

The taxonomy of the *Pollenia rudis* species-group in the Holarctic Region (Diptera: Calliphoridae)

KNUT ROGNES Havørnbrautene 7a, Madla, Norway

ABSTRACT. A *rudis* species-group is defined within *Pollenia* Robineau-Desvoidy, and new characters found useful in the taxonomy of this genus are presented. *P. rudis* (Fabricius), *P. angustigena* Wainwright, stat.rev. and *P. pseudorudis* Rognes are redescribed. *P. hungarica* sp.n., *P. longitheca* sp.n. and *P. luteovillosa* sp.n. are described as new to science. A key is provided, and the terminalia of both sexes are illustrated for all the species. Some features of the puparia are figured for the species where these are known. A neotype is designated for *Musca rudis*, and a lectotype for *P. angustigena*. *P. angustigena*, *P. pseudorudis* and *P. rudis* are Holarctic species, and the latter two have also been found in New Zealand. The remaining species are confined to the western Palaearctic. *P. hungarica* is known from central Europe, including southern parts of Scandinavia, *P. longitheca* from the eastern Mediterranean, and *P. luteovillosa* from Algeria and Morocco in North Africa. In the larval stages *P. rudis*-group members are parasites of or predators on earthworms. The species have several generations each year, and normally overwinter as adults. *Eisenia rosea* (Savigny) serves as a host for *P. hungarica*, *P. pseudorudis* and *P. rudis* according to the reared material available. A previous detailed account of the immature stages and life-cycle of 'rudis' from North America is tentatively assigned to *pseudorudis*. Keilin's (1909, 1915) often cited accounts of the immature stages and life-cycle of a species called 'rudis' are rejected as a source of information for any member of the *rudis* group.

Introduction

The genus *Pollenia* Robineau-Desvoidy, commonly known as cluster flies, is of general biological interest as many of its species, in the larval stages, are known to be parasites or predators of earthworms.

During examination of a large number of Holarctic *Pollenia* in various collections in

Correspondence: Dr Knut Rognes, Havørnbrautene 7a, N-4040 Madla, Norway.

Europe and North America several new or unrecognized species were discovered which all run to *P. rudis* (Fabricius, 1794) in existing keys (Zumpt, 1956; Mihályi, 1976, 1979). The species were all definable by constant external and genital features which have not previously been used in *Pollenia* taxonomy. It is therefore evident that the taxonomy of this section of the genus *Pollenia* has been very far from a satisfactory solution. It is also evident that all the information in the old and recent literature concerning

the biology of '*Pollenia rudis*' as an earthworm parasite in Europe and North America (e.g. Keilin, 1915; Yahnke & George, 1972; Thomson & Davies, 1973a, b, 1974) is, unfortunately, unreliable as far as the exact identity of the parasite as well as of its host is concerned.

The purpose of the present paper is to define a *rudis* species-group, to direct attention to the taxonomically important features in this group, to diagnose in detail its species as far as they are known, and to designate lectotypes and neotypes, where necessary, to aid in stabilizing nomenclature. Some of the results have been published briefly in a previous paper (Rognes, 1985).

Several synonyms are listed under *Pollenia rudis* in existing monographs and catalogues, or listed under *Pollenia* as unrecognized taxa (Bezzi & Stein, 1907; Zumpt, 1956; Schumann, 1986). Possibly some of these may apply to the new taxa being discovered, while others clearly do not. Unfortunately, I am not in a position to embark upon an extensive study of or search for all ancient types, many of which are known to have been destroyed. I also consider it premature to try to apply, in those cases where types no longer exist, the 'oldest probable name' principle of Thompson (1980, 1981) for the new taxa discovered, in view of the insufficient knowledge of the taxonomy of the genus as well as the distribution of its constituent species. I have therefore chosen to give new names to some of the new taxa described.

Material and Methods

The study is based upon material in the collections and museums listed below. Genitalia have been prepared as follows: the whole abdomen broken off and dropped into 10% KOH, boiled for 2 min, dissected in water (if necessary second and third boilings in KOH were carried out), parts transferred to ethanol, and finally glycerol for storage in glass vials; abdominal tergites T1–5 transferred from ethanol to ethyl-acetate, dried under the microscope lamp and glued to small piece of carton on pin so as to expose ventral vestiture; uterus with lateral sacs and spermathecae removed from inner end of telescoped ovipositor with forceps and kept in glycerol in vial, ovipositors then drawn out in full length, usually in glycerol, cut open along one

side with small eye-surgery scissors, transferred to ethanol, and mounted on microscope slide in euparal under coverglass.

For study a WILD M8 stereomicroscope (6–100×) and a LEITZ microscope (40–630×) have been available. Drawings have been made with the aid of a camera lucida or by means of a squared eye-piece.

Abbreviations of depositories

BMNH: British Museum, Natural History, London. CB: private collection of Christer Bergström, Uppsala. CNC: Canadian National Collection, Ottawa. HNHM: Hungarian Natural History Museum, Budapest. MCZ: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts. NZAC: New Zealand Arthropod Collection, Entomology Division, DSIR, Auckland. KR: author's private collection. RM: Rana Museum, Naturhistorisk avdeling, Mo i Rana. RML: collection of Reidar Mehl, Statens Institutt for folkehelse, Oslo. SA: private collection of Stig Andersen, Copenhagen. TM: Universitetet i Tromsø, Tromsø Museum, Tromsø. UWOZ: University of Western Ontario, Faculty of Science, Department of Zoology, London, Ontario, Canada. ZMB: Universitetet i Bergen, Zoologisk Museum, Bergen. ZMC: Zoological Museum of the University, Copenhagen. ZML: Museum of Zoology, Lund. ZMO: Universitetet i Oslo, Zoologisk Museum, Oslo.

Genus *Pollenia* Robineau-Desvoidy

Pollenia Robineau-Desvoidy, 1830: 412. Type species: *Musca rudis* Fabricius, by original designation. For a list of generic synonyms, see Schumann (1986).

Definition of the *rudis* species-group

The *rudis* species-group is characterized by the following combination of characters: (1) mouthedge well below line between large vibrissae; (2) facial carina conspicuous; (3) occiput and most posterior parts of jowl with pale hairs, except for 1–3 irregular rows of black hairs behind upper postocular cilia; (4) posterior thoracic spiracle yellow, never dark brown; (5)

basicosta usually yellow, yellowish brown or brown, very rarely dark brown or black; (6) costa hairy below as far as junction with *sc*, bare below beyond this point (i.e. second costal sector bare below); (7) node at base of r_{2+3} and r_{4+5} with hairs on both surfaces of wing; (8) postalar wall with numerous yellow crinkly hairs; (9) abdomen strongly dusted and with conspicuous shifting tessellations; (10) male with unmodified hind tarsi, i.e. segments rather long and slender, tarsus as long as or longer than hind tibia, definitely not shorter; (11) ST5 of male abdomen with normal vestiture; (12) distiphallus with midventral rounded projection ('lobe hypophallic médian' of Lehrer, 1963); (13) hypophallic lobes triangular, distally pointed and with central sclerotization; (14) paraphallic processes distally unsclerotized in a way that make them look transversely or obliquely truncated; (15) paraphallic processes distally armed with minute tubercles (seen at high magnification, 450 \times) or apparently unarmed; (16) distal part of paraphallic processes proceeding distad more or less parallel with long axis of distiphallus, not curving conspicuously towards midline; (17) male cerci and surstyli moderately broad and of very uniform appearance; (18) T7 and T8 in the female ovipositor middorsally without continuous stripe of microtrichiae from posterior to anterior margin; (19) marginal setae on T8 in ovipositor not absolutely marginal in position, sclerotization forming part of T8 always present behind them; (20) ST8 of ovipositor with dense cover of microtrichiae on posterior third or half; (21) membrane between T8 and ST8 on each side of ovipositor frequently devoid of microtrichiae proximally; (22) tip of ovipositor only with soft, slightly wavy and distally very thin hairs, no stiff blunt straight spines; (23) supra-anal plate of ovipositor completely covered with microtrichiae, cerci with more or less extensive areas devoid of microtrichiae proximally; (24) lateral sacs of the female internal reproductive organs shaped as narrow tubes and sclerotized; (25) puparia (where known) with a constriction at level of puparial horns (Fig. 98), which are prominent; (26) posterior spiracles of puparia and third instar larva (where known) with an angle of about 135° between uppermost and lowermost slits, lower slits approximately vertical.

At present I include six species in the *rudis*-group as defined above: *P. rudis*,

P. angustigena Wainwright, 1940, *P. pseudorudis* Rognes, 1985, *P. hungarica* sp.n., *P. longitheca* sp.n. and *P. luteovillosa* sp.n. One more species of rather doubtful status is illustrated and given a preliminary diagnosis, but is not formally named.

I tentatively exclude the following species from the *rudis*-group, as they are insufficiently known, even though their phallosome is rather similar to the one present in most *rudis*-group members: *P. alajensis* Rodendorf, 1926 (= *P. sytshevskajae* Grunin, 1970), because of a shining black abdomen, distally expanded paraphallic processes, and presence of black hairs on postalar wall; *P. pectinata* Grunin, 1966, because of modified hind tarsi in the male, very narrow cerci and surstyli, and apex of paraphallic processes not appearing obliquely cut off; and *P. semicinerea* Villeneuve, 1911 (as interpreted by Grunin, 1966), because of a shining black abdomen and very narrow cerci and surstyli (Rodendorf, 1926; Grunin, 1966, 1970; Rognes, 1987).

P. varia (Meigen, 1826) is probably a member of the *rudis*-group. Meigen's type has light brown, almost yellow basicosta (Mihályi, 1976). It lacks the bundle of pale hairs on the underside of the *h-sc* node of the wing (L. Matile, Muséum Nationale d'Histoire Naturelle, Paris, pers. comm.). Its identity is still obscure, but in reality of academic interest only as Meigen's original name is a junior primary homonym of *Musca varia* Gmelin, 1790, and therefore unavailable. Several modern authors have named and figured different species (even different in Lehrer, 1963, and Lehrer, 1972) under the name '*Pollenia varia* Meigen' (Wainwright, 1940; Emden, 1954; Zumpt, 1956; Grunin, 1970; Lehrer, 1963, 1972; Lobanov, 1976). '*Pollenia varia*' as used by Wainwright, Emden and Grunin equals *P. griseotomentosa* Jacentkovský, 1944 as used by Mihályi (1976, 1979) (cf. Rognes, 1985). This species is not a member of the *rudis* species-group as shown by the absence of a midventral hypophallic lobe, very weak central sclerotization of the hypophallic lobes, narrow cerci and surstyli, different pattern of abdominal tessellations, black basicosta, absence of facial carina, and other features relating to the ovipositor structure. The identity of the species named '*Pollenia varia*' by the other authors is obscure, but possibly refers to one of the species treated in this paper.

Biology of the *rudis*-group species

So far as is known the larvae are parasitic or predatory on lumbricids. Several North American accounts deal with the relationship between a species named '*Pollenia rudis*' and several species of earthworms (for references, see Yahnke & George, 1972; Thomson & Davies, 1973a, b, 1974). Especially Keilin (1909, 1915) has studied the life-cycle and host relation of '*Pollenia rudis*' in Europe. Most interestingly, there are several discrepancies between the North American and European reports with regard to the biology as well as to the larval morphology. There is good reason to believe that Keilin's work does not apply to any *rudis*-group member at all (see discussion below under *P. rudis*). Since '*rudis*' in North America in fact consists of three different species, it follows that nothing is known for certain about the life-cycle of these species in North America either. Furthermore, any discrepancies amongst the reports of North American authors themselves as to host range and feeding habits may be explained by the possibility of the authors having in fact worked with different species. With these reservations in mind, the existing knowledge of the biology of the *rudis*-group members may be summarized as follows:

Up to 100–130 eggs are laid on the ground in small batches of up to seven eggs and the first instar larva hatches in 3 days. It locates the host by random locomotion through the soil in naturally occurring spaces. Larvae penetrate the body of the worm, either singly or in groups of up to seven individuals, mostly from the dorsal side. All larval stages feed within the body of the host with only the posterior spiracular plate exposed to the surface, but third instar larvae also feed while exposed on the surface of the worm. Larvae may leave the host and reattack either healthier parts of the same worm or a fresh worm. Infestations have been reported in the literature for four species of worms: *Eisenia rosea* (Savigny), *Allolobophora chlorotica* (Savigny), *A. caliginosa* (Savigny) and *Lumbricus terrestris* Linnaeus (Thomson & Davies, 1973a). The former two species seem to be the most common hosts according to one North American study (Thomson & Davies, 1973b). Both are surface-dwelling species occurring mainly within the top 10 cm of the soil. According to bred material in HNHM, *Eisenia*

rosea serve as a host for *P. rudis*, *P. pseudorudis* and *P. hungarica*.

Total development time is 25–30 days at 23°C, of which 11–14 days are spent in the pupal stage (Yahnke & George, 1972). Pupariation occurs in the soil. Most species are on the wing from early spring (February, March) to late autumn (October, November). There are three or four generations per year with adults overwintering. They frequently enter houses and have been reported as being a nuisance.

Taxonomic characters in the *rudis* species-group

Apart from features commonly used in Diptera taxonomy, the following characters have been found useful in diagnosing the different species of the *rudis*-group: (1) width of facial carina; (2) colour, density and quality of vestiture of ventral part of abdominal tergites (careful observation and adequate lighting conditions are necessary, as it is not always easy to appreciate colour of hairs as distinct from colour of light reflected from them); (3) vestiture of *av* surface of t_3 in the male; (4) colour and quality of vestiture on *p* and *pv* surface of mid and hind femora; (5) presence or absence of hairs on the *h-sc* node on underside of wing; (6) shape of sclerotization at base of distiphallus in profile view, explained fully in Fig. 21; (7) shape of hypophallic lobes; (8) width, position and other details of the central sclerotization of the hypophallic lobes; (9) details in the tip of the paraphallic processes; (10) shape and curvature of the paraphallic processes; (11) shape of T6 in the female ovipositor; (12) width of the heavily sclerotized parts of T7 in the ovipositor compared with the almost unsclerotized parts between them; (13) shape of cerci in the ovipositor; (14) distribution of microtrichiae on the cerci in the ovipositor; (15) distribution of microtrichiae on membrane between T8 and ST8 in the ovipositor; (16) shape of the sclerotized lateral sacs in the internal reproductive organs of the female; (17) shape of the spermathecae in the internal reproductive organs of the female.

I have found that occasional specimens of almost all the species have a stalked R_5 , so this character is of no taxonomic value in this section of the genus *Pollenia*. Most species also lack the outer *ph* seta in very rare cases. Nor have I found

the number of scutellar setae very useful for species recognition: the fourth seta (behind the basal marginal seta) is very variable in size even in species where it should be constantly present according to the literature (e.g. Emden, 1954). The lower squama is variable in colour, but most often brownish infuscate in the male and pale in the female. No taxonomic value should be assigned to this feature. I have not explored the possibility of using the shape of the hypandrium in species recognition (cf. Lehrer, 1963).

Sexual dimorphism is rather slight in the *rudis* group, but a subgroup of the *rudis* species-group can be defined by the presence in the male of certain secondary sexual characteristics affecting the vestiture of the ventral surface of the abdominal tergites and the *av* surface of t_3 . This group consists of *rudis*, *hungarica* and *luteovillosa*.

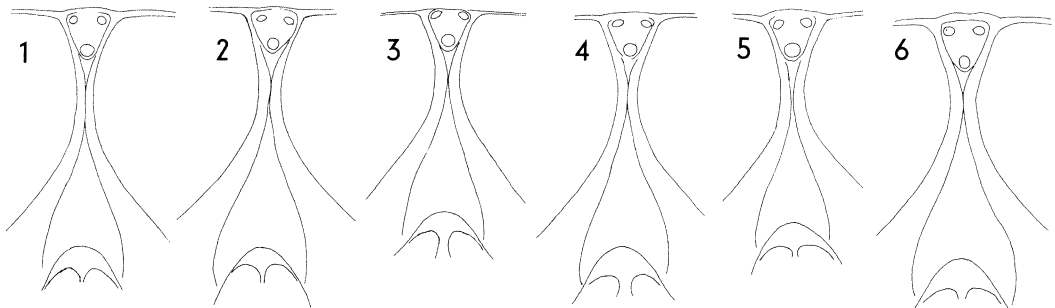
Key to Palaearctic and Nearctic species of the *rudis*-group

Note. Due to individual variation some males and many females are impossible to name with confidence from external characters only. Phallosome, ovipositor, spermathecae and lateral sacs should be examined in doubtful cases. *P. luteovillosa* females are only tentatively incorporated in the key, as they as insufficiently known. See also the section 'Outstanding problems' at the end of the paper.

Males

1 Vestiture on ventral part of abdominal tergites black, similar to that on dorsal part, not particularly fine or dense, about as fine (or coarse), dense and semi-erect as that on dorsal part 2

- Vestiture on ventral part of abdominal tergites black, yellow or yellowish white, strikingly different from that on dorsal part, longer, much finer, more erect and usually more dense than dorsally 4
- 2 *h-sc* node on underside of wing with a bundle of pale hairs (Fig. 14); base of distiphallus in profile view of type II (cf. Fig. 21); t_1 with 2 *pv*; t_2 with 2-3 *ad*; f_2 and f_3 with black hairs on *p* and *pv* surface *pseudorudis*
- *h-sc* node on underside of wing bare 3
- 3 Base of distiphallus in profile view of type I (cf. Fig. 21); t_1 with 2 *pv*; t_2 with 1 *ad* (very rarely 2-3); f_2 and f_3 with yellow hairs on *p* and *pv* surface; frons narrow, about 1.5 times as broad as front ocellus (Fig. 1); frontal orbits narrow, touching, their upper hairless part longer than ocellar triangle, about as long as ocellar setae; facial keel (Fig. 7) distinct and with variable width, most often rather narrow and sharp *angustigena*
- Base of distiphallus in profile view of type II (cf. Fig. 21); facial keel (Fig. 9) broad and low, *pallida*-like, often grooved along summit of ridge; t_1 with 1 *pv*; t_2 with 1-2 *ad*; f_2 and f_3 most often with black hairs on *p* and *pv* surface *longitheca*
- 4 Base of distiphallus in profile view of type I (cf. Fig. 21); t_3 at least on middle third with numerous long erect *av* hairs in addition to *av* setae (Fig. 20); t_2 with 2-3 *ad*; f_2 and f_3 usually with mostly black hairs on *p* and *pv* surface, though specimens with predominantly yellow hairs here occur; ventral abdominal vestiture most often black, sometimes, especially in central Europe, more or less yellow and pale, very rarely extensively so; palpi black, brownish distally *rudis*
- Base of distiphallus in profile view of type II (cf. Fig. 21); f_2 and f_3 , sometimes also f_1 , always with erect pale yellow hairs on at least about basal half of *p* and *pv* surface; abdomen ventrally with fine and dense predominantly yellow vestiture, at least on most of T3 and median half of T1-2 and T4 5
- 5 Facial keel broad (Fig. 10); outer *ph* lacking; t_2 with 1 *ad*; yellow vestiture on *p* and *pv* surface of f_2 and f_3 almost reaching tip; t_3 with a variable number of erect *av* hairs besides *av* setae, sometimes *av* hairs lacking altogether (Fig. 18); distiphallus with central



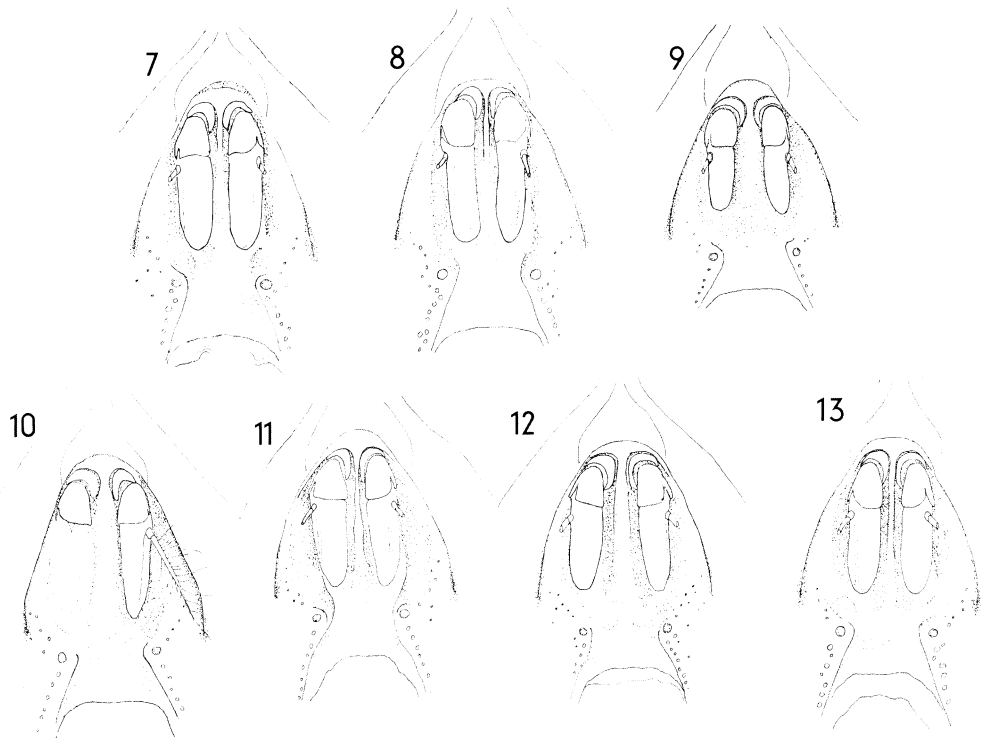
FIGS. 1-6. *Pollenia* spp., ♂ frons: 1, *angustigena*; 2, *hungarica*; 3, *longitheca*; 4, *luteovillosa*; 5, *pseudorudis*; 6, *rudis*.

- sclerotization of hypophallic lobes never strengthened distally (Fig. 48) *luteovillosa*
- Facial keel narrow (Fig. 8); outer *ph* always present; t_2 with 2-3 *ad*; yellow vestiture on *p* and *pv* surface of f_2 and f_3 present on inner half only; t_3 practically without erect *av* hairs among *av* setae, which in most cases are fairly long, sometimes even more than 2× tibial diameter (Fig. 16); distiphallus with central sclerotization of hypophallic lobes strengthened distally (Fig. 32) *hungarica*

Females

- 1 *h-sc* node on underside of wing with a bundle of pale hairs (Fig. 14); *p* and *pv* surface of f_2 and f_3 with black hairs; ventral surface of abdominal tergites with black hairs *pseudorudis*
- *h-sc* node bare on underside of wing 2
- 2 t_1 with 1 *pv*; facial keel broad and flattened, *pallida*-like (Fig. 9); very strikingly elongate spermathecae (Fig. 81) *longitheca*
- t_1 with 2 *pv*; facial keel narrow or broad; circular or oval, not very strikingly elongate spermathecae . 3
- 3 t_2 with 1 *ad*; *p* and *pv* surface of f_2 and f_3 with numerous yellow hairs 4
- t_2 with 2-3 *ad*; facial keel usually narrow (Figs. 8, 13); outer *ph* usually present 5

- 4 Facial keel narrow (Fig. 7); outer *ph* usually present; T6 short (Fig. 29); usually only black hairs on ventral surface of abdominal tergites; round spermathecae (Fig. 77); lateral sacs strongly curved (Fig. 78) *angustigena*
- Facial keel broad (Fig. 10); outer *ph* absent; numerous yellow hairs on ventral surface of abdominal tergites, especially T3; lateral sacs straight (Fig. 84) *luteovillosa*
- 5 Ventral surface of abdominal tergites usually with black hairs only; *p* and *pv* surface of f_2 and f_3 usually with black hairs only; T6 long, strongly sclerotized halves of T7 narrow, cerci truncate at tip, broadest point close to tip (Fig. 69); round spermathecae (Fig. 87); lateral sacs long and spirally curved (Fig. 88) *rudis*
- Ventral surface of abdominal tergites, especially T1-2 and T3, usually with numerous yellow hairs, especially medially; *p* and *pv* surface of f_2 and f_3 usually with a high proportion of yellow hairs, at least in basal half; T6 short, strongly sclerotized halves of T7 broad, cerci round at tip, broadest point far from tip (Fig. 37); elongate spermathecae with a kind of narrow 'handle' at proximal end (Fig. 79); lateral sacs simple, relatively short and weakly curved, usually less curved than figured in Fig. 80
hungarica



FIGS. 7-13. *Pollenia* spp., ♂ facial area: 7, *angustigena*; 8, *hungarica*; 9, *longitheca*; 10, *luteovillosa*; 11, *pseudorudis*; 12, *pseudorudis* (different specimen); 13, *rudis*.

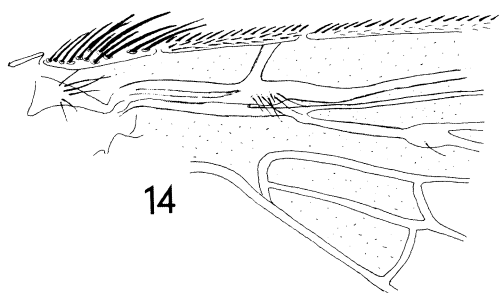


FIG. 14. *Pollenia pseudorudis*, anterior part of wing base viewed from below.

***Pollenia angustigena* Wainwright, stat.rev.**
(Figs. 1, 7, 15, 22–29, 77–78, 89, 96)

Pollenia angustigena Wainwright, 1940: 444 (as subspecies of *rudis* (Fabricius)). Lectotype ♂, here designated, ENGLAND (BMNH), examined.

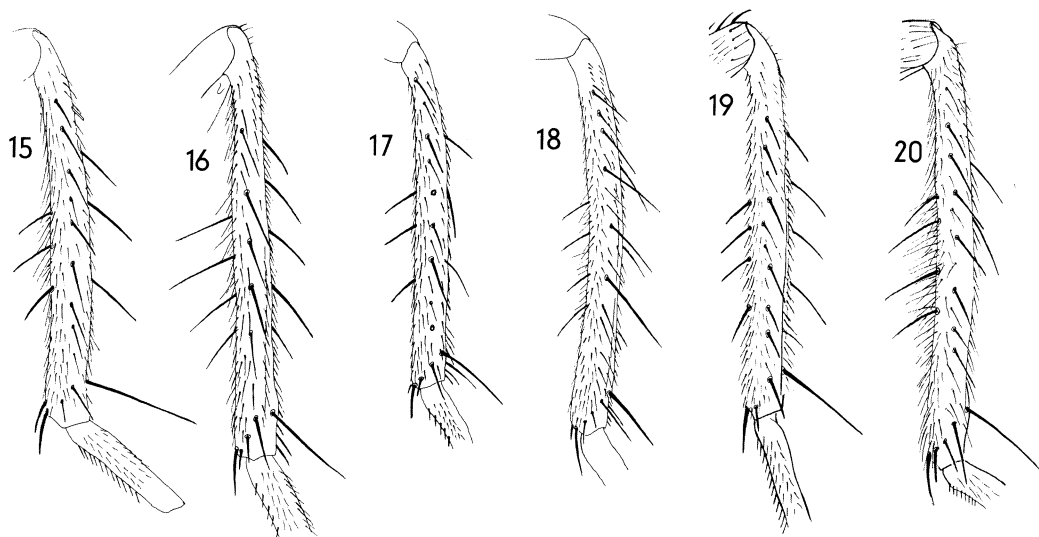
Diagnosis

♂♀. Facial carina (Fig. 7) usually conspicuous and rather sharp, though in small ♀ occasionally indistinct. Palpi vary from black all over to transparent yellow, the usual condition is dark with tip yellowish. Outer *ph* seta normally present, rarely absent, but apparently more often so than in the other species. Vestiture on

ventral surface of abdominal tergites in both sexes normal, black and about as dense and fine (or coarse) as that on dorsal surface, rather decumbent in the ♂. *t*₁ with 1 or most often 2 *pv* setae. *t*₂ normally with 1 *ad* seta. *f*₂ and *f*₃ with numerous erect pale yellow hairs on *p* and *pv* surface at least on inner half (less erect in ♀). *h-sc* node on underside of wing bare.

♂. Frons narrow (Fig. 1), parafrontals contiguous. *t*₃ with or without some erect *av* hairs besides *av* setae (Fig. 15), these hairs never conspicuous or as striking as e.g. in *rudis*, but nevertheless usually present. Genitalia as in Figs. 22–28. Base of distiphallus of type I (cf. Fig. 21). Hypophallic lobes shaped as in Fig. 24. Central sclerotization usually strikingly wide, usually wider than clear area in front of it. Tip of paraphallic processes armed with a row of minute tubercles (Fig. 26). Paraphallic processes rather strongly curved as seen in profile, their highest point much closer to base of distiphallus than to tip of the processes themselves.

♀. Eye in profile much higher than gena (jowl) in profile. Ventral abdominal vestiture mostly black. Ovipositor as in Fig. 29. T6 rather short. Strongly sclerotized parts of T7 as wide as or slightly narrower than the almost unsclerotized area between them. Cerci normal, widest rather far from tip. About basal fifth or less of cerci devoid of microtrichiae. Spermathecae (Fig. 77) short, oval. Lateral sacs (Fig.



FIGS. 15–20. *Pollenia* spp., left *t*₃, lateral view: 15, *angustigena*; 16, *hungarica*; 17, *longitheca*; 18, *luteovillosa*; 19, *pseudorudis*; 20, *rudis*.

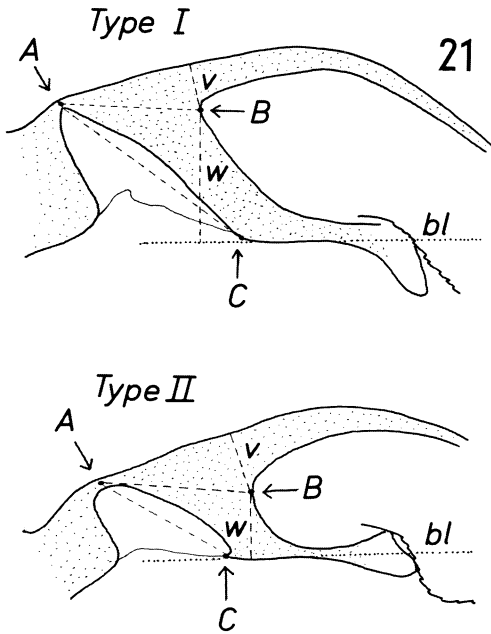


FIG. 21. *Pollenia rudis* species-group, shape of sclerotization at base of distiphallus in profile, semidiagrammatic. *Type I*: high, vaulted, imagined transverse section of base of distiphallus at level of point C narrow; point B close to dorsal wall, i.e. v much shorter than w ; w meets bl at a right angle at or proximal of point C; AB much shorter than AC . *Type II*: low, imagined transverse section at level of point C rounded; point B about midway between dorsal and ventral wall, i.e. v about as long as w ; w meets bl at a right angle distad of point C; Ab longer than or equal to AC .

78) strongly curved, not quite as long as in *rudis*.

Larval stages. Unknown.

Puparium. Posterior spiracles as in Fig. 89. Ratio of distance between posterior spiracles inclusive and greatest width of puparium equals 0.1188–0.1375 ($n=2$) (mean 0.1282). Anterior spiracles with 4 branches (Fig. 96) ($n=2$).

Biology

Host unknown. The two puparia available (in ZMC) were found in soil on 6.viii and 2.ix. The adult flies emerged on 28.viii and 30.ix., respectively. Outdoors they are on the wing mostly from March to October, with (in central Europe) a pronounced peak in numbers in early spring. They have also been captured during the winter months. In southern Europe (Sierra Nevada, Pyrenees, Apennines) they have been taken at altitudes of up to 1200 m.

Type material

Lectotype ♂, ENGLAND: Worcestershire, Abberley Hill, 4.ix.1938 (Wainwright) (BMNH). From the syntypic series (1♂, 1♀), the ♂ is here designated as lectotype, the ♀ as paralectotype.

Other material examined

445 specimens from the following countries (number of specimens in parentheses): AUSTRIA (1), CANADA (B.C., Ont., Que.) (51), CZECHOSLOVAKIA (1), DENMARK (EJ, F, LFM, NEJ, NEZ, NWZ, SZ, WJ) (107), FRANCE (10), GREAT BRITAIN (Cumbria, Devon, Durham) (13), HUNGARY (118), ITALY (1), NORWAY (AK, VAY, Ø) (16), PORTUGAL (Madeira) (2), SPAIN (14), SWEDEN (Bl., Boh., Gtl., Hall., Sk., Sm., Upl., Öl.) (60), SWITZERLAND (1), U.S.A. (Calif., Mich., N.Y., Nev., Utah, Va.) (6), WEST GERMANY (42), YUGOSLAVIA (1).

Discussion

P. angustigena is a fairly easily identified species. Zumpt (1955, 1956) and all later authors have misunderstood this taxon, ignoring Wainwright's perceptive description of the male ventral abdominal vestiture and the male av vestiture of the t_3 of *rudis* and *angustigena*, and treating it as a synonym of *rudis*. It was ranked as a separate species by Rognes (1985).

Usually it gives the impression of being a rather pale and lightly coloured species, especially as regards the anterior parts of the head. However, dark specimens also occur, even with almost black basicosta. In some specimens from North America and even occasional ones from Europe, I have seen a slight indication of a very short middorsal stripe immediately in front of the transverse suture. Occasional specimens, especially females, may lack the outer ph seta on one or both sides. Such specimens can easily be mistaken for *griseotomentosa* Jacentkovský, 1944. This species, not a member of the *rudis*-group, lacks a facial carina, has an extremely narrow frons in the male, most often a different pattern of tessellations on the abdomen, front and hind tarsi shorter than the corresponding tibiae, and usually mostly black p and pv hairs on the f_2 and f_3 . The male cerci are

narrower than in *rudis*-group members and the surstyli narrow and curved. The phallosome lacks a median hypophallic lobe and the central sclerotization in the lateral hypophallic lobes is very weak, discernible only at their very tip. The ovipositor has a middorsal stripe of microtrichiae from the posterior to the anterior edge of both T7 and T8. The female reproductive system also lacks sclerotized lateral sacs. Specimens of *P. tenuiforceps* Séguy, 1928 are also similar to *angustigena* in many respects. But the male has an even narrower frons, and also narrower jowls when seen in profile. t_2 usually has 2–3 *ad* setae. t_3 is entirely without erect *av* hairs. The male genitalia are very different, *tenuiforceps* not being a member of the *rudis*-group. Mihályi (1976) has pointed out that the ocellar setae of *tenuiforceps* males are rather short,

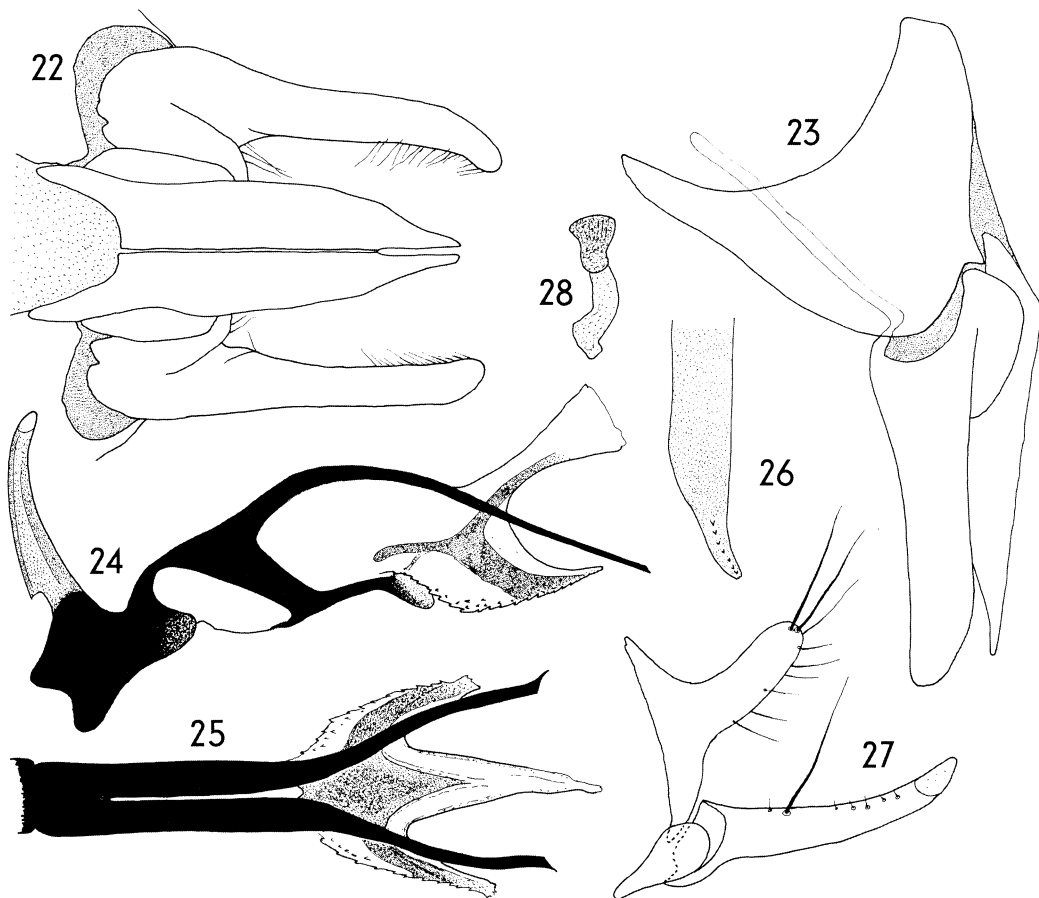
shorter than the hairless part of frons as seen in profile. The hind tarsi are definitely shorter than the tibia, as in the other *tenuiforceps*-group members (*similis*, *dasyпода*).

***Pollenia hungarica* sp.n.** (Figs. 2, 8, 16, 30–37, 79–80, 90)

Holotype ♂, HUNGARY (HNHM).

Diagnosis

♂♀. Facial keel conspicuous and most often rather sharp (Fig. 8). Palpi usually black, sometimes tip slightly brownish, very rarely all yellow. Outer *ph* seta present. Usually only 3 marginal scutellar setae present. Ventral



FIGS. 22–28. *Pollenia angustigena*, ♂ terminalia: 22, cerci and surstyli, posterior view; 23, cerci, surstyli, epandrium, processus longus, lateral view; 24, phallosome, lateral view; 25, distiphallus, dorsal (posterior) view; 26, tip of paraphallic process; 27, pre- and postgonites; 28, ejaculatory sclerite.

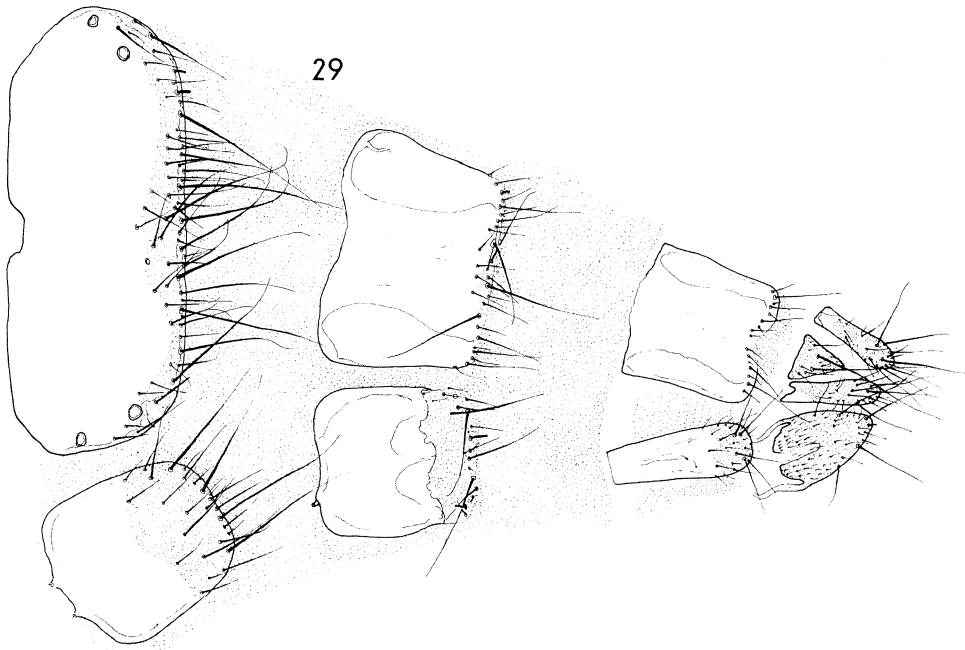


FIG. 29. *Pollenia angustigena*, ♀ ovipositor. Stipple indicates extent of microtrichiae.

abdominal vestiture sexually dimorphic; dorsal abdominal dusting in some cases rather dense, in which case tessellated pattern not conspicuous; *bc* yellow. t_1 with 2 *pv* setae. t_2 with 2–3 *ad* setae. f_2 and f_3 with numerous erect yellow hairs on *p* and *pv* surface at least on inner half (less erect in ♀). f_1 mainly with black *p* and *pv* hairs although often with rather numerous yellow ones basally. *h-sc* node on underside of wing bare.

♂. Frons rather narrow, narrower than distance between posterior ocelli inclusive, parafrontals contiguous (Fig. 2). Vestiture on ventral surface of abdomen mostly yellow (at least back to anterior half of T4), much finer, denser, and more erect than on dorsal surface. f_1 with mostly black hairs on *p* and *pv* surface. t_3 with 3–4 *av* setae which are rather long, about 2× tibial diameter, practically no erect *av* vestiture besides *av* setae (Fig. 16). Genitalia as in Figs. 30–36. Base of distiphallus of type II (cf. Fig. 21). Hypophallic lobes shaped as in Fig. 32. Central sclerotization which is not always as broad as figured in Fig. 32, strengthened distally. Midventral hypophallic lobe prominent. Tip of paraphallic processes armed with a row of minute tubercles (Fig. 34). Paraphallic processes gently curved when seen in profile, their highest

point equidistant from base of distiphallus and their own tip.

♀. Abdomen ventrally with numerous yellow hairs, at least on T1–2 and T3, more rarely also on T4 and T5, especially medially. Ovipositor as in Fig. 37. T6 rather short. Strongly sclerotized part of T7 broader than the almost unsclerotized area between them. Cerci normal, widest rather far from tip. Basal two-fifths of cerci devoid of microtrichiae. Spermathecae (Fig. 79) rather elongate-oval, two of the three sometimes even with a constricted 'handle'-like part proximally. Lateral sacs (Fig. 80) more or less curved as seen in profile, but never to the extent shown by *angustigena* or *rudis*, sometimes very weakly curved.

Larval stages. Unknown.

Puparium. A single puparium is present in HNHM. The posterior spiracles are as in Fig. 90. Ratio of width of both posterior spiracles inclusive to width of puparium at widest equals 0.143 ($n=1$). Lid with anterior spiracles has been lost.

Biology

This species has been reared from *Eisenia rosea* by Professor Zicsi (HNHM). Adults are on

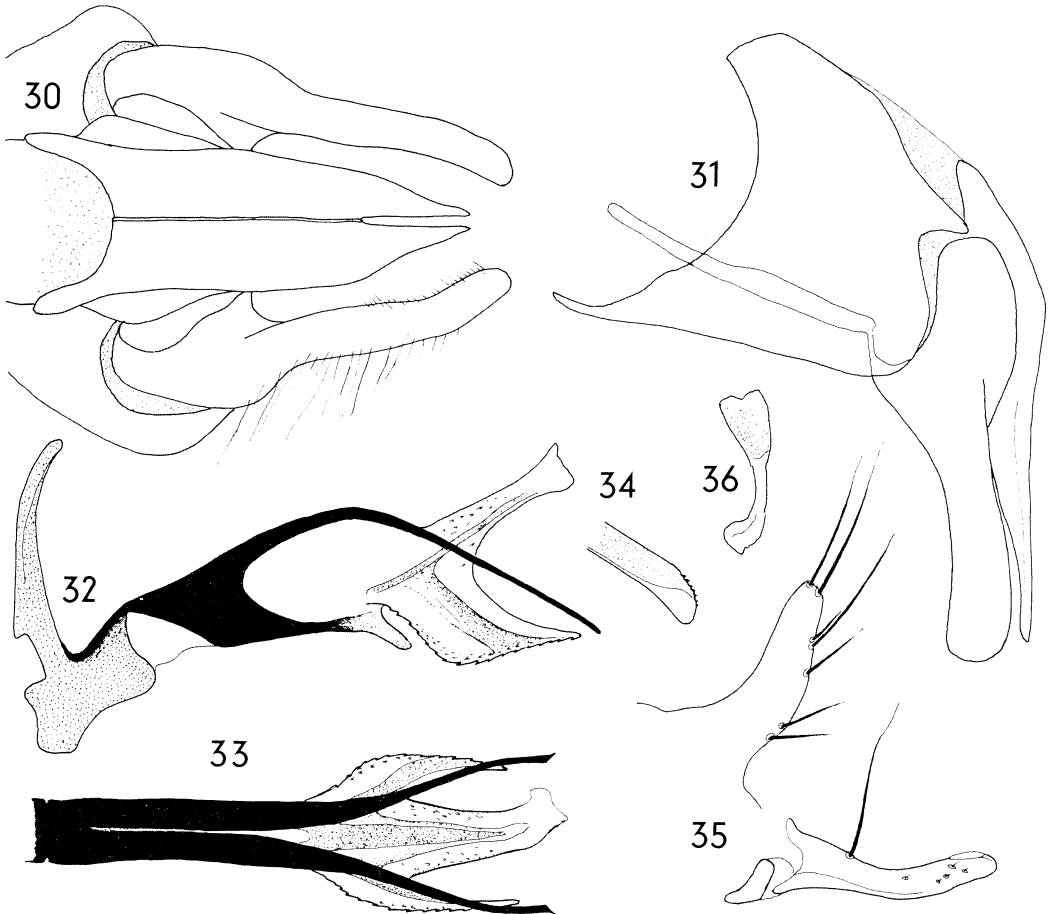
the wing outdoors mostly from March to October, but occasional specimens have been captured in February and November. In Central Europe there is a pronounced peak in numbers in March. In Central Europe it has been taken at altitudes up to 1600 m (Magas Tatra mountains in Czechoslovakia).

Type material

Holotype ♂, HUNGARY: Albertirsa, 16.vi.1958 (*Kutas*) (dissected, preabdominal tergites glued to card on pin, ST1-5 and postabdomen in glycerol in vial on pin) (HNHM).

Paratypes, 19♂, 4♀, as follows: AUSTRIA: 1♂, Burgenland, Illmitz, 21.viii.1960 (head

lost) (*Lyneborg*) (ZMC); CZECHOSLOVAKIA: 1♂, Bohemia, Hrebecniky, 22.iii.1957 (*Benes*) (ZML); HUNGARY: 1♂, Farkasgyepü, 25.iii.1963 (light trap) (HNHM); 1♂, Bakony hg., Márkó, 25.vii.1958 (*Papp*) (HNHM); 1♂, Kunfehértó, 4.vi.1965 (light trap) (KR); 2♂, Kiskun-Dorozsma, 1.vii.1963 (*Tóth*) (1♂ dissected) (HNHM); 2♂, Győr-Kismegyer, 28.iii.1964 (light trap) (HNHM); 1♂, Dömsöd, Apajpuszta, 19.ix.1957 (*Kakassné*) (dissected) (KR); 1♂, Dömsöd, Apajpuszta, 21.viii.1959 (salty pasture) (*Mihályi*) (HNHM); 1♂, Tass, 21.vii.1965 (light trap) (postabdomen on card on pin) (HNHM); 1♀, Kehida, kaszáló, 31.vii.1957 (*Mihályi*) (dissected) (KR); 1♀, Bükk-hgs, Bankút,



FIGS. 30-36. *Pollenia hungarica*, ♂ terminalia: 30, cerci and surstyli, posterior view; 31, cerci, surstyli, epandrium, processus longus, lateral view; 32, phallosome, lateral view; 33, distiphallus, dorsal (posterior) view; 34, tip of paraphallic process; 35, pre- and postgonites; 36, ejaculatory sclerite.

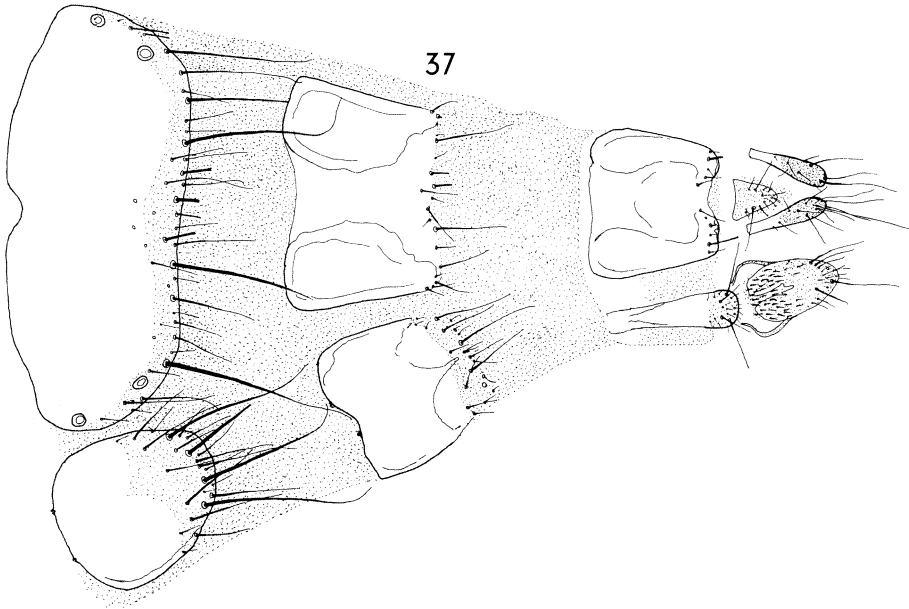


FIG. 37. *Pollenia hungarica*, ♀ ovipositor. Stipple indicates extent of microtrichiae.

20.ix.1959 (forest path) (*Tóth*) (KR); 1♀, Nagykovácsi Remetevölgy, 20.iii.1957 (forest) (dissected) (KR); NORWAY: 3♂, Akershus, Frogn, Håøya, 19.iv–5.v.1984 (Malaise-trap in Quercus, Ulmus, Tilia forest) (*Midtgaard*) (1♂ dissected) (KR); SWEDEN: 1♂, Blekinge, Eringsboda, 1–10.vii.1977 (*Andersen*) (dissected) (SA); 1♂, Bohuslän, 1.vii.1945 (*Wieslander*) (ZML); 1♂, Småland, Hallaryd area, 26.vi–8.vii.1983 (*Andersen & Michelsen*) (ZMC); 1♀, labelled 'G 25/7 17' (dissected) (ZML); SWITZERLAND: 1♂, Delémont, 10.x.1981 (*Andersen*) (SA).

Other material examined

392 specimens from the following countries (number of specimens in parentheses): CZECHOSLOVAKIA (4), HUNGARY (380), ITALY (2), SWEDEN (Sk.) (1), WEST GERMANY (5).

Discussion

Male *P. hungarica* are readily identified by the characters given in the key. By external features it is separable in most cases from *rudis* by the

virtual absence of *av* hairs besides the *av* setae on t_3 , by the rather long *av* setae on t_3 , and by the predominantly light yellow colour of the ventral abdominal vestiture. In rare cases *rudis* may resemble *hungarica* in one or more of these features. The phallosome structure, however, is quite different from that of *rudis* and in difficult cases should always be examined. In external features *hungarica* is separable from *luteovillosa* by the presence of outer *ph* seta, by the narrow facial carina, by having mostly black hairs on the *p* and *pv* surface of f_1 , by having 2–3 *ad* on t_2 , and by a different *av* vestiture of the t_3 (compare Figs. 16 and 18). This latter species also gives the impression of being a paler coloured and more slender species.

In females the combination of rather narrow (short) T6, wide T7 halves, evenly rounded tips of cerci (not truncate as in *rudis*), simple curved lateral sacs and elongate spermathecae is characteristic.

Some very rare freak female specimens resemble *pseudorudis* in having a few hairs on the *h-sc* node on the underside of the wing. They are recognizable as *hungarica* by the numerous yellow hairs on the *p* and *pv* surface of f_2 and f_3 and on the ventral surface of the abdominal

tergites, by the elongate shape (sometimes with a kind of constricted 'handle' at one end) of the spermathecae and the curved lateral sacs.

Note that the female of the 'Unknown species no. 1' discussed below (from Spain) appears very similar to that of *hungarica*. Great caution should therefore be exercised when dealing with series of females without accompanying males from southwestern Europe.

The species named '*Pollenia varia*' by Lobanov (1976) shows rather elongate spermathecae. Possibly females of *hungarica* were before Lobanov when he made the drawings. The genitalia he figured definitely do not belong to '*Pollenia varia*' in the sense of, for

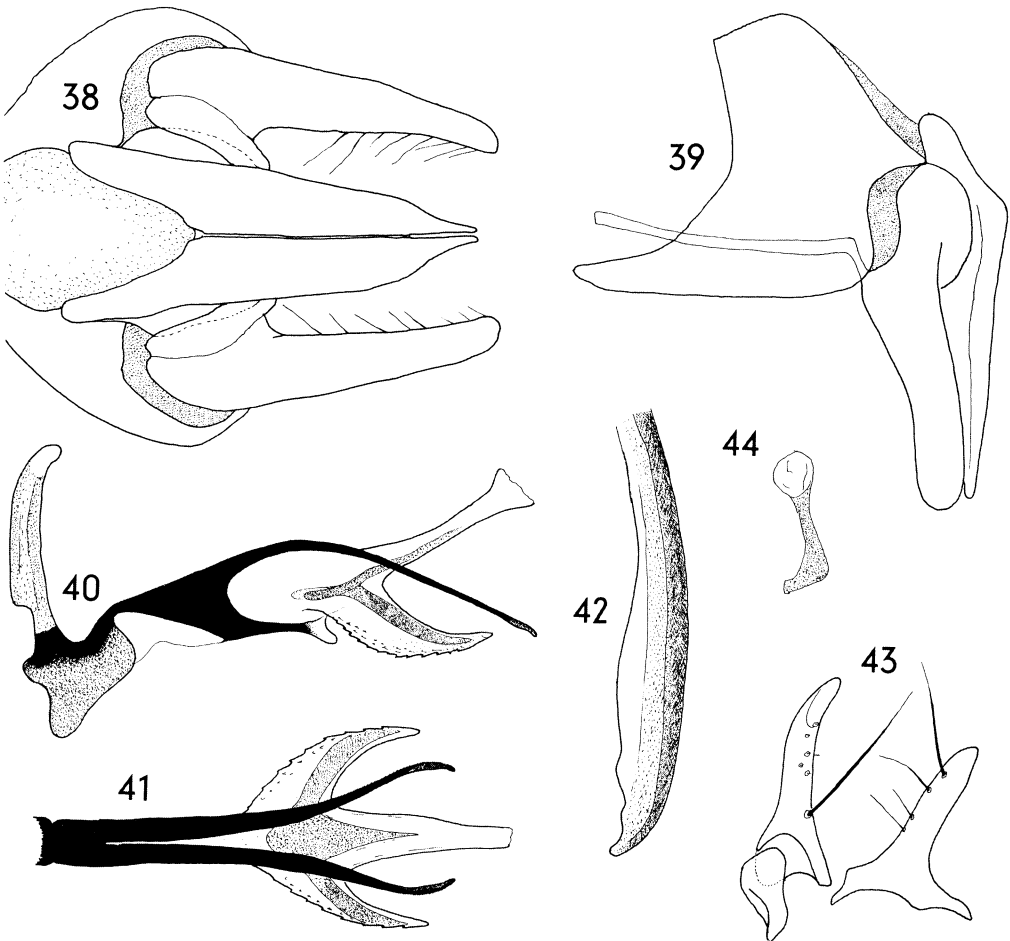
example, Grunin (1970) (= *P. griseotomentosa* Jacentkovský, 1944, see above), which has round spermathecae.

***Pollenia longithec* sp.n.** (Figs. 3, 9, 17, 38–45, 81–82)

Holotype ♂, CYPRUS (BMNH).

Diagnosis

♂♀. Facial carina very broad and low, sometimes even grooved along summit, strikingly *pallida*-like (Fig. 9). Palpi black. Outer *ph* seta normally present, rarely absent on



FIGS. 38–44. *Pollenia longithec*, ♂ terminalia: 38, cerci and surstyli, posterior view; 39, cerci, surstyli, epandrium, processus longus, lateral view; 40, phallosome, lateral view; 41, distiphallus, dorsal (posterior) view; 42, tip of paraphallic process; 43, pre- and postgonites; 44, ejaculatory sclerite.

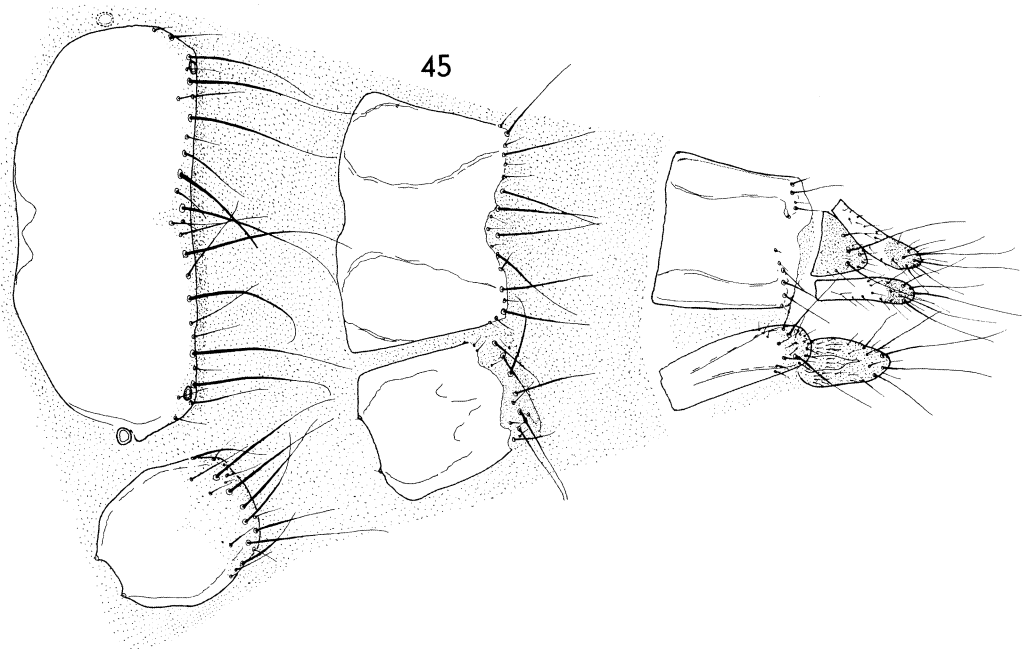


FIG. 45. *Pollenia longitheca*, ♀ ovipositor. Stipple indicates extent of microtrichiae.

one or both sides. Vestiture on ventral surface of abdominal tergites normal, black and similar to that on dorsal surface. t_1 with 1 *pv* seta. t_2 with 1–2 *ad* setae. *bc* yellow, *h-sc* node on underside of wing bare.

♂. Frons as in Fig. 3. t_3 without erect *av* hairs besides *av* setae, which are rather short (Fig. 17). Genitalia as in Figs. 38–44. Cerci rather short. Vestiture on median side of surstyli reaching far towards base. Base of distiphallus of type II (cf. Fig. 21). Hypophallic lobes long, rather narrow, and strikingly elongate (Fig. 40). Central sclerotization wide, appearing close to anterior margin in profile view. Median hypophallic lobe reduced in some specimens. Tip of paraphallic processes (Fig. 42) unarmed, less strongly sclerotized than rest of paraphallic processes, slightly expanded and weakly curving medially (Fig. 41).

♀. Ovipositor as in Fig. 45. Strongly sclerotized parts of T7 relatively broad. Cerci normal, broadest far from tip. Basal three-quarter to half devoid of microtrichiae. Spermathecae extremely elongate (Fig. 81). Lateral sacs straight (Fig. 82).

Larval stages. Unknown.

Puparium. Unknown.

Biology

Host unknown. Dates of capture range from February to November. This species occurs from sea level to about 2300 m (Iran).

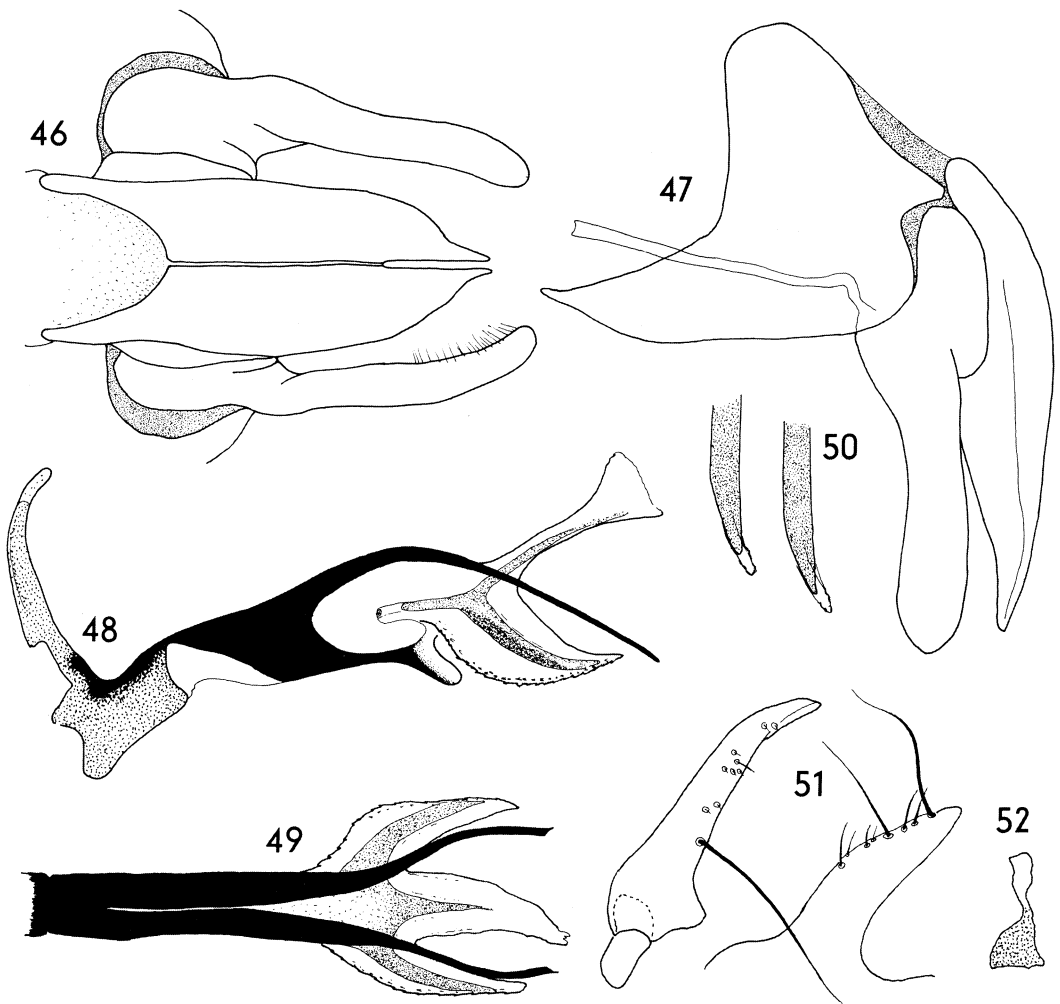
Type material

Holotype ♂, CYPRUS, Amathus, 11.ii.1936 (*Mavromoustakis*) (dissected, preabdominal tergites glued to stage, ST1–5 and postabdomen in glycerol in vial on pin) (BMNH).

Paratypes, 28 ♂ 17 ♀, as follows: CORSICA: 1 ♂, Castirla, 30.iv.1978 (stonny hillside) (*Stubbs*) (BMNH); CYPRUS: 1 ♂ 1 ♀, Amathus, 5.ii.1935 (*Mavromoustakis*) (♀ dissected) (BMNH); 1 ♂, Amathus, 3.ii.1936 (*Mavromoustakis*) (BMNH); 7 ♂, 2 ♀, Amathus, 14.ii.1936 (*Mavromoustakis*) (1 ♂ dissected) (BMNH); 1 ♂, Limassol, ii.1933 (*Mavromoustakis*) (BMNH); 1 ♂, Limassol, ii.1934 (*Mavromoustakis*) (BMNH); 1 ♂, Limassol, 20.iii.1935 (*Mavromoustakis*) (dissected) (BMNH); 1 ♂, Limassol, 3.iii.1953 (*Buxton*) (BMNH); 1 ♀, Yermasoyia Hills, 15.ii.1952 (*Mavromoustakis*) (BMNH); GREECE: 1 ♂, Rhodes, Trianta, 15.iv.1962

(*Thams.*) (BMNH); 2♂, Pelopónnisos, 5 km S Monemvasia, 18–27.vi.1982 (*Skule & Langemark*) (both dissected) (ZMC); 1♀, same locality, 28.iv.1984 (*Christensen*) (dissected) (ZMC); 1♀, same locality, 6.v.1984 (*Christensen*) (ZMC); 1♂, 1♀, same locality, 26–31.viii.1983 (Zool. Mus. Copenh. Exped.) (♂ dissected) (ZMC); 1♀, same locality, 17.xi.1983 (*Christensen*) (ZMC); IRAN: 1♂, Negar, 40 miles S of Kerman (7500 ft), vii–x.1950 (Oxford Univ. Exped. to Persia) (dissected (*by Zumpt?*)) (BMNH); ITALY: 3♂ 1♀, Toscana, Fiesole, Plan Mugore, 28.x.1918 (200

m) (*Querci*) (♀ dissected) (BMNH); 1♂, Sicilia, no further data, (*Schiødte*) (ZMC); 1♀, Sicilia, Cesaro, Monte Soro (1200 m), 28.iv.1968 (*Langemark*) (ZMC); 1♀, Sicilia, Catania, Fiume Sumeto, 10 km fra udløb, 6.v.1968 (*Langemark*) (dissected) (ZMC); Sicilia, Paternó, Fiume Sumeto, 7.v.1968 (*Langemark*) (ZMC); MALTA: 1♂, iii. (BMNH); 1♂ 1♀, W. Ghasel, 2.iv.1978 (*Gatt*) (both dissected) (BMNH); 1♀, Buskett, 21.vii.1978 (*Gatt*) (BMNH); 2♂, 2♀, Mellieha, 25–29.iv.1980 (*Hansen*) (1♂, 1♀ dissected) (ZMC); TURKEY: 1♂, Mersin, Alata near Mersin,



FIGS. 46–52. *Pollenia luteovillosa*, ♂ terminalia: 46, cerci and surstyli, posterior view; 47, cerci, surstyli, epandrium, processus longus, lateral view; 48, phallosome, lateral view; 49, distiphallus, dorsal (posterior) view; 50, tip of paraphallic process; 51, pre- and postgonites; 52, ejaculatory sclerite.

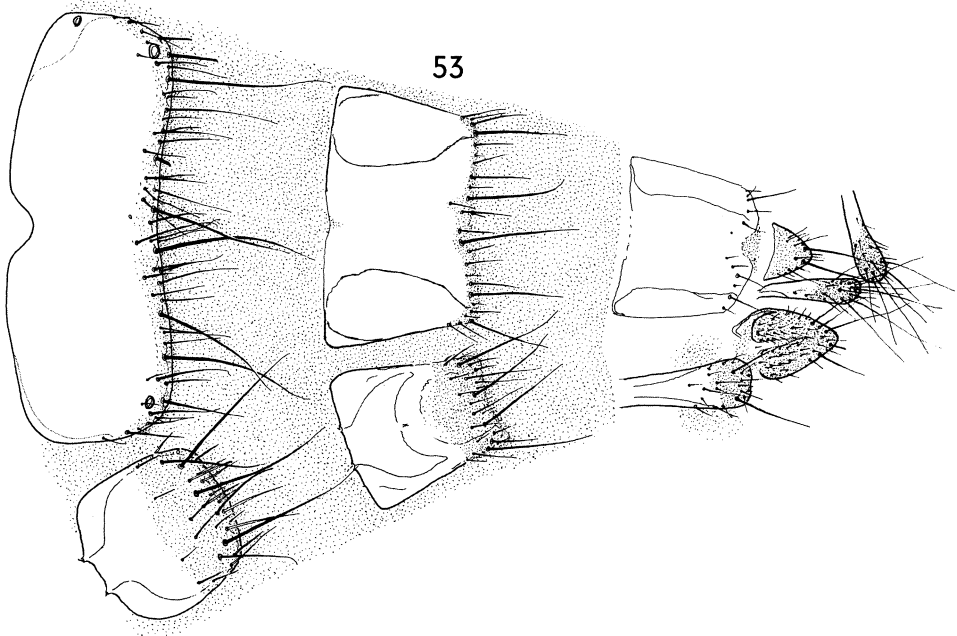


FIG. 53. *Pollenia luteovillosa*, ♀ ovipositor. Stipple indicates extent of microtrichiae.

28.v.1960 (Guichard & Harvey) (BMNH); 1♀, Adapazari, Kocaali (swept by stream), 6.viii.1974 (Cranston) (BMNH).

Other material examined

ALGERIA: 1♂, Algiers, 14.iv.1898 (Ricardo) (BMNH). ITALY: 1♀, Sicilia, no further data, (Schjødt) (dissected) (ZMC). These specimens have both 2 *pv* on the *t*₁.

Discussion

In external features *P. longitheca* is extremely similar to *P. pallida* Rodendorf, 1926 as currently understood (= *P. carinata* Wainwright, 1940), and in the BMNH collection numerous specimens were found under the series of *pallida*. However, the female of *longitheca* is distinguished from *pallida* by the fact that the tip of the ovipositor (usually easily inspected in ordinary pinned material) has only normal soft, thin, slightly wavy hairs. In the *pallida* species-group (*pallida*, *bisulca* Macquart and *bulgarica* Jacentkovský) the female cerci, supraanal plate, subgenital plate and posterior part of ST8 are armed with stiff, straight, blunt, though slender,

spines of striking appearance. This feature was first described by Mercier (1927) in *bisulca*. Male (and female) *longitheca* are usually separable from *pallida* by the black palpi. Dissections should be made, however, to ensure safe identification as some *pallida* also may have rather dark palpi.

P. longitheca is easily separable from other *rudis*-group members on external features by the characters given in the key, although some specimens have some pale hairs on the *p* and *pv* surface of the *f*₂ and *f*₃. I have also seen a female with unsclerotized lateral sacs. Females are readily recognizable by the very long spermathecae.

***Pollenia luteovillosa* sp.n.** (Figs. 4, 10, 18, 46-53, 83-84)

Holotype ♂, MOROCCO (BMNH).

Diagnosis

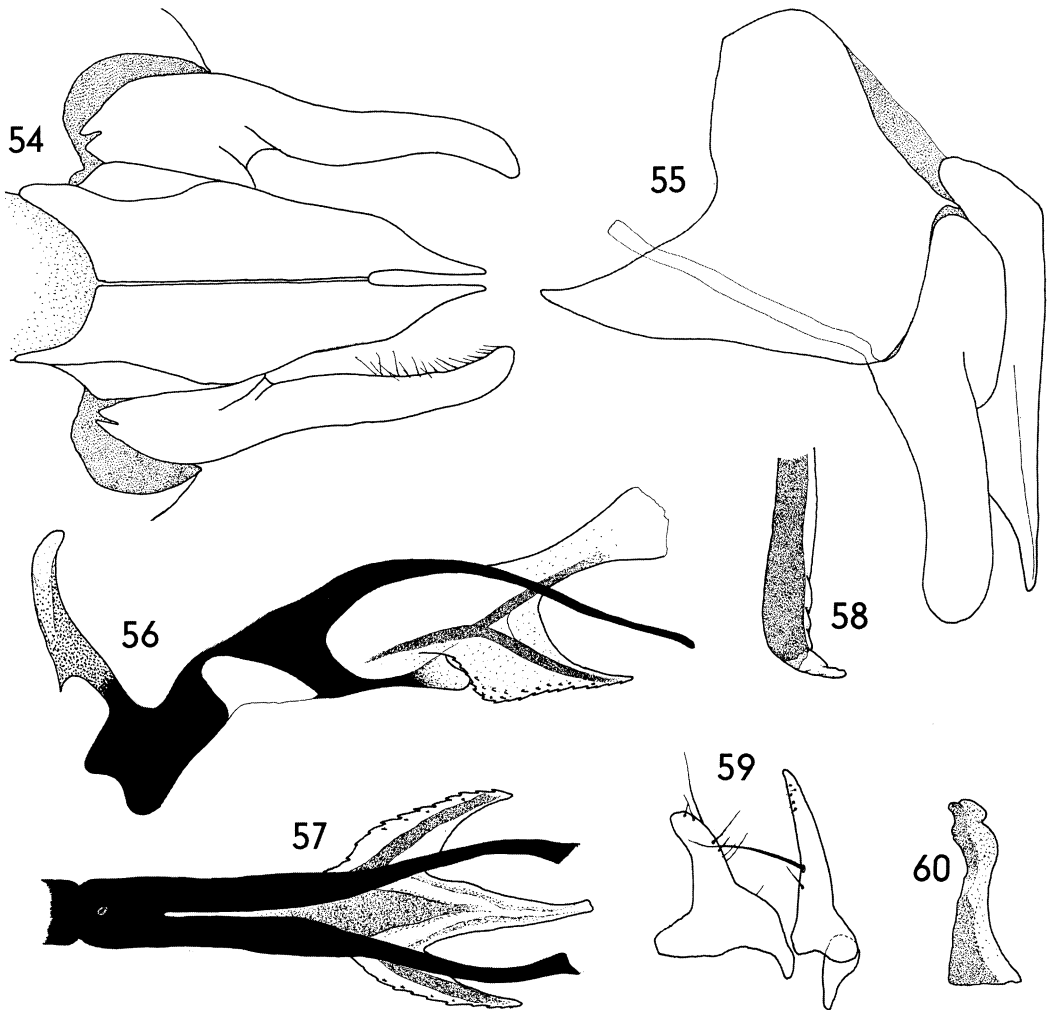
♂♀. Facial carina broad and low, *pallida*-like, often grooved along summit (Fig. 10). Palpi black with yellow tip, sometimes all black or extensively yellow. Outer *ph* seta absent. 3

marginal scutellar setae. Ventral vestiture of abdominal tergites sexually dimorphic. t_1 with 2 *pv*. t_2 with 1 *ad*. f_2 and f_3 with numerous yellow *p* and *pv* hairs. *bc* pale yellow contrasting dramatically with the black tegula. *h-sc* node on underside of wing bare.

♂. Frons as in Fig. 4. Ventral vestiture of abdominal tergites extensively yellow, fine and erect, yellow vestiture also invading T5. Yellow *p* and *pv* hairs on f_2 and f_3 reaching tip of femora, also numerous yellow *p* and *pv* hairs on f_1 . t_3 with a varying number of short more or less erect *av* hairs besides the *av* setae (Fig. 18), sometimes

such *av* hairs altogether absent. Genitalia as in Figs. 46–52. Base of distiphallus of type II (cf. Fig. 21). Hypophallic lobes as in Fig. 48. Tips of paraphallic processes appearing obliquely cut off, apparently unarmed (Fig. 49, 50).

♀. Ovipositor as in Fig. 53. T6 short anteroposteriorly. ST6 with numerous yellow hairs. T7 short, heavily sclerotized parts broad but separated by a distance larger than width of each half. Membrane between T8 and ST8 with microtrichiae in posterior half only. Cerci devoid of microtrichiae on proximal half or more. Supraanal plate rather short. Note also



FIGS. 54–60. *Pollenia pseudorudis*, ♂ terminalia: 54, cerci and surstyli, posterior view; 55, cerci, surstyli, epandrium, processus longus, lateral view; 56, phallosome, lateral view; 57, distiphallus, dorsal (posterior) view; 58, tip of paraphallic process; 59, pre- and postgonites; 60, ejaculatory sclerite.

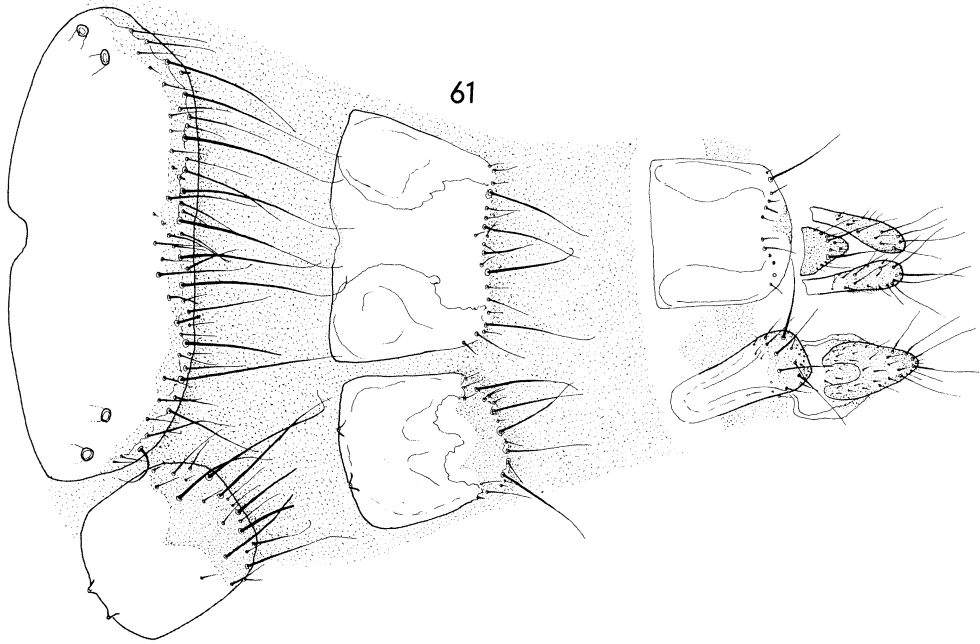


FIG. 61. *Pollenia pseudorudis*, ♀ ovipositor. Stipple indicates extent of microtrichiae.

shape of main sclerotization of ST6 and ST7. Spermathecae elongate (Fig. 83). Lateral sacs rather straight (Fig. 84).

Larval stages. Unknown.

Puparium. Unknown.

Biology

Host unknown. It has been captured in May, July and August.

Type material

Holotype ♂, MOROCCO, Haut Atlas, Jebel Ayachi, Mikdane (orchard), 4.viii.1963 (*Singh*) (dissected, ST1–5 and terminalia in glycerol in vial on separate pin carrying the same holotype label as the specimen itself, T1–5 glued to piece of card on pin) (BMNH).

Paratypes, 7♂ 2♀, as follows: ALGERIA: 2♂, Chr ea, 10.viii.1952 (*Clements*) (1♂ dissected) (BMNH); 1♂, Hamman Rhira, v.1911 (*Rothschild & Hartert*) (BMNH); MOROCCO: 1♂, Haut Atlas, Jebel Ayachi, River Jaffar 800–1500 m, 25.vii.1963 (*Pont*) (BMNH); 1♂ 1♀, Haut Atlas, Jebel Ayachi, Mikdane (stream I south of road), 6.vii.1963 (*Pont*) (BMNH); 1♂, same (stream III, south of road), 17.vii.1963

(*Pont*) (BMNH); 1♂, same, 18.vii.1963 (*Pont*) (BMNH); 1♀, Haut Atlas, Jebel Ayachi, Tizin-Zou (river A, south of road), 24.vii.1963 (*Pont*) (dissected) (BMNH). (Further information on Haut Atlas localities in *Pont & Singh* (1963)).

Discussion

Male *P. luteovillosa* are recognizable by the combination of the constant lack of the outer *ph* seta, the very broad *pallida*-like facial carina and the single *ad* seta on t_2 . Males can be distinguished from *hungarica* also by the yellow *p* and *pv* hairs on the f_2 and f_3 almost reaching the femoral tips, by having more widespread and more numerous pale yellow hairs on the f_1 , and by a different vestiture of the t_3 . The tight, erect, fine and pale yellow ventral vestiture on the abdominal tergites separates it from *angustigena* which also has only a single *ad* on t_2 . Females, of which, unfortunately, only two specimens are available, are superficially rather similar to *hungarica* by having numerous yellow hairs ventrally on the abdomen, but the spermathecae of the single dissected specimen lack the ‘handle’ proximally. However, I consider female *luteovillosa* still unidentifiable with confidence.

For a discussion of some female specimens from Spain, which I have left unidentified and which share several characteristics with the *luteovillosa* female paratypes, see the section 'Outstanding problems'.

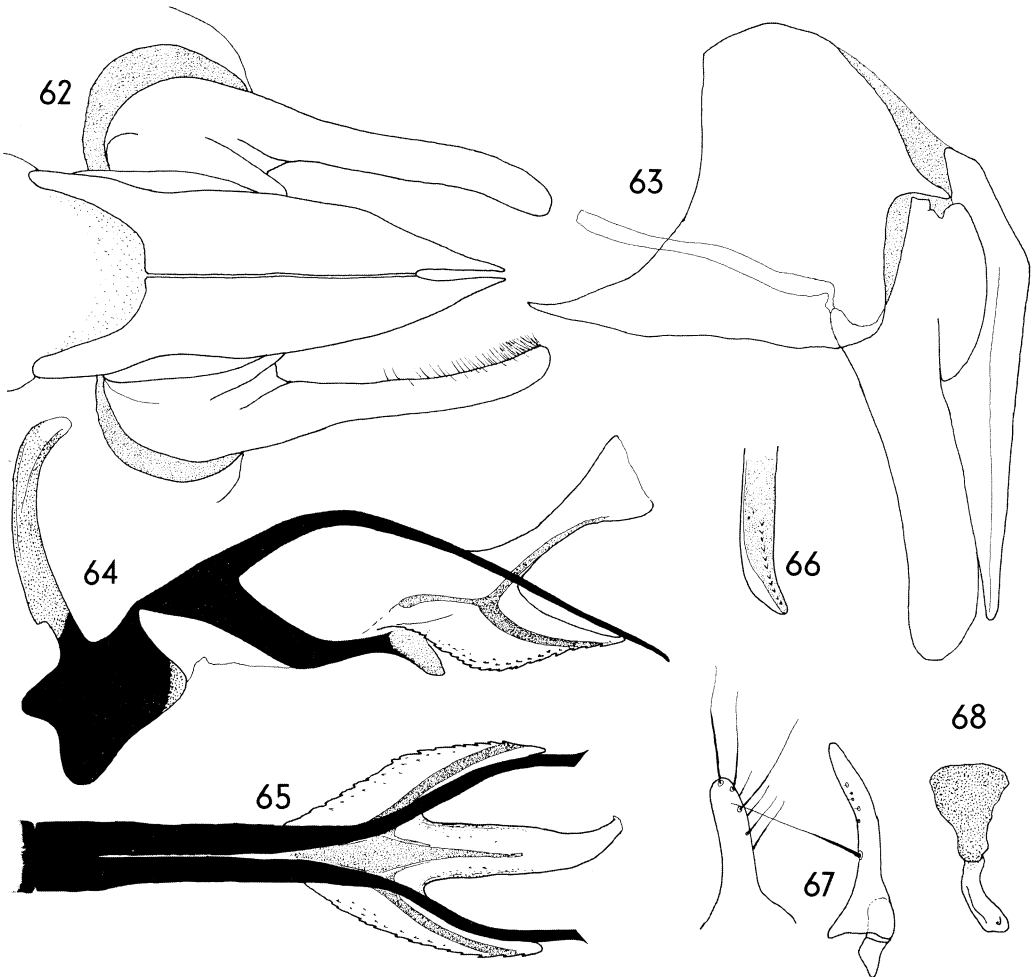
***Pollenia pseudorudis* Rognes** (Figs. 5, 11–12, 14, 19, 54–61, 85–86, 91–94, 97–98)

Pollenia obscura Bigot, 1888a: 597. Holotype ♂, NORTH AMERICA (BMNH), examined; junior secondary homonym of *Musca obscura* Fabricius, 1794 (= *Pollenia rudis* Fabricius).

Pollenia pseudorudis Rognes, 1985: 90; replacement name for *Pollenia obscura* Bigot.

Diagnosis

♂♀. Facial carina variable, from rather narrow and sharp to rather broad, occasionally even with a weakly indicated furrow along summit (Figs. 11, 12). Palpi black. Outer *ph* seta present, except in extremely rare cases. Vestiture on the ventral surface of the abdominal tergites normal, black and similar to that on dorsal surface. *t*₁ with 2 *pv* setae. *t*₂ with 2–4 *ad* setae. *t*₃ with 2–6 *av* setae. Black hairs on *p* and *pv* side of *f*₁, *f*₂ and *f*₃. *bc* yellow, very rarely darkened. *h-sc*



FIGS. 62–68. *Pollenia rudis*, ♂ terminalia: 62, cerci and surstyli, posterior view; 63, cerci, surstyli, epandrium, processus longus, lateral view; 64, phallosome, lateral view; 65, distiphallus, dorsal (posterior) view; 66, tip of paraphallic process; 67, pre- and postgonites; 68, ejaculatory sclerite.

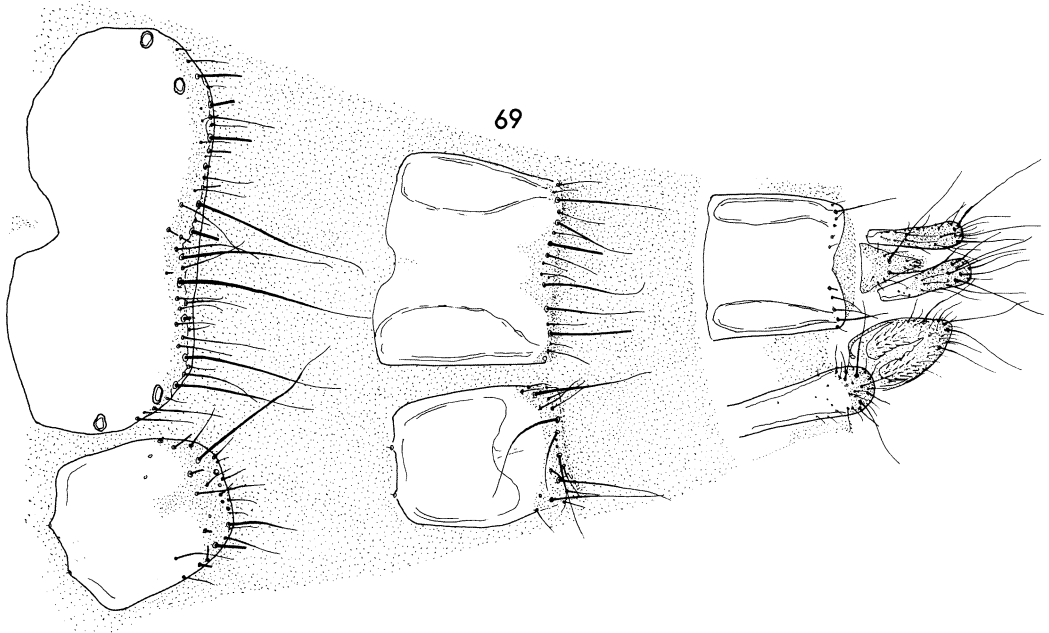


FIG. 69. *Pollenia rudis*, ♀ ovipositor. Stipple indicates extent of microtrichiae.

node on underside of wing with a bundle of pale hairs (Fig. 14) (extremely rarely reduced to only a few hairs).

♂. Frons often rather broad for a *rudis* group member (Fig. 5). t_3 without erect *av* hairs, with only decumbent setulae besides the *av* setae (Fig. 19). Genitalia as in Figs. 54–60. Base of distiphallus of type II (cf. Fig. 21). Hypophallic lobes as in Fig. 56. Central sclerotization usually rather oblique. Tip of paraphallic processes apparently unarmed (as seen at 450× magnification) (Fig. 58), in frontal view rather broad distally (Fig. 57), often appearing more transversely than obliquely cut off.

♀. Ovipositor as in Fig. 61. T6 rather short. Strongly sclerotized parts of T7 wider than pale area between them. Cerci rounded distally, broadest far behind tip, and devoid of microtrichiae on basal half to quarter. Spermathecae as in Fig. 85. Lateral sacs straight (Fig. 86), occasionally not or weakly sclerotized.

Larval stages. The description of Yahnke & George (1972) probably refers to this species. I have examined a sample of thirty-nine adult specimens of '*rudis*' (formerly in UW0Z, now in KR) from the very locality where these authors obtained their material. Unfortunately it was

mixed. About 90% were *pseudorudis*, while the rest were *rudis*.

Puparium. Posterior spiracles variable, as shown in Figs. 91–94. Ratio of distance between posterior spiracles inclusive and greatest width of puparium equals 0.1570–0.1944 ($n=8$) (mean 0.1668). Anterior spiracles with 4–5 branches (Fig. 97). Puparial horn as shown in Fig. 98.

Biology

Two male *P.pseudorudis* with puparia in HNHM were bred from *Eisenia rosea* in Hungary. The North American material studied by Yahnke & George (1972), which for the most part consisted of *pseudorudis* (cf. above), was also predatory on this lumbricid in the larval stages. Seven puparia available in CNC were found in soil in autumn. The adults emerged on dates between 16.viii and 27.ix. Outdoors the adults are on the wing mostly from March to October, but several specimens have been captured during the winter months. In North America and in central and northern Europe it has a pronounced peak in numbers in early spring. In southern Norway it has been captured at levels up to the subalpine birch zone (730 m),

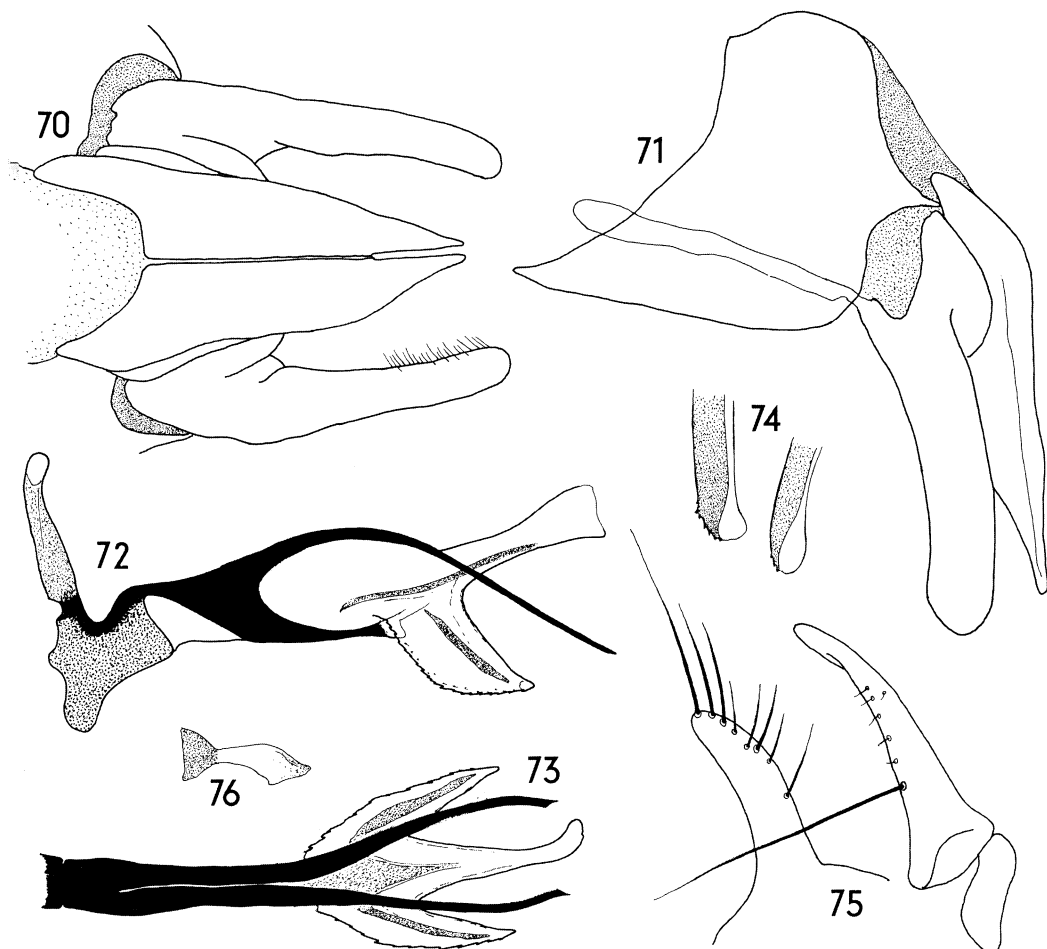
in Czechoslovakia up to 1300 m, in Yemen at 2400 m and in North America at about 2500 m in New Mexico and 1750 m in Colorado.

Type material

Holotype ♂, 'Amér. septentr. 1 spécimen', unknown date (Bigot collection) (dissected, T1-5 glued to card, ST1-5, T6, T7+8 and terminalia kept in glycerol in vial, card and vial on separate, appropriately labelled pin) (BMNH). The specimen is in good condition. All legs are preserved on left side, on right side only p₁ remains. It fits the description in Bigot (1888a: 597; 1888b: clxxi), except for the palpi which are black (described as '... fulvis'). I accept it as the holotype of *obscura*.

Other material examined

1585 specimens from the following countries (number of specimens in parentheses): ANDORRA (1), AUSTRIA (11), CANADA (Alta., B.C., Man., NB., N.S., Nfld., Ont., P.E.I., Que.) (189), CYPRUS (14), CZECHOSLOVAKIA (10), DENMARK (B, EJ, F, LFM, NEJ, NEZ, NWZ, SJ, SZ) (126), FRANCE (including CORSICA) (10), GREAT BRITAIN (Avon, Berks., Cumbria, Glos., Kent, London, Oxon., Staffs., Wilts.) (17), GREECE (1), HUNGARY (873), India (Jammu & Kashmir) (1), IRAN (1), ISRAEL (1), ITALY (3), JORDAN (1), NEW ZEALAND (17), NORWAY (AAY, AK, BV, HEN, HES, HOI, HOY, MRI, MRY, NSY,



FIGS. 70-76. *Pollenia* sp. ('Unknown species No. 1'), ♂ terminalia: 70, cerci and surstyli, posterior view; 71, cerci, surstyli, epandrium, processus longus, lateral view; 72, phallosome, lateral view; 73, distiphallus, dorsal (posterior) view; 74, tip of paraphallic process; 75, pre- and postgonites; 76, ejaculatory sclerite.

OS, RI, RY, SFI, SFY, TEI, VAI, VAY, VE, Ø) (147), PAKISTAN (Chitral) (1), PORTUGAL (Madeira, also mainland according to E. A. Fonseca, pers. comm.) (1), ROMANIA (9), SPAIN (6), SWEDEN (Bl., Dir., Dlsl., Gstr., Gtl., Hall., Jmt., Sk., Sm., Upl., Vg., Ög., Öl.) (96), SWITZERLAND (2), TURKEY (2), U.S.A. (Calif., Colo., D.C., Idaho, Ill., Ind., Iowa, Maine, Mass., Md., N.C., N.H., N.Mex., N.Y., Ohio, Pa., Utah, Va.) (30), U.S.S.R. (Kazakh S.S.R., Turkmen S.S.R.) (3), WEST GERMANY (7), YEMEN (2), YUGOSLAVIA (1).

Discussion

The presence of a bundle of pale hairs on the underside of the *h-sc* node in *pseudorudis* is practically unique within the *rudis*-group, and both sexes can be reliably identified by this feature in combination with the black colour of hairs on ventral surface of abdominal tergites and *p* and *pv* side of f_2 and f_3 . Apart from very rare freak specimens of *hungarica* (see above), hairs on the *h-sc* node occur regularly in *P. atramentaria* Meigen, and irregularly in *P. bicolor* Robineau-Desvoidy. I have also seen some hairs in this position in freak specimens of *P. vagabunda* Meigen.

***Pollenia rudis* Fabricius** (Figs. 6, 13, 20, 62–69, 87–88, 95)

Musca rudis Fabricius, 1794: 314. Holotype ?sex, 'Germania', lost except for pin and label (examined); Neotype ♂, W. GERMANY (ZMC), by present designation (see below for details).

Musca obscura Fabricius, 1794: 315. Holotype ♂, GERMANY (ZMC), examined.

[*Musca familiaris* Harris, 1869: 336; Syntypes ♂♀, U.S.A. (MCZ), examined (see below for details). Junior primary homonym of *Musca familiaris* Panzer, 1804. No lectotype designated as the name is unavailable.]

Note on synonymy

Zumpt (1956) and Schumann (1986) both treat *Dasypollenia angustifrons* Jacentkovský, 1941 as a synonym of *rudis*. In my opinion this is quite unjustified. Jacentkovský (1941, 1942)

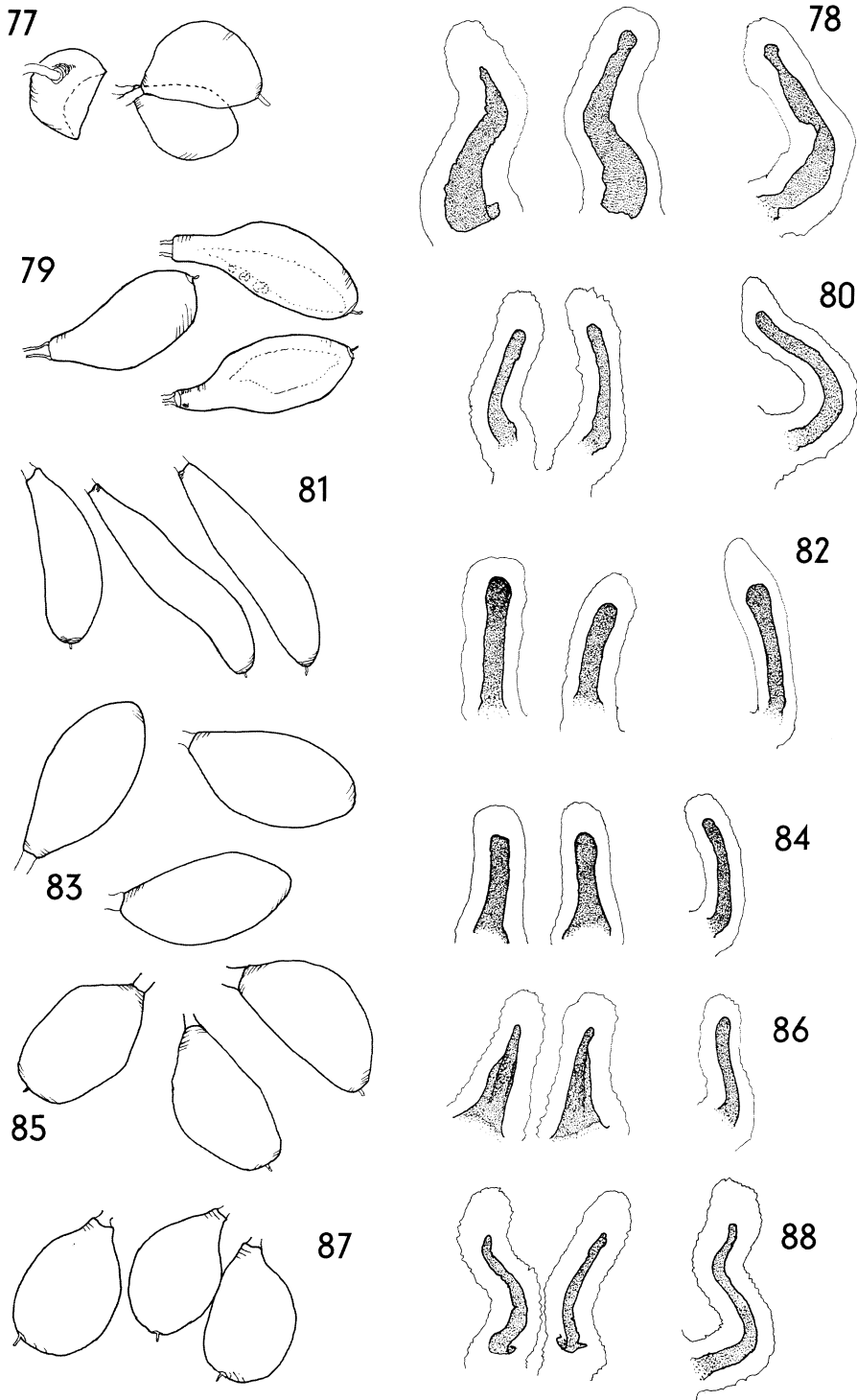
explicitly groups his *angustifrons*, because of its phallosome structure, together with *dasypoda*, *similis* and *landrocki* (Jacentkovský) (the latter probably = *dasypoda*, teste Zumpt, 1956) in the genus *Dasypollenia* Jacentkovský, 1942, i.e. in what I regard as the *tenuiforceps*-group of *Pollenia*. Externally it differs, according to Jacentkovský's description, from the other included species in having a narrower frons and unmodified vestiture on the hind leg in the males. In my opinion this indicates quite clearly that *P. angustifrons* (Jacentkovský, 1941) is a junior synonym of *P. tenuiforceps* Ségué, 1928. It should consequently be removed from synonymy with *rudis*.

Diagnosis

♂♀. Facial carina conspicuous and rather sharp (Fig. 13). Palpi black, tip usually pale. Outer *ph* seta usually present. Usually 4 marginal scutellar setae. t_1 with 1–2 *pv* setae. t_2 with 2–4 *ad* setae (2 freak specimens in CNC with 1 *ad* only). f_2 and f_3 usually with black vestiture on *p* and *pv* surface, although specimens, especially from central Europe, sometimes have many yellow hairs in this position not unlike *angustigena* and *hungarica*. *h-sc* node on underside of wing bare.

♂. Frons as in Fig. 6. Vestiture on ventral surface of abdominal tergites erect, very dense, fine and curled at tip, normally black (but see reservations made in the key and the discussion below). t_3 with numerous erect *av* hairs besides the *av* setae (Fig. 20). Genitalia as in Figs. 62–68. Cerci rather long. Base of distiphallus of type I (cf. Fig. 21). Hypophallic lobes as in Fig. 64. Central sclerotization rather narrow, narrower than distance from its anterior edge to the anterior edge of the hypophallic lobe itself (Fig. 64). Tip of paraphallic processes armed with a row of minute denticles (Fig. 66). Paraphallic processes strongly curved, highest point much closer to base of distiphallus than to tip of paraphallic processes themselves (Fig. 64).

♀. Eye in profile about as high as gena (jowl) in profile. Ovipositor as in Fig. 69. T6 strikingly long, a line connecting the two anterior spiracles across T6 divides the sclerite into anterior and posterior halves, of which the anterior one is practically as long as the posterior one. T7 rather long, its strongly sclerotized parts narrow, usually much narrower than transparent area



FIGS. 77–88. *Pollenia* spp., spermathecae (77, 79, 81, 83, 85, 87) and lateral sacs (78, 80, 82, 84, 86, 88; to the left: dorsal view; to the right, lateral view): 77–78, *angustigena*; 79–80, *hungarica*; 81–82, *longithecica*; 83–84, *luteovillosa*; 85–86, *pseudorudis*; 87–88, *rudis*.

between them. Cerci rather long, truncate at tip, broadest point close to tip, devoid of microtrichiae at basal quarter to third. Membrane between T8 and ST8 usually devoid of microtrichiae on at least basal half. Spermathecae oval, short (Fig. 87). Lateral sacs long and strongly curved, in a spiral fashion (Fig. 88).

Larval stages. Unknown (cf. discussion below).

Puparium. Posterior spiracles as in Fig. 95. Ratio of distance between posterior spiracles inclusive and greatest width of puparium equals 0.1646–0.1742 ($n=2$) (mean 0.1694). Anterior spiracle with 4–5 branches.

Biology

A male specimen in HNHM without a puparium was bred from *Eisenia rosea*. The two puparia available (in CNC) were found in soil on 6.viii and 2.ix and the adult flies emerged on 28.viii and 30.ix, respectively. Adults are on the wing from March to October, but several specimens have also been taken during the winter months. In northern Europe this species show a pronounced peak in numbers in early spring (April). In northern Europe *rudis* has been captured up to the subalpine and alpine regions, in Czechoslovakia up to 1020 m, in Italy (Sicily) at 1200 m, in the U.S.S.R. (Gruziya) up to 1700 m, and in North America up to about 1200 m (North Carolina).

Type material

Musca rudis Fabricius, 1794: 314.

Holotype ?sex, 'Habitat in Germania', apparently lost. Empty pin with a Fabrician label reading 'rudis' in Fabricius' hand remains in the Kiel collection (ZMC).

Neotype ♂, W. GERMANY: Schleswig-Holstein, Grömitz, 5–6.vii.1980 (*Pont*) (ZMC), here designated. The specimen is in excellent condition. The right t_1 has 3 *pv* seta and the right one 2, very close together. Otherwise it corresponds exactly to the concept of *rudis* defined above. The ventral abdominal vestiture and the *p* and *pv* vestiture of f_2 and f_3 are black.

Musca obscura Fabricius, 1794: 315.

Holotype ♂, 'Habitat in Germania', examined (Kiel collection, ZMC). The speci-

men carries a label reading 'obscura' in Fabricius' hand. It lacks the head and all legs. The abdominal vestiture shows that it belongs to *rudis* as defined here.

[*Musca familiaris* Harris, 1869: 336.

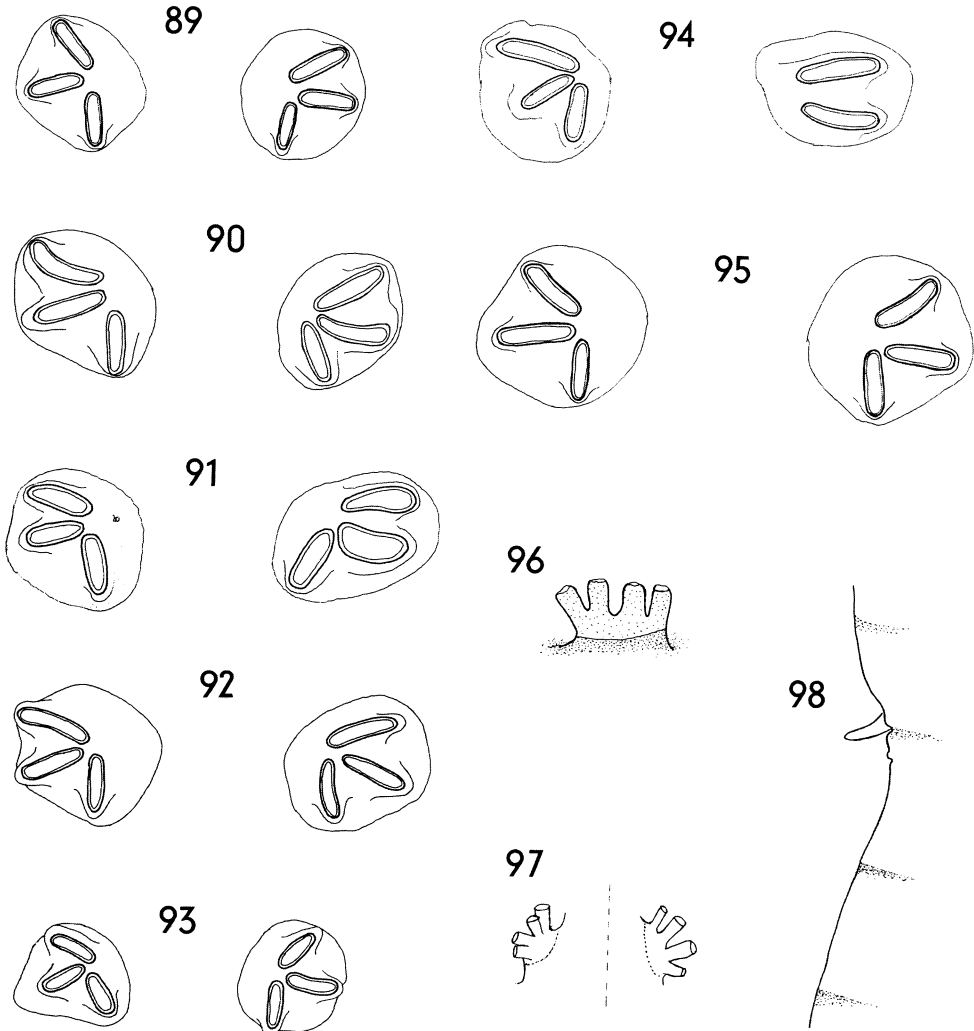
Syntypes ♂♀, U.S.A. (MCZ), examined. The syntypic series of six specimens is mixed: 1♂, 1♀ = *Pollenia rudis* Fabricius, 1♂, 1♀ = *Pollenia angustigena* Wainwright; 1♂ 1 unknown sex = *Pollenia pseudorudis*. As the name is unavailable it serves no purpose to designate a lectotype. The name can well remain in the synonymy of *rudis* where it was placed by Hall (1965).]

Other material examined

1557 specimens from the following countries (number of specimens in parentheses): ALGERIA (1), AUSTRIA (1), CANADA (B.C., Man., N.B., N.S., Nfld., Ont., P.E.I., Que.) (158), CYPRUS (1), CZECHOSLOVAKIA (39), DENMARK (B, EJ, F, LFM, NEJ, NEZ, NWJ, NWZ, SJ, WJ) (149), FINLAND (N) (3), FRANCE (1), GREAT BRITAIN (Beds. Cumbria) (14), GREECE (12), HUNGARY (185), INDIA (Jammu & Kashmir) (2), IRELAND (1), ITALY (also Sicily) (7), MOROCCO (3), NEW ZEALAND (2), NORWAY (AAI, AAY, AK, BV, BØ, HEN, HES, HOI, HOY, MRI, MRY, NNV, NSI, NSY, NTI, NTY, ON, OS, RI, RY, SFI, SFY, STI, TEI, TRY, VAI, VAY, VE, Ø) (689), SPAIN (39), SWEDEN (Bl., Dir., Dsl., Gstr., Hall., Jmt., Nrk., Sdm., Sk., Sm., Upl., Vb., Vg., Vrm., Öl) (223), U.S.A. (Calif., Hawaii, Ill., Ind., Iowa, Ky., Mass., N.C., Oregon) (16), U.S.S.R. (Gruziya) (2), WEST GERMANY (6), YUGOSLAVIA (1).

Discussion

Male *rudis* are easily identified by the ventral abdominal, f_2 , f_3 , t_2 and t_3 vestiture. Some specimens, especially from central Europe, have rather pale yellowish hairs on the ventral surface of abdomen, thus resembling *hungarica*, and occasional specimens may also have rather yellowish hairs on the *p* and *pv* side of the femora. Such specimens have been taken at localities together with quite normal specimens.



FIGS. 89–98. *Pollenia* spp., posterior spiracles of puparia (89–95), anterior spiracles of puparia (96–97) (right (left) and left sides in 97) and parts of left side of puparium showing puparial horn (98): 89, 96, *angustigena* ♀; 90, *hungarica* ♂; 91–94, 97, 98, *pseudorudis* (various specimens) ♂; 95, *rudis* ♂.

In these cases the t_3 vestiture and structure of the distiphallus are diagnostic.

Female *rudis* and *hungarica* are more difficult to separate by external features only, although most *rudis* females seem to be recognizable by the lack of yellow hairs on the ventral surface of the abdominal tergites and on the *p* and *pv* surface of f_2 and f_3 . The structure of the lateral sacs, spermathecae and ovipositor should be examined for reliable identification.

Keilin (1909, 1911, 1915) described the larval stages and life cycle of a species named '*Pollenia*

rudis' which overwintered as first instar larva within the earthworm host, and which had only one generation each year. His work has until now been accepted in Europe as the main source of information on the biology of this species. However, his figures of the posterior spiracle of the third instar larva (Keilin, 1915: Planche VII, Fig. 32; Keilin, 1915: 81, Fig. IX; the former figure redrawn by Hall, 1948: Pl. 46, H) differ in important aspects from the spiracles of true *rudis*. They show that the angle between the upper and lower slit is considerably less than a

right angle, and that the lower slit is almost horizontal and not vertical as is the case in all the *rudis*-group members where the posterior spiracle of the third instar larva is known (Figs. 89–95). It is therefore almost certain that the species which Keilin studied is not a member of the *rudis*-group. According to a figure of the internal female genitalia of the material he studied (Keilin, 1915: 65, Fig. IV), sclerotized lateral sacs are present which are shown to be rather straight. Outside the *rudis*-group I have seen such lateral sacs only in freak *P. intermedia*. However, it is also possible that the illustrated female is not conspecific with the larval stages that were described. At present, it is not possible to determine what species Keilin studied.

Outstanding problems

I have been unable to refer five male and eight female specimens from Spain to any of the taxa described above. The males are described below as 'Unknown species no. 1'. Until more material becomes available it is impossible to decide whether they represent a separate taxon or rather should be regarded as freak specimens of one of the taxa described above. Most of the females, obviously all belonging to the *rudis*-group, share many features with the *luteovillosa* female paratypes, e.g. a broad facial carina and numerous yellow hairs on the ventral part of the abdomen. However, I hesitate to assign them to that species because of some characteristics of the ovipositor, especially the length of the T6, and because the two males captured together with them (i.e. in the Orgiva, Lanjarón, Motril area of Granada province) belong to the still obscure taxon described below.

Unknown species no. 1 (Figs. 70–76)

Material examined

SPAIN: 3♂, Jaraco, 12–16.iv.1974 (*Dear*) (all dissected) (BMNH); 1♂, Granada, Barranco de Miranda, 8 km SW Orgiva (300 m), 21.iv.1966 (*Lyneborg, Martin, Langemark*) (phallosome lost); 1♂, same locality, 16.iv.1966. (*Lyneborg, Martin, Langemark*) (dissected) (ZMC).

Description

Three of the specimens listed above share with *hungarica* and *luteovillosa* the dense yellow

vestiture on the ventral surface of the abdominal tergites. The fourth specimen has lost the abdomen. In the fifth specimen the vestiture is dense and black as in *rudis*. All specimens differ from *hungarica* by having a broad facial carina and (in four of them) several erect *av* hairs on t₃ besides the *av* setae. They differ from *luteovillosa* by having (in four of them) 2–3 *ad* on t₂ and an outer *ph* seta. The basicosta is brown and the colour of the wing base, squama and body is generally much darker than in *luteovillosa*. The genitalia are shown in Figs. 70–76. The base of the distiphallus is of type II (cf. Fig. 21). The very low median hypophallic lobe is noteworthy, the lower edge of which makes almost no angle whatsoever with the ventral surface of distiphallus basad of it.

Acknowledgments

I would like to thank the following colleagues and friends for gift or loan of material, useful information and other invaluable assistance: A. C. Pont, BMNH; E. A. Fonseca, Bristol; B. E. Cooper, CNC; F. Mihályi, HNMH; J. Carpenter, MCZ; L. Matile, Muséum National d'Histoire Naturelle, Paris; B. A. Holloway, NZAC; P. Straumfors, RM; R. Mehl, Oslo; C. Bergström, Uppsala; J. A. George, formerly UWOZ; S. Andersen, ZMC; L. Lyneborg, ZMC; T. Pape, ZMC; and R. Danielsson, ZML.

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Accepted 18 November 1986