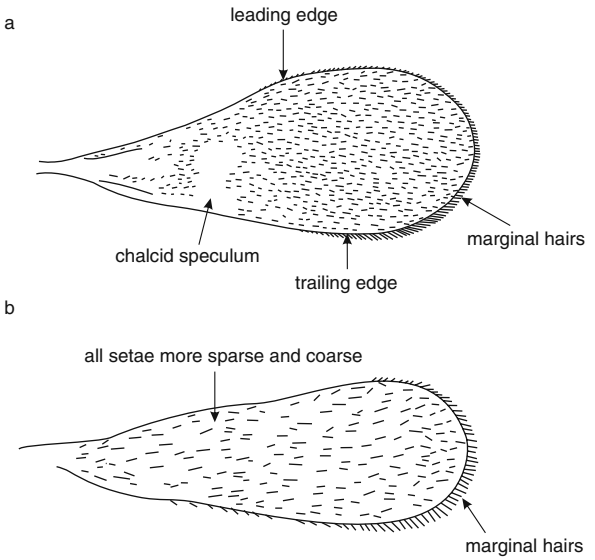

Fig. 3.49 Forewing of (**a**) *Platygaster subuliformis* (modified after Goulet and Huber 1993), and (**b**) another *Platygaster* sp

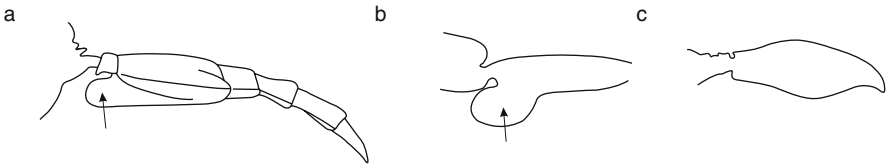

Fig. 3.50 Gasters (lateral views) of (**a**) *Platygaster subuliformis* ♀ (modified after Murchie et al. 1999), (**b**) another platygastrid species ♀ and (**c**) *Platygaster subuliformis* ♂. Protrusions of ♀ first sternite *arrowed*

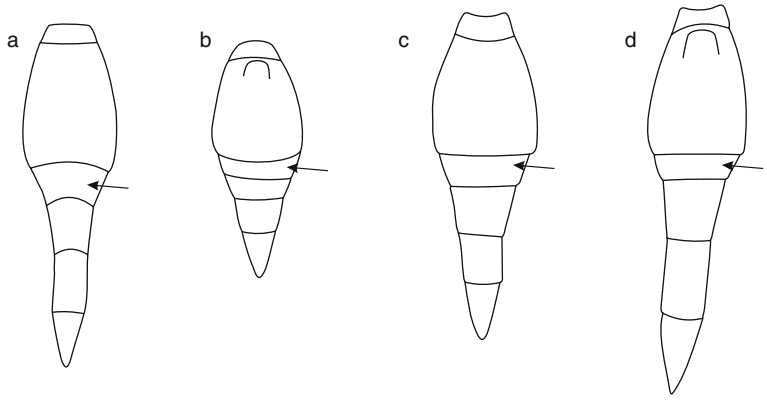

Fig. 3.51 Gasters (dorsal views) of ♀ (**a**) *Platygaster subuliformis*, (**b**) *Platygaster iolas*, (**c**) *Platygaster oebalus*, and (**d**) *Platygaster tisias*. Third tergites *arrowed* (**a** redrawn after Murchie et al. 1999; **b**, **c**, and **d** redrawn after Vlug 1985)

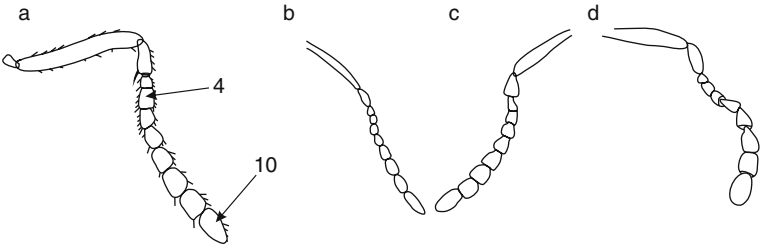

Fig. 3.52 Antennae of ♀ (**a**) *Platygaster subuliformis*, (**b**) *Platygaster iolas*, (**c**) *Platygaster oebalus*, and (**d**) *Platygaster tisias* (**a** redrawn after Murchie et al. 1999; **b**, **c**, and **d** redrawn after Vlug 1985)

Key characters of *Platygaster subuliformis* ♂♂

Males are more difficult to identify with confidence than females. To qualify as 'probable *P. subuliformis* males', specimens should, in addition to the key characters of the genus, also have the following characters:

1. Colour exactly as females. Specimens with brownish bodies or paler brown or red-brown legs are not *P. subuliformis*.
2. Wings as females. Specimens with brown-tinged wings, without a clear chalcid speculum, with coarser and less dense hairs, or with longer fringing hairs are not *P. subuliformis*.
3. Mesosoma as females.
4. Gaster not elongated in males (Fig. 3.50c).
5. Antennae as Fig. 3.53. In life, flagellum usually kinked at second segment. First segment of flagellum appears triangular in outline when viewed from a certain angle. Segments three to six of flagellum more globular than in female.
6. Head as females except reticulate sculpture on vertex may be more deeply embossed than in female and transverse component may be less marked.

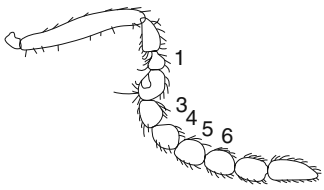

Fig. 3.53 Antenna of ♂ *Platygaster subuliformis.* Numbers indicate flagellar segments (redrawn after Murchie et al. 1999)

3.7 Parasitoids of the Family Proctotrupidae

Brachyserphus parvulus is the only member of the Proctotrupid family reported to be a parasitoid of a pest of oilseed rape; it can be a common parasitoid of the pollen beetle on spring rape in some years and sites.

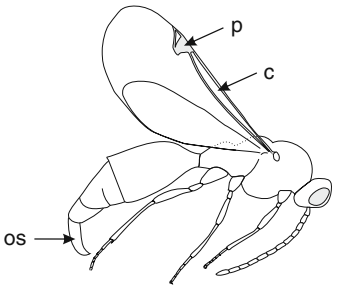

Fig. 3.54 *Brachyserphus parvulus* ♀. p = pterostigma, c = costal cell, os = ovipositor sheath

Key characters of *Brachyserphus parvulus*

1. General appearance as in Fig. 3.54.
2. Ovipositor usually tightly enclosed by its sheath which is short and broad, parallel-sided basally and curved in a ventral direction towards its tip (Fig. 3.54).
3. Pterostigma at least as wide as long (Fig. 3.54).

3.8 Glossary

Anellus (pl. anelli)	small segment(s) on antennae of chalcids, between pedicel and flagellum.
Apical	end of body or of appendage further from head.
Areolet	small cell in wing of ichneumonids, open apically in Tersilochinae.
Basal	end of body or of appendage nearer head.
Carina	ridge.
Cell	area of wing membrane enclosed partly or completely by veins.
Clypeus	lower part of face of insect, above mouthpart appendages.
Cornutus	elongate projection of petiole.
Costal cell	most anterior vein of wing, running along costal margin.
Coxa (pl. coxae)	first segment of leg.
Ectoparasitoid	parasitoid that feeds externally from its host.
Endoparasitoid	parasitoid that feeds within its host.
Flagellum	distal section of antenna, beyond pedicel.
Gaster	part of abdomen behind petiole in Parasitica.
Granulated	surface covered with small grain-like protruberances
Koinobiont	parasitoid that allows its host to continue to develop.
Mesepistenum	anterior part of mesopleuron.
Mesonotum	dorsal surface of second thoracic segment.
Mesopleuron	lateral and ventral part of mesothorax.
Mesoscutum	mesonotum without scutellum.
Mesothorax	second segment of thorax.

Metanotum	dorsal part of metathorax.
Metasoma	petiole plus gaster (second abdominal segment 2 onward)
Metathorax	third segment of thorax.
Notaulus (pl. notauli)	longitudinal groove on mesonotum.
Nucha	neck at apex of the propodeum
Ocellus (pl. ocelli)	light-sensitive, simple eyes. Three usually present in triangle between compound eyes at top of head.
Ovipositor	egg-laying structure in female.
Palp	segmented, sensory mouthpart arising from the maxilla or labium.
Pedicel	second segement of antenna, located between scape and flagellum.
Petiole	narrow waist or stalk in Parasitica between gaster and propodeum, comprised of second abdominal segment.
Pronotum	dorsal surface of prothorax.
Propodeum	first segment of abdomen fused with thorax.
Prothorax	first segment of thorax.
Pterostigma	pigmented area on margin of forewing towards apex of costal vein.
Reticulate	surface covered with net-like sculpture
Scape	basal segment of antenna.
Scutellum	middle part of mesonotum.
Seta (pl. setae)	bristle
Sternaulus	curved furrow or depression dividing lower part of mesopleruon.
Tarsus	distal part of leg.
Tegula	small lobe covering base of forewing.
Tergite	dorsal sclerite on abdomen.
Thyridiae	depressions of upper anterior corners of first tergite of gaster.
Trochanter	second segment of leg between coxa and femur.
Truncate	cut off squarely with straight edge.
Vertex	top of head, behind the frons.

Acknowledgements We are indebted to Prof. Dr. Klaus Horstmann, Universität Würzburg, Germany, for his generous sharing of expertise on the taxonomy of Tersilochinae, for examination of specimens and for discussions of characters for separating species. We are especially grateful for his advice on a draft version of the section of this chapter devoted to Tersilochinae, which is based to a great extent upon his keys (Horstmann 1971, 1981). We also thank Dr. Kees van Achterberg, Natuurhistorisch Museum, Leiden, Netherlands, for examination of specimens and the sharing of his expertise in identification of Braconid species, Dr. Gary Gibson, Agriculture and Agri-Food Canada, Ottawa, Canada, Dr. Hannes Baur, Natural History Museum, Bern, Switzerland, and Dr Stephan Vidal, Georg-August University, Göttingen, Germany, for similar assistance in separation of Pteromalid species. We thank Dr. Archie Murchie, Agri-Food and Biosciences Institute, Belfast, UK, for advice on the identification of *Platygaster subuliformis*, *Trichomalus perfectus* and *Omphale clypealis.* We acknowledge the support of the EU co-funded

project: MASTER (QLK5-CT-2001-01447), for providing travel funds to attend project meetings for invaluable taxonomic discussions, particularly with Dr. Bernd Ulber, Georg-August Universität, Göttingen, Germany, Dr. Christer Nilsson and Britt Åhman, Swedish University of Agricultural Sciences, Alnarp, Sweden, Dr. Zdzisław Klukowski, Wroclaw University of Environmental and Life Sciences, Poland and Dr. Eve Veromann, Estonian University of Life Sciences, Tartu, Estonia. Preparation of the guide was funded by the UK Department for Food and Rural Affairs and the Estonian Targeting Financing Projects SF0172655s04 and SF0170057s09. Rothamsted Research is an institute of the Biotechnology and Biological Sciences Research Council of the United Kingdom.

References

Achterberg C van (1993) Illustrated key to the subfamilies of the Braconidae (Hymenoptera: Ichneumonidae). *Zoologische Verhandellingen* 283: 1–189.

Achterberg C van, Quicke DLJ (2000) In: Unpublished course notes from *Taxonomy and biology of parasitic Hymenoptera*, 12–20 April 2000, Natural History Museum and Imperial College, London.

Alford DV (ed.) (2003) *Biocontrol of oilseed rape pests*. Blackwell, Oxford, UK.

Askew RR (1968) Hymenoptera 2. Chalcidoidea. *Handbooks for the Identification of British Insects* 7(2b): 1–39. Royal Entomological Society, London.

Barari H, Ferguson AW, Piper RW, Smith E, Quicke DLJ, Williams IH (2005) The separation of two hymenopteran parasitoids, *Tersilochus obscurator* and *Tersilochus microgaster* (Ichneumonidae), of stem-mining pests of winter oilseed rape using DNA, morphometric and ecological data. *B Entomol Res* 95: 299–307.

Bouček Z, Rasplus J-Y (1991) Illustrated key to West-Palearctic genera of Pteromalidae (Hymenoptera: Chalcidoidea). INRA, Paris.

Delucci V, Graham MWR (1956) La revision du genre *Trichomalus* Thomson (1878) (Chalcidoidea: Pteromalidae). *Beitrage zur Entomol* 6: 543–576.

Fitton M, Notton D, Henderson S (2000) Key to subfamilies of Ichneumonidae In: Unpublished course notes from *Taxonomy and biology of parasitic Hymenoptera,* 12–20 April 2000, Natural History Museum and Imperial College, London.

Gibson GAP, Baur H, Ulmer B, Dosdall L, Muller F (2005) On the misidentification of chalcid (Hymenoptera: Chalcidoidea) parasitoids of the cabbage seedpod weevil (Coleoptera: Curculionidae) in North America. *Can Entomol* 135: 381–403.

Goulet H, Huber JT (eds.) (1993) *Hymenoptera of the world: An identification guide to families*. Agriculture Canada, Canada.

Graham MWRdeV (1959) Keys to the British genera and species of Elachertinae, Eulophinae, Entedontinae, and Euderinae (Hym., Chalcidoidea). *Trans SocBrit Entomol* 13: 169–204.

Graham MWRdeV (1963) Additions and corrections to the British list of Eulophidae (Hym., Chalcidoidea), with descriptions of some new species. *Trans Soc Brit Entomol* 15: 167–275.

Graham MWRdeV(1969) *The Pteromalidae of north-western Europe (Hymenoptera, Chalcidoidea*). British Museum (Natural History) Entomology Supplement 16.

Horstmann K (1971) Revision der europäischen Tersilochinen I (Hymenoptera, Ichneumonidae). *Veröffenlichungen der Zoologischen Staatsamlung München* 15: 47–138.

Horstmann K (1981) Revision der europäischen Tersilochinen II (Hymenoptera, Ichneumonidae). *Spixiana Sup* 4: 3–76.

Medvedev GS (ed.) (1978) *Keys to the insects of the European part of the USSR, Volume III, Hymenoptera, Part II*. Nauka: Leningrad. [In Russian].

Murchie AK, Polaszek A, Williams IH (1999) *Platygaster subuliformis* (Kieffer) (Hym., Platygastridae) new to Britain, an egg-larval parasitoid of the brassica pod midge *Dasineura brassicae* Winnetrz (Dipt., Cecidomyiidae). *Entomologist's Monthly Magazine* 135: 217–222.

Noyes J (1985) Chalcidoids and biological control. *Chalcid Forum* 5: 5–10.

Noyes J (2000) Chalcids – Chalcidoidea and Mymarommatoidea. Chapter 7 In: Unpublished course notes from *Taxonomy and biology of parasitic Hymenoptera*, 12–20 April 2000. Natural History Museum and Imperial College, London.

Noyes J, Notton D, Polaszek A (2000) Chalcids – 'Proctos': Proctotrupoidea, Platygastroidea and Ceraphronoidea. Chapter 9 In: Unpublished course notes from *Taxonomy and biology of parasitic Hymenoptera*, 12–20 April 2000, Natural History Museum and Imperial College, London.

Rosen H von (1964) Untersuchungen über die Verbeitung und Biologie von zwei Pteromaliden in Rapsschoten (Hym., Chalcidoidea). *Statens Växtskyddsanstalt – Meddelanden* 12: 451–465.

Tobias WJ, Belokobylskii SA, Kotenko AG (eds.) (1986) [*Keys to the Fauna of the European Part of the USSR, Volume III, Hymenoptera, Part IV*.] Nauka: Leningrad. [In Russian].

Vidal S (2003) Identification of Hymenopterous parasitoids associated with oilseed rape pests. In: Alford DV (ed.) *Biocontrol of oilseed rape pests*. Blackwell, Oxford, UK.

Vlug HJ (1985) The types of Platygastridae (Hymenoptera, Scelionidae) described by Haliday and Walker and preserved in the National Museum of Ireland and in the British Museum (Natural History). 2. Keys to species, redescriptions, synonymy. *Tidschrift voor Entomologie* 127: 179–224.

Vlug HJ (1995) Catalogue of the Platygastridae (Platygastroidea) of the world. *Hymenopterorum Catalogus* 19: 1–168.

List of Other Keys Useful for Identification of Parasitoids

Achterberg C van (1990) Illustrated key to the subfamilies of the Holarctic Braconidae (Hymenoptera: Ichneumonoidea). *Zoologische Mededelingen Leiden* 64: 1–20.

Annecke DP, Doutt RL (1961) The genera of the Mymaridae Hymenoptera: Chalcidoidea. *Entomology Memoirs* 5. The Government Printer, Pretoria.

Aubert J-F, Jourdheuil P (1958) Nouvelle description et biologie de quelques Ichneumonides appartenant aux genres *Aneuclis* Först., *Isurgus* Först. et *Thersilochus* Holm. *Revue Path* 37: 175–193.

Buhl PN (1999) A synopsis of the Platygastridae of Fennoscandia and Denmark. *Entomofauna* 20: 17–52.

Dessart P, Cancemi P (1986) Tableau dichotomique des genres de *Ceraphronoidae* (*Hymenoptera*) avec commentaires et nouvelles espêces. *Frustula Entomologica, Nouvelles Séries* 7–8(20–21): 307–372.

Fitton MG, Graham MWRdeV, Bouček ZRL, Fergusson NDM, Huddleston T, Quinlan J, Richards OW (1978) A Check List of British Insects. Part 4: Hymenoptera. *Handbooks for the Identification of British Insects* 11(4): 1–159.

Gahan AB (1941) A revision of the parasitic wasps of the genus *Necremnus* Thomson (Eulophidae; Hymenoptera). *J Washington Acad Sci* 31: 196–203.

Gauld I, Bolton B (eds.) (1988) *The Hymenoptera*. British Museum of Natural History and Oxford University Press, London.

Gibson GAP (1989) Phylogeny and classification of Eupelmidae, with a revision of the world genera of Calostinae and Metapelmatinae (Hymenoptera: Chalcidoidea). *Mem Entomol Society of Canada* 149: 1–125.

Graham MWRdeV (1987) A reclassification of the European Tetrastichinae (Hymenoptera: Eulophidae), with a revision of certain genera. *B Brit Mus (Natural History) Entomology Series* 55(1): 1–392.

Haeselbarth E (1973) Die Blacus-Arten Europas und Zentral-Asiens (Hymenoptera, Braconidae). *Veröffentlichungen der Zoologischen Staatsammlung Munchen* 16: 60–170.

Hellén W (1958) Zur Kenntnis der Braconidae (Hym.) Finnlands. II. Subfamilie Helconinae (part). *Fauna Fennica* 4: 3–37.

Horstmann K (1967) Bemerkungen zur Taxonomie der Tersilochinen (Hym., Ichneumonidae). *Opuscula Entomol* 32: 123–130.

Horstmann K, Yu DS (1999) Bemerkungen zur Taxonomie und Nomenklatur westpaläarktischer Ichneumonidae (Hymenoptera). *Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomolgen Wien* 50: 65–74.

Jourdheuil P (1960) Influence de quelques facteurs écologiques sur les fluctuations de population d'une biocénose parasitaire: étude relative á quelques Hyménoptères (Ophioninae, Diospilinae, Euphorinae) parasites de divers Coléoptères inféodés aux Crucifères. *Ann des Épiphyties* 11: 445–658.

Masner L, Huggert L (1989) World review and keys to genera of the subfamily Inostemmatinae with reassignment of the taxa to the Platygastrinae and Sceliotrachelinae (Hymenoptera: Platygastridae). *Memoirs Entomol Soc Can* 147: 1–214.

Medvedev GS (ed.) (1987) *Keys to the insects of the European part of the USSR, Volume III, Hymenoptera, Part II*. Oxonian Press, New Delhi. Translation of publication in Russian by Nauka Publishers, Leningrad 1978.

Medvedev GS (ed.) (1995) *Keys to the insects of the European Part of the USSR, Volume III, Hymenoptera, Part IV*. Lebanon, NH.

Nixon GEJ (1938) A preliminary revision of the British Proctotrupinae (Hym. Proctotrupoidea). *Trans R Entomol Soc* 87(19): 431–465.

Oelke J (1969) Beitrage zur Insektenfauna der DDR: Hymenoptera, Bestimmungstabellen bis zur Unterfamilie. *Beitrage zur Entomol* 19: 753–802.

Osborne P (1960) Observations of the natural enemies of *Meligethes aeneus* (F.) and *M. viridescens* (F.) [Coleoptera: Nitidulidae]. *Parasitology* 50: 91–110.

Perkins JF (1959) Hymenoptera, Ichneumonoidea, Ichneumonidae. *Handbooks for the Identification of British Insects* 7(2): 1–29. Royal Entomological Society, London.

Schmiedeknecht O (1930) Die Hymenopteren Nord- und Mitteleuropas. *Verlag Gustav Fischer 2. Aufl.* p. 630.

Stresemann E (2000) *Exkursionsfauna von Deutschland. Band 2: Wirbellose, Insekten*. Spektrum Akademischer Verlag Gustav Fischer, Heidelberg.

Yu DS, Horstmann K (1997) A catalogue of world ichneumonidae (Hymenoptera). *Mem Am Entomol Inst Gainesville* 58: 1–2.