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MALE AND FEMALE MORPHOLOGY OF SOME CENTRAL EUROPEAN DELIA (ANTHOMYIIDAE) PESTS

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Based on male and female genitalia and chaetotaxy of legs, the authors give a key for the identification of some important *Delia* (Anthomyiidae) pests of vegetables. The article contains descriptions and drawings of male genitalia (*D. antiqua*, *D. floralis*, *D. florilega*, *D. platura*, *D. radicum*). The drawings and descriptions of female genitalia (*D. antiqua*, *D. platura*, *D. radicum*), are based on specimens from laboratory breeding.

Key words: Anthomyiidae, *Delia*, male, female, genitalia, pests, cabbage, onion

INTRODUCTION

Some of the most serious European dipterous pests may be found among *Delia* (Anthomyiidae) species. *Delia antiqua* (MEIGEN), *Delia florilega* (ZETTERSTEDT), *Delia platura* (MEIGEN) and *Delia radicum* (LINNAEUS) are the most common pests of vegetables. In North Europe (*i.e.*, Scandinavia), *Delia floralis* (FALLÉN) is an additional cabbage pest; but coexistence with *D. radicum* is very rare. A further minor vegetable pest is *Delia echinata* (SÉGUY) in spinach. In North Europe, *Delia coarctata* (FALLÉN) is the most common pests on monocotyledonous cultivated plants (DARVAS *et al.* 2000).

Identification of anthomyiid pests is not easy. External morphology – based mainly on chaetotaxy of head, thorax and legs – is generally insufficient for generic identification and has caused most of the confusion in previous literature. Examination of the male genitalia is needed for genus and species identification. Most anthomyiid females cannot be identified without a suitable species key. Breeding of the species is useful for correctly describing the characteristics of females. A further problem is the huge number of species in this family; at least 39 genera (900 species) exist in the Palaeactic region (SUWA & DARVAS 1998). As a consequence of the low numbers of anthomyiid specialists, national collections are usually poor for support of such a task (DARVAS *et al.* 2001, DARVAS 2001). Consequently, there are enormous numbers of questionable records in the applied literature. During the present work we widen our knowledge on male and female morphology on some pest species in vegetables, especially because we started a fore-

cast-aimed trapping work (DARVAS & TÓTH 2001) with some plant-originated, odorous adult attractants.

MATERIAL AND METHODS

D. antiqua males and females were bred from onion (DARVAS 1979), *D. radicum* from kohlrabi (TÓTH-VILMOS 1972), *D. platura* from *Lupinus albus* (DARVAS & KOZMA 1982) and *D. florilega* from watermelon seedlings (DARVAS & KOZMA 1982). *D. floralis* originated from Denmark (JÖRGENSEN 1976). A quick (2–4 minutes) NaOH treatment at 100°C was used for preparation of male and female genitalia. Opton and Olympus (BX 40) microscopes were used for immediate investigations. The body length of five males and females each were measured and analysed using one-way analysis of variance. Further *Delia* specimens originated from the anthomyiid collection of the Hungarian Natural History Museum and different host plant originated odorous attractant containing sticky traps (*e.g.*, *D. radicum* – allyl iso-thiocyanate; *D. antiqua* – dipropyl-disulphide) from Agárd (canola; leg. M. TÓTH) and Kiszombor (onion; leg. A. SZEREDI).

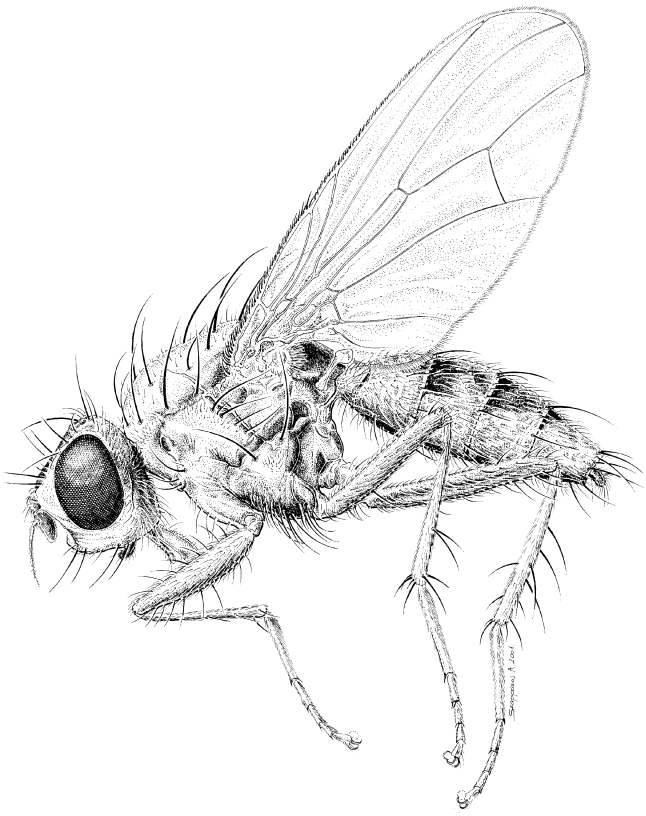

Fig. 1. *Delia radicum* female

RESULTS AND DISCUSSION

Adults of the *Delia* species dealt with in this paper are 5–9 mm long, greyish, moderately setose, without any characteristic coloration on the body or wings. A_1 vein extending to wing margin (Fig. 1). Lower calypter as large as or smaller than upper one. The longest hairs on arista are distinctly shorter than the width of first flagellomere. The propleuron is bare (HUCKETT 1924, Figs 1–2). The apical posteroventral seta of the hind tibia is absent or hardly distinguishable from adjacent setulae.

Delia *males*

Parafrontals without orbital setae. Fore tibia without an anterodorsal seta (Fig. 2, SUWA 1974). The aedeagus is long and well sclerotized and hidden under

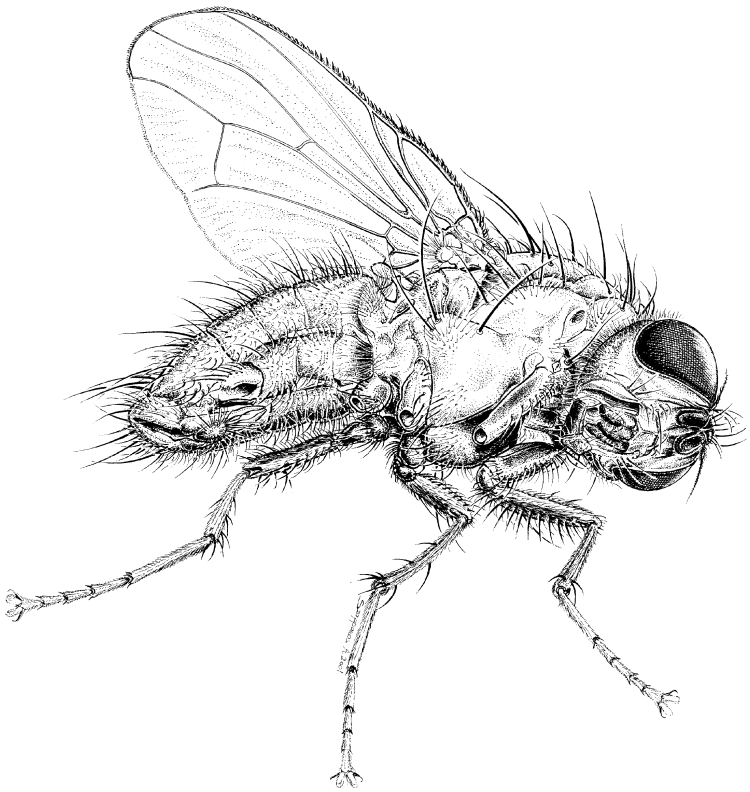

Fig. 2. *Delia antiqua* male

Table 1. Body length of some *Delia* pests. Values are signed by same letter are significantly not different at $SD_{0.1}$% (0.56 mm)

Name	Sex	Mean ± standard deviation (mm)
D. florilega	male	6.65±0.17a
	female	6.84±0.33a
D. platura	male	6.85±0.23a
	female	6.82±0.13a
D. radicum	male	7.87±0.18b
	female	7.98±0.37bc
D. antiqua	male	8.16±0.26bc
	female	8.47±0.20c

5th sternite (Fig. 2). The distal section of the aedeagus consists of a pair of ventral processes (paraphalli), a central prolongation of the sclerotized dorsal surface of the distal section, and an apical acrophallic sclerite in *D. radicum* and *D. floralis*, the latter being absent in *D. platura*, *D. florilega* and *D. antiqua* (HUCKETT 1924, HENNIG 1974*a*, GRIFFITHS 1982–1998, MICHELSEN & BAEZ 1985).

Possible key for males is as follows:

1 Hind tibia with a posteroventral fringe of about 20 erect setulae (comb) of more or less the same length on whole length (Figs 3, 4*a, c*). Prealar seta shorter than posterior notopleural seta. Fore tibia with a blunt posteroventral

Fig. 3. Hind leg of *Delia platura* male

spur which is curved forwards. Costa of wing bare ventrally. Distal section of aedeagus without a sclerotized acrophallus 2

– Hind tibia without a posteroventral fringe of erect setulae on whole length(Figs 4*e, g*), though some posteroventral setulae of varying length may be present on basal half to three-quarters of tibia, these setulae becoming distinctly shorter distally 3

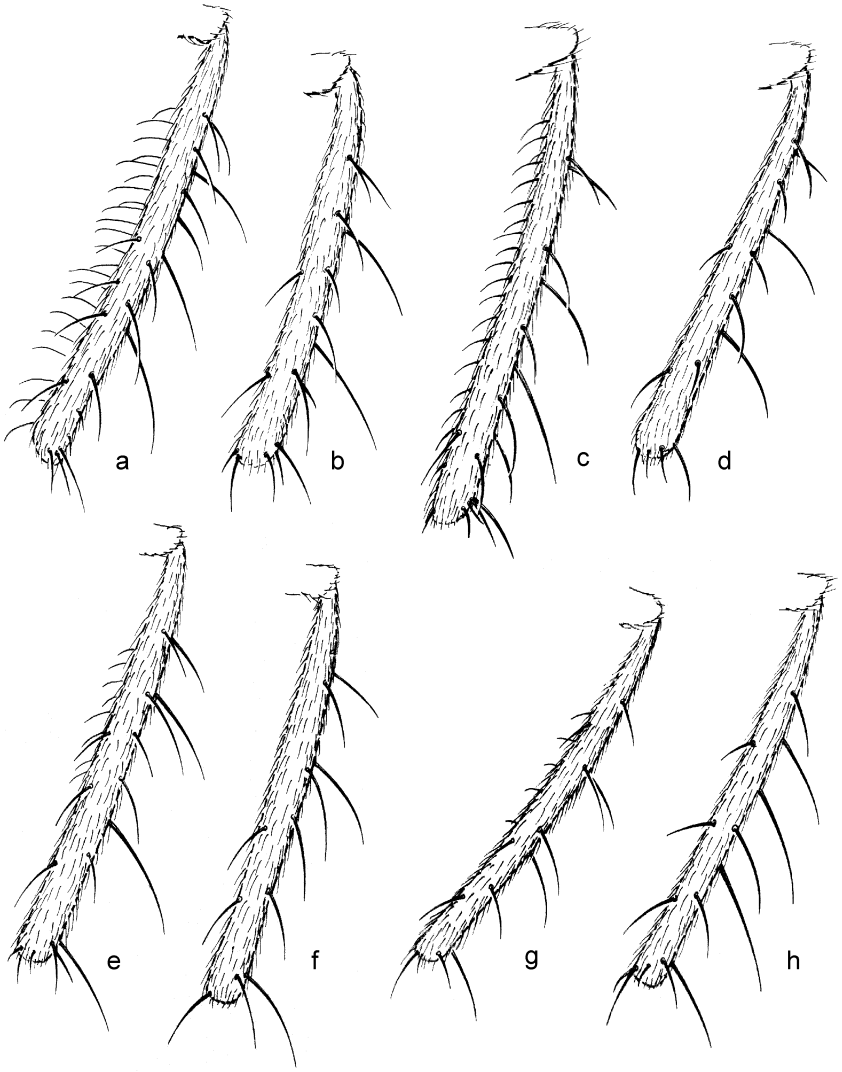

Fig. 4. *Delia* male and female hind tibiae. *D. platura*: a = ♂, b = ♀; *D. florilega*: c = ♂, d = ♀; *D. antiqua*: e = ♂, f = ♀; *D. radicum*: g = ♂, h = ♀

2 Mid tibia with a lengthened dorsal fringe on metatarsus, most of the setulae being longer than depth of metatarsus *D. florilega* (ZETTERSTEDT, 1845)

There is one blunt apical seta on the processes of the "V" shaped 5th sternite (HENNIG 1974*b*, GRIFFITHS 1982–1998). The cercus reaches only one-third of the surstyli. The inner shape of the surstyli is double bent and there are hairs and microtrichia on their dorsal end.

– Mid tibia without a lengthened dorsal fringe on metatarsus, any dorsal setulae being shorter than depth of metatarsus *D. platura* (MEIGEN, 1826)

There are two (one or three in 20% of the males) robust blunt spinules apically on the processes of the "V" shaped 5th sternite (DARVAS & KOZMA 1982, Fig. 5). The cercus reaches to the middle of the surstyli HENNIG 1974*a, b*, Figs 6–7). There are strong and long setae on the cercus. The surstyli bear hairs and microtrichia on their whole dorsal surface (GRIFFITHS 1982–1998). The inner shape of surstyli is linear. In lateral view, the distiphallus is nearly as long as surstyli (Fig. 7).

3 Prealar seta shorter than posterior notopleural seta. Mid tibia with a strong anterodorsal seta (Fig. 2). Notopleural depression bare apart from the two strong setae. Fore tibia with a strong blunt posteroventral spur which curves forwards. Hind tibia with three strong and long anteroventral setae (Fig. 4*e*). Lower posterior katepisternal seta strong, nearly as long as upper posterior seta. Costa bare ventrally. Processes of 5th sternite (Fig. 2) with two rather weak blunt apical spinules *D. antiqua* (MEIGEN, 1826)

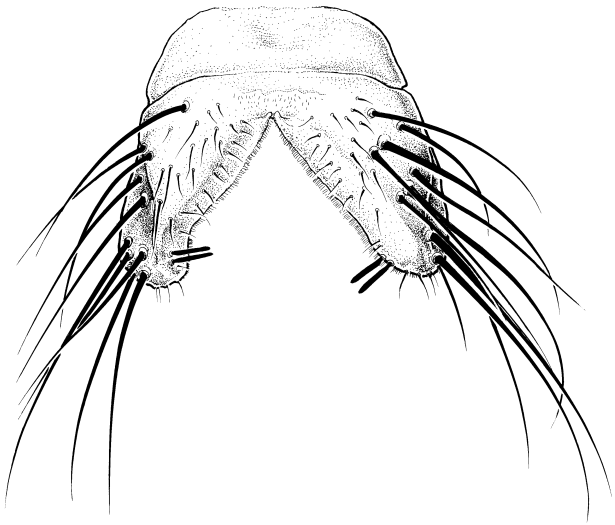

Fig. 5. Pregenital (5th) sternite of *Delia platura* male

Fig. 6. Surstyli and cercus of *Delia platura* male

Fig. 7. Male terminalia of *Delia platura* in lateral view

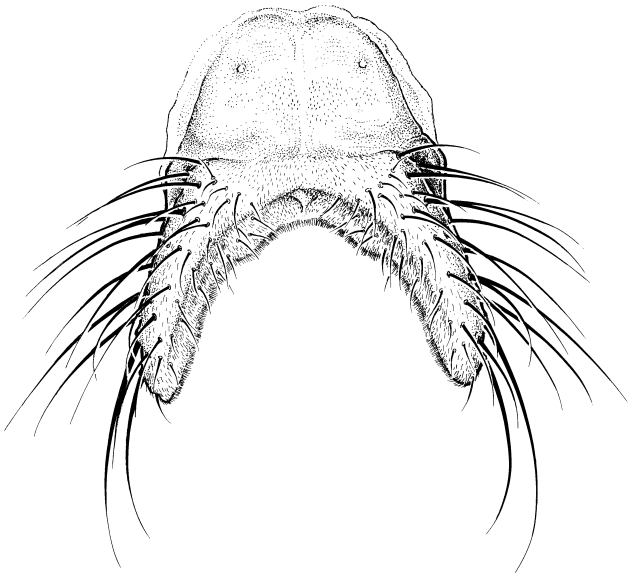

Fig. 8. Pregenital (5th) sternite of *Delia radicum* male

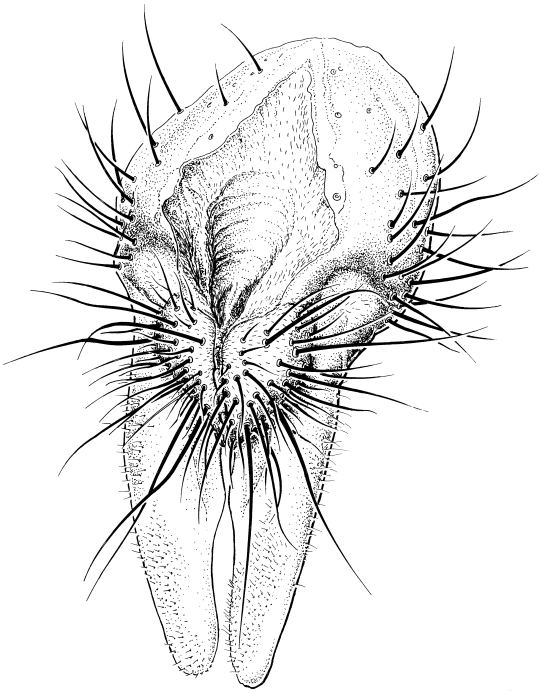

Fig. 9. Surstyli and cercus of *Delia radicum* male

Processes of 5th sternite each with 2 blunt setae or spinules on the inner apical corner (HENNIG 1974*b*). The cercus reaches nearly to the middle of the surstyli. Surstyli has microtrichia and hairs on their dorsal surface apically. The inner shape of surstyli is double bent (Fig. 2; HUCKETT 1924, GRIFFITHS 1982–1998).

– Prealar seta longer than posterior notopleural seta. Mid tibia without an anterodorsal seta. Notopleural depression usually with a few fine hairs in addition to the two strong setae. Fore tibia with a pointed posteroventral apical seta. Hind tibia with 8–12 shorter anteroventral setae (Figs 4*e, g*). Processes of 5th sternite without blunt apical spinules. Distal section of aedeagus with a sclerotized acrophallic sclerite 4

4 Hind femur with a dense ventral brush of hairs and setulae basally on anteroventral, ventral and posteroventral surfaces, which become shorter towards middle of femur, no distinct anteroventral or posteroventral setae. Processes of 5th sternite with the longest apical lateral setae not longer than length of processes (Fig. 8) *D. radicum* (LINNAEUS, 1758)

There are no characteristic apical setae on the processes of the 5th sternite, and it becomes slightly narrower in its inner space (fig. 727 of SCHNABL & DZIEDZICKI 1911, HENNIG 1974*b*; Fig. 8). The cerci do not reach the middle of surstyli. Although not figured by HUCKETT (1924) and HENNIG (1974*b*) the surstyli contain a very characteristic depression, distinctly visible in dry excerted genitalia (with visible microtrichia under higher magnification) – extending over the basal three-fifths of the surstylus (Fig. 9). Surstyli with hairs dorsally before apex (HENNIG 1974*a*). In lateral view, the surstyli are bent (Fig. 10). The distiphallus resembles the leg of *Arctiodactyla* (Fig. 10) if we used a careful preparation

– Hind femur without a ventral brush of hairs basally, but with full row of 10–12 long anteroventral setae, which are nearly twice as long as depth of femur. Hind tibia with 9–12 anteroventral setae on almost whole length. Processes of 5th sternite with longest lateral apical setae much longer than length of processes (Fig. 11) *D. floralis* (FALLÉN, 1824)

There are no robust setae apically on the processes of the "V" shaped 5th sternite (Fig. 11). The cerci do not reach the upper third of surstyli. The surstyli bear a very characteristic depression (containing microtrichia) – reaching the middle of surstylus – starting in its upper part (opposite of HENNIG 1974*b*, but see fig. 392 of SUWA 1974; cf. Fig. 12). Surstyli are hairy, and touch each other in the upper third (Fig. 12).

Delia *females*

Occiput bare or nearly so on dorsal part below the postocular row of setulae (Fig. 1). Mid tibia without anteroventral or ventral setae (Fig. 1). The four-segmented (the appendices of the last segment are cerci) ovipositor are telescopi-

Fig. 10. Male terminalia of *Delia radicum* in lateral view

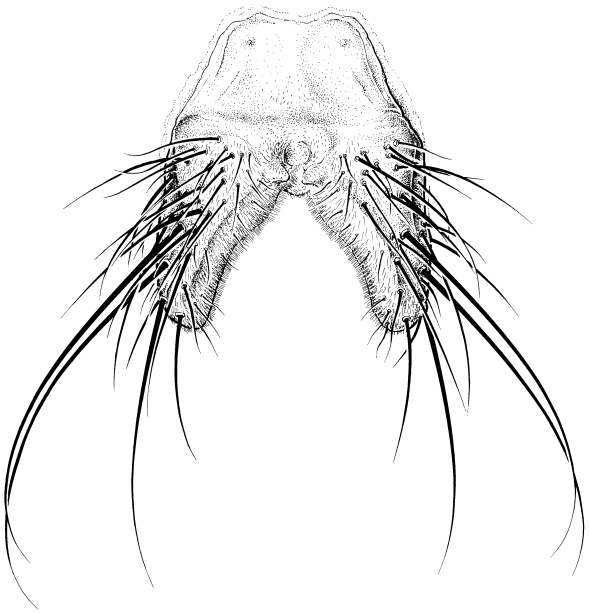

Fig. 11. Pregenital (5th) sternite of *Delia floralis* male

cally hidden in the segment 5 (HUCKETT 1924, SUWA 1974, KOTRBA 2000). The intersegmental membranous part of each ovipositor segments is without sclerotized fields. There are different shaped tergites (dorsal or dorsolateral) and sternites (ventral) on the surfaces of the larger segments (6–8). Segment 8 is the genital segment; its tergal and sternal plates protect the genital opening (MICHELSEN 1988). There are two pairs of spiracles on the 6th segments of the ovipositor. Terminal segments (9–10) are fused. The dorsal supra-anal plate probably originated from tergites 9 and 10, and ventral subanal plates from sternite 10. Sternite 9 is reduced to form a "genital fork". Terminal segments are not laterally compressed in *Delia* species (as in *Phorbia* for example).

Usually the body size of *D. radicum* and *D. antiqua* is about 8 mm and the wing membrane is honey yellowish. The body size of *D. platura* and *D. florilega* is about 7 mm (Table 1), the membrane of wing is colourless.

Possible key for females is as follows:

1 Lower posterior katepisternal seta absent or represented by a fine hair. Costa bare on ventral surface. Prealar seta shorter than posterior notopleural seta. Mid tibia with a single rather long anterodorsal seta

D. platura, D. florilega

Dorsal side of *D. platura* ovipositor: 6th tergite – the two "C" shaped, heavily sclerotized parts have dorsolateral position. Small setae only posteriorly; 7th tergite – the two "L" shaped sclerotized parts situated mainly dorsally, joined posteriorly; 8th tergite – its two "L" shaped thin parts situated dorsally, joined posteriorly (DARVAS & KOZMA 1982).
Ventral side of *D. platura* ovipositor: 6th sternite – the elongated heavily sclerotized part is not longer than 8th segment. There are only small setae posteriorly. Its final part (towards cerci) is bifurcate; 9th sternite – its elongated sclerotized part is wider towards cerci and bifurcate; 9th sternite – its two thin parts situated ventrally, and the lower part of this segment (DARVAS & KOZMA 1982). These data based on mass bred of *D. platura* (DARVAS & KOZMA 1982) is partially different to fig. 1763 of GRIFFITHS (1982–1998).
Because of its omnivorous lifestyle, it is easily collected between April–November in any kind of environment. It has 4–5 generations in Central Europe. The anterior spiracle of the larva has 6–7 stigmae. Contrary to HENNIG (1968), under the posterior spiracles the outer apical, inner apical and ventroapical papillar pairs are one-peaked in the papillar line (DARVAS & KOZMA 1982). In the papillar ring, the papillar height is nearly half as long as the posterior spiracle diameter (SUWA & DARVAS 1998).

– Lower posterior katepisternal seta distinct, half to three-quarters length of upper posterior seta. 2

2 Costa bare on ventral surface. Notopleural depression bare apart from the two strong setae. Fore tibia with 2 anterodorsal, 2 posterodorsal and 1 postero-

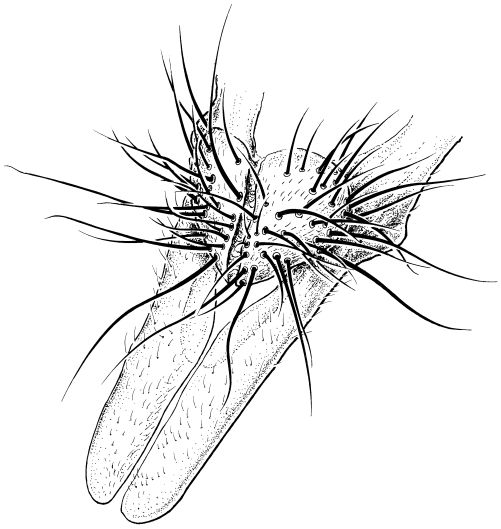

Fig. 12. Surstyli and cercus of *Delia floralis* male

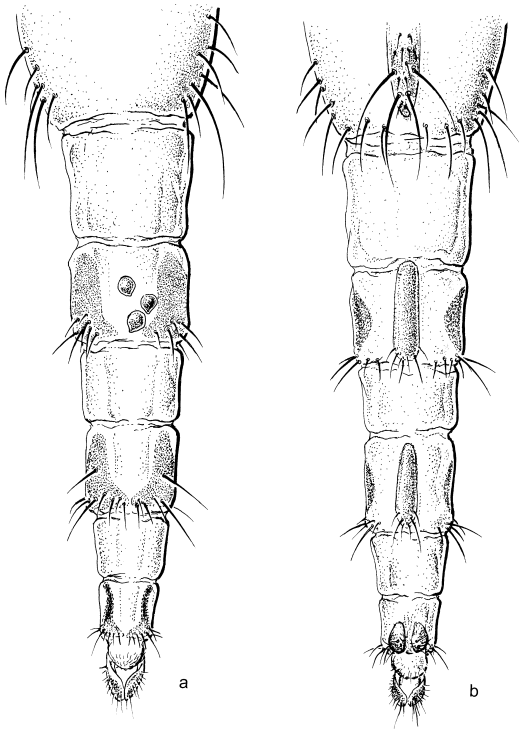

Fig. 13. Female terminalia of *Delia radicum*: a = dorsal and b = ventral view

ventral setae. Mid tibia with 2–3 anterodorsal and 2 posterodorsal setae. Prealar seta slightly shorter than posterior notopleural seta *D. antiqua*

Dorsal side of ovipositor: 6th tergite – the two heavily sclerotized, "C" shaped parts visible only in dorsal position. Small setae only posteriorly; 7th tergite – its two, "L" shaped sclerotized parts situated dorsally, joined posteriorly; 8th tergite – its two "C" shaped parts situated dorsally, and finally joined posteriorly (Fig. 14).
Ventral side of ovipositor: 6th sternite – the elongated heavily sclerotized part is a little longer than 6th segment. There are small setae posteriorly; 7th sternite – its elongated sclerotized part is wider towards cerci, and bifurcate at its posterior part; 8th sternite – its two thin parts situated ventrally, and the posterior part of this segment (Fig. 14).
It has 2–3 generations in Central Europe. It is collected between May–August in onion (sometimes garlic) fields; oligophagous. The anterior spiracle of the larva has 10 stigmae. Outer apical, inner apical and ventroapical papillar pairs are one-peaked in the papillar line under the posterior spiracles. Inner apical papillae are bigger than outer apical ones (SUWA & DARVAS 1998).

– Costa setulose on ventral surface. Notopleural depression with a few fine hairs in addition to the 2 strong setae. Mid tibia with 1 anterodorsal and 1

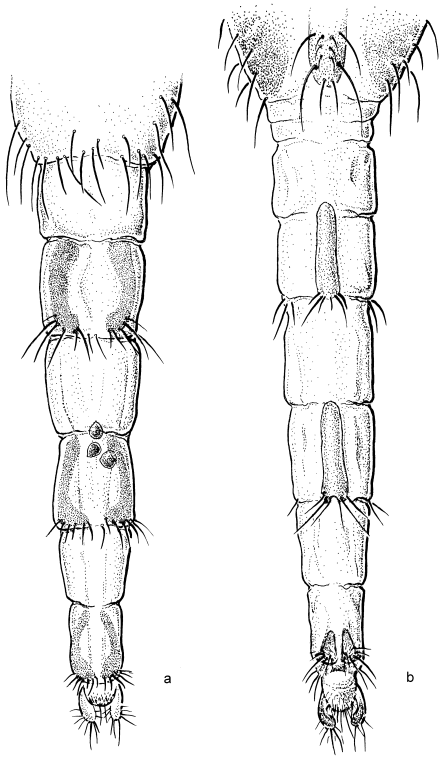

Fig. 14. Female terminalia of *Delia antiqua*: a = dorsal, b = ventral view

posterodorsal setae. Prealar seta slightly shorter than posterior notopleural seta. Fore tibia with 1 anterodorsal and 1 posteroventral setae. 3

3 Abdomen viewed from behind with a diffuse darker median vitta, and lateral patches on tergites which are slightly shining and shift position according to angle of view or lighting. Mid femur with strong anteroventral setae near base *D. radicum*

Dorsal side of ovipositor: 6th tergite – the two heavily sclerotized parts have a dorsolateral position. There are only small setae posteriorly. 7th tergite – its two sclerotized parts situated mainly dorsally and joined posteriorly. There is a strong seta at the middle of each part; 8th tergites – its two thin parts situated dorsally, blended and finally touch each other posteriorly (Fig. 13).
Ventral side of ovipositor: 6th sternite – the elongated heavily sclerotized part is a little bit longer than 6th segment. Small setae only posteriorly; 7th sternite – its elongated sclerotized part is wider posteriorly; 8th sternite – its two thin parts situated ventrally, and the posterior part of this segment (Fig. 13). Our figure, based on *D. radicum* mass bred (TÓTH-VILMOS 1972) is significantly different from fig. 1178 of GRIFFITHS (1982–1998), especially on 8th sternite.

It has 3 generations in Central Europe. *D. radicum* is collected between April–May, June–July and after a short aestivation during September–October in *Brassica* spp. fields; oligophagous (DARVAS & TÓTH, unpubl.). The anterior spiracle of the larva has 12 stigmae. Inner apical and ventroapical papillae are fused and bifurcate (SUWA & DARVAS 1998).

– Abdomen viewed from behind without median vitta or shifting tessellations, more densely dusted and not or only slightly shining in some lights. Mid femur without strong anteroventral setae near base *D. floralis*

It has 1–2 generations only in North Europe (JÖRGENSEN 1976). Many records are questionable originated from Central and South Europe, for example there is no specimen in the Hungarian collection originated from applied works which stated its earlier damage in Hungary (DARVAS 2001). We also did not find this species, during the last 3 years (from April to October) in an extended trapping works in *Brassica* spp. (DARVAS & TÓTH unpubl.). It is collected between June–August in *Brassica* spp. (sometimes *Raphanus* sp.) fields. The anterior spiracle of the larva has 15–17 stigmae. Outer apical, inner apical and ventroapical papillar pairs are one-peaked. Outer and inner apicals are distinctly bigger than ventroapical papillae (SUWA & DARVAS 1998).

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