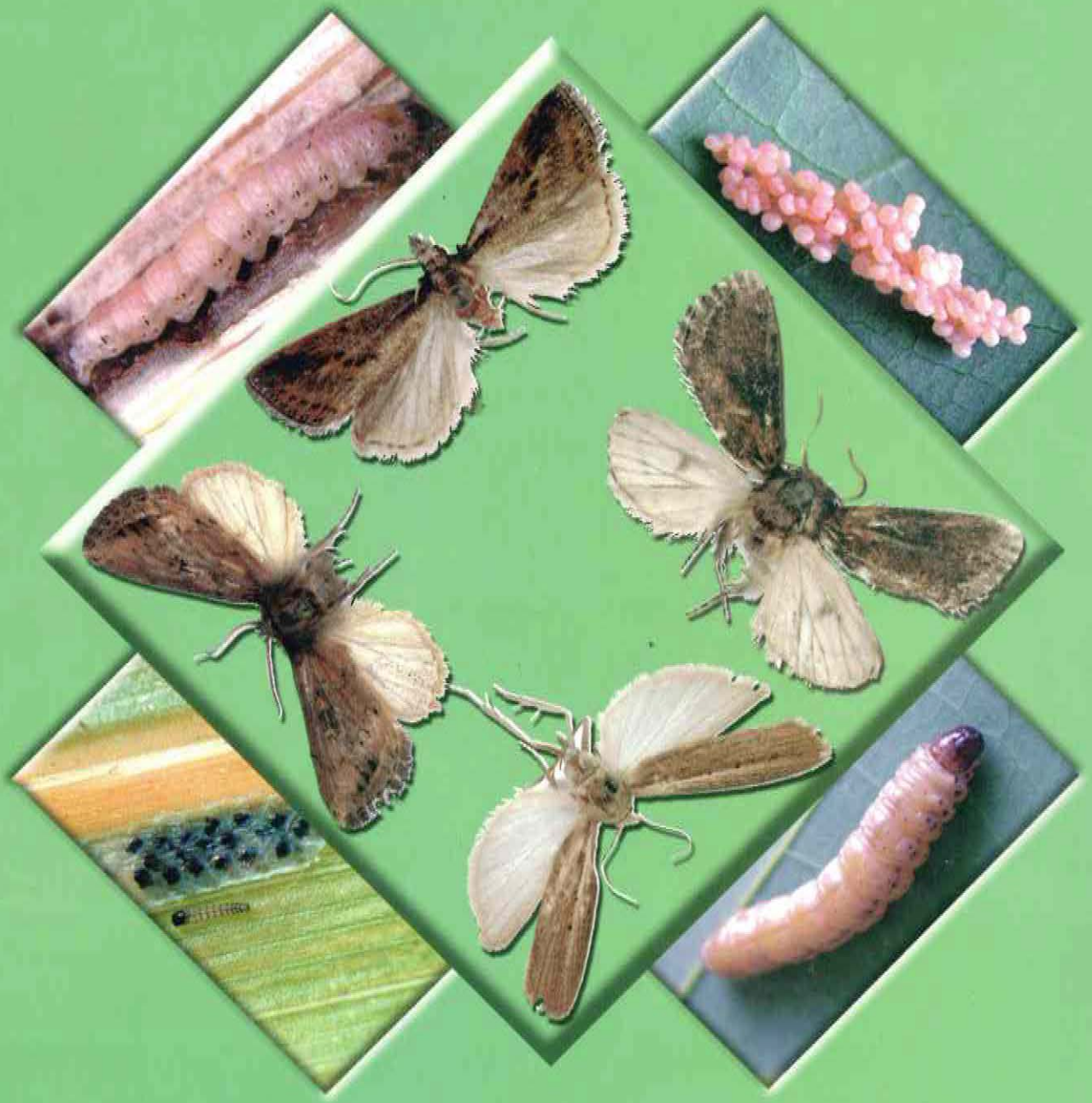
MANUAL FOR THE IDENTIFICATION OF GRASS STEMBORERS AND ASSOCIATED PARASITOIDS IN KENYA



Alberto T. Barrion, Robert S. Copeland and Zeyaur R. Khan

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icipe – African Insect Science for Food and Health

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Manual for the Identification of Grass Stemborers and Associated Parasitoids in Kenya

by

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FOREWORD

This manual illustrates many of the stemborers and associated insects of grasses in Kenya, and provides keys for their identification. It can be used together with *icipe*'s booklet *A Primer on Grass Identification and Their Uses in Kenya*, which provides diagnostic and pictorial information on grass species that abound in and around agricultural lands in Kenya.

It is of paramount importance to identify stemborers and their natural enemies associated with grasses to implement ways of using native grasses to manage insect pests in farmers' fields. Wild grasses may act to repel or physically block pests of cereal crops, limiting access to crop plants. Grasses may also serve as a preferred habitat for beneficial insects and spiders that parasitise or prey on pest species. Proper management of wild grasses around crop fields can provide a natural resource of beneficial species of parasitoids and predators, increasing the chances of self-sustainable agriculture development among resource-poor farmers throughout Kenya. In this manual, the focus is on the pests and their parasitoids. As the technologies for self-regulatory pest management and sustainable agriculture grow more sophisticated and specific, correct identification of pest insects and their enemies is very important. However, there is presently no single manual available that offers users a tool to identify insects to at least the generic level. This manual addresses that need.

The primary target users of this manual are field or laboratory technicians and researchers. Technical language has been minimised as far as possible. However, many species of stemborers on grasses look similar, and identification based solely on external morphological features can be frustratingly difficult. This is particularly true for moth species of the genera *Chilo*, *Sesamia* and *Busseola*, especially when adult specimens are rubbed. Therefore, photographic images of the genitalia of most stem-boring moths have been included to provide help in identification to the species level. The illustrations and photos should facilitate the identification of stemborers and their associated insects reared from tall grasses. These data will help to determine the grass species that are important for conservation and maintenance of insect biodiversity.

I hope the manual will be a useful tool in identifying the stemborers on grasses and their natural enemies associated with the wild and cultivated grasses of Kenya, and that it also provides information useful for supporting self-regulatory pest management for sustainable agriculture and the conservation of biological diversity.

C. Borgemeister
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INTRODUCTION

The Global Environment Facility (GEF) with implementation support from the United Nations Environment Programme (UNEP) funded the project GFL/2711-01-4345 focusing on *"Conservation of Gramineae and Associated Arthropods for Sustainable Agricultural Development in Africa"*. The goal of the project was to document the diversity of wild grasses (Gramineae) and associated insects in different agroecosystems and their adjacent natural habitats, and to exploit the relationships between certain grasses and insects to integrate self-regulatory and sustainable pest management strategies into traditional farming methods. The primary objective was to identify and implement conservation and management measures that would prevent the loss of biodiversity of wild grasses and their associated insects, and to conserve these rich genetic resources in and around agroecosystems in Ethiopia, Kenya and Mali.

A rich community and diverse taxonomic array of stemborers and their associated insects—parasitoids and hyperparasitoids—were reared during the project. The great diversity of stemborers and associated insects present on grasses presented two serious challenges: (1) successfully rearing stemborers from small grass stems and (2) identifying the stemborers and their associated parasitoids, at least to the genus level, depending on availability of species descriptions, keys and taxonomic experts. Experience showed that the small stems of wild grasses were not suitable for rearing field-collected larvae in the laboratory. Grass stems shrivelled easily, killing the young larvae inside. After considerable experimentation, a standard method for handling and rearing borer larvae was developed and has been made available with the publication of the handbook *"How to Handle Grass Stemborer Larvae"*, available in a revised edition in French as *"Comment mener à terme un élevage de foreurs?"*. These methods contributed to the successful rearing of stemborers and their parasitoids. The present work aims to provide an identification tool to enable field workers and researchers to identify stemborers and their associated parasitoids reared from grasses.

Composition of the Manual

The manual comprises keys to various insect taxa that bore in grasses or that parasitise the borers. Some hyperparasitoids (parasitisers of primary parasitoids) are also included. The keys are supplemented by figures of most of the species and, in the case of lepidopteran stemborers, photographic plates of adults and their genitalia. An examination of genitalia is the gold standard for identification of stem-boring moths. Adult wing patterns and colours are highly variable and scales easily rubbed. Characteristics of genitalia are highly conserved with minimal intraspecific variability. To our knowledge, no regional guide exists that includes an extensive photographic treatment of both adult moths and their genitalia. A glossary is also provided. **All words that appear in the glossary are in bold in the main text.**

Sixty-eight (68) species of stemborers are keyed and most of these are illustrated with line drawings and photograph plates (moths). An effort was made to provide illustrations of all developmental stages (except the egg) for each species, whenever stage-specific specimens were available. The borers were represented by the beetles (order Coleoptera) with 6 families, 14 genera and 33 species; the moths (order Lepidoptera) with 5 families, 13 genera, and 25 species and the flies (order Diptera) with 4 families, 7 genera and 10 species. Fifty-three (53) species of parasitic insects were reared from stemborers. These were of two orders, the wasps (Hymenoptera) with 11 families, 26 genera and 48 species, and the flies with 1 family, 4 genera and 5 species.

Many of the identifications are to the level of genus only. This was due to the absence of published taxonomic work on several groups of insects and because some of the insects we reared represent new species. In these cases, morphospecies are designated within genera.

Figures illustrating the general morphology of the four orders—Lepidoptera (Figures 1a–3c), Coleoptera (Figures 15 a–s), Diptera (Figures 50 a–d) and Hymenoptera (Figures 58 a–f) are referred to at the beginning of the treatment of each order. These illustrations should help the novice identify grass stemborers and associated parasitoids.

THE INSECT ORDERS REARED FROM WILD AND CULTIVATED GRASSES

Key to the insect orders associated with Gramineae in Kenya, based on adult characters

1 Two pairs of membranous wings present (rarely wingless); mouthparts either with strong mandibles or modified into a coiled proboscis 2

1′ One pair of membranous wings present, the other pair (forewing or hindwing) modified; mouthparts mandibulate (for chewing) or suctorial (for sponging or lapping) 3

2 Forewings and hindwings covered **dorsally** and **ventrally** with overlapping scales; mouthparts modified into a coiled proboscis ..... **Lepidoptera** (p. 3)

2′ Wings without scales, hindwings with fewer veins and cells than forewings (rarely wingless); mouthparts with strongly developed mandibles for chewing ..... **Hymenoptera** (p. 24)

3 Forewings modified into hardened and rigid **elytra,** usually covering the entire abdomen and the membranous hindwings; mouthparts mandibulate ..... **Coleoptera** (p. 12)

3′ Forewings membranous, hindwings reduced to club-like halteres; mouthparts suctorial ..... **Diptera** (p. 20, 24)

Key to the insect orders associated with Gramineae in Kenya, based on larval characters

1 **Prolegs** present on two or more segments of the abdomen, usually on abdominal segments III to VI and anal segment; **crochets** well developed ..... **Lepidoptera**

1′ **Prolegs** absent on abdominal segments III to VI; **crochets** absent 2

2 Head well developed and visible **dorsally**; thoracic legs present; **ampullae** and **transverse plicae** present **dorsally** ..... **Coleoptera**

2′ Head hardly visible **dorsally** or totally absent; thoracic legs absent; **ampullae** and **transverse plicae** absent 3

3 Body commonly U-shaped, wider at midlength and bluntly rounded on both ends; mouthparts reduced to a pair of opposable sharply-pointed mandibles or **sclerotised** plates fused to the head segment ..... **Hymenoptera**

3′ Body maggot-like or **vermiform, anterior** end pointed, **posterior** end blunt; hook-like mouthparts visible ..... **Diptera**

Key to the insect orders associated with Gramineae in Kenya, based on pupal characters

1 Appendages hidden (**coarctate** pupa) or, if visible, the appendages fused to the body wall and incapable of moving (**obtect** pupa) 2

1′ Appendages not adhering to the body wall, and capable of moving (**exarate** pupa) 3

2 **Obtect** type; appendages visible but fused to each other and to the body wall forming a cover plate; antennae, wing pads and galea visible; **spiracles** distinct on the mesothorax and some abdominal segments; antennae adjacent to the inner margins of wings; **cremaster** usually present; body elongate with pointed **posterior** end; genital and anal openings distinct ..... **Lepidoptera**

2′ **Coarctate** type; appendages not visible on the outside; caudal and thoracic **spiracles** present as scars; antennae not visible; **cremaster** absent; body barrel-shaped to elongate, often with paired **spiracles posteriorly**; genital and anal openings not visible ..... **Diptera**

3. Body constricted between thorax and **gaster; ocellar triangle** distinct; wing rudiments not **elytra**-like; legs against the lateral side of body; prothorax not concealing the head; legs with **femur** and **tibia** almost parallel to each other ..... **Hymenoptera**

3′ Body without marked constriction between thorax and **gaster; ocellar triangle** not visible; wing pads **elytra**-like; legs against the **ventral** side of body; prothorax concealing the head; legs strongly elbowed at **posterior** end of **femur** ..... **Coleoptera**

THE STEMBORERS

LEPIDOPTERA: MORPHOLOGY OF A LEPIDOPTERAN STEMBORER

(Figures 1 a–i, 2 a–d, 3 a–c)

Key to the families of lepidopteran stemborers, based on adult characters

1 Small to medium-sized moths (8.5–16 mm long) with slender bodies; head and thoracic dorsum without thick hair tuft; forewings straw-coloured to dull brown and pinkish-red; if dull-coloured, forewings bear brown dots or silvery markings; labial palps prominently visible, **porrect** or ascendingly recurved 2

1′ Robust-bodied moths (11–26 mm long); head and thorax covered with thick hairtuft; forewings with variable colour pattern ranging from light beige with a **longitudinal** brown stripe, grey-brown with median and terminal blackish-grey bands, or whitish and mottled with light grey spots; labial palps short and hardly visible 4

2 Terminal margin of forewings obliquely truncate or rounded; forewing vein R_4 and R_5 not stalked, M_2 and M_3 approximated at base; hindwing vein CuP present; **basal** lobe and **basal** fringes of long hairs absent; head with or without a **corneous** point; labial palp long and snout-like, if short, terminal segment pointed downwards; **ocelli** and **chaetosemata** present; **tympanal organ** usually present (absent in Tortricidae); hind **tibiae** without long hairy scales 3

2′ Terminal margin of forewings acute or pointed; forewing vein R_4 and R_5 stalked, M_2 and M_3 wide apart; hindwing vein CuP absent or poorly developed, **basal** lobe distinct and with long fringe of hairs; head rounded, without a **corneous** point; labial palp upcurved with a short terminal segment; **ocelli** and **chaetosemata** absent; **tympanal organ** wanting; hind **tibiae** with long hairy scales ..... **Gelechiidae** (p. 5)

3 Labial palps **porrect** and beak-like; forewings vary from straw-coloured with brown dots and silvery markings, to light beige, to pinkish red; **costa** not strongly arched, vein CuP absent, R_3 and R_4 stalked, **chorda** absent; hindwing vein Sc + R_1 fused with Rs beyond discal cell, CuP complete, Rs and M_1 stalked near the discal cell; **tympanal organ** present at base of abdomen ..... **Pyralidae** (p. 9)

3′ Labial palps ascendingly recurved with the small terminal segment pointed downward; forewings light brown mottled with yellow brown to dark brown scales, **costa** strongly arched; vein CuP present near the wing margin, R_3 and R_4 separated, **chorda** present; hindwing vein Sc + R_1 separated from Rs beyond discal cell, CuP incomplete not reaching margin, Rs and M_1 close to each other **basally**; **tympanal organ** absent from base of abdomen ..... **Tortricidae** (p. 11)

4 **Tympanal organ** located in the metathorax; forewing vein M not forked inside the discal cell, **areole** present, **chorda** absent; hindwing vein Sc + R_1 shortly fused with Rs beyond discal cell, CuP absent ..... **Noctuidae** (p. 6)

4′ **Tympanal organ** absent; forewing vein M forked forming a small cell inside the discal cell, **areole** absent, **chorda** present; hindwing vein Sc + R_1 separated from Rs beyond discal cell, CuP present ..... **Cossidae** (p. 4)

Key to the families of lepidopteran stemborers, based on larval characters

1 Prespiracular (L) group of **setae** on the prothorax (T1) bisetose 2

1′ Prespiracular (L) group of **setae** on the prothorax (T1) trisetose 3

2 Head semiprognathous; primary **setae** usually on strongly pigmented **pinacula; crochets** on **prolegs** arranged in a complete circle or **penellipse;** anal shield on A10 indistinct; body slender, small to medium-sized larvae ..... **Pyralidae**

2′ Head **hypognathous** to semihypognathous; primary **setae** not on strongly pigmented **pinacula; crochets** on **prolegs** uniordinal, arranged in a linear pattern; anal shield on A10 distinct; body cylindrical to stout, larvae medium-sized to large ..... **Noctuidae**

3 **Prothoracic shield** (T1) humped and **rugose** with a **posterior** band of spicules or small peg-like spines; large larvae, 25–65 mm long ..... **Cossidae**

3′ **Prothoracic shield** usually flat and smooth..... 4

4 **Crochets biordinal** in complete circle; abdominal **prolegs** with a surrounding **sclerotised** collar..... **Gelechiidae**

4′ **Crochets** uniserial in a complete circle; abdominal **prolegs** without a surrounding **sclerotised** collar..... **Tortricidae**

FAMILY COSSIDAE

General features: Cossids are medium-sized to large-bodied moths commonly found in the tropics and subtropics. In general, adults have elongated and slender forewings much shorter than the hindwings, and often mottled with brown, grey or cream-white shades. Head with elevated and slender scales lining the vertex and a mass of converging scales along the **frons. Chaetosemata** and **ocelli** absent, proboscis very short and naked to reduced, labial palp moderately short and upturned, **epiphysis** often present. Antennae **bipectinate** in male and usually **filiform** in female. Forewings elongate with an **areole,** pterostigma absent, **retinaculum** on Sc or Sc and **costa,** strongly forked M cell, **chorda** present, R_3 stalked with R_4 to **termen** and CuP present. Hindwings broad and rounded, vein M forked, CuP reduced and 2A veins present.

Male genitalia: **Uncus** usually broad and well developed, gnathi linked by the **scobinate** and bilobed **bulla** but may be weak, separate, long and slender with **sclerotised** bands, or totally absent as in *Phragmataecia;* **valves** with a **basal** spine and fused with the **juxta,** a **scobinate** structure associated with **juxta basally** and **sacculus ventrally, aedeagus** may be a simple rod or broad, short, and **apically** cleft into **dorsal** and **ventral** longitudinally corrugate 'jaws'.

Female genitalia: Elongate and slender **ovipositor** lobes, segment 8 and the apodemes distinct.

Larva: Commonly wood and stemborers with broad head longer than wide and with large mandibles. Prothorax with a distinct shield that is very rough centrally and very smooth along the caudal margin. **Pinacula** present, heavily **sclerotised, setae** very small to reduced. **Prolegs** present with **crochets** in complete circle.

Pupa: Long, cylindrical, distinctly **sclerotised.** Head with spines. Abdominal segments III–VII in males and III–VI in females movable. Segments II–VII of males and II–VI in females each with two **transverse** rows of spines, segments VII–VIII in female and VIII in male with one row only. **Cremaster** absent. During moulting, pupae are extruded from tunnel.

Biological information: The larva of *Phragmataecia boisduvalii* Herrich-Shäffer was dissected only from the stems of *Echinochloa pyramidalis* (Lam.) Hitchc. & Chase and *Phragmites karka* (Retz.) Steud.

Phragmataecia boisduvalii Herrich-Shäffer

(Figures 14 a–l)

Diagnosis: Adult robust with thick tuft of hairs on the thorax. Forewings white, heavily mottled with grey spots towards the **apical** half, **basal** half generally greyish. Head light brown with frontal tufts brown to pale reddish-brown. **Basal** 2/3 of antenna bipectinate, **distal** segments **serrate** except simple tip. **Pectinate** segments around 25 with middle segments having longest arms. Labial palpi short and projected forward. Hindwings creamy white to light yellow-brown without marks. Underside of both wings (fore and hind) striated, **striae** on forewings only visible in the upper side. **Frenulum** a single stout spine. **Retinaculum** distinct and well developed. Legs, except tarsi, light brown and fringed with hairy scales. Venation of forewing shows a long **areole** with nearly a third of its length outside the cell angle. R_1 emanates from the **basal** one-third of the **areole,** R_2 from close to tip of **areole,** R_3 shortly stalked and anastomosed with base of vein R_4 + R_5. M_1 comes well below the upper angle of cell, large median cell with upper and lower branches terminating between veins M_1–M_2 and the distinctly **basally** separated M_2–M_3. Hindwing with M_1 far below Rs, large median cell with its branches ending nearly between M_1–M_2 and Cu_{1A}–M_3. Veins M_2 and M_3 widely separated.

Male genitalia with highly **sclerotised uncus** with bluntly rounded **distal** end, subtriangular **tegumen, vinculum** relatively wide medially, **saccus** short, **juxta** subglobose without clear median lobes but lateral lobes slender, **aedeagus** developed with no distinct base and relatively large **vesica** thickened on one side only.

Mature larva 25–31 mm long and 5–6.5 mm wide. Body cylindrical, robust, dull white. **Prothoracic shield** broad with rough central area bordered with yellow markings. Head wider than long. **Coronal suture** pale to absent. **Frons** widened at midhalf. Epicranial notch absent. Adfrontals distinctly broad towards the mouth. Prothoracic **spiracle** large and oblongate, about twice the size of abdominal segment I–VII **spiracles.** On thorax, **subdorsal seta** 2 (SD2) almost caudad to **subdorsal seta** 1 (SD1) on the prothorax (T1); lateral (L) group trisetose, present in all thoracic segments, lateral **seta** 1 (L1) closer to L3 than to L2 in the mesothorax (T2) and metathorax (T3). On the abdomen, SD1 large and above **spiracle** on abdominal (A) segments A1–A7, SD2 very small, located **anterior** of **spiracle** on A1–A7. **Spiracles** of segment VIII ovoid, visible **dorsally**. Caudal end cleft medially. Last abdominal segment (A10) shield with four **setae** on each side. **Prolegs** on A3–A6 and A10 short.

Pupa dark reddish-brown, not more than 31 mm long, cylindrical with tapering head and short wing pads. Abdominal segments II–VIII with **transverse** row of spines, segment III–VIII each with a long row of **anterior** spines reaching and passing in front of the **spiracles** and a short row **posteriorly**. Segments IX–X with strong spines **dorsally**, laterally and **ventrally**.

Biological information: *P. boisduvalii* has been reported in Kenya to breed on tall grasses. The pupa is host to a pteromalid wasp, *Norbanus* sp. (Hymenoptera: Pteromalidae) that parasitises grass stemborers (e.g. *Chilo partellus*) that attack maize. Rearing records showed that second to third instar larvae took four months to pupate using moderately mature 8.75 cm long maize stalks. Adult emerged from the pupa in 42 days.

FAMILY GELECHIIDAE

General features: Small moths with relatively broad wings; antennae simple, **scape** rarely with an **anterior** comb of stiff hairs or **pecten;** head smooth with scales closely pressed to the body; proboscis (tongue) thickly covered with hairs **basally**; labial palps slender and stout, recurved or upturned, segment II tufted underneath, segment III slender and pointed; maxillary palps usually 4-segmented; **ocelli** present or absent; **chaetosemata** absent; **epiphysis** present; **tibia** III bears long hairlike scales; forewing lacking pterostigma, vein R_4 and R_5 stalked, R_5 to **costa**, CuP absent; **retinaculum** of adult females a row of curved specialised scales on vein R; hindwing usually trapezoidal with distinct apex, **termen sinuate** or emarginate, veins Rs and M_1 approximate at base or stalked, CuA sometimes with a **basal pecten,** CuP usually absent; abdomen rarely with spines **dorsally;** male genitalia with a broad or slender **uncus; aedeagus** bulblike, strong and loosely connected to a membrane, **cornuti** often present; **valves** rodlike, long and slender; **gnathos** well developed, hooklike or elongate and pointed; **sternite** VIII divided into **distal** lobes covering the genitalia in some cases; female genitalia with variable **ostium** ranging from membranous and ill-defined to strongly **sclerotised,** or with elaborate foamlike structure and with projecting ostial plate; **bursa copulatrix** with 1–2 **signum/signa** of various designs.

The larva usually lacks secondary **setae** on **prolegs;** sometimes with an anal fork; **crochets** vary from uni- to **biordinal,** arranged in a circle or mesal **penellipse.**

Pupae with labial palps and fore femora hidden; **cremaster** sometimes present; maxillary palps always present.

Biological information: Larvae have different feeding habits, mining or boring in leaves, stems, seeds, fruits and tubers. Generally, larvae feed in concealed habitats (e.g. rolled leaves or within shoots). Pupae in silken threads or cocoon in or near larval shelter; not protruded on **eclosion.**

Stegasta sp.

(Figures 4 a–g [adult]; 4 h–l [pupa])

Diagnosis: Small brownish-yellow moth, 15 mm long, forewing span 30 mm. Forewings sparsely mottled with dark brown scales, **basally** uniformly chocolate brown, apex pointed and **costal** margin moderately convex. Hindwings clothed **costally** and **basally** with very

long tuft of grey hairs almost reaching the wing tip. Labial palpi chocolate brown except **basal** segment covered with white scales, upcurved, pointed tip well beyond the vertex and twice as long as diameter of eye. Head rounded, **ventral** margins lined with long cream-white hairs extending to midlength of eyes. Antenna simple, **scape** without long hairs. Legs I and II covered with brown scales and **tibia** III with white scales. Abdomen dull brown.

Full grown larva about 17 mm long, yellowish-white with brownish median area of head, blackish-brown to reddish-brown mandibles, pale brown marks on the meso- and metanotum and sides of the body. Legs yellowish-brown, **prolegs** with circular **crochets.**

Pupa about 18 mm long, yellowish-brown with a roughened head. Venter of segments V and VI with a pair of scale-like **tubercles**, each **tubercle** lined with three short white hairs in a **transverse** row and a very long white hair anterolaterally. **Posterior** end with a pair of dark reddish-brown tooth-like projections. **Cremaster** downcurved and projected **anterior**ly toward segment VIII.

Biological information: *Stegasta* sp. is the only gelechiid we reared. It was reared from *Sorghum bicolor* (L.). When reared on maize stems the larval period was 16 days (L3–L5) and pupation lasted for 8 days.

FAMILY NOCTUIDAE

General features: Small to large heavily-bodied, dull-coloured moths easily distinguished from other moths by the postspiracular location of the counter-tympanal hood and the presence of a thick tuft of scales on the thoracic dorsum. **Ocelli** present, antennae usually **filiform** but may be dentate or **pectinate,** labial palps **porrect** or curved upwards, maxillary palps with a single segment, **epiphysis** present, **tibial spurs** 0-2-4, spines sometimes present on the **tibiae** and tarsi. Forewings fairly narrow, hindwings distinctly broadened. **Areole** present in forewing, vein M_2 much closer to M_3 than to M_1, **cubitus** 4-branched, 1A+2A forming a **basal** branch. Hindwing with $Sc + R_1$ separated at base but fused shortly with Rs near base of discal cell, vein M_2 present or absent. If present it is weak and borne closer to M_1 than to M_3 (trifine group) or strong, arising closer to M_3 than to M_1 (quadrifine group).

Noctuids represent a very diverse group with many subfamilies. Only the trifine subfamily Amphipyrinae will be dealt with, as the grass stemborers—*Sesamia* Guenee, *Busseola* Thurau and *Manga* Bowden—belong to this group. Members of this subfamily have stout adults, thorax crested with hairlike scale coverings or uncrested and clothed with hairs only, trifine hindwing venation without vein M_2, hairy and lashed eyes, and spines on **tibia.**

Male genitalia with valve entire, **sacculus** separate from **cucullus,** manica spinose to membranous and **cornutus** bulbed or unbulbed. Valvae usually with a clavus (a structure on the **dorsal** margin of the **sacculus**). Base of abdomen provided with paired hair-pencils.

Female genitalia with or without **signa** in the **bursa copulatrix.** Ostial segment with or without a membranous pad before the **ostium.**

Larvae of most species usually with only primary **setae** but others may show well developed secondary **setae** present on **verrucae.** Head rarely with secondary **setae. Crochets** uniordinal, well developed on **prolegs** of abdominal segments III–VI and X.

Pupae with smooth to rough head, prominently circular **spiracles** and punctures along the **dorsal anterior** portion or nearly the entire area of abdominal segments II–VIII. Segment VI–VII with a pair of round swellings in some species. **Cremaster** present.

Biological information: Noctuids are generally nocturnal moths. Larvae demonstrate diverse feeding habits represented by fruit-piercers, defoliators and stem cutters, stem and fruit borers. A few species are predacious. Stem-boring females lay eggs in groups of 30–150 on the inner surface of the leaf sheaths. The incubation period is 5–7 days. Newly hatched larvae live aggregately between the stem and the leaf sheath and disperse only after about a day. Young leaves in the whorl provide food, shelter and protection to the dispersing larvae from predators and parasitoids.

Key to the adults of noctuid stemborers

1 Forewings light beige; thorax clothed with hairs only; hairlike scales absent ..... (Genus *Sesamia*) 2

1′ Forewings dull brown to dark brown; thorax clothed with hairs and hairlike scales..... 9

2 Antennal segments **serrate** or **bipectinate** (males) 3

2′ Antennal segments simple (females) 7

3 Antennal segments not pectinate, weakly **serrate,** saccular process of male genitalia lacking spines, **costal** spine absent ..... *Sesamia* sp. nov. (Plates 11, 12 and 26)

3′ Antennal segments **pectinate** or **bipectinate,** saccular process always spinose, **costal** spine present 4

4 Antennal segments strongly **bipectinate,** pectinations mostly longer than width of antennal shaft 5

4′ Pectinations of antennal segments never longer than width of antennal shaft 6

5 **Juxta** of male genitalia as wide or nearly as wide as long. Spine on **costal** process variable, sometimes tapering, more often nearly truncate at apex, usually with small tooth at one end, saccular process robustly spined ..... *Sesamia calamistis* Hampson (Plates 11, 13, 26 and 29; Figure 11 a–h)

5′ **Juxta** of male genitalia much longer than wide, **costal** spine weakly and asymmetrically **bifid,** saccular process not robustly spined ..... *Sesamia nonagrioides botanephaga* (Lefebvre) (Plates 11, 15 and 26; Figure 10 a–f)

6 **Costal** spine clearly **bifid,** strong and more or less symmetrical ..... *Sesamia poephaga* Tams & Bowden (Plates 11, 17 and 26)

6′ **Costal** spine spatulate, sharp, with irregular, fine teeth ..... *Sesamia penniseti* Tams & Bowden (Plates 11, 16 and 26)

7 Base of the **ductus bursae** strongly **sclerotised,** either in **longitudinal** strips or with the **sclerotised** area cut off obliquely and appearing as a dark triangle 8

7′ Base of the **ductus bursae sclerotised** and appearing invaginated; sclerotisation not extending into the ductus ..... *Sesamia* sp. nov. (Plates 12 and 26)

8 Sclerotisation at base of **ductus bursae** cut off obliquely, appearing as a dark triangle, **sclerotised** lateral lobes of lamella vaginalis absent ..... *Sesamia calamistis* Hampson and *Sesamia nonagrioides botanephaga* Tams & Bowden (Plates 14 and 26)

8′ Sclerotisation appearing as **longitudinal** strips, extending into ductus, sclerotised lateral lobes of lamella vaginalis present ..... *Sesamia poephaga* Tams & Bowden and *Sesamia penniseti* Tams & Bowden (Plates 14 and 26)

9 Antennae **bipectinate** (males) 10

9′ Antennae more or less simple, not **bipectinate** (females and some males) 12

10 Antennal pectinations very short, appearing nearly **serrate, juxta** with a pronounced, **ventral** finger-like process, **aedeagus** with two robust blade-like **cornuti** ..... *Sciomesa piscator* Fletcher (Plates 10 and 27)

10′ Antennal pectinations obvious, **juxta** without **ventral** process, **cornuti** not as described 11

11 **Aedeagus** with paired lateral dentate processes and terminal **cornutus, clasper** of **valve** large and heavily **sclerotised** ..... *Busseola fusca* (Fuller) (Plates 19, 28 and 29; Figures 13 a–e)

11′ **Aedeagus** with paired lateral dentate processes but lacking terminal **cornutus, clasper** of **valve** small and lobelike ..... *Busseola phaia* Bowden (Plates 19 and 28)

12 Males 13

12′ Females 15

13 **Sacculus** with heavily toothed and well-developed **clasper, aedeagus** with a **sclerotised** band ending, when everted, in a variable number of small spines (usually three or four) ..... *Manga nubifera* (Hampson) (Plates 21, 22 and 27; Figures 12 a–f)

13′ **Sacculus** lacking **clasper, aedeagus** not as above 14

14 **Aedeagus** with heavily **sclerotised,** long, slightly curved and pointed **cornutus,** about one-half length of **aedeagus** ..... *Busseola obliquifascia* (Hampson) (Plates 19 and 28)

14' **Aedeagus** with **cornuti** confined to one end, one a group of longish recurved spines and the other more or less wheel-like with a **serrate** margin ..... *Sciomesa* cf. sp. nov. (Plate 18)

15 Sclerotisation of ductus uniform and not patterned 16

15' Sclerotisation of ductus with a distinctly beaded pattern 17

16 Corpus bursae with two obvious **signa,** ductus inserted obliquely between sclerotised lateral lobes of lamella vaginalis ..... *Busseola fusca* Fuller (Plates 20, 28 and 29)

16' Corpus bursae with one obvious **signum** (the **dorsal** one very faint, if present); **sclerotised** lateral lobes absent ..... *Busseola phaia* Bowden (Plates 20 and 28)

17 Sclerotisation of ductus starting at base and continuing asymmetrically into the ductus, ending obliquely; the two **signa** ellipsoid, each with one or two ridges ..... *Manga nubifera* (Hampson) (Plates 22 and 27)

17' Sclerotisation of ductus weak or absent from bottom 1/3 of ductus, extensive and prominent in middle, often appearing expanded and sac- or appendix-like; **signa** variable, usually two, sometimes only one apparent **signum;** the **signa** oblong or ellipsoid, each usually with a more or less central dark spot, lacking ridges ..... *Busseola obliquifascia* (Hampson) (Plates 20 and 28)

Key to the larvae of common noctuid stemborers

1 Larva with a brown head, brownish-yellow body with pale pink **dorsal** markings; elevated chitinised plate with **setae** broad and relatively darker; angle between **dorsal setae** (D2 and D1) and subdorsal **seta** (SD1) always greater than 140° angle; **prothoracic shield** pale yellow brown; caudal plate yellow brown; body about 30 mm long and 3.5 mm wide ..... *Sesamia* spp. (Plate 29, Figure 11 i–m)

1' Larva with dark brown head, body usually buff to purple brown with elevated chitinised plate bearing **setae** narrow and pale yellow brown; angle between **dorsal setae** (D2 and D1) and subdorsal **seta** (SD1) narrow, often less than 120° angle; **prothoracic shield** lighter than head; caudal plate same colour as the **prothoracic shield** ..... *Busseola fusca* (Fuller) (Plate 29, Figure 13 f–j)

Key to the pupae of common noctuid stemborers

1 **Anterior** region (head) with rough stony-like pattern; **cremaster** indistinctly separated from the last abdominal segment 2

1' **Anterior** region smooth, without rough stony-like pattern; **cremaster** on a distinct platform 4

2 **Cremaster** with four short but robust spines, two inner and two outer all slightly projected **posteriorly** to upcurved; midanter**oventral** part of the head with rough stony appearance, **dorsal** portion smooth; abdominal segments V–VI each with a pair of minute swellings ..... *Sesamia calamistis* Hampson (Figure 11 n–q)

2' Without the above combinations of characters 3

3 **Cremaster** with four spines, two strong dorsolaterals and two small **ventrals;** antero**ventral** tip of head entirely rough; abdominal segments V–VI with pronounced pair of swellings, connected to each other by concave punctures ..... *Sesamia nonagrioides botanephaga* Tams & Bowden (Figure 10 b–f)

3' **Cremaster** reduced to a heavily **sclerotised** dark reddish-brown process without spines; entire head region **dorsally** and laterally rough and stony; abdominal segments VI–VII roughly **punctate anteriorly** and finely **punctate posteriorly,** VIII roughly **punctate anteriorly** ..... *Sesamia poephaga* Tams & Bowden

4 **Cremaster** with two short strongly diverging spines arising from a common base ..... *Manga nubifera* (Hampson) (Figure 12 g–i)

4' **Cremaster** with two short diverging spines widely separated **basally** and arising from a half-rounded plate ..... *Busseola fusca* (Fuller) (Figure 13 k–m)

FAMILY PYRALIDAE

General features: Small to moderately-sized moths representing some of the most economically important species associated with agricultural crops. Majority dull-coloured and yellowish-brown. Pyralids are known as snout moths due to the long, **porrect** and beaklike labial palpi with three segments. Head bears smooth scales, some species have **anterior** tuft. Proboscis thickly covered with scales at base, but may be reduced or vestigial. **Ocelli** and **chaetosemata** present or absent. Compound eyes large and distinct, or reduced. Maxillary palpi usually 4-segmented, some species with two or three segments only but always scaled. Antennae variable, from simple and **filiform** in both sexes, to slightly thickened and **serrate** or **bipectinate** in males. **Epiphysis** present, **spurs** usually 0-2-4 and rarely 0-2-2. Wings variable in venation and provide useful characters in species identification. Forewing elongate or triangular with **cubitus** showing four branches, Cu_2 greatly reduced to a tubular vein in terminal part of the wing or entirely absent, **chorda** absent and vein M stem in cell with R_3 and R_4 stalked or running together, M_2 approximated to M_3 at base, 1A + 2A commonly with a large fork, CuP usually absent. Hindwing usually broad, with 1–3 frenular bristles in female, vein Sc + R_1 always free from base to a little beyond angle, close to or shortly fused with Rs beyond discal cell, M_2 approximated to M_3 **basally**, CuP often present, large anal area with two anal veins, CuA with **basal pecten** in some species, **coremata** often present, and **tympanal organ** located at base of abdomen. Abdomen with tympanic **bullae** located in the **ventral** part of the **basal** segment close to the midline. When present, a longitudinally-oriented median chitinous plate (praecinctorum) hangs in the cavity between the abdomen and thorax in front of the **bullae.** The plate is sometimes absent. When present, it may be well developed, **transversely** flattened and prominently bilobed, or poorly divided **distally,** reduced to a lobe, or simply composed of **distal** tufts of scales.

Male genitalia with a strong, hooklike **gnathos,** simple to complex **valve,** well developed **anellus,** and a prominent **juxta.** The simple tegumen, which may be broad or narrow, connects laterally to the U- or V-shaped **vinculum. Saccus** poorly developed or absent. **Coremata** usually visible on 7th–8th abdominal segments and strongly developed in some species.

Female genitalia: **Ovipositor** shape variable, ranging from simple and short to long and drawn out with blade-like or **serrate** lobes. **Ostium** variable, from simple and membranous to **sclerotised** and very complex; **signum/signa** present, either single, double or multiple, varying from simple and thornlike, star-shaped, **serrate,** platelike, **scobinate,** to a group of spines or complex bands.

Biological information: Larvae exhibit a variety of behaviours. Many species feed while concealed (shoot, stem and fruit borers) while others live under folded or rolled leaves. The pupae are either naked or covered with silken threads and may be found inside the stem or concealed inside rolled leaves. In this manual, the focus is only on the stemborers reared from grasses; those belonging to the subfamilies Crambinae, Galleriinae, Peoriinae and Phycitinae.

Key to the adults of pyralid stemborers

1 Head with **frons** truncate; **ocelli** and **chaetosemata** absent; **scape** long, about length of diameter of eye; proboscis developed; labial palp whitish, slightly longer than diameter of eye, small **apical** segment with two brown spines; forewings light straw-coloured with rounded apex and terminal margins, two grey brown **longitudinal** bands and two small black dots present; hindwings creamy-white; male genitalia with rounded **valve,** triangular **uncus** with an inverted V-shaped row of spines, no **costal** process; **aedeagus** slightly bent medially; female genitalia with very long **posterior** apophysis, V-shaped **ostium,** narrow **ductus bursae;** corpus bursae with a large appendix ..... Subfamily Galleriinae, *Eldana saccharina* Walker (Plates 1, 2 and 23; Figure 5 a–g)

1' Head with conical **frons,** sometimes with a **corneous** point; **ocelli** and **chaetosemata** present; **scape** short, barely one-half diameter of eye; proboscis poorly developed; labial palpi long and **porrect,** about 2–3.5x diameter of eye, terminal segment spineless; forewing pale brown to straw coloured, with or without dark brown scales in the **costal** area and silvery scales and black dots medially and subterminally, or pinkish red; genitalia of both sexes not as above 2

2 Forewings often pale brown or straw-coloured, often with metallic scales, truncated along **apical** margin, discal area sometimes with brown and silvery spots, **costal** band indistinct; **ocelli** well developed; labial palp 3–3.5x as long as the diameter of eye ..... Subfamily Crambinae, *Chilo* species.....3

2′ Forewings yellow-brown to reddish-pink, without metallic scales, apex rounded, **costal** band distinct; **ocelli** small to vestigial; labial palp 2–3x as long as the diameter of eye 6

3 Forewings without metallic scales..... 4

3′ Forewings with metallic scales..... 5

4 Male genitalia with **juxta** plate symmetrical with large central part, lateral arms truncate **apically** and not extending past **costa, costa** with pronounced submedian projection, **aedeagus** with a strong **basal** projection, **ventral** arm present. Female genitalia with ostial pouch heavily **sclerotised,** delicately wrinkled throughout, and with a pronounced invaginated notch, **signum** present, lamellate, with a median ridge..... ..... *Chilo partellus* (Swinhoe) (Plates 1, 3 and 23; Figure 6 a–l)

4′ Male unknown. Female genitalia with ostial pouch wrinkled at opening, heavily **sclerotised,** without invaginated notch, **signum** absent ..... *Chilo incertus* (Sjöstedt) (Plate 2)

5 Male genitalia with **valve** broad and moderately acute to rounded at apex; **vinculum** robustly U- or V-shaped; left arm of **juxta** plate shorter than right arm, or the arms subequal in length, apices of both arms broad and with bristles, **aedeagus** without a sub**apical digitate** process. Female genitalia with seventh sternum not heavily **sclerotised,** subtriangular and thickly lined with minute spikes; two semi-triangular spikes on each side of the slightly sunken or enclosed ostial pouch; **ductus bursae** long and slender, gradually widening towards the **bursa copulatrix;** genital opening small; single long, **scobinate signum**..... ..... *Chilo orichalcociliellus* (Strand) (Figure 7 a–g)

5′ Male genitalia with **valve** moderately narrow forming a very distinct bluntly rounded apex; **vinculum** slender and narrowly U-shaped; left arm of **juxta** plate spine-like **apically,** much shorter than the bent right arm; **aedeagus** with a distinct sub**apical digitate** process; female genitalia with seventh sternum heavily **sclerotised,** subquadrate and lined with variably developed spikes on the entire plate, ostial pouch deeply enclosed; **ductus bursae** long and slender, parallel-sided, and without distinct widening towards the **bursa copulatrix;** genital opening large; single long, **scobinate signum**..... ..... *Chilo thyrsis* Bleszynski (Plates 1, 3 and 23; Figure 8 a–g)

6 Forewings pinkish, copper-red, or with red areas, without black spots..... 7

6′ Forewings pale to dull yellow-brown, usually with black spots or bands, occasionally with extensive diffuse black area..... 8

7 Upper surface of forewing more or less uniformly copper-red or pinkish-red, sometimes with lighter areas **posteriorly,** but never with a pale **costal** band; **aedeagus** with two **cornuti,** one large, opaque and dagger-like, the other short, subelliptical, and with a **serrate** outer margin; **posterior** half of female **ovipositor** **unsclerotised,** pad-like, uniformly bristly .... Subfamily Peoriinae, taxon A (Plates 4, 5 and 24)

7′ Upper surface of forewing with definite pale **costal** band, darker band **posterior** to it, and rest of surface reddish; **cornutus** of **aedeagus** not dagger-like, but covered with **denticles**... ..... *Maliarpha concinnella* (Ragonot) (Plates 6 and 24)

8 **Medial** process of **gnathos** of male genitalia distinctly tongue-like, wing without extensive areas of black scales 9

8′ **Medial** process of **gnathos** not tongue-like, wing with extensive areas of black scales 10

9 Costal spine of male genitalia attached broadly to **valve** at its midlength; apex of **valve** acute; **aedeagus** distinctly swollen towards one end. Female genitalia without pronounced sclerotisation of the ductus bursae..... *Ematheudes* sp. nov. (Plates 7, 8 and 25)

9′ Costal spine of male genitalia weakly attached to **valve** near its base; apex of **valve** blunt, **aedeagus** not distinctly swollen at one end, nearly parallel sided, oblong. Female genitalia with ductus bursae strongly sclerotised along its entire length..... ..... *Ematheudes straminella* Snellen (Plates 7, 8 and 25)

10 Forewing with dark bands alternating with light bands, pattern evident; male genitalia with large centrally-located transtilla appearing as mirror image 'J'-shaped structures..... ..... *Saluria lentistrigella* Hampson (Plates 10 and 25)

10′ Forewing with black scales diffuse, darker at base, without recognisable pattern; saccular process of male genitalia ending in lobe bearing two hook-like processes..... ..... Peoriinae taxon B (Plates 9 and 24)

Key to the larvae of common pyralid stemborers

1 **Crochets** arranged in circles, complete and **triordinal;** body segments usually with brown **sclerotised** plates bearing **setae** 2

1′ **Crochets** usually arranged in an oblong pattern, sometimes circular, complete and **biordinal;** body segments often without brown **sclerotised** plates ..... Peoriinae

2 Lateral **sclerotised** plate located in front of prothoracic **spiracle;** body greyish-black with golden yellow hairs; each abdominal segment with M-shaped dotted marks, head blackish-brown; **prothoracic shield** dark brown ..... *Eldana saccharina* (Walker) (Figure 5 h–n)

2′ Lateral **sclerotised** plate located below the prothoracic **spiracle;** body covered with brown **sclerotised** plates with or without **setae** 3

3 Abdominal segments I–VII each with a distinct lateral asetose **tubercle;** mesothorax and metathorax each without a small **dorsal** asetose **tubercle anterior** of the prominently large asetose **tubercle** ..... *Chilo partellus* (Swinhoe) (Plate 29; Figure 6 m–r)

3′ Abdominal segments I–VII without traces of lateral **tubercle;** mesothorax and metathorax each with a small asetose **tubercle anterior** of the prominently large **dorsal** asetose **tubercles** ..... *Chilo orichalcociliellus* (Strand) and *Chilo thyrsis* Bleszynski (Figure 8 h–l)

Key to the pupae of common pyralid stemborers

1 Abdominal dorsum with median **longitudinal** ridge strongly developed on the head and thorax, forming a rough **anterior** edge ..... *Eldana saccharina* (Walker) (Figure 5 o–r)

1′ Abdominal dorsum without median **longitudinal** ridge 2

2 **Dorsal** abdominal segments with small to relatively stout spines ..... *Chilo* spp. (Figure 6 s–u, Figure 8 m–o)

2′ Abdominal segments without spines; with fine punctures ..... Peoriinae

FAMILY TORTRICIDAE

General features: Adults are small moths with broadly rectangular forewings, usually brown, green or grey in ground colour. A number of species live on agricultural and horticultural crops but are common also in forest habitats. While some species are pests of cultivated crops, others are beneficial providing biological control of certain grasses viz. genus *Bactra*. Adults with **ocelli** and **chaetosemata,** proboscis without scales, labial palps beaklike and usually **porrect,** maxillary palp 1–4 segmented, 0-2-4 **tibial spurs,** antenna **filiform.** In males, forewings often with a **costal** fold and **retinaculum** on vein Sc, pterostigma usually absent, **chorda** present and with vein M stem sometimes present in cell, CuA with cubital **pecten basally,** CuP present **distally,** 1A + 2A on a distinct fork. Female with three frenula, abdomen without **dorsal** spines.

Male genitalia: **Aedeagus** generally short and curved, loosely connected to a membrane or attached to a **sclerotised juxta, vesica** with internal spinelike **cornuti** or barbs, **vinculum** V- or U-shaped with poorly developed **saccus, valves** simple with **sacculus** and **costa** distinct and **cucullus** well bounded, **gnathos** prominently developed to weak and vestigial, **uncus** shape varying from long and bonnetlike or narrow to weakly or deeply notched.

Female genitalia: **Signum** shape varies from two hornlike structures, two triangular hollow plates, single or double circle of rasplike projections, or pocketlike to prominent dentate patches masking large area of the bursa.

The larvae are common leaf feeders, rolling and joining the leaves and shoots but some may mine and tunnel through stems, fruits and inflorescences. They have a distinct **prothoracic shield** with **sclerotised pinacula, crochets** circular in uni-, bi- or **triordinal** pattern, and the anal fork with straight prongs above the anus. Tortricid larvae are easily recognised by the presence of a lateral (L) group of trisetose **setae** on the prothorax, and by having L1 and L2 **setae** adjacent on abdominal segments I–VIII and usually borne on the same **pinaculum.**

The pupa remains in the larval chamber and protrudes only during moulting. Head with spines, **posterior** end with **cremaster** and hooked **setae,** abdomen with two rows of **dorsal** spines arranged **transversely** on segments III–VII.

The grass stemborers reared from grasses belong to the subfamily Lethreutinae. They are characterised by the presence of one annulus (a ringlike segment) on the antennal **flagellum, strigulae** along the **costa** of the forewing and **aedeagus** united with the **anellus** and **juxta.** Two genera, *Bactra* and *Thaumatotibia,* have been recorded from grasses in Kenya. However, only the latter genus was found during the study. Unlike *Thaumatotibia,* the genus *Bactra* represents a group of true grass stemborers.

Thaumatotibia leucotreta (Meyrick)
(Figure 9 a–f)

Diagnosis: Brown-coloured with dark reddish-brown concave band in the middle of the forewing touching the **costa.** Margin of **costa** with alternating rows of creamy-white and reddish-brown bands. The head is covered with dark brown to brown scales projected towards the curvature of the eyes. **Ocelli** distinct and small, **chaetosemata** present. Labial palps 1.5x as long as diameter of eye, laterally covered with white scales except for brownish, downcurved **apical** segment. Crown with a converging set of creamy-white and reddish-brown, small paddlelike scales with forked tips. **Patagium** covered with chocolate-brown appressed scales. **Tegula** thickly covered with broad paddlelike creamy-white, and black and reddish-brown scales provided with 2–7 serrations. At resting position the two broad bands are connected to each other by a thin **transverse** stripe **anteriorly,** thoracic and **dorsal** side of the forewings with puffed out hairlike scales. Legs with chocolate-brown, slender and needlelike scales on **tibia** III, inner **tibial spur** of leg III very long, almost as long as **basal** segment of **tarsus** III.

Larva pink to pale yellow with a reddish tinge. Mature larva about 15 mm long and 2.5 mm wide. Light brown head wider than long. **Ocelli** 3 and 4 very close to each other. Body **tubercles** often **unsclerotised** or with pale pigmentation, spines with sharp and needlelike tips. **Spiracles** circular. Anal comb distinct. **Tubercle** of **ventral seta** not touching **coxa** on II and III.

Pupa yellow-brown to reddish-brown, about 8–10 mm long and 2–2.5 mm wide. **Ventral** part of **face** without depression or cavities, front distinctly elevated. Abdominal segment II rough, strongly punctured **dorsally,** with two rows of spines. Spines on segments VIII and IX prominently developed. Segment X with spines and two pairs of hooked **setae.** Leg III very close to but not touching wing tips.

Biological information: This species is a common generalist pest of commercial and wild fruits. It is well recognised as a pest of fruits and cotton bolls in Africa (Schmutterer, 1969). In a recent study in Kenya it was reared from fruits of 79 host species, representing 33 plant families (RSC, unpubl. data). Not technically a stemborer, *T. leucotreta* is included here because during our survey of the wild and cultivated grasses of Kenya, it was found attacking maize cobs.

COLEOPTERA: MORPHOLOGY OF A COLEOPTERAN GRASS STEMBORER
(Figure 15 a–s)

Key to the families of coleopteran stemborers, based on adult characters

1 Head produced forward into a **rostrum** or snout 2

1′ Head not **rostrum**-like 3

2 **Rostrum** short, broad and flattened; labrum distinct and separated; antennae not elbowed, **scape** short; prothorax with distinct lateral **longitudinal** edges; mid**coxae** widely closed by sterna; abdomen with four **sternites** fused together, **apical sternite** movable; body smooth, bare of scale cover ..... **Anthribidae** (p. 13)

2′ **Rostrum** elongate, long and slender with lateral **scrobes** housing antennae; antennae elbowed with **scape** longer than the combined length of the next three segments, club with 3–4 segments; lateral margins of prothorax without **longitudinal** edges; mid**coxae** slightly separated, abdomen with five visible **sternites,** the first two fused together; body smooth but covered with clubbed **setae** ..... **Curculionidae** (p. 15)

3 Antenna with 11 segments, usually more than two-thirds as long as the body, arising from the frontal prominences in the emargination of the eyes, and able to be directed backwards, parallel to the body, **funicular** segments long and slender; head strongly deflexed and **hypognathous; tarsal formula** 5-5-5, 3rd segment deeply bilobed hiding the small **penultimate** segment ..... **Cerambycidae** (p. 14)

3' Antenna not as above, **funicular** segments short; head either **prognathous** or **hypognathous; tarsal formula** 5-5-4, 3rd segment not bilobed 4

4 Tip of abdomen exposed forming a stout spine; body strongly convex, humped and strongly arched in appearance and laterally compressed; head with a sharp angular constriction behind the eyes; hind **coxae** form a large thin rounded plate ..... **Mordellidae** (p. 18)

4' Tip of abdomen blunt or rounded, covered by **elytra;** body elongate and more or less dorso**ventrally** flattened; head without a sharp angular constriction behind the eyes; hind **coxae** small, not producing a rounded thin plate 5

5 Body uniformly dull brown to black; eyes notched; fore **coxal** cavities closed behind; tarsi simple; abdomen with five visible **sternites,** three **basal** segments strongly connected ..... **Tenebrionidae** (p. 19)

5' Body shiny and narrow; prothorax and **elytra** with different coloration, pronotum usually reddish-orange; eye without notch; fore **coxal** cavities open behind; tarsi with 3rd segment bilobed, hiding the 4th segment; abdomen with five immovable **sternites** ..... **Languriidae** (p. 17)

FAMILY ANTHRIBIDAE

General features: Anthribids are minute to small (0.4–12 mm long) beetles with broad noses. They vary in shape from moderately elongate to ovoid and from slightly to strongly convex. Body usually clothed with white decumbent scales instead of **setae,** often with an obvious pattern. Beak very short to relatively long but stout and flattened. Labrum distinct and separated from **rostrum,** the maxillary palpi four-segmented. The 11-segmented antennae are straight and, in males, prominently long, resembling those of the Cerambycidae. Club indistinct to 3-segmented. Mandibles strongly developed and relatively acute. Pronotum with a **basal** or pre**basal transverse** ridge. **Elytra** often striate. Legs without **apical tibial spurs,** prothoracic **coxae** clearly separated and tarsi pseudotetramerous with fourth segment hidden. Abdomen with visible **sternites** I–IV usually connate.

Larva glossy white, C-shaped, typically resembling the curculionids. Diagnostic characters are the two-segmented thoracic legs lacking a terminal clawlike segment or **tubercle,** head distinctly separated from prothorax, **epicranial stem** long, frontoclypeal **suture** prominent showing distinct **clypeus. Ocelli** absent. Antenna large, conical with one segment. Mandibles with three teeth consisting of two marginals and a sharper **apical** tooth. Abdominal segments I–VII each with two **dorsal transverse plicae,** segment X without ovoid lobes separated by a **longitudinal** furrow. **Spiracles** commonly **annular** with thoracic **spiracles** on mesothorax or between the prothorax and mesothorax.

Pupa **exarate** with the legs held **transversely** parallel to each other, body oblongate with rounded head and tapering **posterior** end. Head prominent with large black eyes and short white hairs. Abdomen without prominent marking, lateral margins with short white hairs.

Biological information: Only one genus of anthribid was collected and successfully reared from grasses in Kenya. The two species are tentatively placed in the genus *Phloebius*. Previous to this the genus *Sintor* was reported to bore, feed and live in stems.

Key to the adults of anthribid stemborers

1 Body brown with grey tinge; pronotum longer than wide with three **longitudinal** white stripes almost converging **anteriorly**; legs brown ..... *Phloebius* sp. A (Figure 16 a–c)

1' Body uniformly black, clothed with short and very fine white hairs, stripes absent; pronotum slightly wider than long without white **longitudinal** stripes; legs black ..... *Phloebius* sp. B (Figure 17 a–c)

FAMILY CERAMBYCIDAE

General features: Adults with cylindrical, elongate and relatively flattened bodies with extremely long, usually 11-segmented antennae, at least half as long as the body and often much longer. Because of the noticeably long antennae, these insects are called longhorn beetles. Antennae are inserted on prominences facilitating movement of antennae towards the rear on top of the body. Eyes commonly emarginated or deeply notched on the inner margins, the antennae arising in front of or within the clefts. Prothorax without lateral carina, but often with lateral spines, and mesonotum sometimes with stridulatory file. All legs with **tibial spurs,** the 5-segmented tarsi appearing 4-segmented with the bilobed third segment concealing the small fourth segment. Tarsal claws simple.

Larvae commonly bore in stems or branches of trees and grasses. Many species are destructive to fruit trees, ornamental plants, bamboos and forest trees. Larval body whitish, long and cylindrical, without legs, mildly **sclerotised** with fine **setae** or small spines. Head deeply grooved, retracted into the enlarged prothorax, possessing large and robust mandibles and short antennae. Legs small, wide apart, absent in some species. Abdomen with fleshy **ampullae,** blisterlike structures present on the first six or seven abdominal segments, that aid in larval movement.

Pupa typically **exarate,** body elongate with a narrow to wide cleft on the head formed by the bases of antennae lining the anterolateral one-half of the body. Head **hypognathous,** varying in shape from short and subtriangular to oblongate. Mandibles distinctly developed. Dorsum of abdomen with spines or oblong, blister-like structures.

Key to the adults of cerambycid stemborers

1 Body flat with antenna a little shorter than the body; eyes small, located close to the midlength of the head; head longer than wide 2

1′ Body cylindrical with antenna prominently longer than the body; eyes large, located in the anterolateral corner of the head; head as long as wide 4

2 Pronotum with three white **longitudinal** bands or ridges; tips of **elytral striae** 2, 3 and 4 separated **distally,** not reaching wing tip, **striae** 2 and 4 not Y-shaped ..... *Hypamazso pauli* (Fairmaire) (Figure 29 a–m)
(NOTE: This species shows considerable variation in shape of the **elytra** as well as the pattern, number of **striae,** and form of hairs present on the **elytra** [Figure 30 a–i]. It may represent a species complex).

2′ Pronotum with only the median **longitudinal** ridge distinct, sublateral white bands indistinct; tips of **elytral striae** 2 and 4 merged sub**distally** leaving **stria** 3 unconnected and forming a Y-shaped pattern, base of the Y merged with **stria** 6 before the wing tip 3

3 **Scape** without a **ventral tubercle** or swelling ..... *Hypamazso* sp. B (Figure 31 a–i)

3′ **Scape** with a sub-baso**ventral tubercle** or swelling ..... *Hypamazso* sp. C (Figure 32 a–g)

4 Pronotum and **elytra** uniformly yellow; last abdominal **sternite** with a cleft in the **posterior** margin ..... *Obeneopsis* sp. (Figure 33 a–l)

4′ Pronotum and **elytra** with alternating grey and cream white **longitudinal** stripes; **posterior** margin of the last abdominal **sternite** slightly elevated medially ..... *Hyllisia* near *vittata* Fåhraeus (Figure 34 a–d)

Key to the larvae and pupae of cerambycid stemborers

1 Larva 2

1′ Pupa 5

2 **Ampulla** or blisterlike structure on abdominal **tergite** VIII entire and lip-like, similar to those in IV–VII; **epicranial stem** long and entire; anal **posterior** margin strongly rounded 3

2′ **Ampulla** on **tergite** VIII broken in the middle; **epicranial stem** present or absent; anal **posterior** margin differently shaped 4

3 **Prothoracic shield** white and slightly **sclerotised; ampulla** on **tergite** VIII lip-like, with constriction in the middle; head relatively wider below midlength ..... *Hypamazso pauli* (Fairmaire) (Figure 29 n–s)

3′ **Prothoracic shield** with a yellowish median sclerotisation; **ampulla** on **tergite** VIII more elevated and sausage-shaped; head strongly rounded laterally ..... *Hypamazso* sp. C (Figure 32 h–k)

4 **Ampullae** on abdominal **tergites** VII–VIII widely divided medially, similar in shape and extended laterally; **prothoracic shield** broad with median reddish markings and a few spines **posteriorly**; **epicranial stem** present..... *Hypamazso* sp. B (Figure 31 j–o)

4′ **Ampulla** on abdominal **tergite** VIII large and narrowly divided medially, **ampulla** on VII thin and entire; **prothoracic shield** not strongly **sclerotised; epicranial stem** absent ..... *Obeneopsis* sp. (Figure 33 m–t)

5 Body slender with a snoutlike head viewed laterally; liplike **ampullae** present on **dorsal** abdominal segments IV–IX; **apical** segment of antennae barely reaching the tip of the wing ..... *Hypamazso pauli* (Figure 29 t–w)

5′ Body relatively stout with no snoutlike process **anteriorly**; abdominal **tergites** III–IX with **transverse** rows of spines, single row in the **posterior** margins of **tergites** III, IV, VII and two rows in tergites V–VI; antennae exceeding wing tips, coiling back towards the head and looping around the eyes..... *Obeneopsis* sp. (Figure 33 u–y)

FAMILY CURCULIONIDAE

General features: Adults with head distinctly produced in front of the eyes producing an elongate **rostrum** or snout that houses the folded, **geniculate** antennae. Antennal **scape** very long. Club compact. Body compact, usually heavily **sclerotised,** robust and strongly convex, lined with scales or bristles. Mouthparts modified, lacking labrum, maxilla reduced to short but robust palps, and **gular sutures** fused. Legs with five-segmented tarsi. **Penultimate** segment very small and hidden at the base of lobed third segment. **Trochanters** small and triangular, femora **clavate** or dilated towards **apical** one-half or grooved to house the **tibiae**. Abdomen with five visible **sternites**.

Larvae usually C-shaped, white. Body slightly **sclerotised** with brown patches. Head heavily **sclerotised, hypognathous. Epicranial suture** long. **Clypeus** distinctly developed, labrum with rounded, sinuous or emarginate **anterior** margin, mandibles robust. Single-segmented antennae minute, membranous with pronounced conical or plate-like sensory structure. Maxillary palpi two-segmented, labial palpi with a single segment. Larvae without thoracic legs but sometimes bearing ventrolateral swellings called pedal lobes with stiff **setae.** Dorsum of abdomen with three or four **transverse** folds in each segment, lateral sides without partitioning.

Pupae generally whitish in colour and **exarate** in form.

Key to the adults of curculionid stemborers

1 **Scape** inserted very close to the **anterior** of the eye; body uniformly black with heavy punctations on the thorax, **elytra** and legs; **rostrum** long and slender, slightly **punctate** along **anterior** one-half, strongly **punctate** towards base; pronotum narrow **anteriorly** and nearly parallel-sided laterally; **posterior** of abdomen exposed; body length c. 10 mm (Subfamily Rhynchophorinae) ..... ?*Odoiporus* (Figure 18 a–g)

1′ **Scape** inserted far away from the eye usually at midlength of the **rostrum** or between midlength and **anterior** tip of **rostrum;** body colour variable; **rostrum** short and stout; pronotum distinctly wider **posteriorly**; **posterior** end of abdomen usually not exposed 2

2 Body length 8–14 mm; **femur** III without a **ventral** spine 3

2′ Small-bodied curculionids, less than 4 mm long; **femur** III with a **ventral** spine..... 7

3 **Elytra** lined with white and grey **longitudinal** stripes; at resting position **posterior** tips of **elytra** forming a distinct deep cleft; tip of each **elytron** pointed 4

3′ **Elytra** black or grey-brown with patches of white hairs or brown bands, not forming cleft at resting position; tip of each **elytron** relatively rounded or truncate 5

4 Midpronotum with a narrow **longitudinal** dark grey band lined with mild punctations on both sides, lateral sides of pronotum each with a greyish **longitudinal** band running parallel to the middle band; venter of abdomen clothed with thick hairs; male genitalia with **sclerotised** central region and a ring segment on one end..... *Lixus* sp. A (Figure 19 a–i)

4′ Midpronotum with broad median and lateral bands, not running parallel to each other; venter of abdomen lined with short fine hairs; male genitalia without **sclerotised** central area, ring segment absent ..... *Lixus* near *germaini* Hustache (Figure 20 a–l)

5 **Elytra** with a broad brown V-shaped band below midlength and lighter brown to grey central band **anteriorly**; white hairs lining the lateral and **posterior** ends of V-shaped band; midpronotum with **transverse striae; dorsal** tip of **rostrum** with triangular **punctate** marking ..... *Tanymecus* near *dilaticollis* Gyllenhal (Figure 21 a–c)

5′ **Elytra** with a pale white V-shaped band of white hairs below midlength extending, with interruptions, laterally and incurved to the base of the wings, or V-shaped band absent and **elytra** heavily **punctate** 6

6 Tip of abdomen exposed; **elytra** not strongly **punctate,** tip narrowly rounded; midpronotum with triangular punctations not reaching the **anterior** margin; abdominal venter lined with short fine hairs ..... *Tanymecus* sp. A (Figure 22 a–o)

6′ Tip of abdomen completely covered; **elytra** strongly **punctate** with truncated tip; midpronotum with a light grey band, finely **punctate** marking entire; abdominal venter strongly **punctate** ..... ?*Tanymecus* sp. (Figure 23 a–i)

7 Entirely black except for areas of white scales on the body and legs. White scales on the pronotum lining the central and lateral areas, and on the **elytra** along the **anterior** margin extending posterad in the middle of each **elytron** and connecting to a **transverse** band of white scales sub**posterior**ly 8

7′ Entirely brown without white scales forming a distinct pattern on the pronotum and **elytra,** elongated scales present in each **elytral** puncture 9

8 Midpronotum lined longitudinally with slender, white, fine scales with truncated tips converging towards each other, similar scales present in the posterolateral, midlateral and anterolateral areas of the pronotum; lateral side of the pronotum sparsely **punctate; ventral** spine of femora III relatively short and stout; male genitalia with long median lobe, internal sac connected to two **sclerotised** parallel arms of the **anterior** piece with prominent anterolateral swellings and forming a broadly truncated median plate; **spermatheca** narrowly curved forming a U or V pattern, membrane bent outwards from the enlarged base ..... Unknown genus sp. A (Figure 24 a–z4)

8′ Midpronotum with a **longitudinal** band of broad, white, fine scales strongly truncated at apices, interrupted at midlength, posterolateral half and lateral side of pronotum thickly covered **apical**ly with blunt white scales but **anterior** one-half with few scales; **ventral** spine of femora III sharply pointed, its length equal to or slightly longer than the **basal** width of spine; male genitalia with a short median lobe, internal sac connected to two **sclerotised** and strongly convex arms of the **anterior** piece and converging to form a narrowly blunt median plate; **spermatheca** sickle-shaped, membrane projected **anterior** of the enlarged base..... Unknown genus sp. B (Figure 25 a–p)

9 **Distal** half of **elytra** distinctly narrower than the proximal half; **spermatheca** shoe-like with a prominent globose area near the transparent membrane; two teeth on each mandible ..... Unknown genus sp. C (Figure 26 a–i)

9′ **Elytra** almost parallel-sided without prominent constriction towards **distal** one-half; **spermatheca** not shoe-like; mandibular teeth 2-2 or 1-3 10

10 **Coxa** III relatively elongate; **ventral tibial spur** in leg III slightly bent; apodeme well **sclerotised** with curved apex; left mandible with three teeth, right mandible with only one ..... Unknown genus sp. D (Figure 27 a–e)

10′ **Coxa** III globose; **ventral tibial spur** in leg III acutely pointed and perpendicular to the **femur;** apodeme slightly **sclerotised** and straight towards apices; mandibular teeth 2-2 ..... Unknown genus sp. E (Figure 28 a–j)

Description of Curculionidae unknown genus larva and pupa
(Figure 24 w–z4)

Diagnosis: Larva moderately crescent-shaped, curvature more pronounced towards the **posterior** abdominal area. Head **hypognathous,** bearing few hairs, longer (0.93 ± 0.06 mm, n = 17) than wide (0.79 ± 0.05 mm, n = 17), with a head length (HL): head width (HW)

ratio of 1.16 ± 0.07. **Epicranial stem** long with a prominent endocarina. **Frons** broadly triangular with four **transverse** rows (2-2-2-4) of **setae** close to the endo**carina** and six **setae** lining the **sclerotised** frontoclypeal margin, corner **setae** about twice as long as the four submedian **setae.** Mandibles strong, almost triangular with two submedian **setae** and two **apical teeth.** Epipharynx with 14 **setae** in two **transverse** rows; pale, long and U-shaped labral rods. Maxillae of two segments, with lateral scars or light **sclerotised** margins. Outer flange with eight **setae,** three **apical** and five **basal.** Abdomen with distinct dumb-bell-like **plicae. Prolegs** absent but golden erect hairs present. Larvae of all five of the species of this genus are similar and very difficult to separate from each other.

Young pupa oblongate, **exarate** with a globose head and pointed abdominal tip. **Anterior** half of the globose head with seven **setae** and two each posterolaterally. Wing pads show 4–5 oblique **striae**. Abdominal **tergites** each with two pairs of sub**dorsal setae.** Last abdominal segment heavily **sclerotised.** Older pupa compact, with broad to rectangular pronotal plate lined marginally with fine hairs.

Biological information: The genus has been reared from three species of native grasses in Kenya; *Cymbopogon nardus* (L.) Rendle, *Sorghum versicolor* Anderss and *Themeda triandra* Forssk.

FAMILY LANGURIIDAE

***General features*:** Adults with elongate, subcylindrical, flattened and narrow bodies, pronotum and **elytra** often different in colour pattern. **Elytra** commonly black, prothorax often red, some species with yellow **elytra** or **posterior** one-half of **elytra** black. Head large, recessed into the prothorax which reaches the hind eye margin, hiding the vertex. Antennae 11-segmented with 3–5 segmented club. Pronotum elongate or quadrate, with smooth lateral margins, always with paired furrows at base and with a **transverse** groove. **Elytra** elongate with apices truncate, or rounded, or pointed and separated with a groove in between. **Dorsal** surface of **elytra** may be shiny, glabrous or hairy. Legs simple with 5-5-5 **tarsal formula.** Pro**coxal** cavities open behind, meso**coxal** cavities closed externally by sterna. Abdomen with four visible **sternites**.

Larva often white, elongate, with **ocelli,** 3-segmented antennae, and bidentate mandibles. Head rounded to relatively long with short frontal arms and indistinct frontoclypeal **suture.** Maxillary palpi 3-segmented, labial palps 2-segmented. Thoracic legs present, each with a distinct terminal claw. Abdomen nearly parallel-sided, **tergite** IX bearing 1–2 upturned spines or **urogomphi** or a **setiferous tubercle,** X located poster**oventrally** and either rounded or cleft.

The pupa is **exarate** with pointed wing tips, large eyes on a rounded head and broad pronotum strongly rounded **anteriorly** and truncated **posteriorly**. Dorsum of abdomen with or without a sub**posterior transverse** row of spines. **Tergite** IX with 1 or 2 **urogomphi.**

***Biological information*:** Languriids are basically herbivores and detritivores. The larvae have been reported to feed on plant stems. For instance, *Anadastus parvulus* (Wiedemann) is a recorded pest of Italian millet, *Setaria italica* and the reddish-brown languriid, *A. filiformis* (F.) is a rice stemborer in Indonesia. With respect to languriids boring in the stems of tall grasses in Kenya, information is scanty. Eight species belonging to three genera—*Barbaropus*, *Promecolanguria* and *Stenolanguria*—were collected and reared on cut maize stems. These are true grass stemborers reported for the first time in Kenya. *Setaria incrassata* (Hochst.) Hack was the host of *Barbaropus* and *Hyparrhenia rufa* (Nees) Stapf was the host of *Stenolanguria caudata* Kraatz.

Key to the adults of languriid stemborers

1 Tips of **elytra** pointed and separated; pronotum red and strongly convex; **elytra** dark blue.... 2

1′ Tips of **elytra** rounded or truncated; pronotum usually yellowish; **elytra** entirely yellow or with **posterior** half bluish-black 3

2 Tips of **elytra** widely separated; pronotum **punctate** towards **anterior** two-thirds and relatively smooth in **posterior** one-third .....*Stenolanguria caudata* Kraatz (Figure 42 a–n)

2′ Tips of **elytra** narrowly separated; pronotum smooth ..... *Stenolanguria* sp. (Figure 43 a–l)

3 Tips of **elytra** truncated 4

3′ Tips of **elytra** rounded 7

4 Pronotum smooth and finely **punctate, posterior longitudinal** groove small and shallow .. .. *Barbaropus* near *olseni* Pic (Figure 44 a–m)

4' Pronotum generally roughly **punctate, posterior longitudinal** groove short to long and distinct 5

5 Pronotum with a greyish triangular tinge mid**anteriorly** 6

5' Pronotum without a broad greyish triangular tinge, slight bulge midlaterally; head and pronotum heavily **punctate;** posteromedian pair of grooves distinct .... *Barbaropus* sp. C (Figure 45 a–h)

6 Mid **anterior** margin of pronotum with a broad grey tinge reaching **apical** one-third of pronotal length ..... *Barbaropus* sp. B (Figure 46 a–h)

6' Mid **anterior** margin of pronotum with a faint narrow grey tinge along **apical** one-third of pronotal length ..... *Barbaropus* sp. D (Figure 47 a–c)

7 Head, pronotum and entire **elytra** yellow; posteromedian pair of grooves prominently long..... *Barbaropus* sp. E (Figure 48 a–h)

7' 'Head, pronotum and **posterior** one-third of **elytra** bluish-black; posteromedian pair of grooves indistinct..... *Promecolanguria rufocephala* Villiers (Figure 49 a–i)

FAMILY MORDELLIDAE

General features: Commonly called tumbling flower beetles, adults are small (2–12 mm long) and characterised by the strongly wedge-shaped or humpbacked appearance. Body laterally flattened, pointed **posteriorly** with the terminal **tergite sclerotised,** and projected as a swordlike process beyond **posterior** margins of **elytra.** Head wider than long, **transverse,** and bent down covering the prosternum, pro- and mid-**coxae**. Lateral **carina** on pronotum complete. Legs with **tarsal formula** of 5-5-4, hind **coxae** very broad, **tibiae** and tarsi with oblique rows of comb-like spines, tarsal claws **serrate** or **pectinate.**

Larva white to glossy whitish-yellow, elongated, with a rounded head, long **epicranial stem,** robust mandibles and short legs without claws. **Tergite** IX with a pair of minute **tubercles** or median terminal spine. Pupa **exarate,** elongated with a large **prothoracic shield** extended to the upper margins of the eyes. Head subtriangular laterally, slightly bean-shaped frontally. Terminal segment of abdomen long with a posteromedian spine.

Biological information: Mordellids are generally decomposers feeding on decaying wood but some species have been reported to feed and mine in grass stems and other herbaceous plants (Booth et al., 1990). In Kenya, species belonging to the genus *Stenalia* were reared from stems of *Hyparrhenia cymbaria* (L.) Stapf, *H. rufa* (Nees) Stapf., *Setaria incrassata* (Hochst.) Hack., *S. sphacealata* (Schumach.) Moss and *Panicum maximum* Jacq.

Key to the adults of mordellid stemborers

1 Head mostly black; **elytra** dominantly yellow with blackish margins; leg III with 3–4 oblique rows of spines on **tibia,** 2–3 on basitarsus and one on the third tarsal segment 2

1' Body uniformly black or bluish-black; **tibia** of leg III with 2–3 oblique rows of small spines, one row on **basal** tarsal segment and none on the third tarsal segment 4

2 Pronotum black with broad yellow margins; **elytra** grey to black baso-medially and along entire length of lateral margins extending to **apical** one-fourth; **frons** slightly swollen in the middle; **coxa** III yellow except black on **anterior** one-half; oblique rows of spines on leg III (**tibia: tarsomere** I: **tarsomere** II: **tarsomere** III) 4:3:1:1 .... *Stenalia* near *occidentalis* Pic (Figure 35 a–f)

2' Pronotum black without yellow margins; margins of **elytra** with thin grey lines; oblique rows of spines on leg III 3:2:1:1 or 3:3:1:1 3

3 Head black with a median **longitudinal** line; **elytra** yellow with thin black bands only on the inner and outer lateral margins; leg III spines 3:3:1:1 ..... *Stenalia* sp. B (Figure 36 a–f)

3' Head without a median **longitudinal** line; **elytra** yellow with all margins black; leg III spines 3:2:1:1 ..... *Stenalia* sp. C (Figure 37 a–g)

4 Body entirely black with pale white hairs on the wings; oblique spines on leg III 3:1:1:0.... ..... *Stenalia* sp. D (Figure 38 a–e)

4' Body uniformly black except shiny yellow hairs on the wings; oblique spines on leg III 2:1:1:0..... *Stenalia* sp. E (Figure 39 a–e)

Larva of *Stenalia* nr. *occidentalis* Pic

(Figure 35 g–k)

Description: Larva 4–6.8 mm long by 1.4–1.8 mm wide, shiny white and lightly **sclerotised** except the dark pigmented mouthparts and **urogomphi** at the tip of abdominal **tergite** IX; elongate to cylindrical with lateral abdominal swellings. Head abruptly curved downward with **epicranial stem,** endo**carina** and frontal arms absent, 3-segmented antennae very small, frontoclypeal **suture** distinct with anterolateral bulges near the antennae, **ocelli** visible. Mandibles symmetrical without mola, maxillae with small rounded mala. **Prothoracic shield** large, slightly **sclerotised** with the subtruncated **anterior** margin distinctly wider than the concave **posterior** margin. Legs very short with no distinct segments, **coxae** widely apart. Abdominal **tergites** I–VII each with a pair of posteriorly converging ovoid markings, **tergite** IX light brown, covered with hairs, four small spines arranged mid-**dorsally** in a **longitudinal** row, forked spine at the tip. Abdominal segment X slightly rounded postero**ventrally**. **Spiracles annular,** those on abdominal segment VIII the largest.

Pupa of *Stenalia* nr. *occidentalis* Pic

(Figure 35 l–q)

Description: Pupa whitish-yellow to yellowish-brown, c. 6.5 mm long and 1.4 mm wide, **exarate** and slender, head bluntly rounded, almost entirely covered by the **transverse** and **anteriorly** rounded pronotum. Eyes large, bean-shaped, touching the lateral sides of the pronotum. **Frons** with a shallow **transverse** scar between the eyes, not reaching eye margins. Appendages broadly attached to the sides of the body. Abdominal segments, except terminal one, with a **dorsal** pair of parallel **longitudinal** lines; lateral edges bulging posterolaterally with a group of hairs on top of the bulge. **Dorsal** tip of last abdominal segment with a hooked spine.

FAMILY TENEBRIONIDAE

General features: The tenebrionids, or darkling beetles, are primarily scavengers, some feeding on plant materials like roots while others are serious pests of stored grain products. Generally, they are black or brown with a variety of shapes. The antennae are moniliform or incrassate with hidden bases. Eyes are distinctly emarginate and the lateral **carina** on the pronotum is simple and complete. Leg **tarsal formula** is 5-5-4.

Larva yellow brown to dark reddish-brown, prominently elongate and subcylindrical, heavily **sclerotised** with darkened head, reddish-brown mandibles and black **urogomphi.** Head with short to indistinct **epicranial stem,** mandibles concave and developed, **ocelli** absent, maxillae with rounded mala, and labium with 2-segmented palpi. Legs relatively similar in sizes with a sharply pointed claw. Abdomen parallel-sided with scars dorsad or **posterior** to the **spiracles, anterior** margins of each segment with or without punctures, **tergite** IX heavily **sclerotised** and **punctate, dorsally** flat with a pointed process or obliquely concave.

Biological information: Although tenebrionids are not known to bore stems of grasses, two genera—*Paramarygmus* and *Zophodes*—have been recently found inside the stems of *Pennisetum polystachion* (L.) Schult. in Busia District, Kenya. Both were mining the root system and feeding inside on the plant tissues producing deadhearts on young plants or whiteheads on flowering ones. Unfortunately, no pupae and adults were available during the preparation of this manual.

Key to the larvae of tenebrionid stemborers

1 Abdominal **tergites** VIII and IX heavily **punctate, tergite** IX strongly concave **dorsally** and oblique laterally; frontal arm fully developed and broadly V-shaped; vertical scars present on **posterior** one-third of segments I–VII, absent on VIII ..... *Paramarygmus* sp. (Figure 40 a–i)

1′ Abdominal **tergite** VIII **punctate** only **anteriorly**; tergite IX entire, cylindrical and rounded **posteriorly** with a median tooth; frontal arm poorly developed; vertical scars **longitudinal** on segments I–VIII but not reaching **posterior** margin..... *Zophodes* sp. (Figure 41 a–g)

DIPTERA: MORPHOLOGY OF A DIPTERAN STEMBORER

(Figure 50 a–d)

Key to the families of dipteran stemborers

1 Head with a pair of strongly diverging long stalks bearing the widely separated eyes and antennae; **scutellum** with a pair of long and diverging strong spines ..... **Diopsidae** (p. 21)

1′ Head normal, without a pair of strongly diverging stalks containing the eyes and antennae; eyes and antennae near each other; **scutellum** without a pair of strong spines..... 2

2 **Ocellar triangle** large and strongly developed; wing without anal cell, cell CuP and vein CuA +1A absent; cell M fused with the discal cell; **costa** with a break before the end of R_1 ... . **Chloropidae** (p. 20)

2′ **Ocellar triangle** weakly developed; wing with anal cell, vein CuA and 1A present, cell M separate from the discal cell; **costa**l break absent 3

3 Wings usually banded or spotted; vein Sc **apically** curved forward at right angle, not reaching **costa**l margin; anal cell with pointed tip, abdominal segment VI of female well developed forming a long pointed process ..... **Tephritidae** (p. 22)

3′ Wings without bands or spots; vein Sc not bent at right angle, complete, joining **costa**l margin; anal cell without a pointed tip; abdominal segment VI of female without a long tubular process ..... **Muscidae** (p. 21)

FAMILY CHLOROPIDAE

General features: Adult chloropids are easily recognised by the strongly **sclerotised,** enlarged and well developed **ocellar triangle,** the absence of strong fronto-orbital **setae,** and convergent to cruciate postvertical **setae. Costa** of forewings with a single break near the apex of vein R_1, subcosta not completely developed except at base, anal vein indistinct, discal cell and second **basal** cell running together, vein $M_3 + M_4$ usually with a flexure (weak or distinct) close to middle of discal cell, anal cell absent, alula prominently developed. Legs without strong **setae.** Abdominal **tergites** 1 and 2 confluent forming syn**tergite** 1 + 2, longer than other **tergites.**

Larva usually white, varying from elongate and flat with narrowing **anterior** and **posterior** ends to oblong and cylindrical with acute head and rounded **posterior** end. In some species, larva with forked **posterior** tip, while in others the tip is rounded with small spiracular knobs.

Pupa **coarctate** with reddish-brown to dark brown sclerotisation.

Biological information: Three genera of chloropids—*Elachiptereicus, Mepachymerus* and *Pachylophus*—have been reared from tall grasses in Kenya. *Elachiptereicus* was commonly isolated from the yellowing and drying shoots of *Rottboellia cochinchinensis* (Lour.) W.D. Clayton. *Panicum maximum* Jacq., *Setaria sphacealata* (Schumach.) and *Echinochloa pyramidalis* (Lam.) Hitchc. & Chase were the hosts of *Mepachymerus. Pachylophus* sp. was reared from *P. maximum.*

Key to the larvae and pupae of chloropid stemborers

1 Larva 2

1′ Pupa 4

2 Body relatively flattened, narrow on both ends with a short, forked **posterior** end; body length c. 4.8–6 mm ..... *Mepachymerus* sp. (Figure 53 a–d)
(NOTE: Adult fly has a yellow-orange body and legs, with a black **ocellar triangle,** three **longitudinal** bands on the thorax and **hyaline** wings. It is very similar to the genus *Chlorops* Meigen 1803)

2′ Body elongate and cylindrical, more or less rounded on both ends 3

3 Body pale yellow, 5–6.5 mm long, with very soft and thin **ventral** integument; **anterior spiracle** fingerlike with 7–10 digitations or branches; cephalopharyngeal skeleton with a U-shaped pharyngeal plate, sharply curved mouth hook and a long bar connecting the plate to the hook ..... *Elachiptereicus abessynicus* Becker (Figure 54 a–d)

3′ Body 6.5–8 mm long, cream-white except brownish **spiracles, anterior spiracle** forming a **transverse**ly elongate rose-like arrangement with 37–42 digitations directed at a right angle to the spiracular trunk; cephalopharyngeal skeleton with a V-shaped pharyngeal plate and a short bar connecting it to the base of mouth hook..... *Pachylophus* sp. (Figure 55 a–d)

4 **Posterior** tip of pupa with a forked tail .....*Mepachymerus* sp. (Figure 53 c)

4′ **Posterior** tip without forked tail 5

5 **Anterior spiracles** located **dorsal**ly and directed upwards and forwards; length about 5–6.5 mm and 1.5 mm wide..... *Elachiptereicus abessynicus* (Figure 54 b)

5′ **Anterior spiracles** located **ventral**ly; length 6.5–8 mm..... *Pachylophus* sp. (Figure 55 b)

FAMILY DIOPSIDAE

General features: Adults with long stalks arising laterally from each side of the head. Eyes and antennae located at or near the end of the stalks. Body slender. Wings with or without spots or bands. **Scutellum** with two strong diverging spines with or without **apical** bristle. Legs slender, femora I enlarged, with two rows of **longitudinal ventral** spines.

Larva dull white, flattened and narrowing on both ends. The two genera of diopsid grass stemborers—*Diopsis* and *Diopsina*—found on cogon grass, *Imperata cylindrica* L. in Kenya are similar in shape and form.

Pupa dark yellowish-brown, c. 6.5 mm long and 1.5 mm wide with segment VI the longest; **posterior** end with a pair of widely separated **porrect** spines. Body segments uniformly lined with fine **transverse striae.**

Biological information: Diopsids are economically important in African agriculture. A number of species are pests, attacking maize, rice and wild *Oryza barthii.* The genus *Diopsis* has been reported as pest of both maize and rice. *Diopsina* sp., on the other hand, are usually found on wild grasses. Two genera of diopsids—*Diopsina* (one species) and *Diopsis* (two species)—were reared from *Imperata cylindrica* L. in Busia District, Kenya.

Key to the adults of diopsid stemborers

1 Wings with three **transverse** bands, a narrow sub-**basal,** broad **medial** and narrow subterminal band; scutellar spines brown, long and robust; facial teeth small..... ..... *Diopsina* sp. (Figure 51 a–d)
(NOTE: Pupa tapers on both ends, with **anterior** end broader than the forked **posterior** end [Figure 51 d])

1′ Wings without bands; scutellar spines yellow or black; facial teeth prominently developed or entirely absent..... 2

2 Body reddish-brown except black shiny thorax, tips of stalks and **tergite** I; **scutellum** rectangular; scutellar spines yellow, strong and diverging; wings **hyaline** with an L-shaped grey-brown sub**apical** spot; facial teeth strongly developed; **face** swollen, without hairs; venter of **femur** I with short spines in two rows, inner row with 19 and outer with 17; body length c. 9.2 mm ..... *Diopsis* near *lindneri* Feijen (Figure 52 a–c)

2′ Body black except brownish legs; **scutellum** trapezoidal; scutellar spines black, short with long **apical** bristle, 3x longer than the spine; wings **hyaline** without spot; facial teeth absent; **face** rounded and hairy; venter of **femur** I with two rows of long slender spines, inner row with 4, outer with 2–3; body length c. 6.6 mm..... *Diopsis* sp. B (Figure 52 d)

FAMILY MUSCIDAE

General features: Muscids are represented by a diverse group of flies making up several subfamilies. The features enumerated here are restricted to the muscid grass stemborers. Adults

with an angular head, **face** long and bare, antennal **flagellomere** long, **arista** bare. A single pair of **reclinate** orbital **setae** are present; hind **tibia** without a posterodorsal **seta** in **apical** one-half and wings bare except the costa. Palpi strongly developed. Thoracic **setae** very small, reduced in size. Wings with vein R_{4+5} and M parallel at wing margin, A1+CuA2 reaching beyond halfway from crossvein CuA2 to wing margin. Male genitalia with hypopygium with surstyli developed normally, cercal plate may be highly modified, **aedeagus** with **juxta** reduced to a simple membranous sac. In the female, the **ovipositor** is long with cylindrical cerci set free from the membrane in nearly its entire length, **tergite** VIII not divided longitudinally, **sternite** VIII reduced to a pair of small hind marginal discs, three **spermathecae** present.

Larva elongate, typically narrow and tapered **anteriorly** but rounded to blunt **posteriorly**, cephalopharyngeal skeleton distinct with developed mandibles; abdominal venter with pseudopads; a pair of **posterior spiracles** present. A unique feature of stem-boring Muscidae is the presence of oral bars adapted for cutting tough plant tissues.

Pupa barrel-shaped, elongate with both ends rounded and the **posterior** end with **spiracles**. Mature pupa always reddish-brown.

Biological information: Among the muscids, members of the genus *Atherigona*, subgenus *Atherigona* are recognised as true stemborers and are sometimes pests of cultivated grasses such as rice, maize, sorghum and millet (Davies and Seshu Reddy, 1981; Kalshoven, 1981).

Atherigona soccata Rondani

(Figure 57 a–h)

Description: Males with dark frontal vitta, palp yellow with **basal** half brown; **scutum** without dark vittae, **femur** I and **tibia** I yellow; fore **tarsus** brown, except **apical** two-thirds of **tarsomeres** yellow. Wings with a weak tinge at tip of subcosta. Abdominal **tergites** 1 + 2 and 5 without spots or marks, **tergite** 3 with a pair of elongate to triangular spots at about one-half of tergal length, **tergite** IV with a pair of oval spots at one-third of tergal length.

Male genitalia: Tip of subtriangular trifoliate process with two strong lateral spines and two pairs in the middle; hypopygial prominence **apically** blunt in side view and concavely separated in **anterior** view.

Female with forelegs dark brown, femora yellow on **basal** two-fifth and **tibia** yellow on **basal** one-half or less; **tergite** VIII strongly W-shaped **anteriorly** and **tergite** VII separated and triangular in shape with a black **longitudinal** median band along **anterior** one half.

Mature larva c. 6–8 mm long, yellow to yellowish-white with black mouthparts, narrow **anteriorly** and blunt to rounded **posteriorly**.

Pupa elongate, dark brown to reddish-brown; c. 4–5 mm long.

Biological information: Flies lay elongated white eggs singly in the morning and afternoon on the base of young seedlings. In two days the larva hatches and penetrates immediately into the shoots of young plants, later damaging the growing point. The maggot damage is called deadheart. In c. 2 weeks, larvae bore through the wall of the shoots. Pupation occurs in the surface layer of the soil. Adult emerges in 8–12 days and in well-irrigated areas where host plants are available year round many generations are developed. Maize and *Panicum maximum* are the most common host plants of *A. soccata* in Kenya.

FAMILY TEPHRITIDAE

General features: Adults are easy to recognise. Flies with spotted or banded forewings and a subcostal vein that bends sharply forward towards the **costa**, the bend at or near a right angle, before it totally fades. In the female, abdominal segment VI is well developed into a long process.

Larva commonly white, elongate with blunt **posterior** end and tapering **anterior** end. The abdominal venter has swellings or pads for movement of the larva.

Pupa elongate and oval.

Biological information: Tephritids are mostly fruit- and flower-feeders but some genera have been reared from the stems of wild grass species. The grass boring habit is rare in the Afro-

tropical region, being known only in the genus *Bistrispinaria*. In Busia District in Kenya, we reared *Bistrispinaria magniceps* (Bezzi) from *Panicum maximum* and *Bistripinaria fortis* (Speiser) from *Pennisetum polystachion*.

Key to the adults of *Bistrispinaria* from wild grasses in Kenya (after Hancock, 1999)

NOTE: We include three *Bistrispinaria* species in this key. Although we reared only *B. magniceps* and *B. fortis*, *Bistrispinaria woodi* was collected, though not reared, at one of our sampling sites (Suba District) in western Kenya.

1 Wing with **costal** bristles at end of both subcostal and humeral veins ..... *Bistrispinaria fortis* (Speiser) (Figure 56 a–b)

1' Wing with **costal** bristles only at end of subcostal vein, lacking **costal** bristles at end of humeral vein 2

2 Basal wing band merging with marginal band ..... *Bistrispinaria magniceps* (Bezzi)

2' Basal band isolated from other bands ..... *Bistrispinaria woodi* (Bezzi)

THE PARASITOIDS

General morphology of a parasitic Hymenoptera

(Figure 58 a–f)

Key to the parasitoids associated with stemborers

1 Forewings developed, hindwings reduced to a pair of halteres; mouthparts forming a sucking proboscis **(Diptera: Family Tachinidae)** 2

1′ Both pairs of wings present (or entirely absent); mouthparts mandibulate ..... **Hymenoptera** 6

2 Proboscis very long and slender, abruptly bent **(geniculate)** 3

2′ Proboscis short, not elongate and **geniculate** 4

3 Terminal segment of proboscis distinctly shorter than the **penultimate** segment; dorsum of abdomen with a grey **longitudinal** band, tip of abdomen black ..... *Siphona* sp. A (Figure 59 a–e)

3′ Terminal segment of proboscis longer than the **penultimate** segment; abdomen yellowish.. ..... *Siphona* sp. B (Figure 60 a–f)

4 Head strongly triangular in profile, **face** deeply excavated; **arista** prominently thickened in its entire length; humeral callus with two **setae;** four dorsocentral **setae** present; wings with brownish bands along all veins ..... *Lydella* near *sesamiae* Mesnil (Figure 61 a–g)

4′ Not entirely as above 5

5 Sternopleuron with two **setae** ..... *Descampsina sesamiae* Mesnil (Figure 62 a–e)

5′ Sternopleuron with three **setae** ..... *Leskia* sp. (Figure 63 a–g)

6 Forewing without closed cells, or wings (rarely) absent 7

6′ Forewing with closed cells 22

7 Lateral sides of pronotum reaching the **tegulae**; forewings with or without stigmal vein; antenna with 8–10 **flagellomeres** 8

7′ Lateral sides of pronotum not reaching the **tegulae** at base of forewing 9

8 Forewing with stigmal and postmarginal vein; antenna with 9–10 **flagellomeres**; marginal vein thickened to form a pseudostigma; **tergite** I normal **(Family Scelionidae)** ..... *Scelio* sp. (Figure 64 a–c)

8′ Forewing without stigmal and postmarginal vein; antenna with 8 **flagellomeres;** marginal vein not thickened to form a pseudostigma; **tergite** I long, curved and extended to the thorax **(Family Platygasteridae)** ..... *Inostemma* sp. (Figure 65 a–c)

9 **Femur** III enlarged and swollen, **ventral** margin with a tooth or row of teeth **(Family Chalcididae)** 10

9′ **Femur** III normal, not enlarged, **ventral** margin without tooth 11

10 Wings present, **gena** hairy, lightly and finely **punctate,** a **longitudinal** groove present below **ocelli; scape** long and slender, as long as **pedicel** and three **funicular** segments; mandibles slightly retracted to hidden; wings with **longitudinal** brown tinges ..... *Brachymeria kassalensis* (Kirby) (Figure 66 a–c)

10′ Wings absent. **Gena** coarsely **punctate, longitudinal** groove below eyes indistinct; **scape** slightly short and stout in **basal** one-half, length less than **pedicel** and two **funicular** segments; mandibles large, distinctly protruding below ..... *Hockeria* sp. (Figure 67 a–d)

11 **Frons** with H-shaped impressed marks; antennal **toruli** much closer to eyes than to each other; forewing without postmarginal vein, stigmal vein reduced to a short process usually arising far before mid**anterior** margin, marginal vein not elongate and venation not beyond **basal** third of wing; blade of hindwing not reaching base, modified to a linear stalk formed by the submarginal vein; tarsi 5-segmented; **petiole** short, broader than long; antenna 11-segmented with 8 **funicular** segments and unsegmented club **(Family Mymaridae)** ..... *Gonatocerus* sp. (Figure 68 a–j)

11' **Frons** without H-shaped lines; antennal **toruli** usually closer to each other than to eye; other features not as above 12

12 Legs with 4-segmented tarsi **(Family Eulophidae)** 13

12' Legs with 5-segmented tarsi 15

13 **Scutellum** with two distinctly parallel **longitudinal** grooves; mesonotum with a median groove; **propodeum** mesad of **spiracle** with an inverted Y-shaped carina; submarginal vein with one or two **dorsal** bristles; **tibial spur** on leg III very short and small ..... *Tetrastichus* sp. (Figure 69 a–c)

13' **Scutellum** without parallel **longitudinal** grooves; median groove absent from mesonotum; **propodeum** with two median carina; submarginal vein with more than three bristles; **tibial spur** noticeably long in leg III 14

14 Hind **tibial spur** reaching well beyond apex of hind tarsus; antennal **scape** 4x length of its greatest width; eyes with indistinct hairs; **ocelli** forming a distinctly acute triangle; frontoclypeus about 2x **dorsal** breadth of eyes; **scutellum** strongly elongate-reticulate laterally, median band of moderate width distinctly finely reticulate; **spiracle** elongate-oval; head dark blue green to blackish blue ..... *Pediobius homoeus* (Waterston) (Figure 70 a–c)

14' Hind **tibial spur** hardly reaching the apex of hind tarsus; antennal **scape** distinctly curved, about 5x length of its greatest width; eyes sparsely but distinctly hairy; **ocelli** forming an obtuse triangle; frontoclypeus more than 2x **dorsal** breadth of eyes; **scutellum** with weaker uniform sculpture, narrow medially but median band glossy and smooth; **spiracle** circular; head bluish-black ..... *Pediobius furvus* (Gahan) (Figure 71 a–c)

15 Pronotum subrectangular and prominent; notaular line incomplete; body non-metallic, usually black; mesopleura large; **propodeum** sloping; median **longitudinal** groove present; **gaster** convex **(Family Eurytomidae)** 16

15' Without the above combination of characters 21

16 Forewings infuscated on and below the **stigma; petiole** distinctly long; **tergite** IV narrow; ground colour yellow ..... *Sycophila* sp. (Figure 72 a–c)

16' Forewings without brown infuscation; **petiole** short; male with five **funicular** segments; **tergite** IV the longest; ground colour mostly black 17

17 Legs uniformly yellow including **coxae** III; head, thorax and abdomen black with deep, rough punctations clothed with white hairs on the head and thorax; hairs in the **face** above the mouth distinctly converging; mesonotum with a deep notaular line; **propodeum** with a narrow median groove and light **transverse striae; funicular** segments black ..... *Eurytoma oryzivora* Delvare (Figure 73 a–c)

17' Not as above 18

18 Middle of **face** with a slightly elevated, hairless triangular plate, upper half with marginal white hairs converging towards each other; **gena** with fine reticulations; **scape** yellow; femora and **tibiae** black with yellow apices, tarsi yellow except black terminal segment ..... *Eurytoma* sp. A (Figure 74 a–c)

18' Middle of **face** without a triangular, hairless plate; **gena** usually roughly **punctate; scape** generally black; femora may be fully black and **tibiae** dark reddish-brown medially and yellow on both ends or variable 19

19 Lower **face** close to the **gena** bulging moderately, facial hairs directed downwards; mandibles reddish-brown except black teeth and base; **tibiae** medially blackish-brown to dark reddish-brown with yellow ends; antennae brownish-yellow with black **pedicel** ..... *Eurytoma* sp. B

19' Lower **face** not bulging; facial hairs converging or totally absent; mandibles black or yellow with black teeth; **tibiae** uniformly yellow or black; antennae black or dark reddish-brown with yellow **scape** 20

20 Head and thorax smooth, without white hairs or **punctation;** mesonotum without prominent lobes, fine **transverse** striations distinct; **femur** and **tibia** black ..... ?*Eurytoma* sp. C (Figure 75 a–c)

20' Head and thorax roughly punctate and with white hairs; mesonotum distinctly lobed and roughly **punctate;** legs yellow except dark brown to black outer **basal** one half of femora ... *Eurytoma* sp. D (Figure 76 a–d)

21 Wings absent. Mesopleuron convex and large without femoral groove; **coxa** II inserted at or close to hind end of mesopleuron; metanotum longer than **propodeum;** mesonotum with lateral carina; pronotum with a forked spine **(Family Eupelmidae)** ..... *Macroneura* sp. (Figure 77 a–c)

21' Wings present. Mesopleuron not large and with a femoral groove; **coxa** II not inserted close to hind end of mesopleuron; mesonotum without lateral carina; pronotum without spine **(Family Pteromalidae)** ..... *Norbanus* sp. (Figure 78 a–c)

22 Hindwing without closed cells; body elongate, dorso-**ventrally** flattened; head elongate and flat, longer than wide and directed forwards; forewing with only the **basal** and subbasal cells present **(Family Bethylidae)** ..... *Goniozus indicus* Ashmead (Figure 79 a)

22' Hindwing with closed cells; body not dorso-**ventrally** flattened; forewing with many closed cells 23

23 Forewing with only one recurrent vein **(Family Braconidae)** 24

23' Forewing with two recurrent veins **(Family Ichneumonidae)** 42

24 Second inter**cubitus** (2rs-m; Figure 58e) of the forewing absent 25

24' Second inter**cubitus** of the forewing very distinct 32

25 Notaular lines very prominent; abdominal **tergite** I very small, **anterior** and median **transverse** grooves of **gaster** very distinct, **posterior** pale or indistinct; mid**posterior** groove slightly swollen forming a small hump; occipital **carina** very prominent; middle of **scutellum** smooth and globosely elevated; antenna 21-segmented, brownish except yellow **scape, pedicel** and **funicular** segments F1 and F2; segment F1 long, as long as combined length of F2 + F3; legs yellowish-brown ..... *Triaspis* sp. (Figure 80 a–c)

25' Notaular lines absent; **tergite** I forming a distinctly squarish or subtriangular **rugose** plate; **funicular** segment F2 as long as F1; legs mostly yellow with brownish coxae 26

26 Ovipositor sheath always shorter than half the length of **tibia** III, seldom protruding beyond abdominal tip; abdominal **tergite I** narrow **anteriorly** and broad **posteriorly** ..... (Genus *Cotesia*) 27

26' **Ovipositor** sheath longer than half length of **tibia** III, prominently protruding beyond tip of abdomen; abdominal **tergite** I nearly parallel-sided ..... (Genus *Dolichogenidea*) .29

27 **Coxa** III usually light brown to brownish-yellow; **aedeagus** of male truncate at apex ..... *Cotesia flavipes* Cameron (Figure 81 a–c)

27' **Coxa** III usually black or dark reddish-brown; **aedeagus** of male rounded at apex 28

28 **Coxa** III black; rough area in **tergite** II wide, not distinctly raised ..... *Cotesia sesamiae* Cameron (Figure 82 a–c)

28' **Coxa** III brownish-red; rough area in **tergite** II narrow and distinctly elevated ..... *Cotesia* near *sesamiae* Cameron (Figure 83 a–c)

29 **Tarsus** III black; ventrolateral segments II–V of abdomen yellow 30

29' **Tarsus** III yellow; ventrolateral segments II–V of abdomen dark brown to black 31

30 **Apical** one-fifth of **tibia** III reddish-brown; **scutellum** with very sparse punctation ..... *Dolichogenidea polaszeki* Walker (Figure 84 a–d)

30' **Apical** one-half of **tibia** III dark reddish-brown; **scutellum** smooth and shiny ..... *Dolichogenidea* sp. C (Figure 85 a–d)

31 **Coxa** III brown except yellow poster**oventral** half; middle of **propodeum** without wide groove, **anterior** two-thirds moderately rough and **punctate; tibia** III entirely yellow ..... *Dolichogenidea* sp. A (Figure 86 a–c)

31' **Coxa** III with light brown **apical** one-fifth; middle of **propodeum** with a wide groove, **anterior** lobe distinctly **punctate** ..... *Dolichogenidea* sp. B (Figure 87 a–c)

32 Abdomen forming a strong carapace, or with an inverted, canoe-like shape with at most three visible **tergites** 33

32' Abdomen not forming a carapace; with more than three visible **tergites** 34

33 Ground colour yellow, except **stigma** and lateral and **posterior** sides of **scutellum** brown; **propodeum** relatively smooth; abdomen with three visible **tergites** ..... *Phanerotoma* sp. (Figure 88 a–c)

33′ Ground colour black except a broad yellow sub**anterior transverse** band; **propodeum** rough, with squarish and circular **punctation;** abdomen without visible **transverse** lines ..... *Chelonus curvimaculatus* Cameron (Figure 89 a–b)

34 Abdominal **tergites** entirely longitudinally sculptured with fine ridges 35

34′ Abdominal **tergites** not entirely longitudinally sculptured 37

35 Tip of abdomen, latero**ventral** margins of meso- and metathorax, postero**dorsal** part of pronotum, and **anterior** part of **scutellum** black ..... *Rhaconotus* sp. A (Figure 90 a–h)

35′ Body uniformly orange-yellow 36

36 Second inter**cubitus** (2rs–m) pale; total length of antenna about as long as body ..... *Rhaconotus* sp. B (Figure 91 a–c)

36′ Second inter**cubitus** (2rs–m) distinct; antenna much longer than body ..... *Rhaconotus* sp. C (Figure 92 a–d)

37 **Femur** III with a **ventral** spine; abdominal **tergites** 2 and 3 uniformly sculptured; wings **hyaline** without bands 38

37′ **Femur** III without a **ventral** spine; **propodeum** smooth and wings with brownish-grey **longitudinal** bands and light white bands bisecting the first cubital, first discoidal and first brachial cells, or **propodeum** slightly rough with ridges and wings totally **hyaline** 40

38 Body orange-red, except pronotum, **scutellum,** most of **propodeum,** mid-dorsum of **coxa** III, **distal dorsal** part of **tibia** III and **ocellar triangle** black ..... *Habrobracon* sp. A (Figure 93 a–h)

38′ Body orange-red except blackened **ocellar triangle** and vertex 39

39 **Ocellar triangle** on a narrow black spot extending at the back of the head towards the **occiput** ..... *Habrobracon* sp. B (Figure 94 a–h)

39′ **Ocellar triangle** on a broad black band on top of the head ..... *Habrobracon* sp. C (Figure 95 a–d)

40 Body uniformly yellow to light yellowish-brown; wings **hyaline; ovipositor** about one-half body length; **propodeum** with an inverted Y-shaped median carina; **tergite** I rough with distinct lateral ridges along **anterior** one-half, converging **posteriorly** ..... *Bracon* sp. (Figure 96 a–d)

40′ Body orange to light orange-red, wings with grey-brown **longitudinal** bands; antenna and **ovipositor** very long, the latter distinctly longer than abdomen; **propodeum** smooth and shining; **tergite** I without elevated ridges laterally 41

41 Wings dark brown with the **proximal** half of **stigma** yellow and a narrow **longitudinal** whitish band bisecting the middle of first cubital cell and the recurrent vein; **ocellar triangle** on a narrow black spot; **tergite** I elevated with smooth lateral margins and strongly rounded **anterior** end; **scape** black; body length 7.5–11 mm ..... *Stenobracon rufus* Szepligèti (Figure 97 a–c)

41′ Wings with brown tinge as above except for a broader light white shade in the first cubital and outer half of first discoidal; **ocellar triangle** on a large black spot; **tergite** I not strongly raised, lateral margins heavily **punctate** and with a nearly truncated **anterior** end; **scape** mostly yellow; body length 7.5 mm ..... *Stenobracon* sp. (Figure 98 a–h)

42 Tip of forewing with a brown tinge, **areolet** distinctly stalked; submetapleural **carina** forming a strong lobe right behind the middle **coxa; propodeum** smooth without **longitudinal** carina; **tergite** I about twice as long as wide; subgenital plate of female conspicuously large when viewed laterally; body generally reddish-brown except black lower portion of mesopleuron, **coxae** II and III and **femur** III ..... *Syzeuctus* sp. (Figure 99 a)

42′ Forewing **hyaline** without any brown markings; other characters not as above 43

43 **Femur** III with a large **ventral** spine and other minute spines subposteroventrally 44

43' **Femur** III without **ventral** spine 47

44 **Area superiomedia** narrowing **posteriorly** with lateral ridges fading, forming an opened and striated **posterior** end; **propodeum** dark brown in **apical** one-third, reddish-brown medially and yellow **posterior** tip; mesonotum with fine **transverse striae** becoming circular medially and rough **posteriorly**; abdomen dark reddish-brown .... *Pristomerus bullis* Fitton (Figure 100 a–d)

44' **Area superiomedia** closed **posteriorly**; **propodeum** entirely black or with combinations of yellow and black; mesonotum relatively rough 45

45 **Propodeum** black **anteriorly**, lateral sides and **posterior** one-half yellow; mesonotum with an M or W-shaped yellow band..... *Pristomerus* sp. A (Figure 101 a–d)

45' Mesonotum either with a U- or V-shaped yellow band, relatively finely **punctate,** or with a median rectangular black band; **scutellum** smooth or **punctate**..... 46

46 Mesonotum with U- or V-shaped yellow band; **propodeum** light brown; **scutellum punctate**..... *Pristomerus* sp. B (Figure 102 a–e)

46' Mesonotum without U- or V-shaped yellow band, but with antero-**medial** rectangular black band; **propodeum** black; **scutellum** smooth..... *Pristomerus* sp. C (Figure 103 a–e)

47 Antennal segments 14–18 white, 1–11 and 19–31 brown and 12–13 yellow; **tergites** V–VI black, I–IV reddish-brown, VII black along **basal** one-half and VIII yellowish-white..... ..... *Dentichasmias busseolae* Heinrich (Figure 104 a–d)

47' Antenna without white segments; **tergite** pattern entirely different 48

48 **Tergite** I prominently long and slender, 4x longer than wide at its widest point; **clypeus** not clearly separated from the **face;** vein 2Rs of **areolet** 2x longer than 1Rs; radiella, cubitella, discoidella and brachiella absent from hindwing, although radiella shows a short arm; abdomen compressed laterally, **tergites** longer than wide (Genus *Venturia*) 49

48' **Tergite** I broadly attached to the **propodeum,** as wide as long; **clypeus** distinctly separated by the frontoclypeal **suture** from the **face;** vein 2Rs of **areolet** as long as 1Rs; radiella, cubitella, discoidella and brachiella all complete in the hindwing; abdomen flattened **dorsally, tergites** as wide as long (Genus *Holcopimpla*)..... 52

49 **Coxa** I yellow; **femur** III reddish-brown; **tergite** I black, reddish-brown posterolaterally..... ..... *Venturia* sp. A (Figure 105 a–d)

49' **Coxa** I all or mostly black; **femur** III brown to blackish-brown; **tergite** I black or with reddish-brown **posterior** one-third..... 50

50 **Coxa** 1 and **tergite** I uniformly black 51

50' **Coxa** black with yellow **distal** end; **tergite** I black with reddish-brown **distal** one-third .... *Venturia* near *jordanae* Fitton (Figure 106 a–c)

51 **Femur** III and **coxae** I–III black; **area superomedia** narrow, constricted medially and roughly **punctate posteriorly**..... *Venturia* sp. B (Figure 107 a–d)

51' **Femur** III brown; **coxa** I black, II and III black with yellow **apical** ends; **area superomedia** wide with lateral ridges parallel to each other at midpoint, widening below, forming parallel ridges again **posteriorly**, and covered with white silvery hairs..... ..... *Venturia* sp. C (Figure 108 a–d)

52 **Areolet** trapezoidal, 2Rs 1.25x longer than 1Rs; forewing length 5.4 mm; head width: height 1.1:1.0; brachial cell 2.2x longer than wide; body length *c.* 8–10 mm..... ..... *Holcopimpla* sp. A (Figure 109 a–d)

52' **Areolet** almost triangular, 2Rs only 1.1x longer than 1Rs; forewing length 7 mm; head width: height 1.4:1.0; brachial cell 2x longer than wide; body length *c.* 10.5 mm..... ..... *Holcopimpla concolor* (Brullé) (Figure 110 a–d)

PLATES

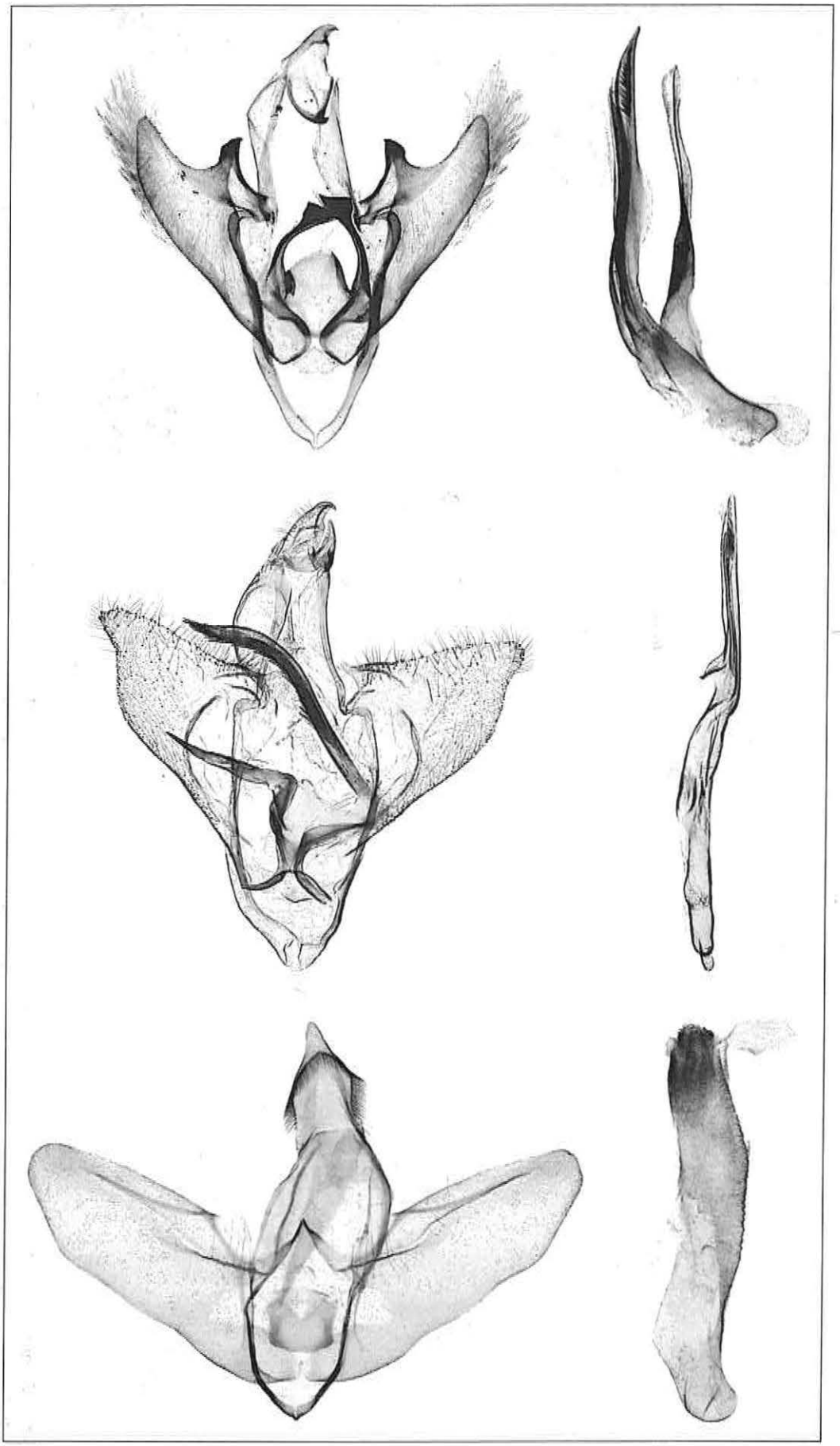

Plate 1. Male genitalia and aedeagus: Top to bottom, *Chilo partellus; C. thyrsis; Eldana saccharina*

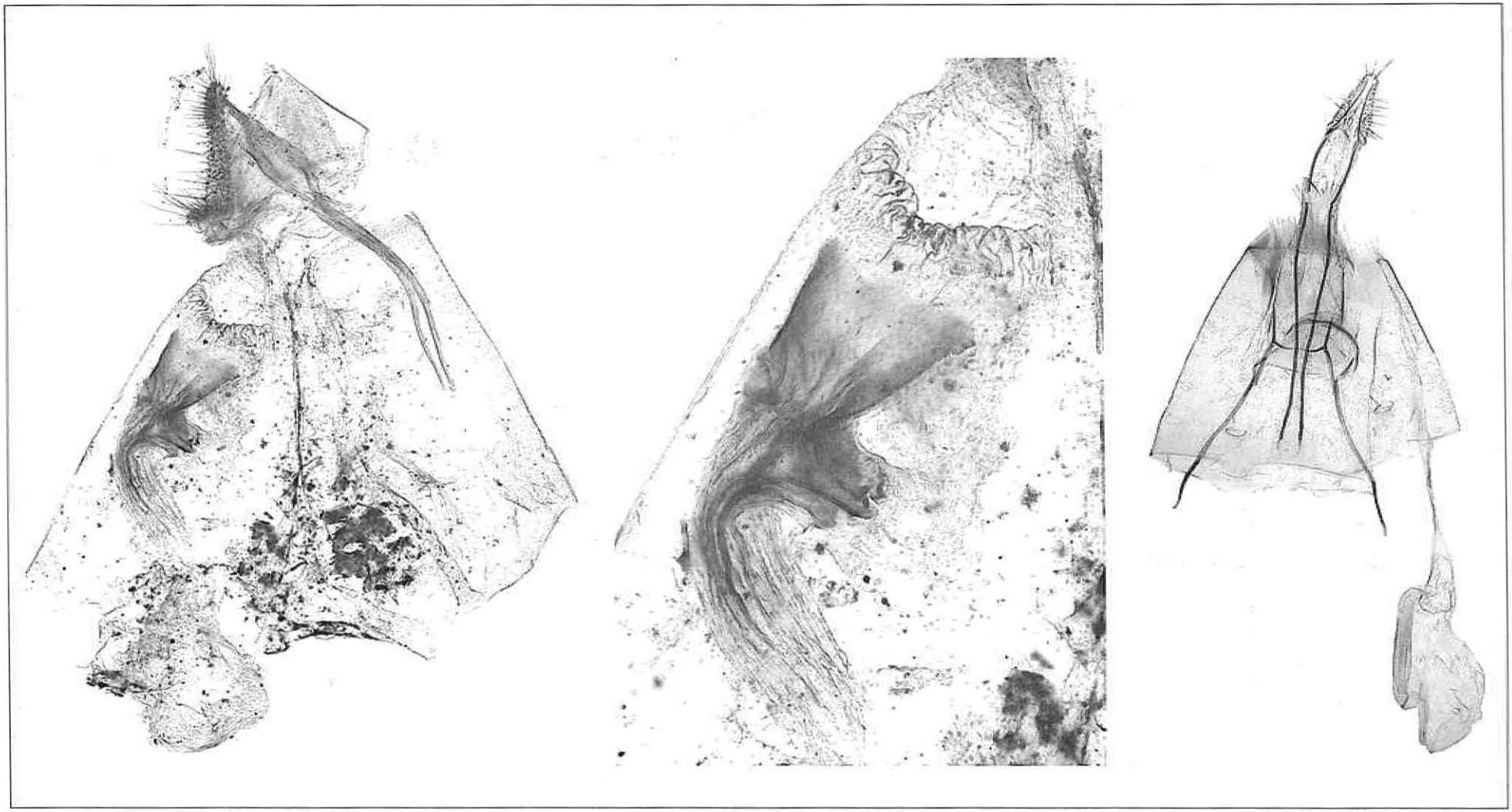

Plate 2. Female genitalia: Left to right, *Chilo incertus*; close up of *C. incertus* showing heavily sclerotised ostial pouch; *Eldana saccharina* (note pronounced appendix in corpus bursae)

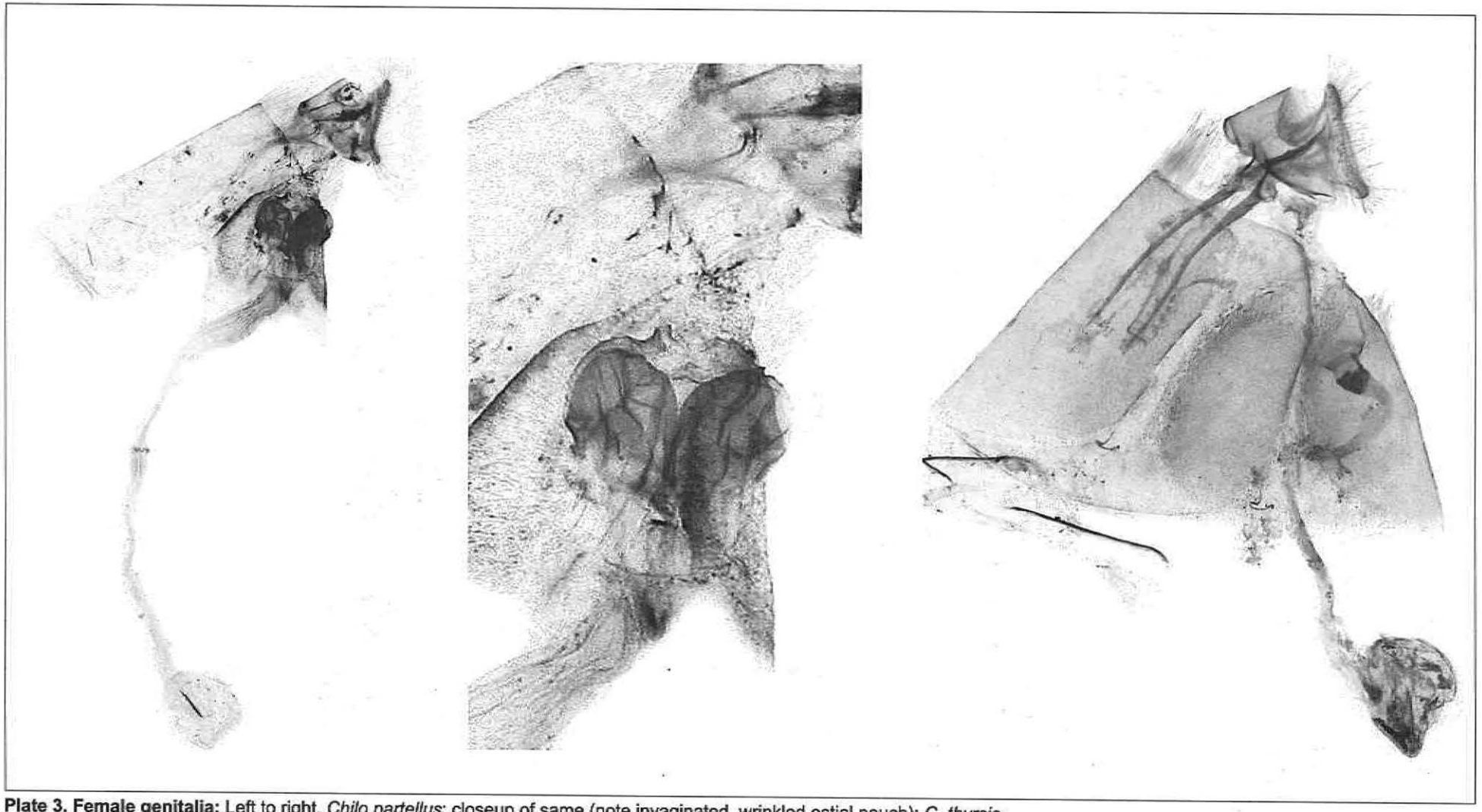

Plate 3. Female genitalia: Left to right, *Chilo partellus*; closeup of same (note invaginated, wrinkled ostial pouch); *C. thyrsis*

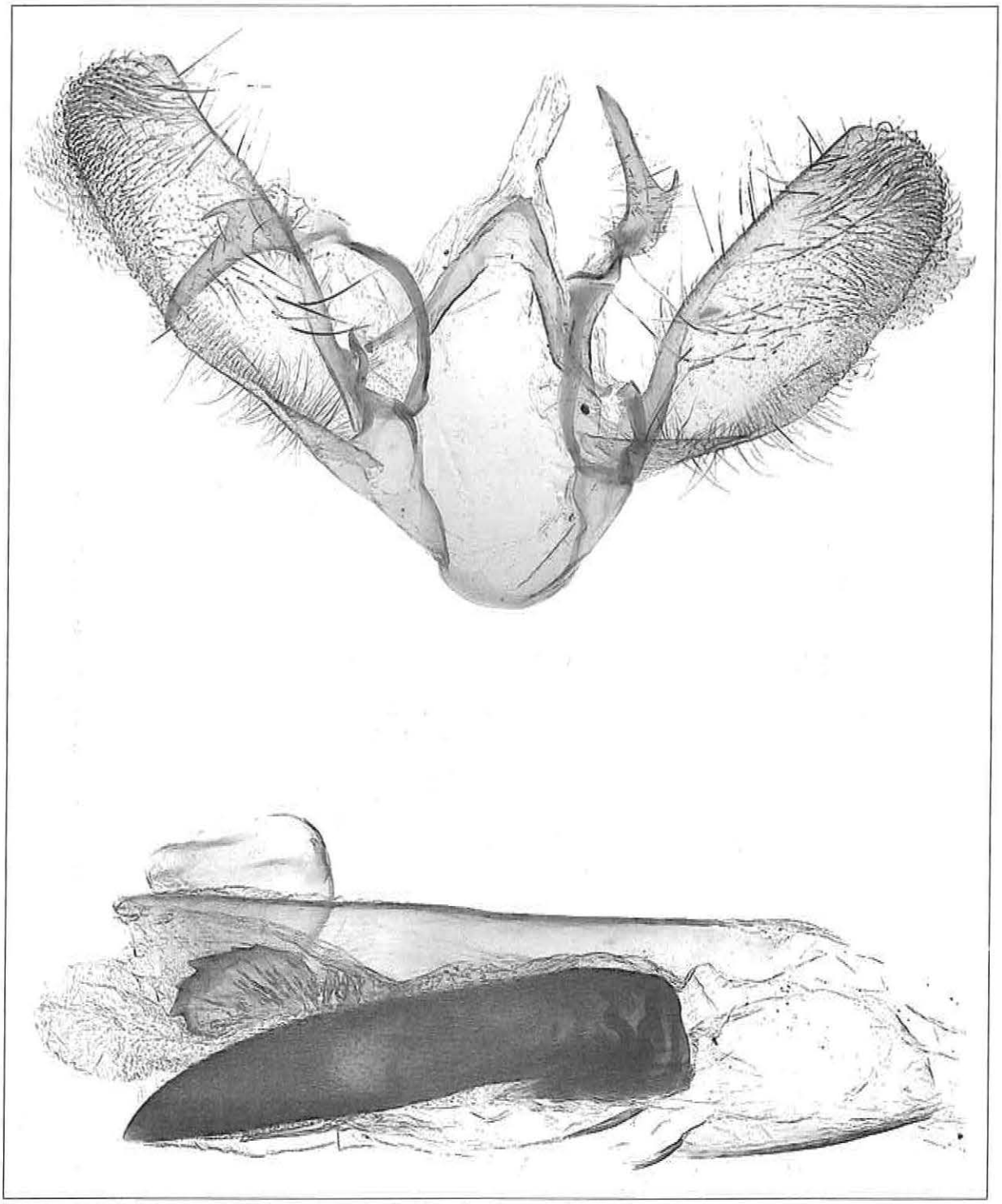

Plate 4. Peoriinae Taxon A: Male genitalia: (top) and aedeagus (bottom)

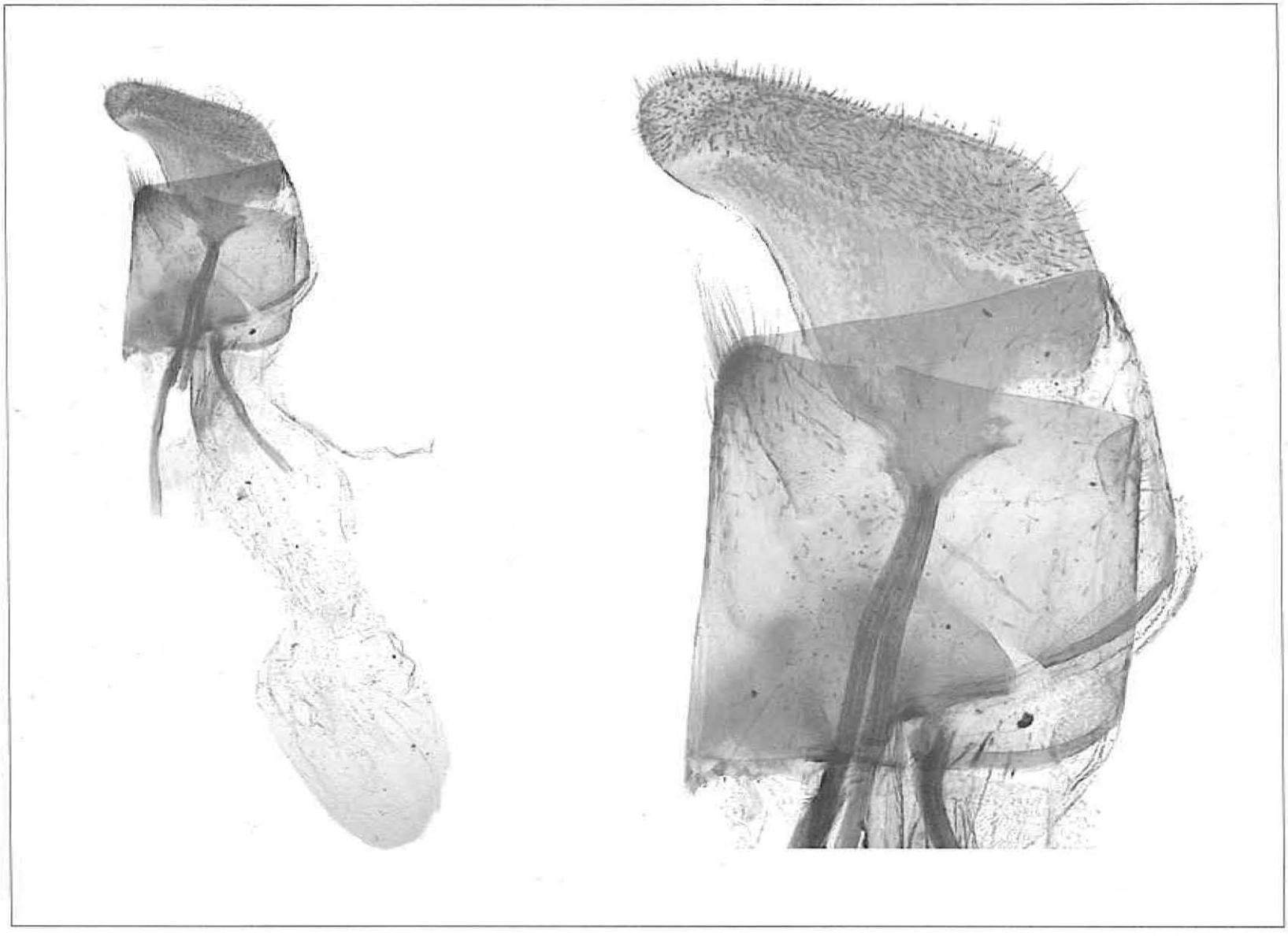

Plate 5. Peoriinae Taxon A: Female genitalia (left) with closeup of ovipositor (right)

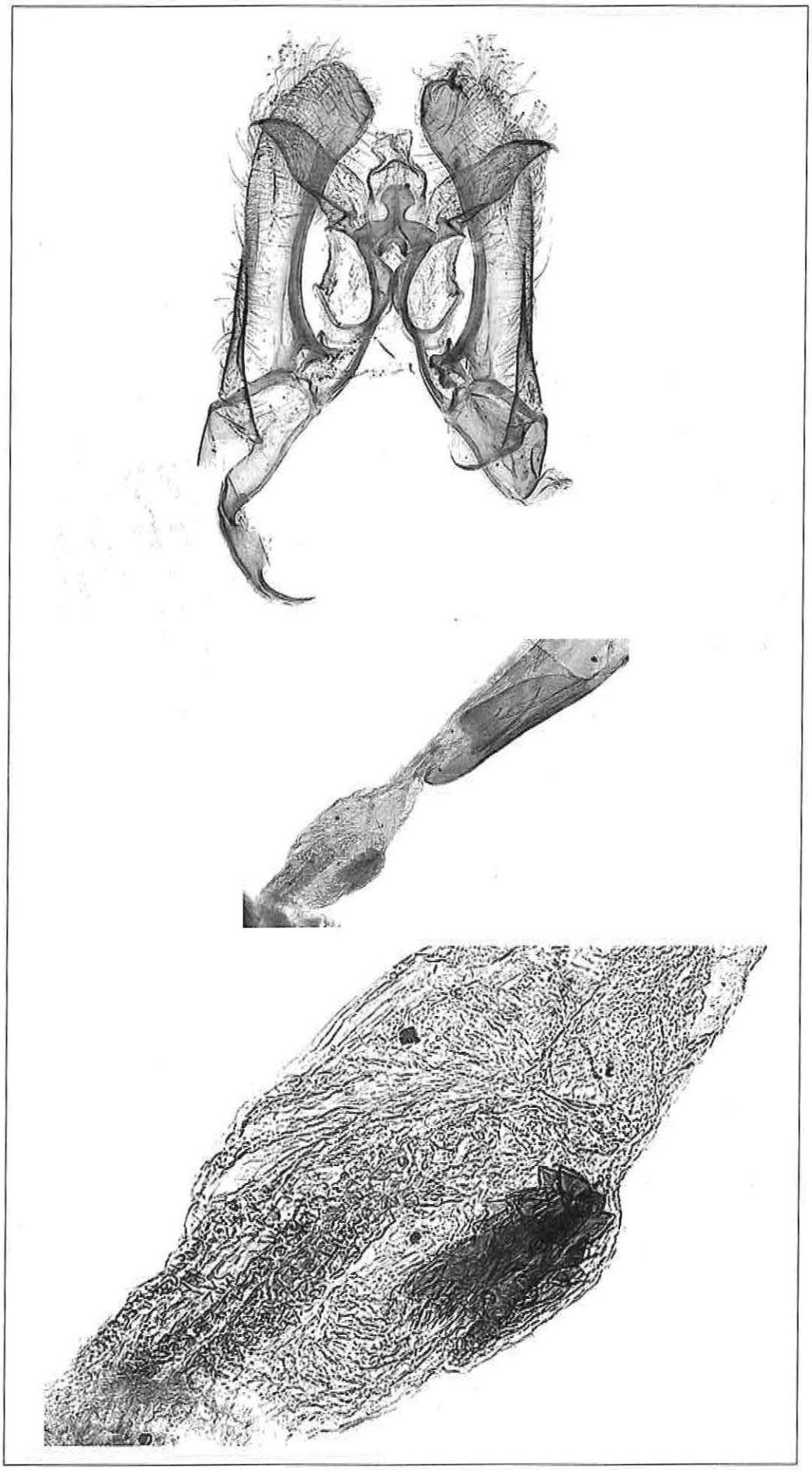

Plate 6. *Maliarpha concinnella:* Top to bottom, male genitalia; aedeagus, closeup of aedeagus showing cornutus with teeth

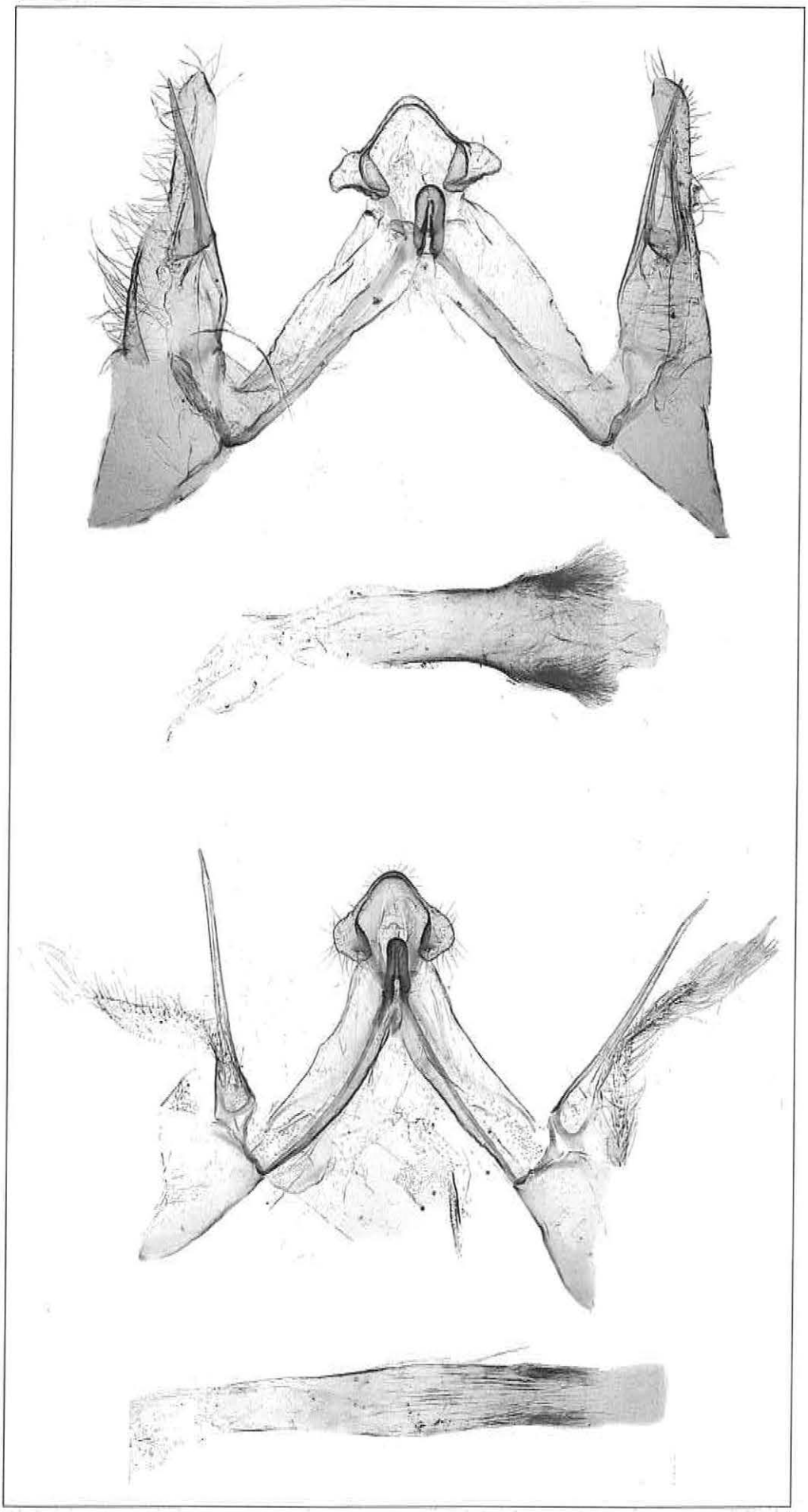

Plate 7. Male genitalia and aedeagus of *Ematheudes* species: E. sp. nov. (top); *E. straminella* (bottom)

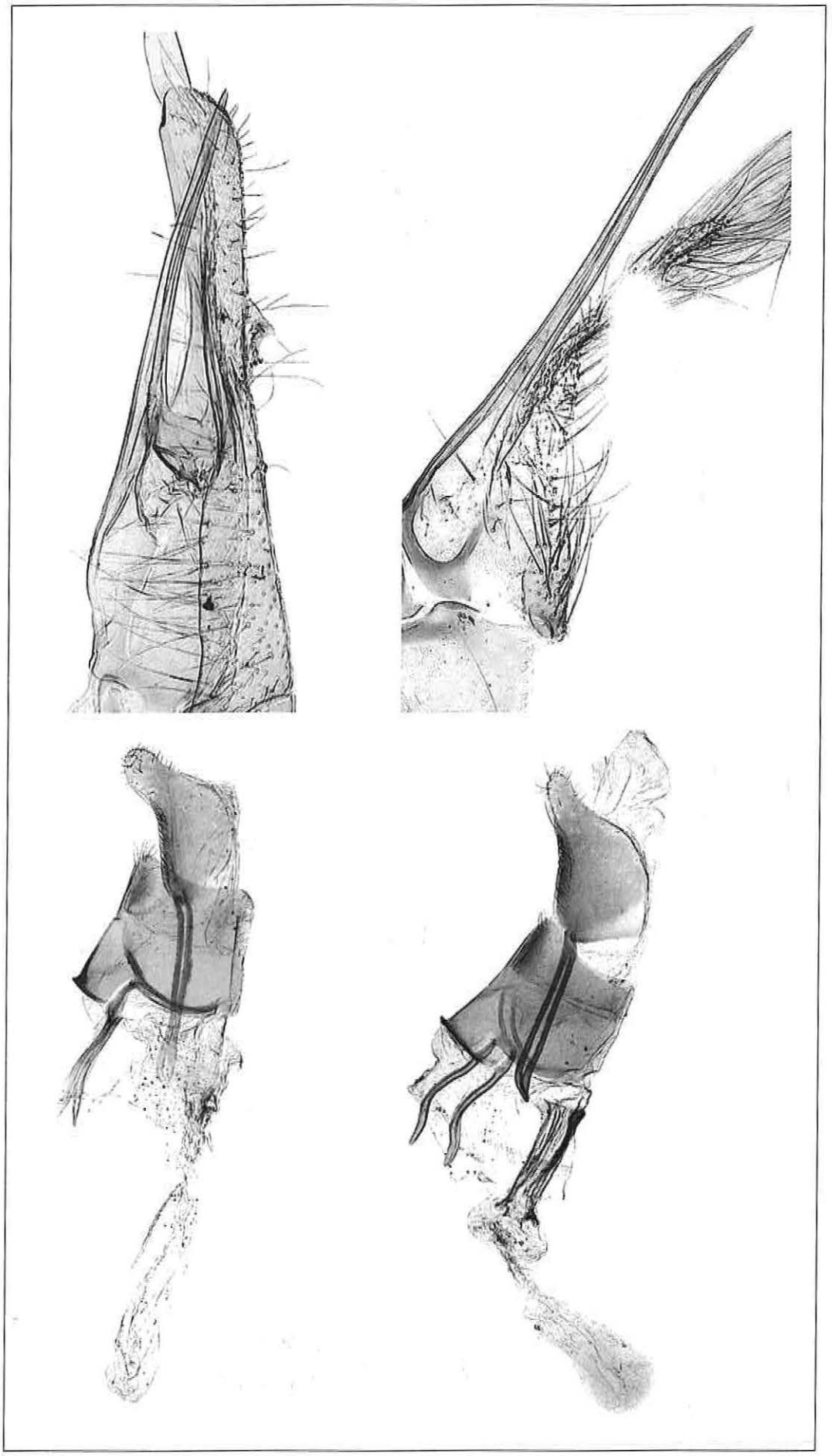

Plate 8. *Ematheudes* species: Top row, male costal spines of E. sp. nov. (left) and *E. straminella* (right); bottom row, female genitalia of E. sp. nov (left) and *E. straminella* (right)

Plate 9. Peorilinae Taxon B: Left to right, male genitalia; closeup of same showing hooked processes; aedeagus

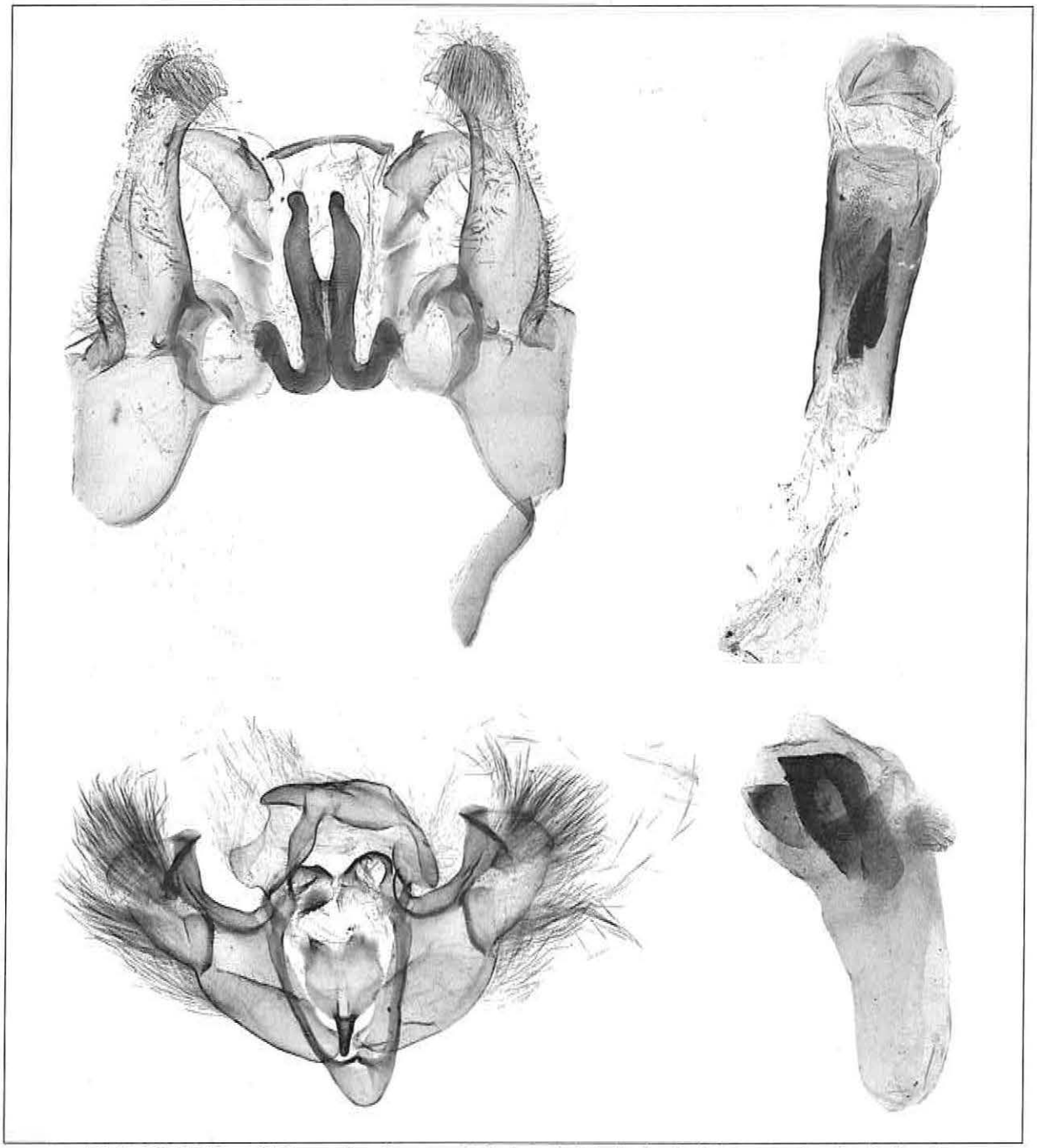

Plate 10. Male genitalia and aedeagus: *Saluria lentistrigella* (top); *Sciomesa piscator* (bottom)

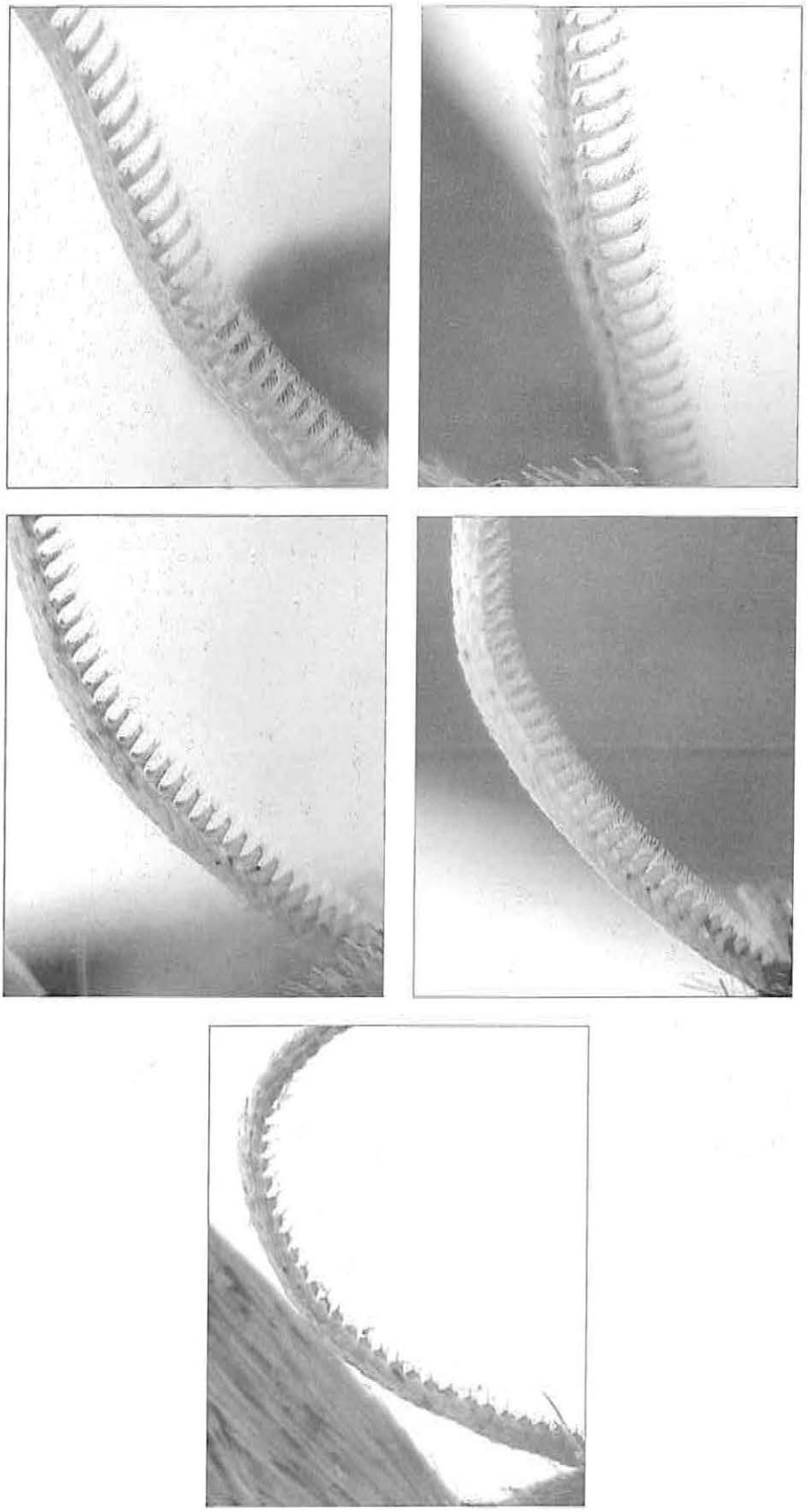

Plate 11. Male antennae of *Sesamia* species: top, left to right, *S. calamistis, S. nonagrioides botanephaga*; middle, left to right, *S. penniseti, S. poephaga*; bottom, *S.* sp. nov.

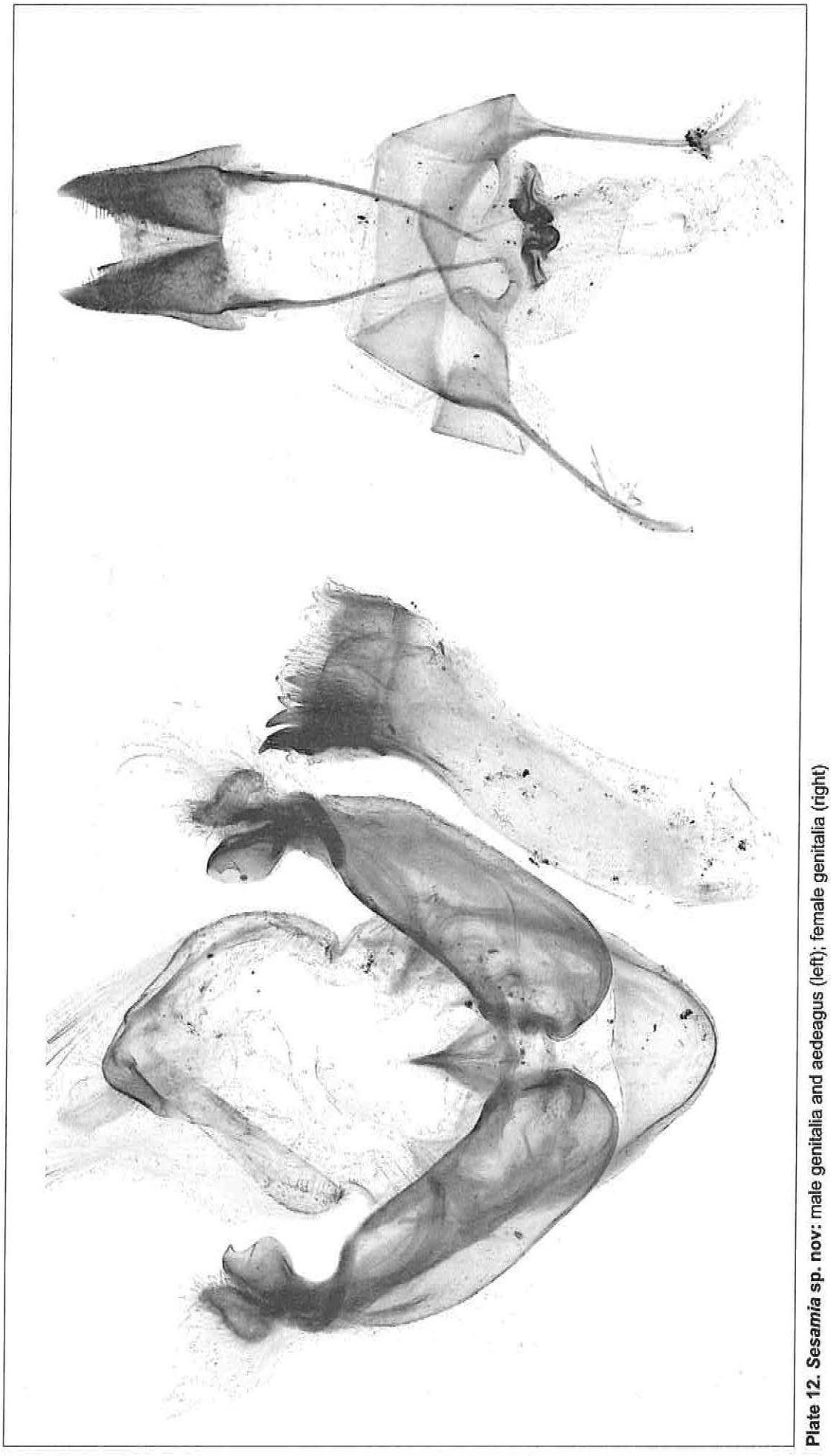

Plate 12. *Sesamia* sp. nov: male genitalia and aedeagus (left); female genitalia (right)

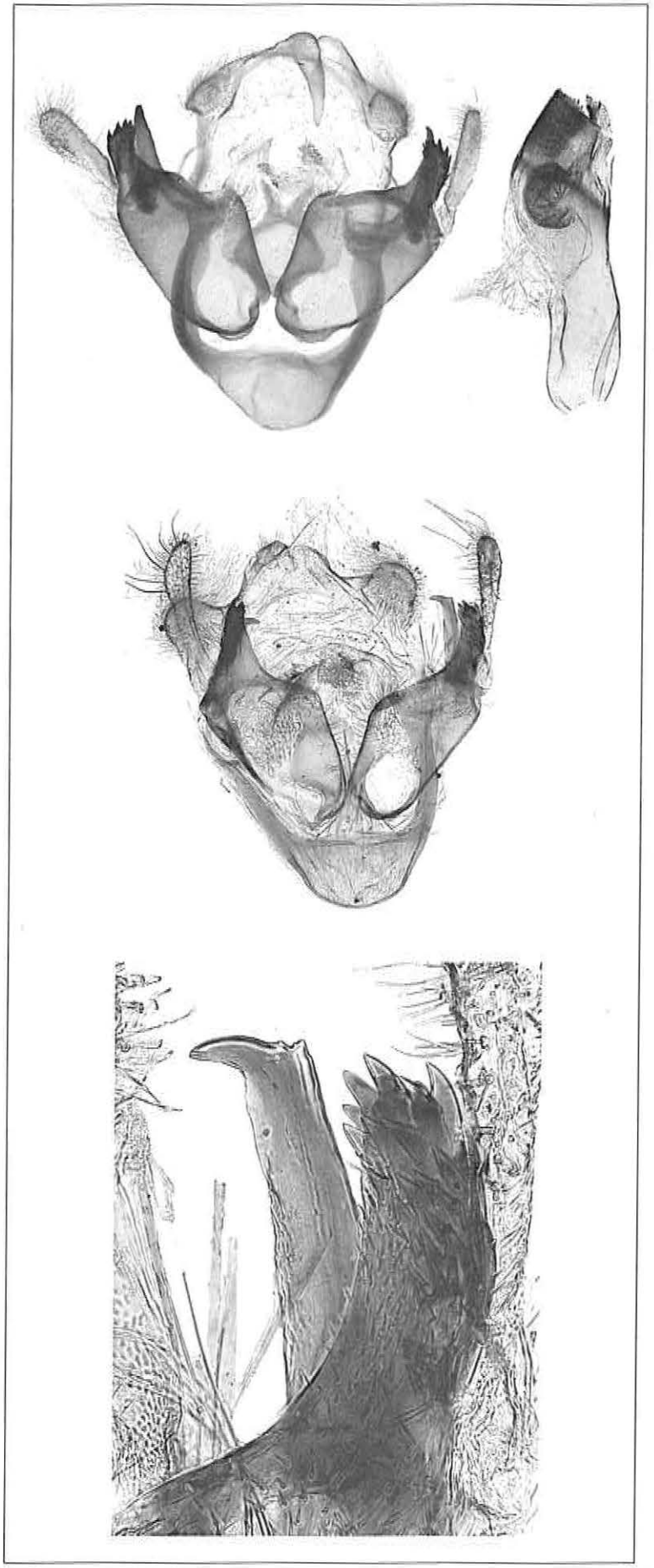

Plate 13. ***Sesamia calamistis:*** male genitalia showing centrally placed flask-shaped juxta (top left) and aedeagus (top right); male genitalia showing more common, nearly truncate variant of costal spine (centre); closeup of costal spine and robustly-toothed saccular process (bottom)

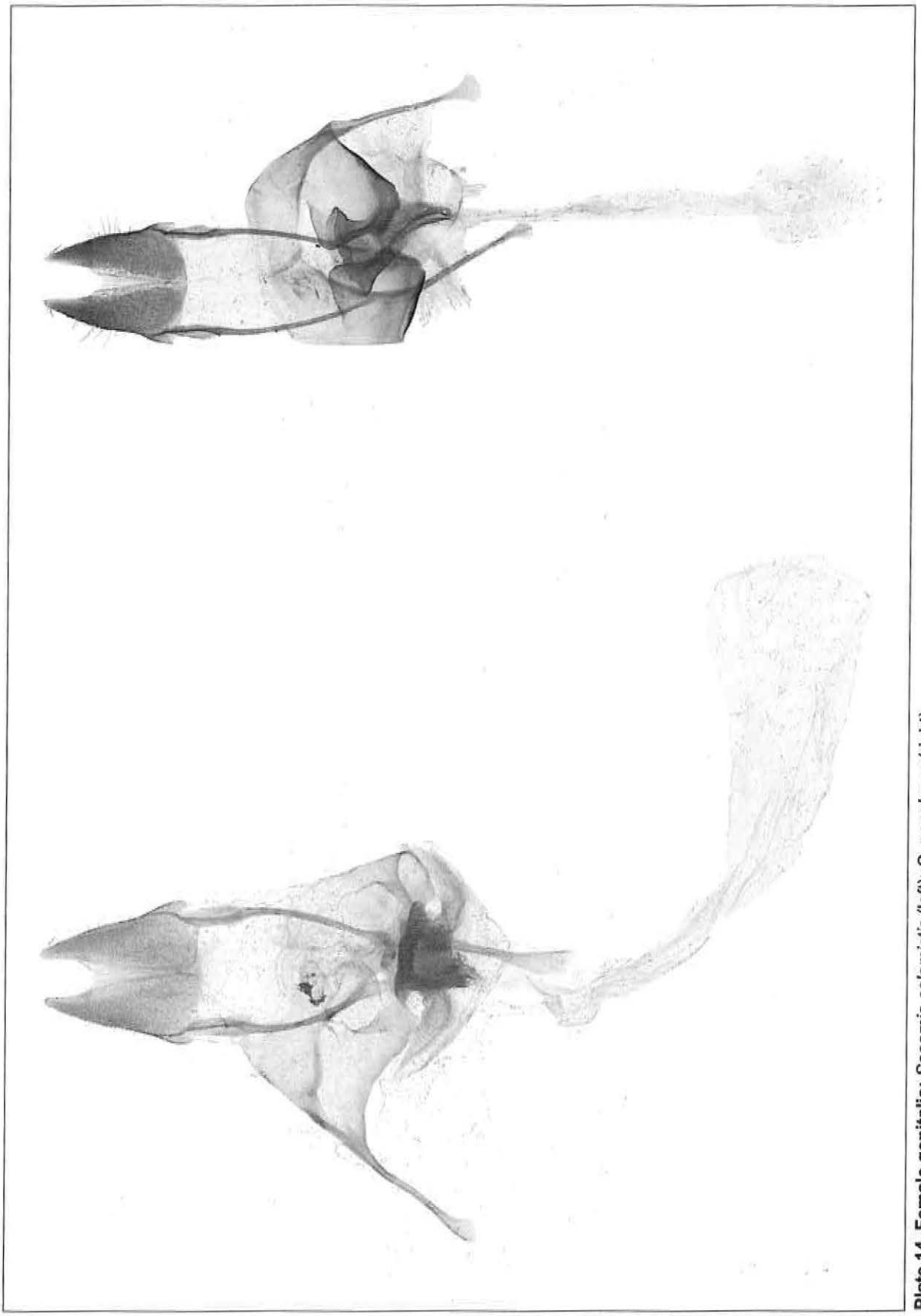

Plate 14. Female genitalia: *Sesamia calamistis* (left); *S. poephaga* (right)

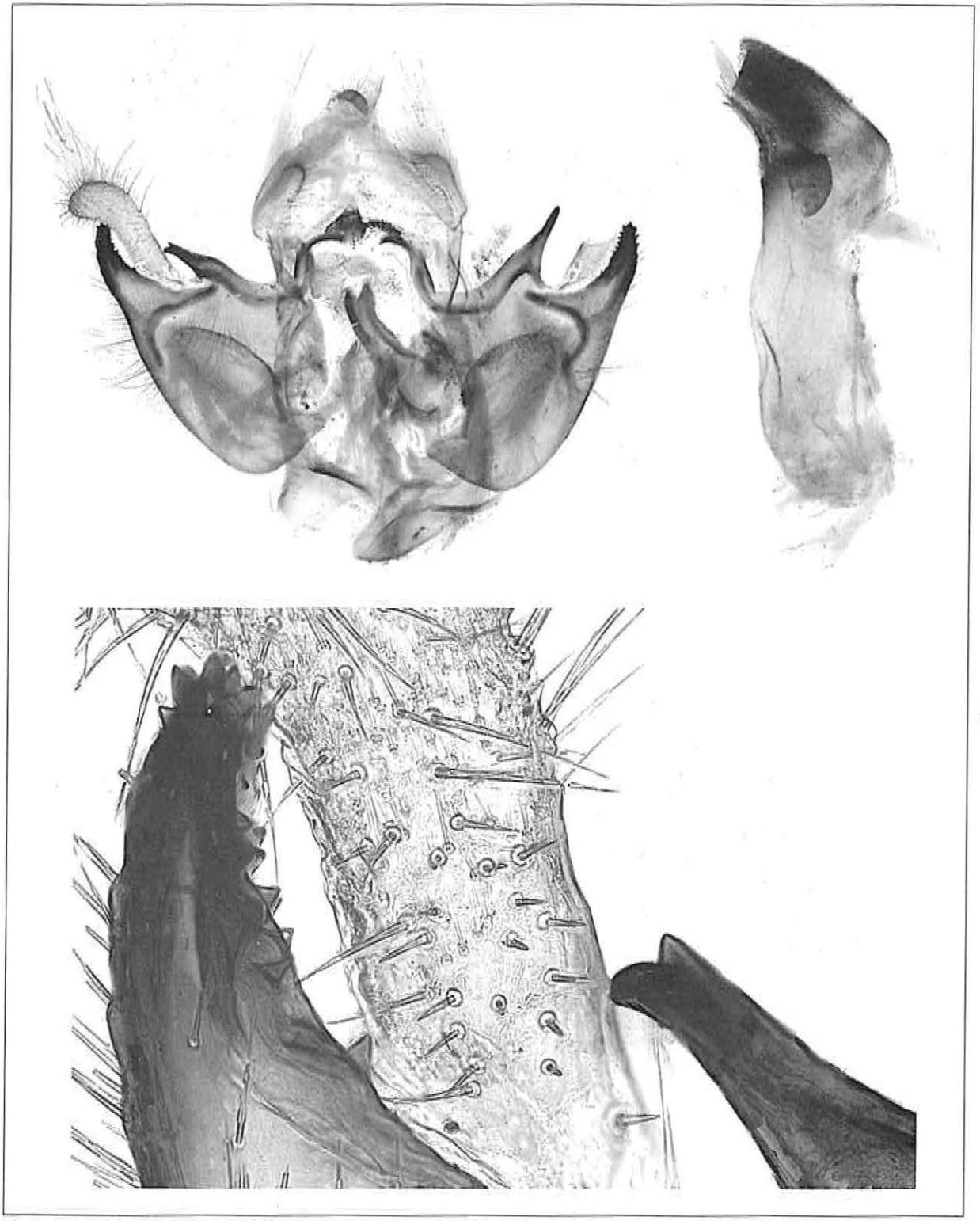

Plate 15. ***Sesamia nonagrioides botanephaga:*** male genitalia showing centrally-placed juxta with extended neck (top left); aedeagus (top right) and closeup of costal spine and moderately-toothed saccular process (bottom)

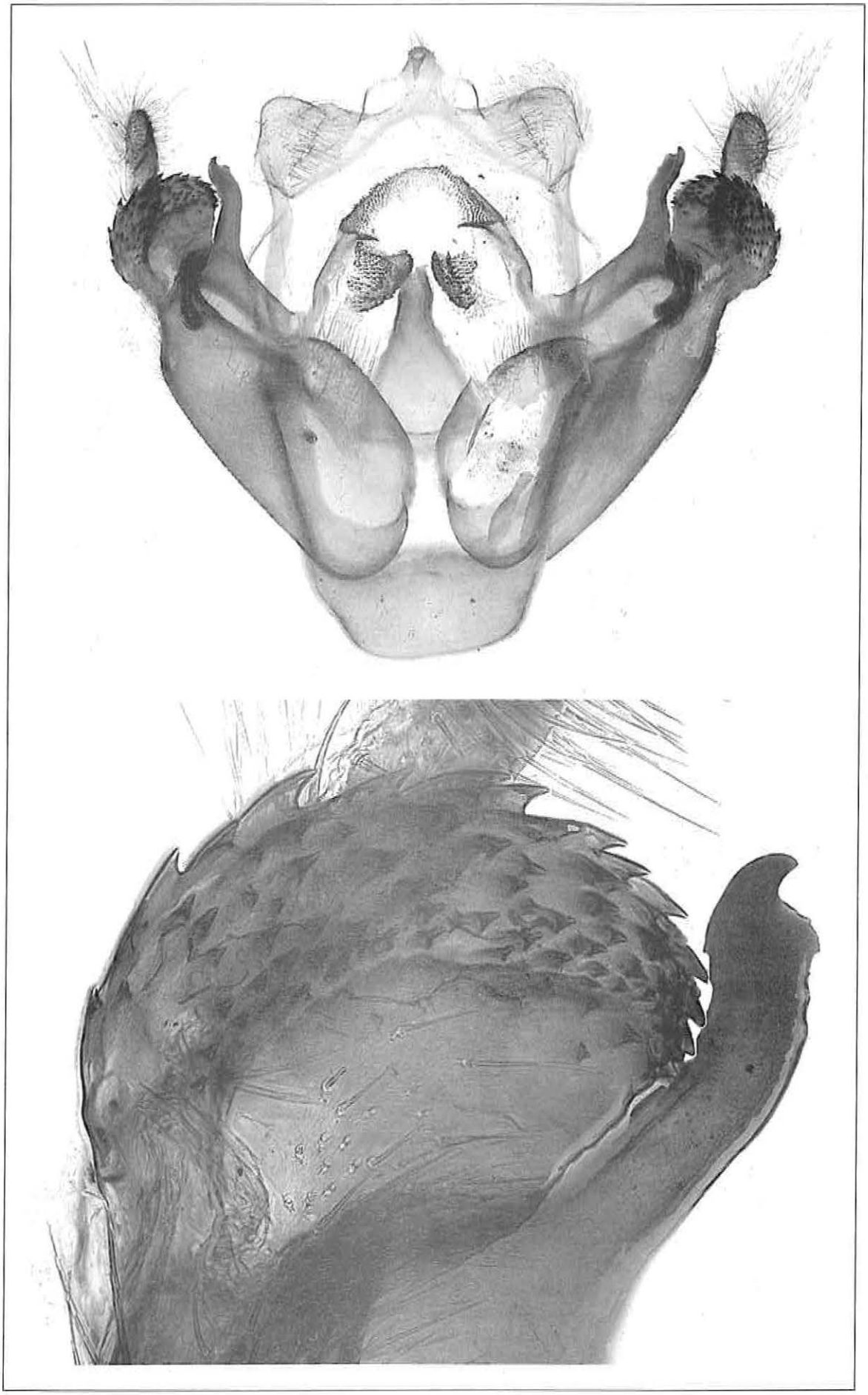

Plate 16. *Sesamia penniseti:* male genitalia (top); closeup of robustly-spined saccular process and spatulate, sharp costal spine with irregular, fine teeth (bottom)

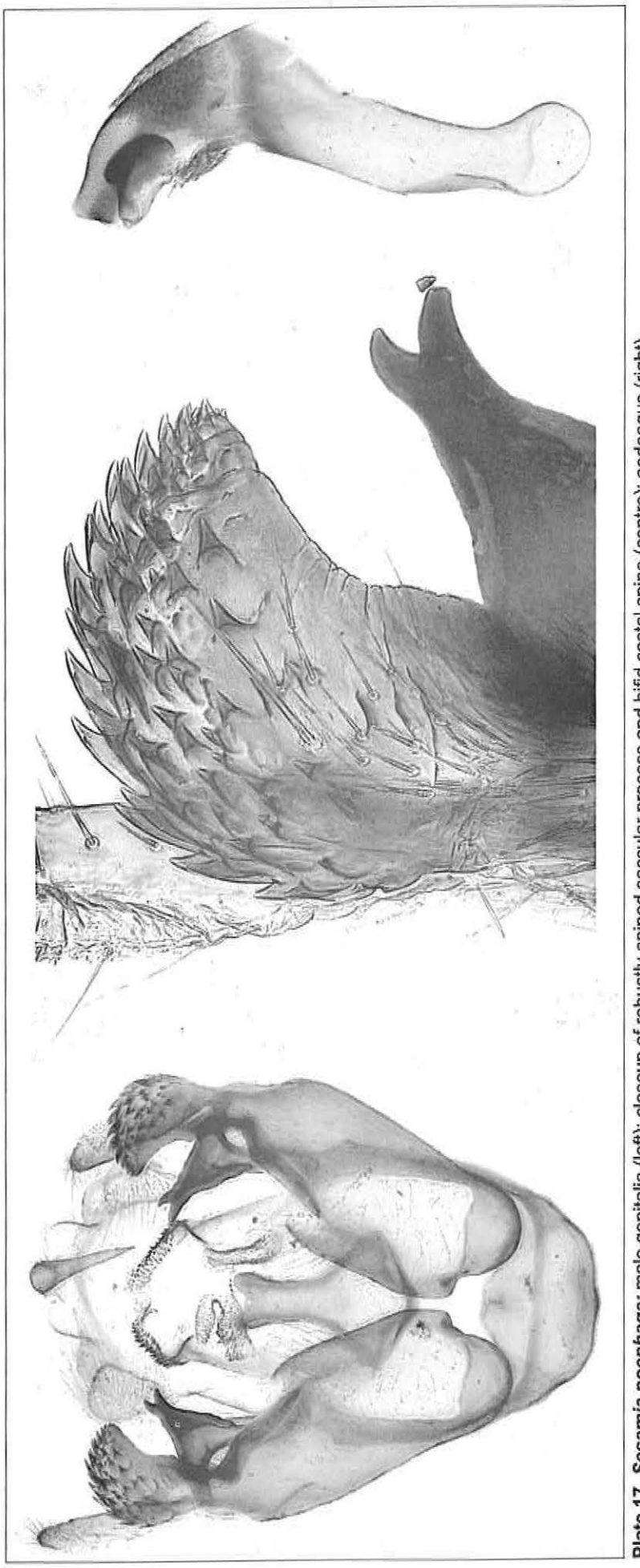

Plate 17. *Sesamia poephaga:* male genitalia (left); closeup of robustly-spined saccular process and bifid costal spine (centre); aedeagus (right)

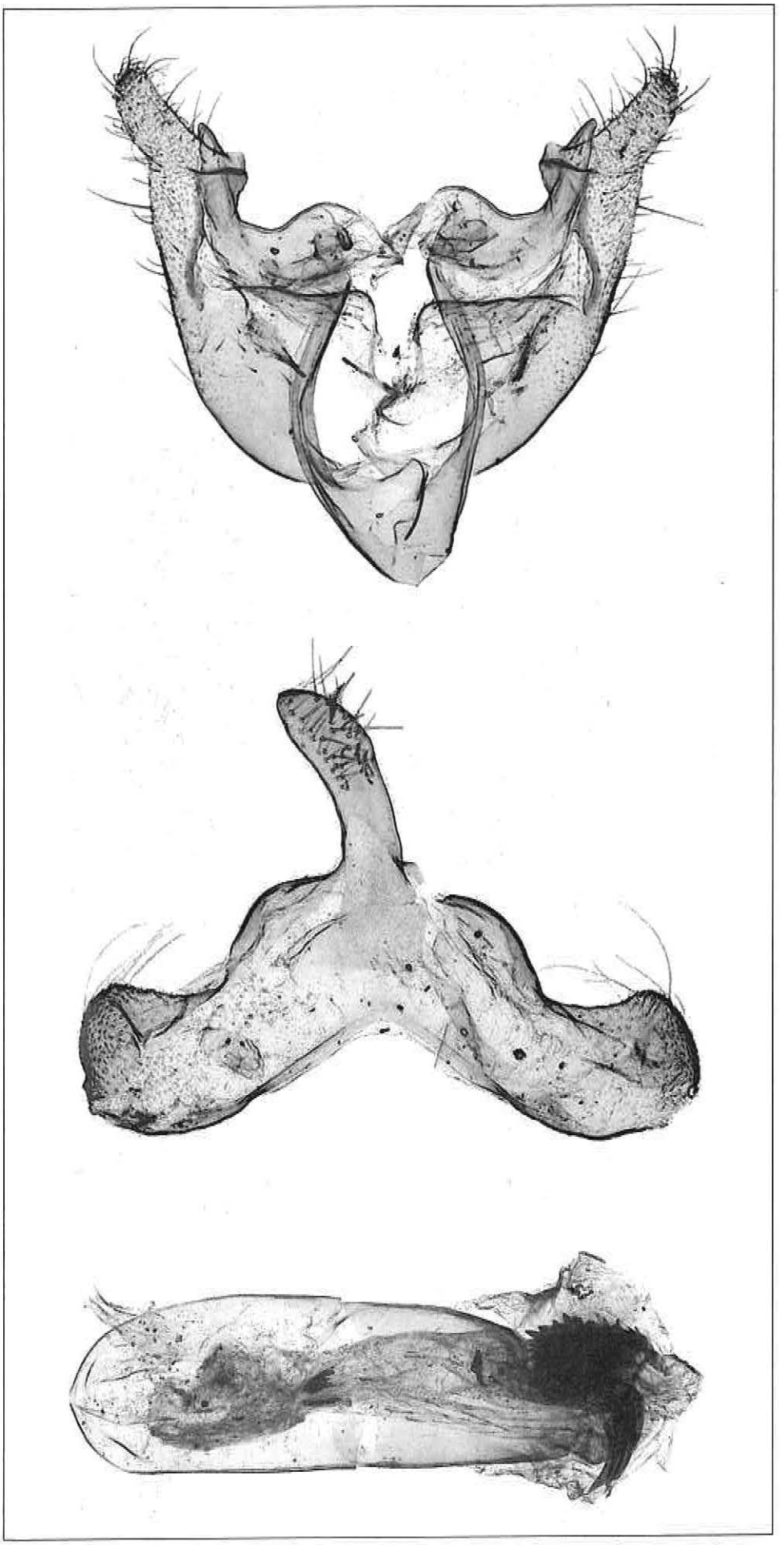

Plate 18. *Sciomesa* cf. sp. nov. top to bottom, male genitalia; closeup of uncus; aedeagus

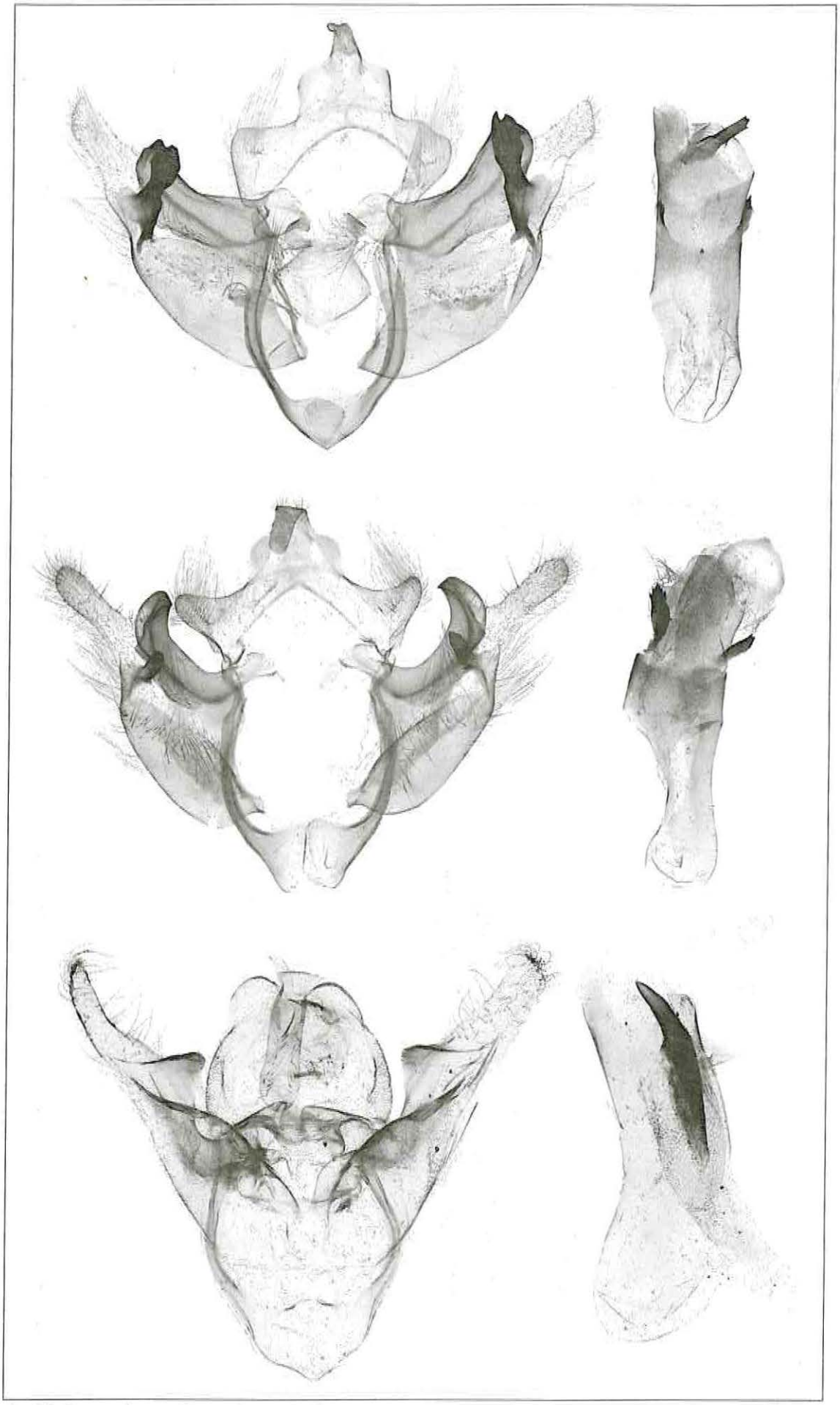

Plate 19. *Busseola* species male genitalia and aedeagus: top to bottom, *B. fusca; B. phaia; B. obliquifascia*

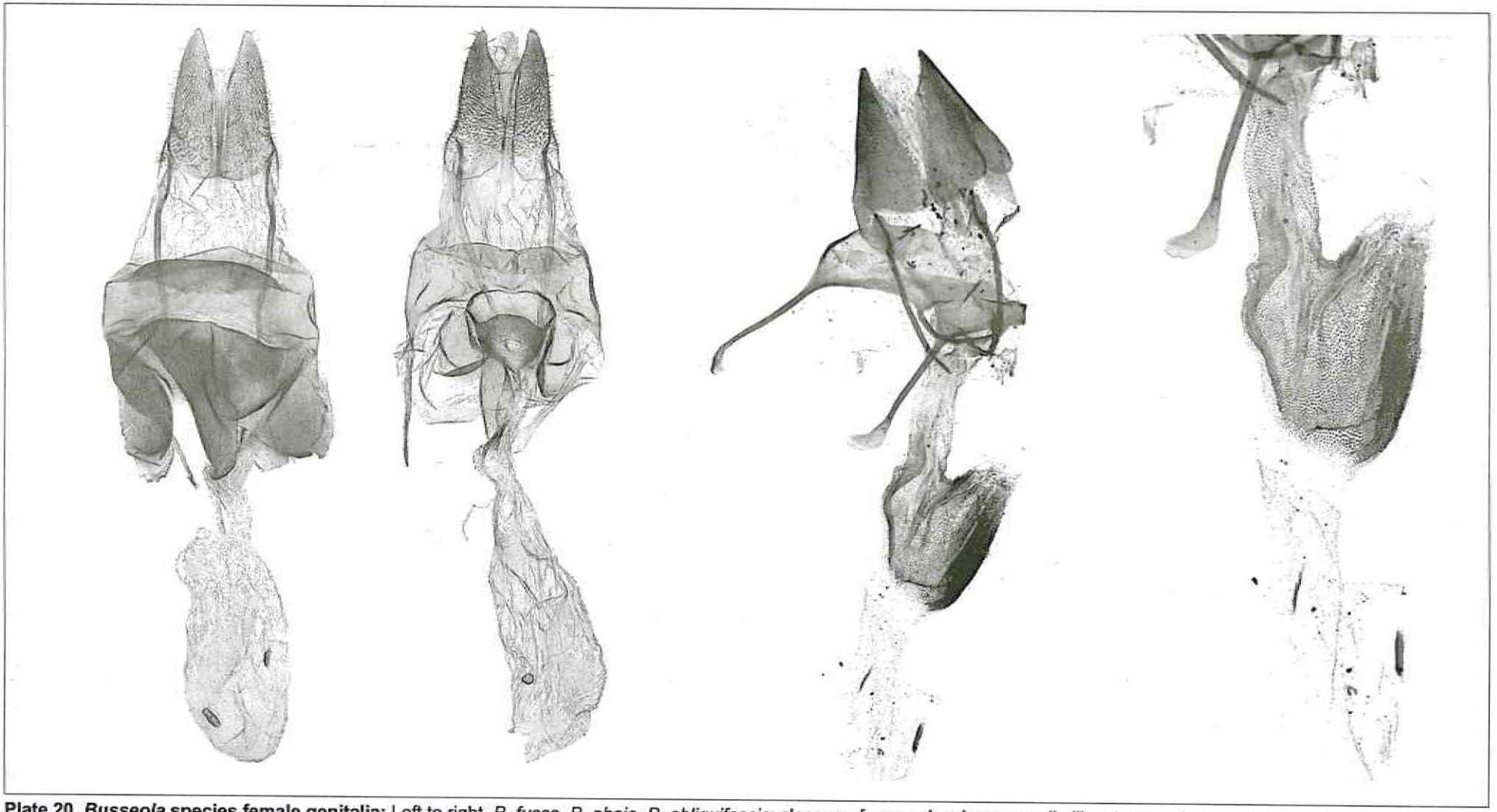

Plate 20. *Busseola* species female genitalia: Left to right, *B. fusca, B. phaia, B. obliquifascia*; closeup of same showing appendix-like structure in corpus bursae and two linear signa

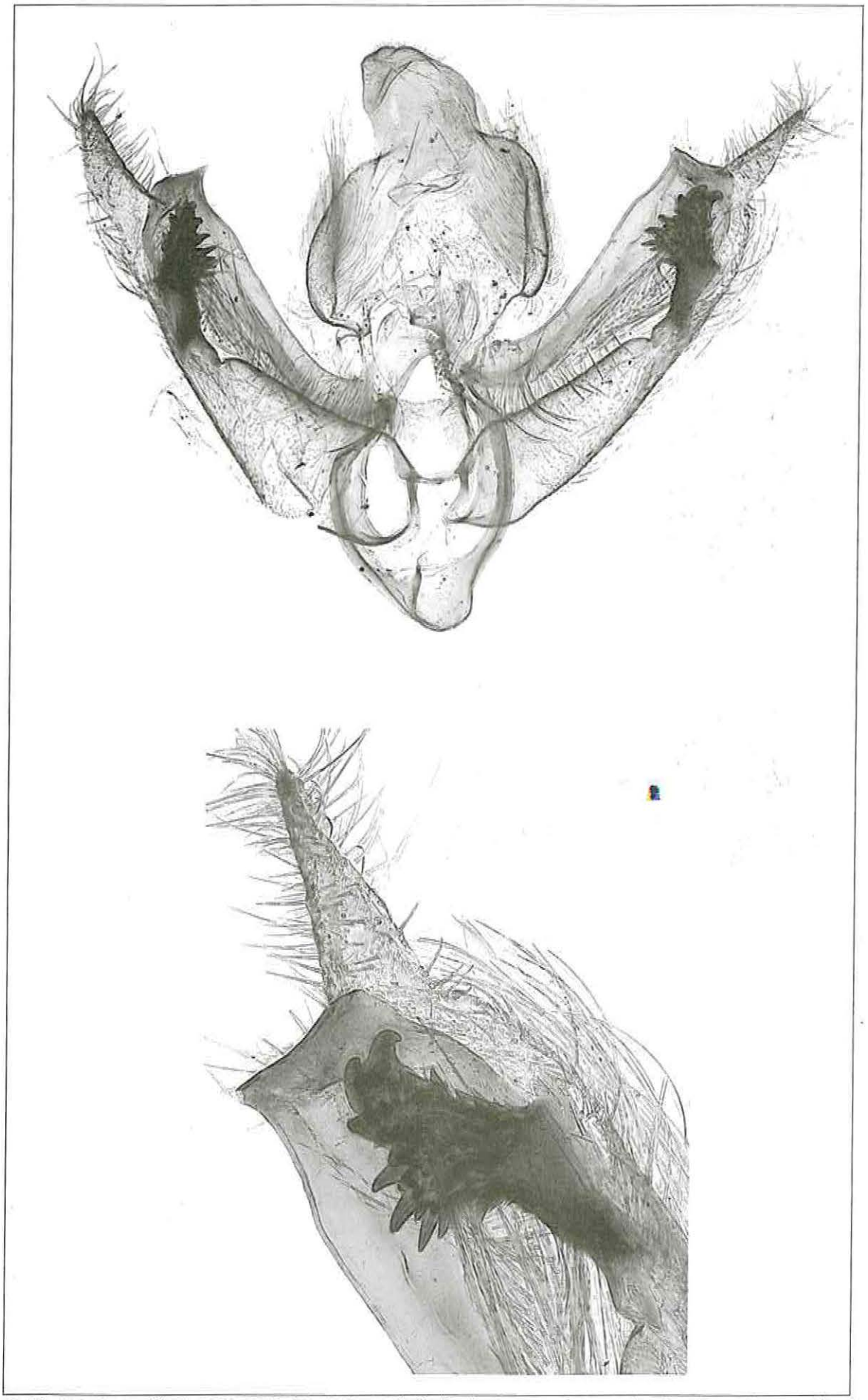

Plate 21. *Manga nubifera* male genitalia: male genitalia (top); closeup of same showing flange-like costal spine and heavily toothed saccular process (bottom)

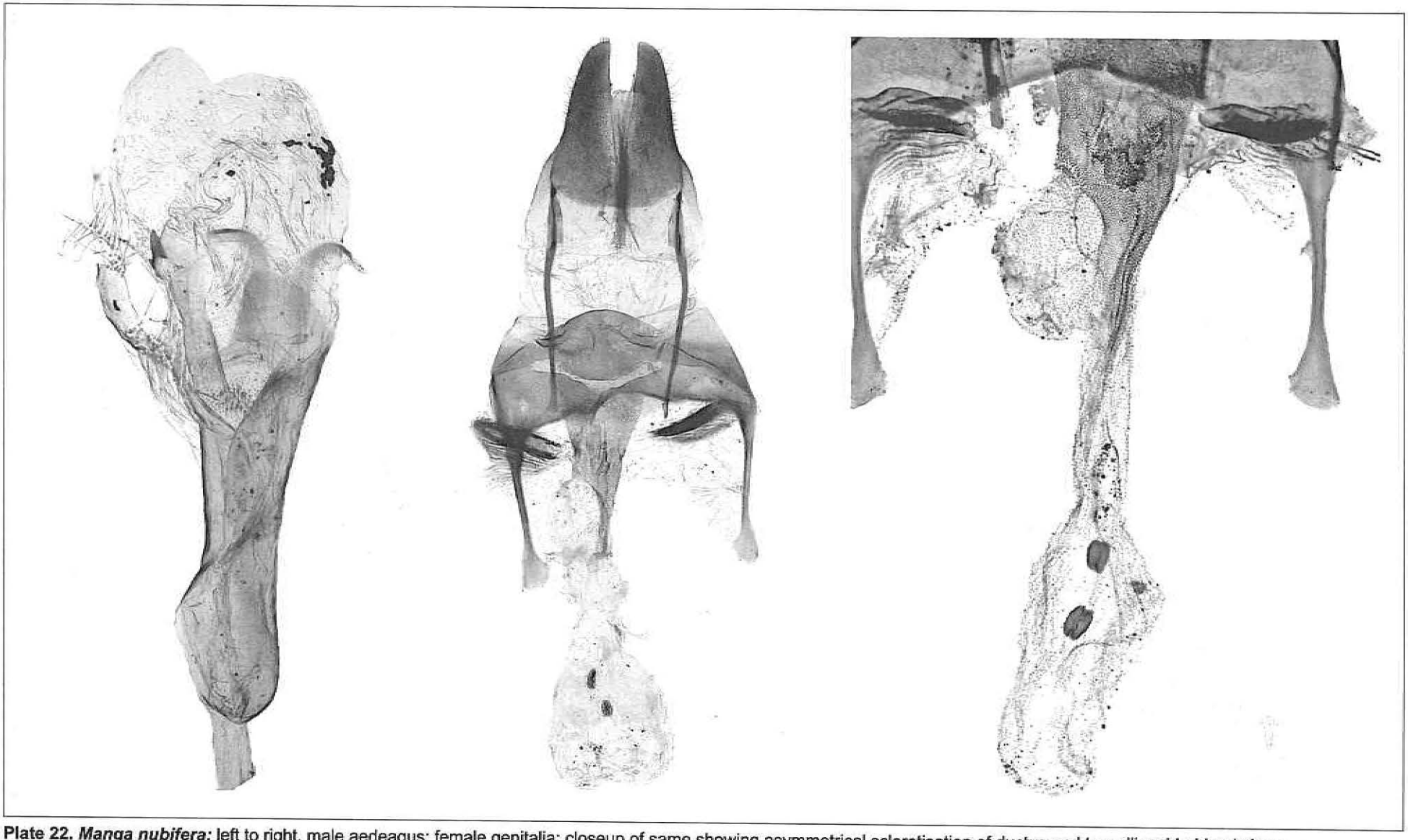

Plate 22. *Manga nubifera:* left to right, male aedeagus; female genitalia; closeup of same showing asymmetrical sclerotisation of ductus and two ellipsoid, ridged signa

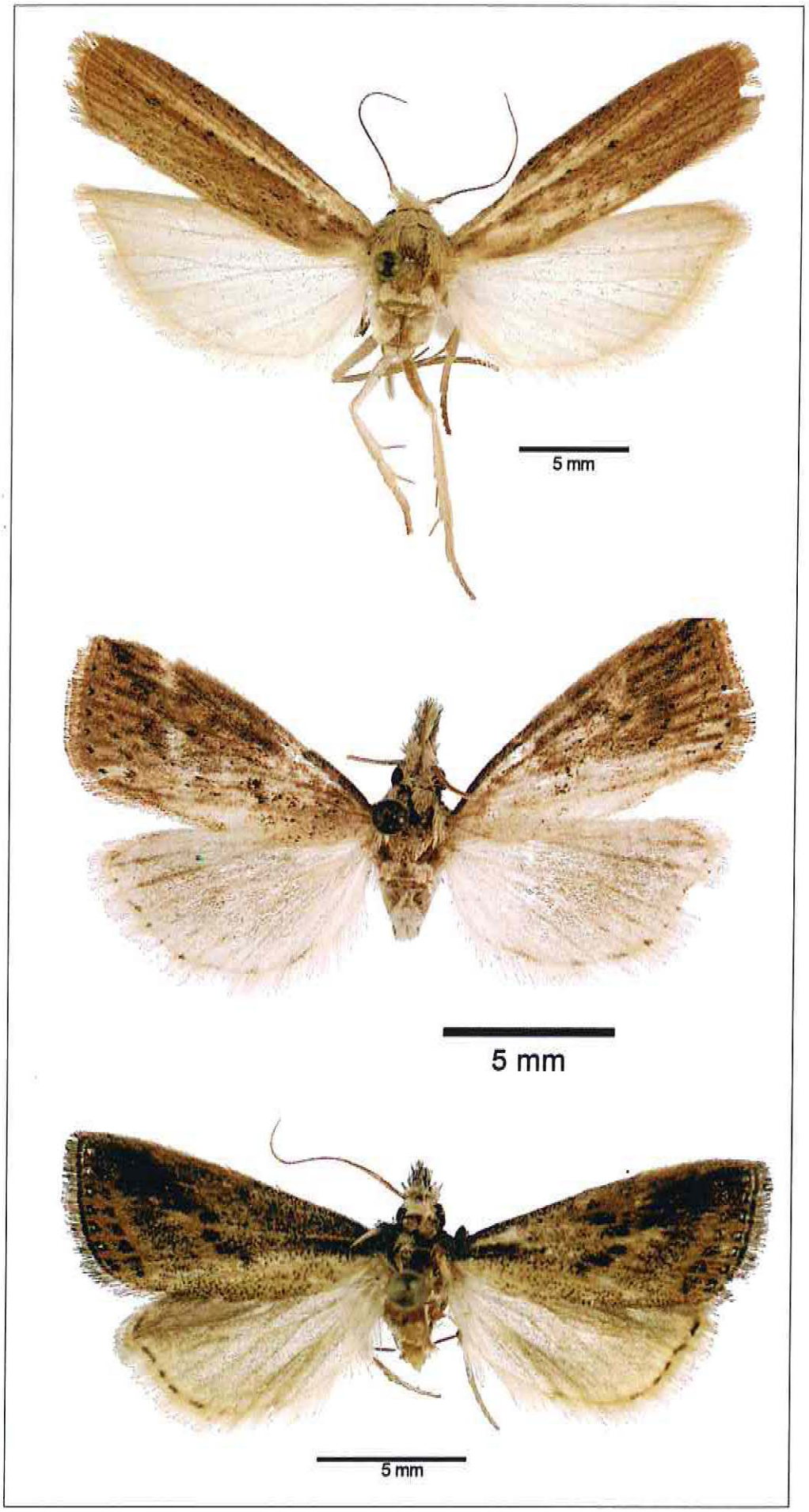

Plate 23. Adult moths: top to bottom, *Eldana saccharina; Chilo partellus; C. thyrsis*

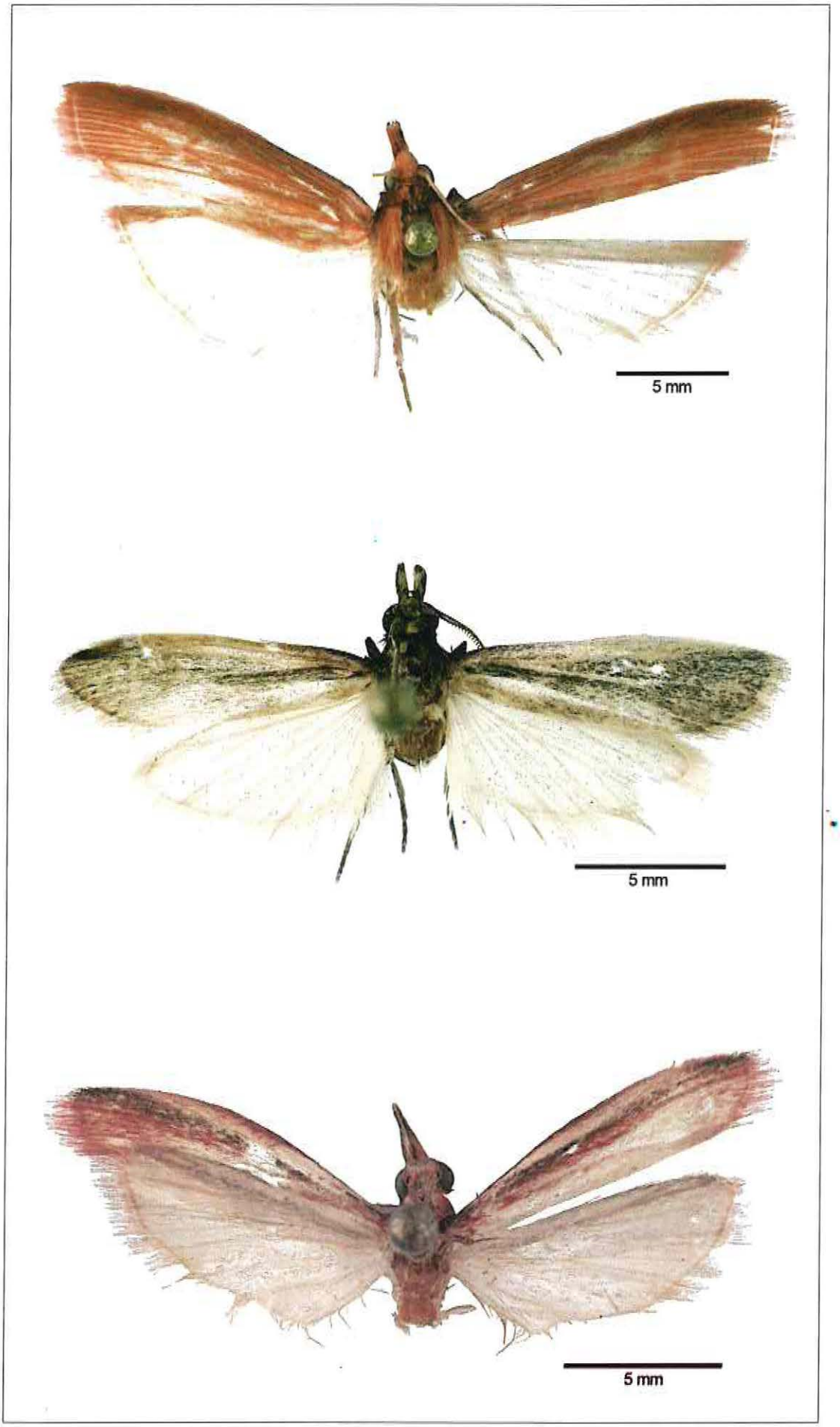

Plate 24. Adult moths: top to bottom, Peoriinae taxon A; Peoriinae taxon B; *Maliarpha concinnella*

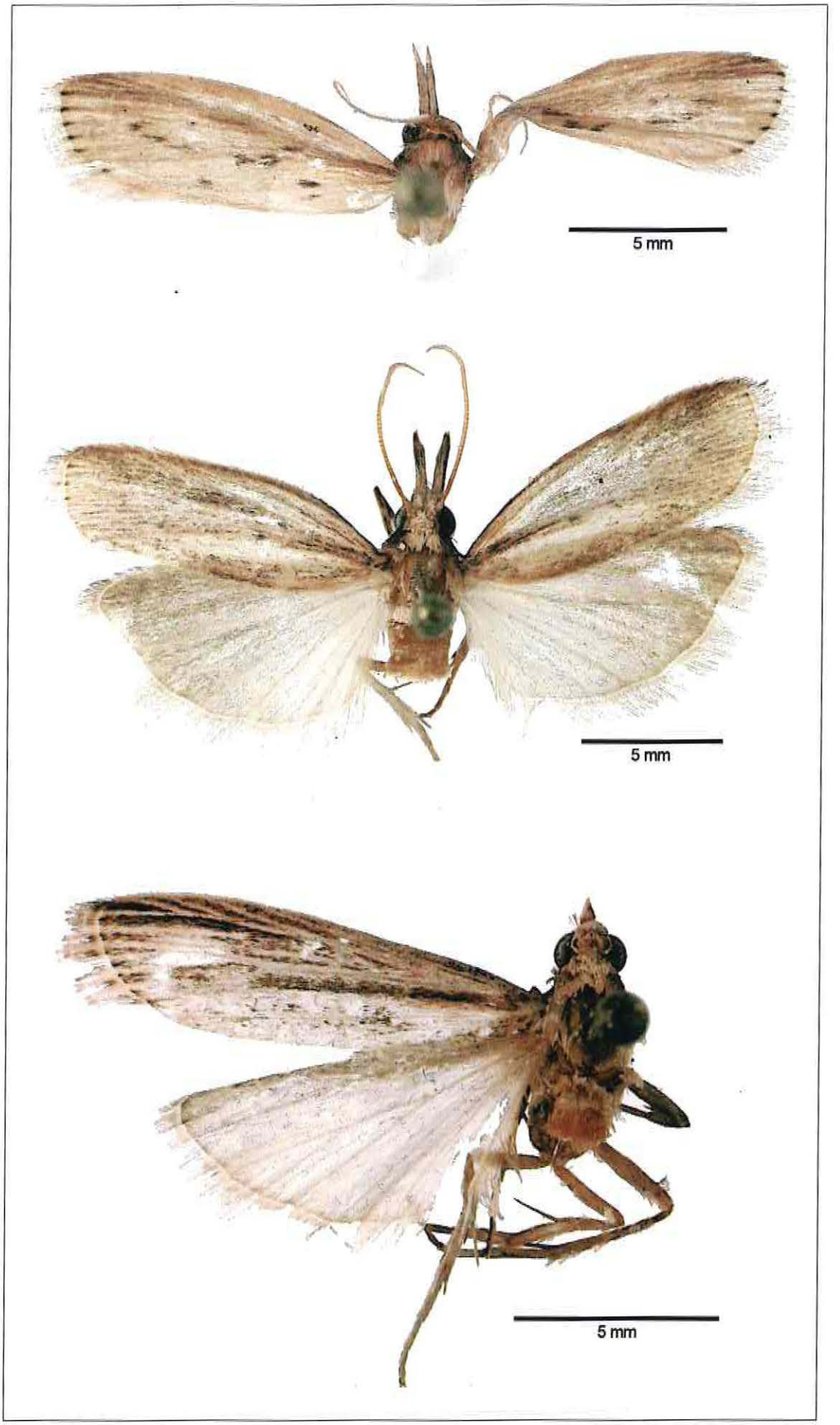

Plate 25. Adult moths: top to bottom, *Ematheudes* sp. nov.; *E. straminella; Saluria lentistrigella*

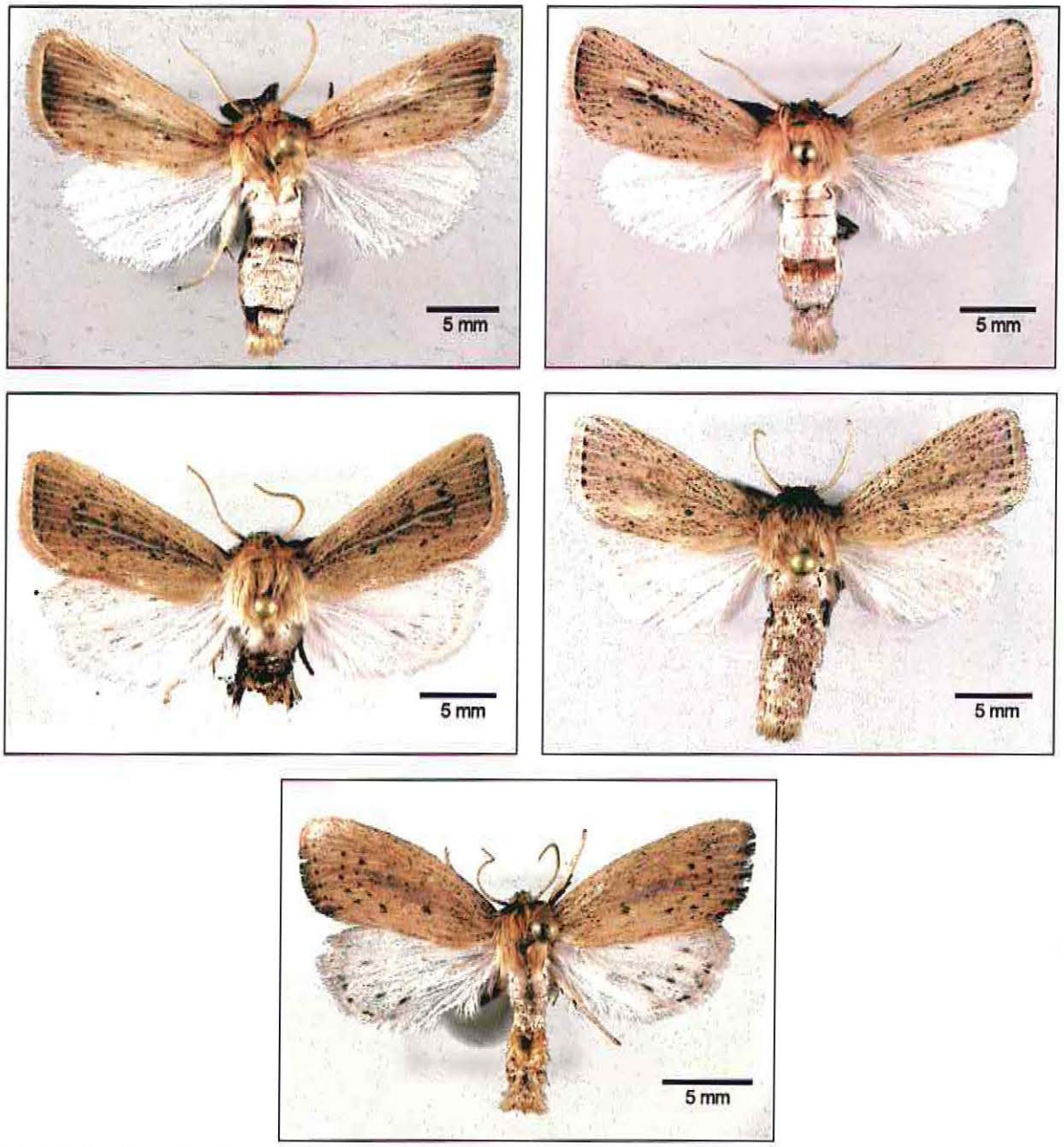

Plate 26. Adult moths *Sesamia* species: top, left to right, *S. calamistis; S. nonagrioides botanephaga*; middle, left to right, *S. penniseti, S. poephaga*; bottom, *S.* sp. nov.

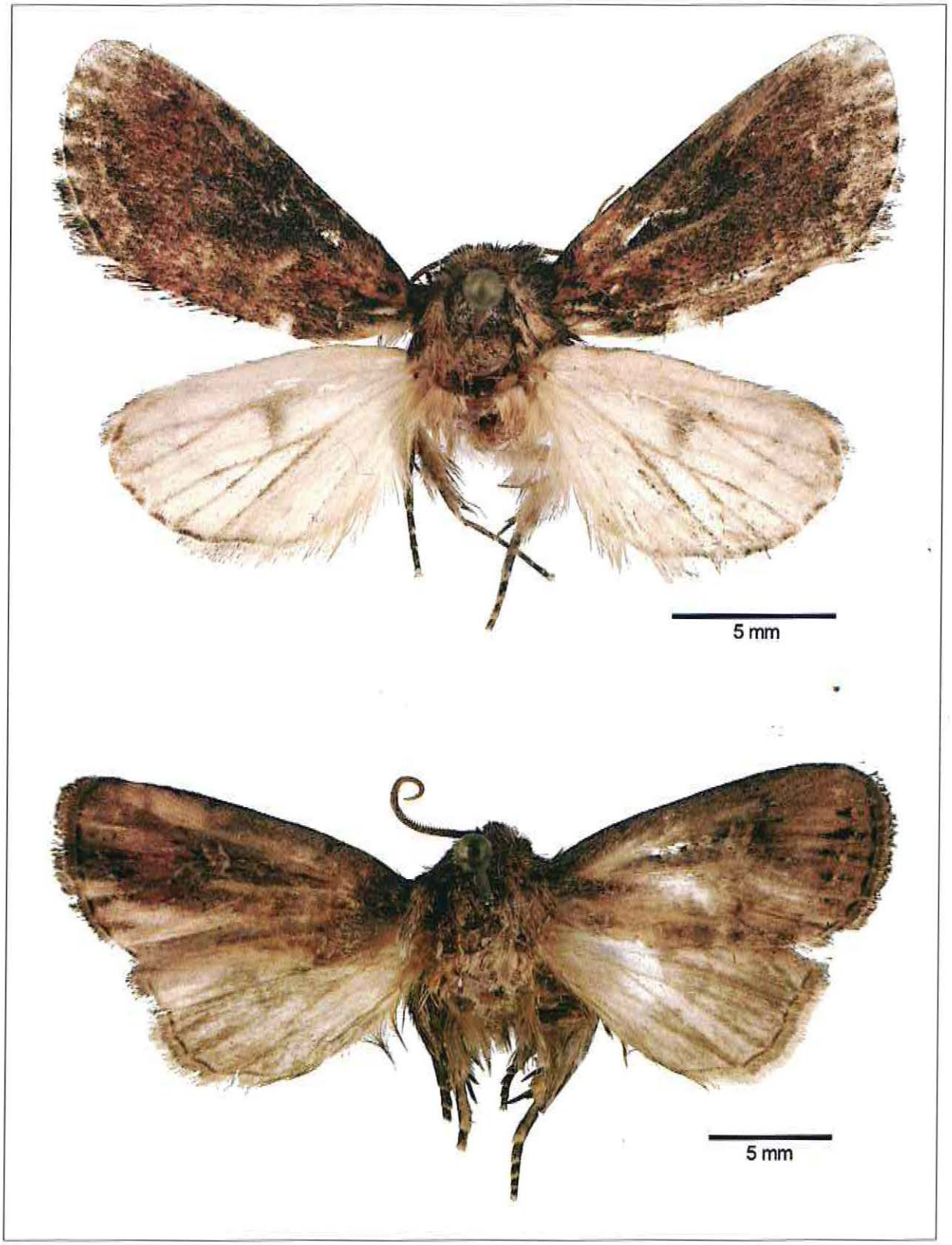

Plate 27. Adult moths: top to bottom, *Manga nubifera; Sciomesa piscator*

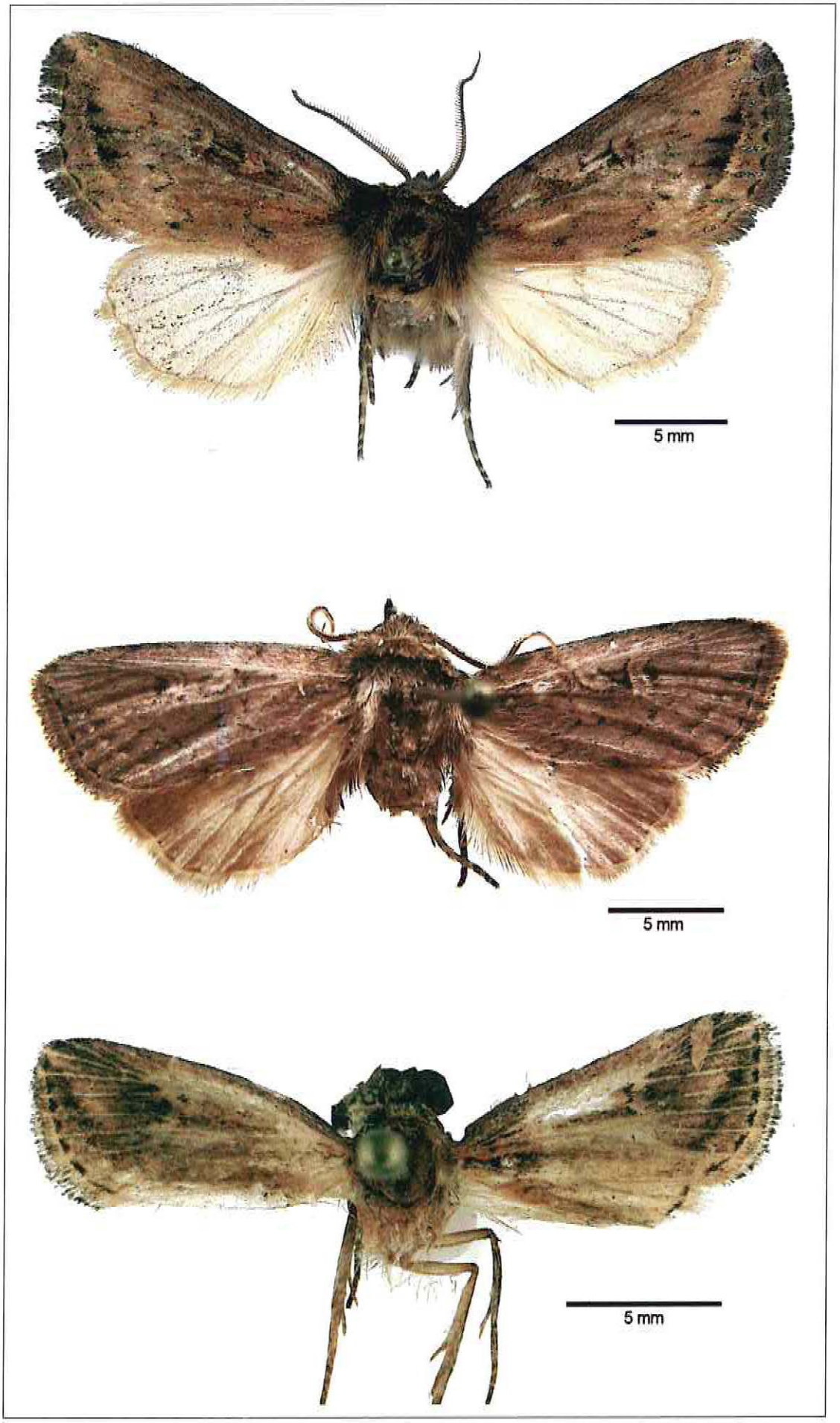

Plate 28. Adult moths, *Busseola* species: top to bottom, *B. fusca; B. phaia; B. obliquifascia*

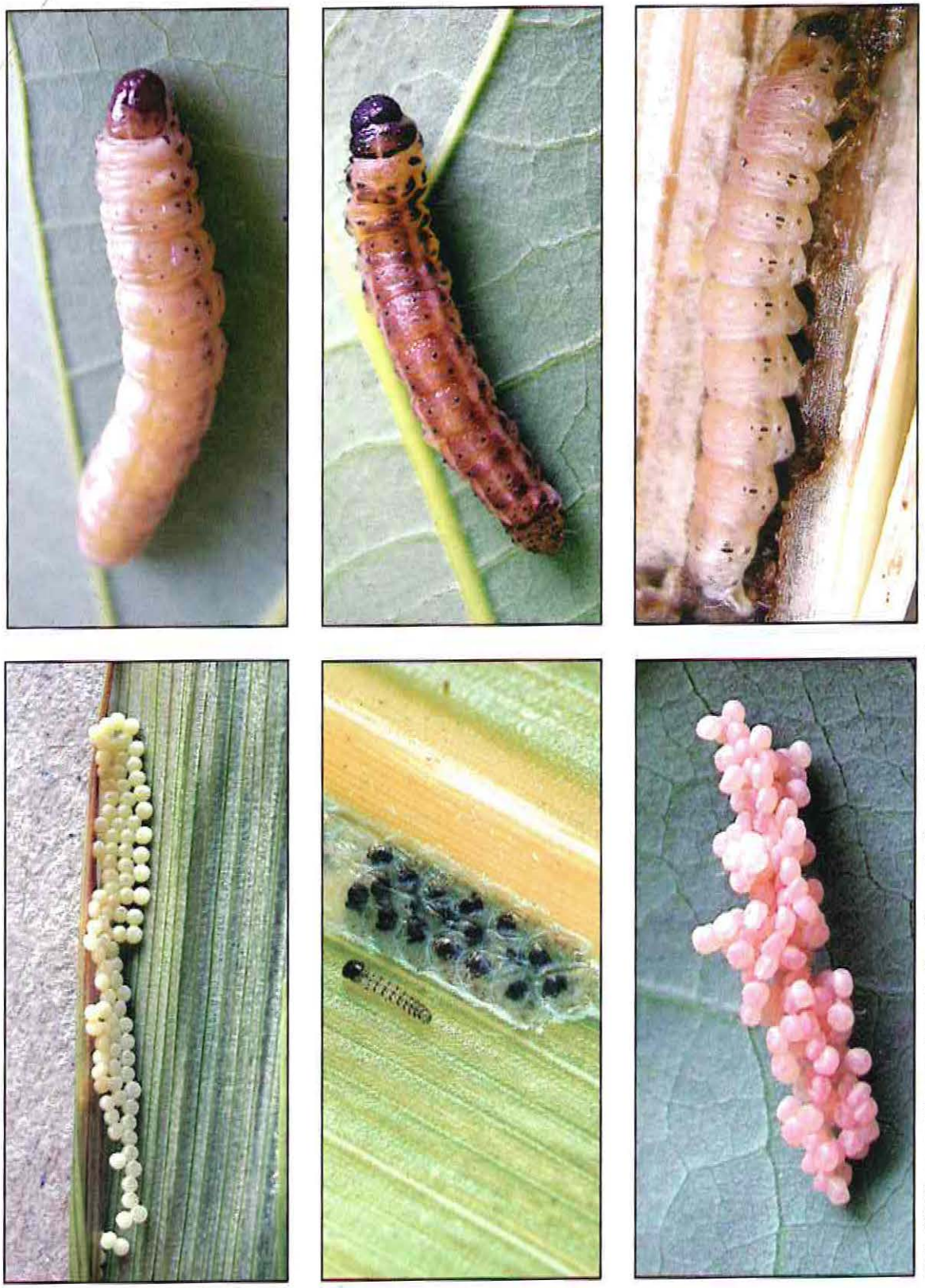

Plate 29. Eggs and larvae: top to bottom, *Busseola fusca; Chilo partellus; Sesamia calamistis*

FIGURES

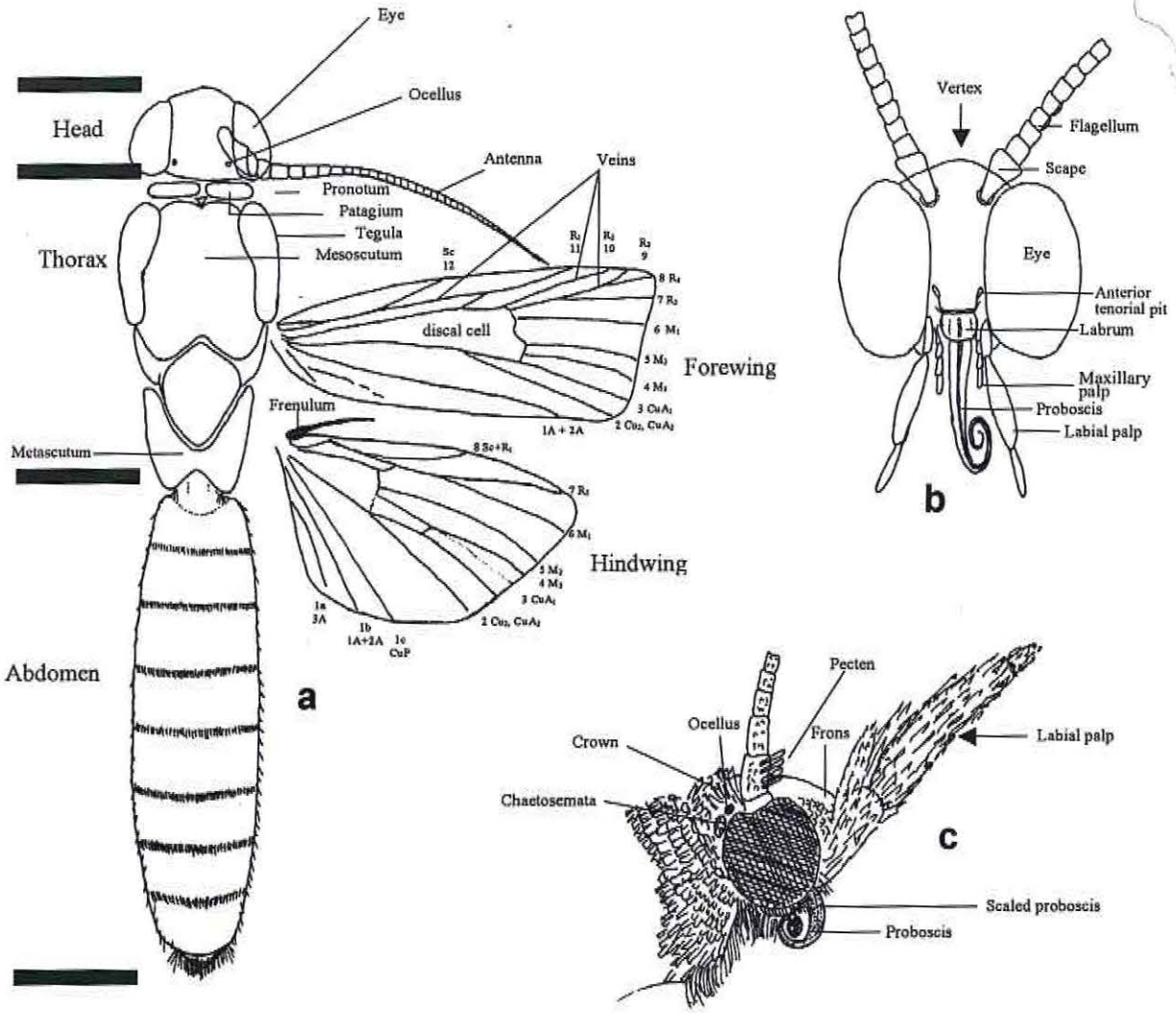

Figure 1 a–c. Adult moth with legs removed (a), frontal (b) and lateral (c) views of the head

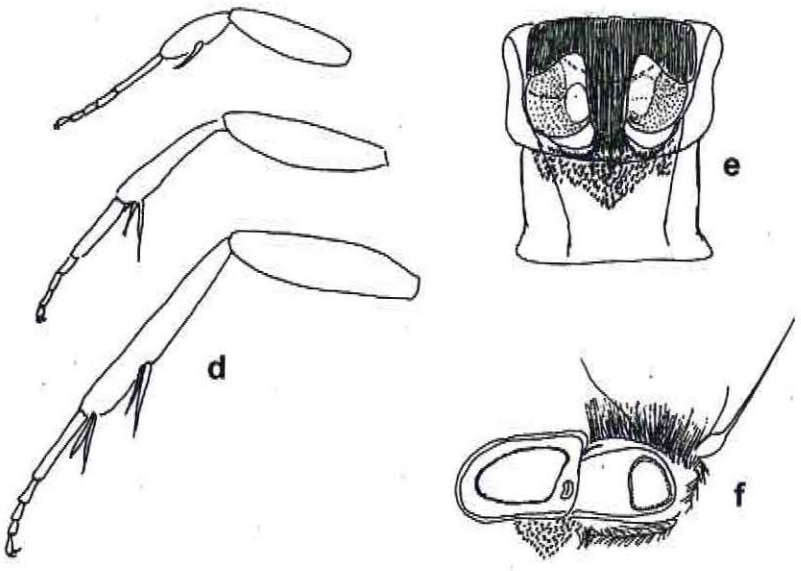

Figure 1 d–f. Legs I–III (d), tympanal organ in family Pyralidae (e) and in Noctuidae (f)

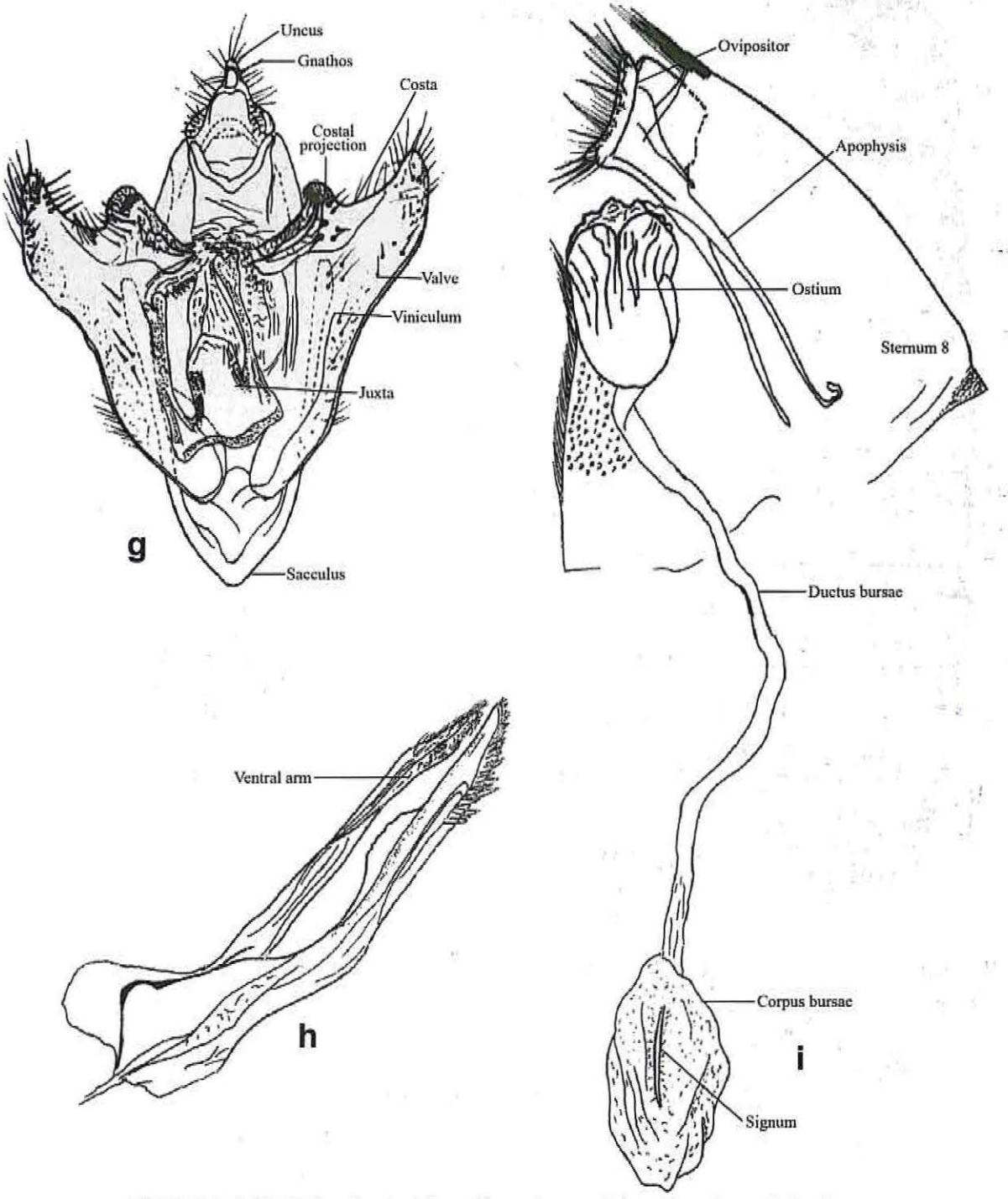

Figure 1 g–i. Genitalia of male (g) and its aedeagus (h) and female genitalia (i)

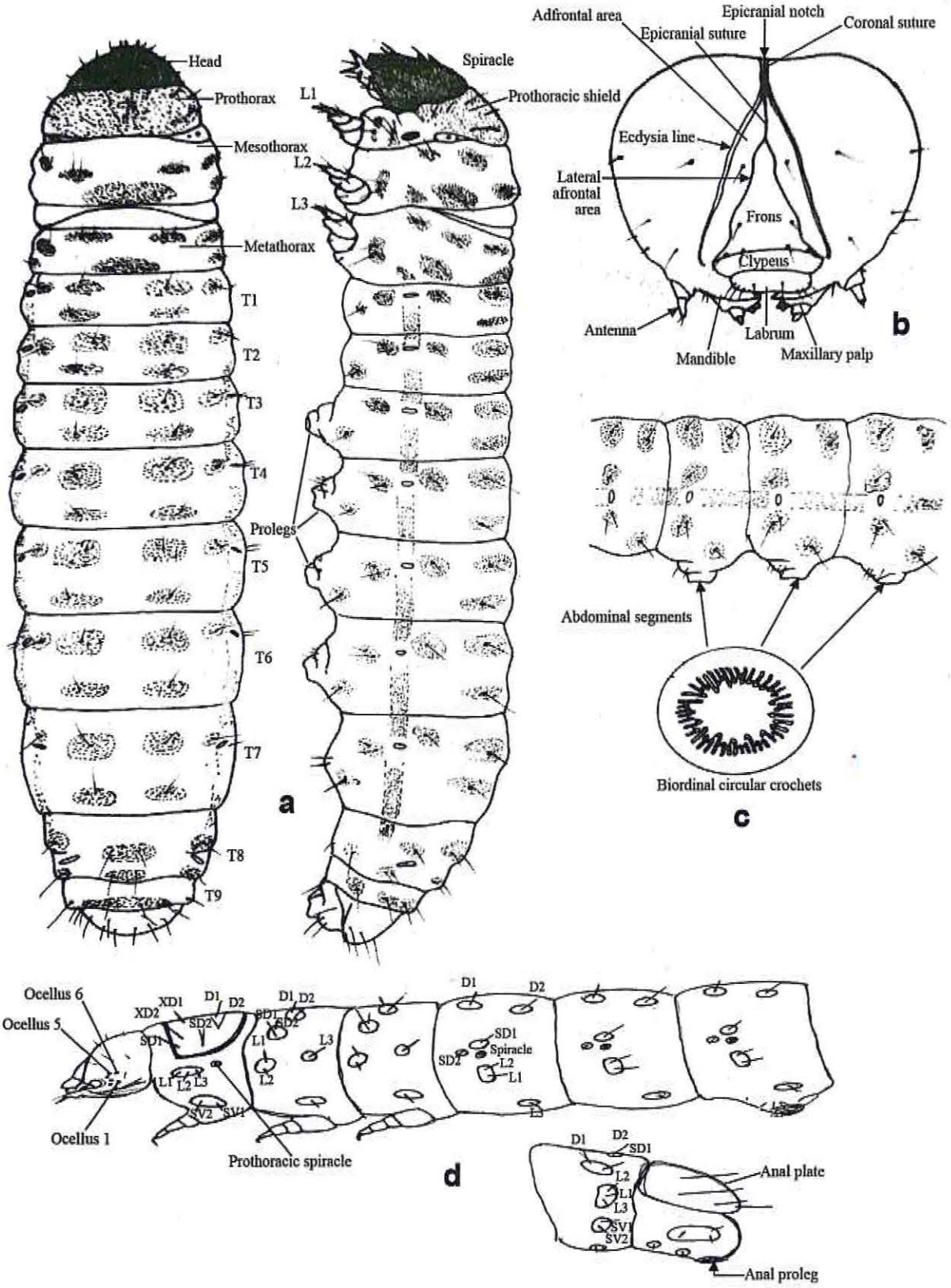

Figure 2 a–d. Dorsal and lateral (a) views of lepidopteran larva. Frontal view of head (b), abdominal prolegs and crochets (c), and larval body setae (d)

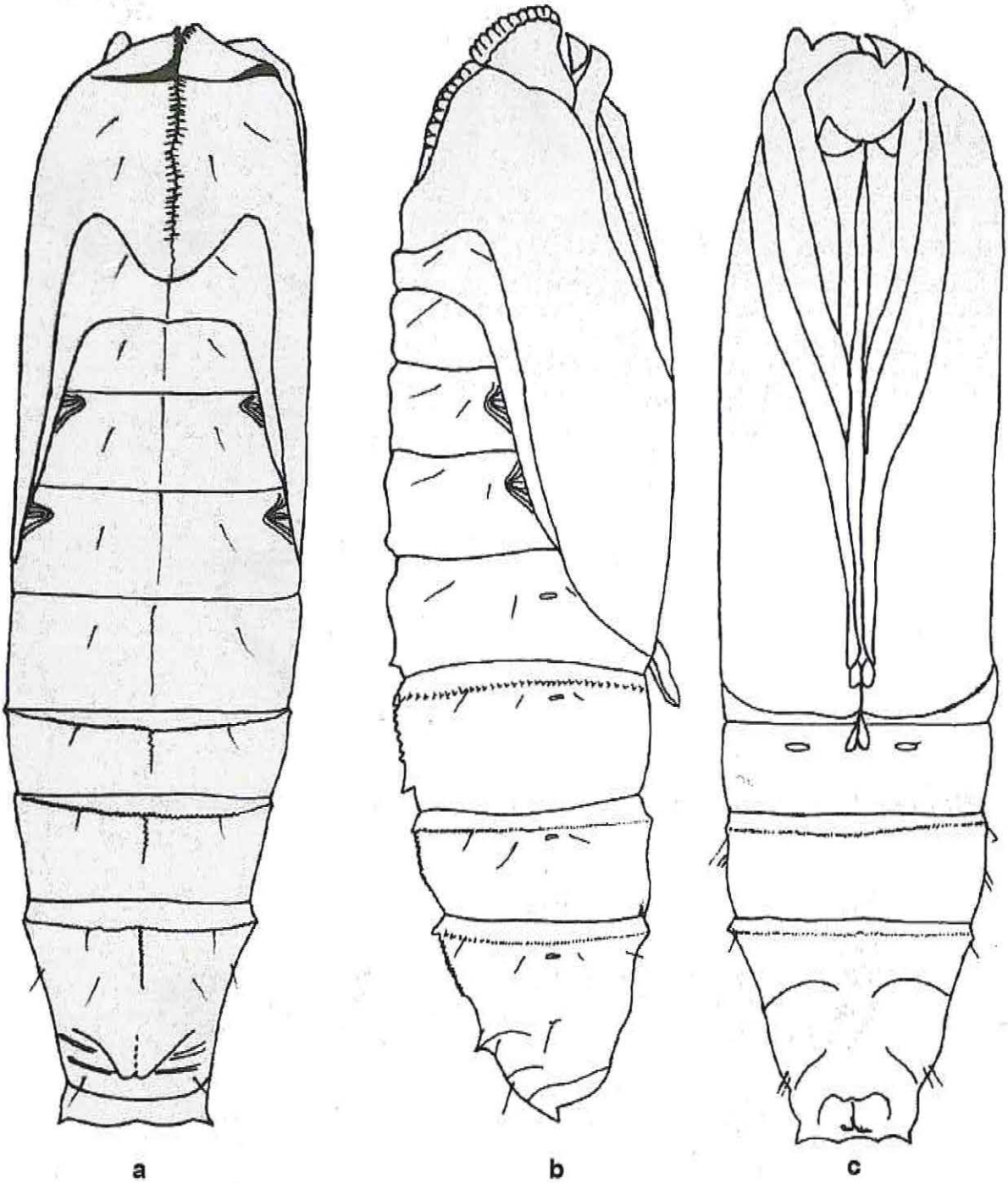

Figure 3 a–c. Dorsal (a), lateral (b) and ventral (c) views of a lepidopteran pupa

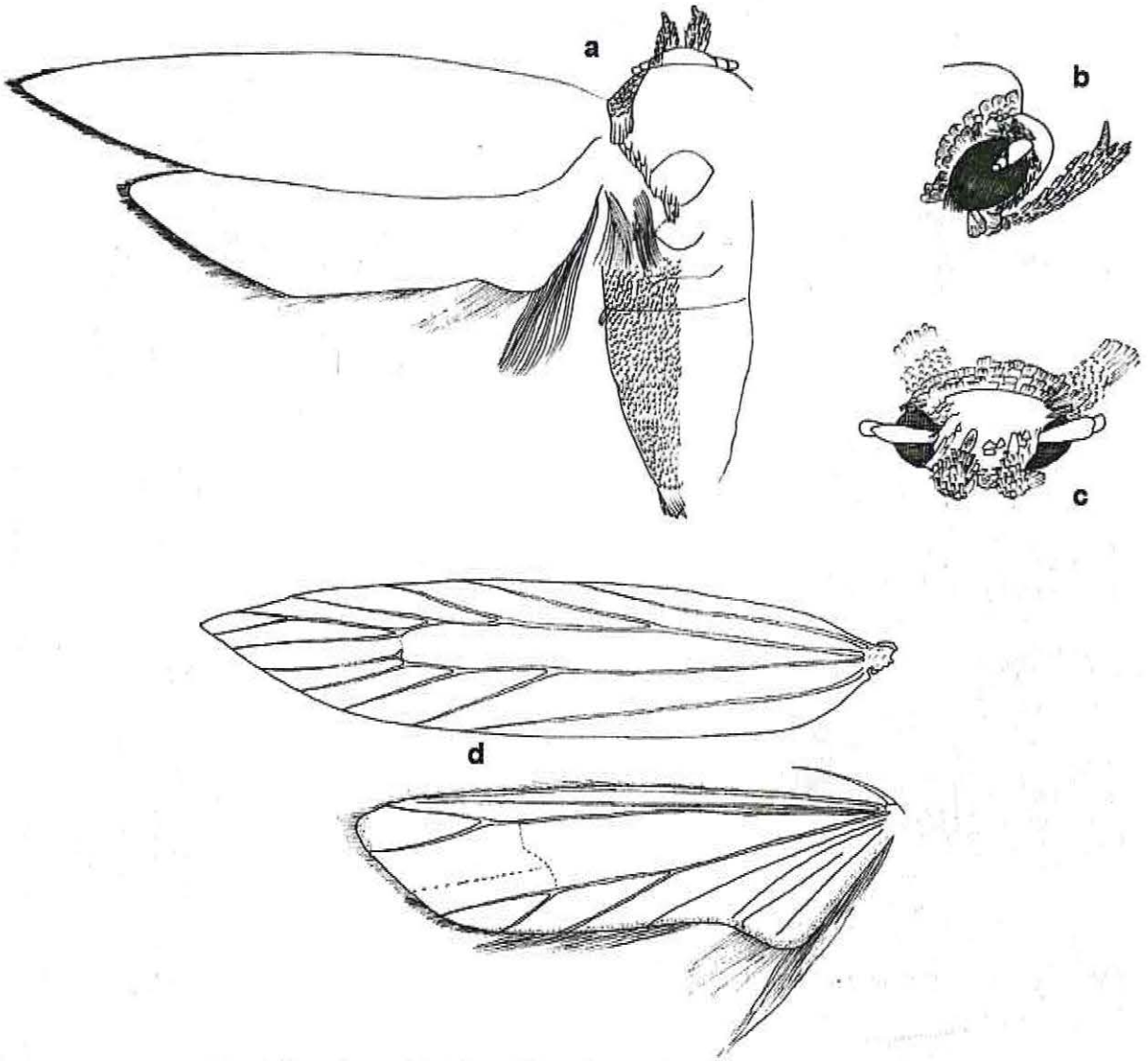

Figure 4 a–d. Adult of *Stegasta* sp. (a), lateral (b) and frontal (c) views of the head and wing venation (d)

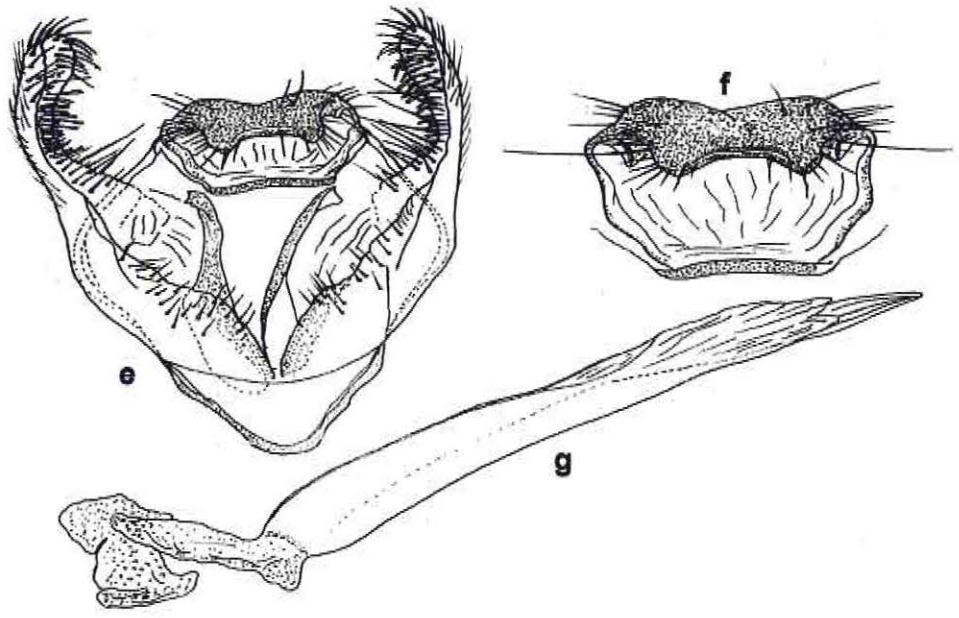

Figure 4 e–g. Male genitalia of *Stegasta* sp. (e), uncus (f) and aedeagus (g)

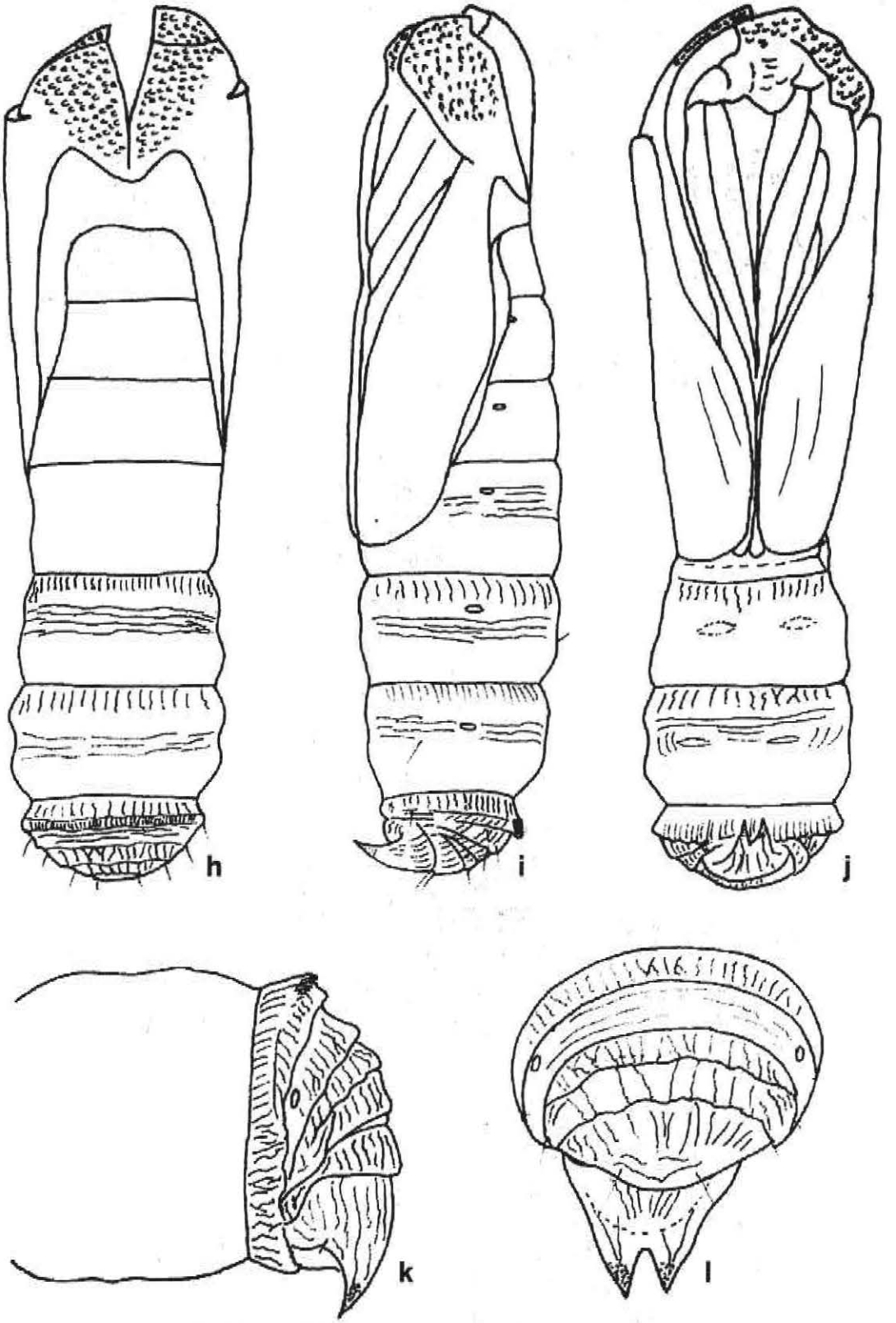

Figure 4 h–l. Pupa of *Stegasta* sp. in dorsal (h), lateral (i) and ventral (j) views and lateral (k) and frontal (l) views of cremaster

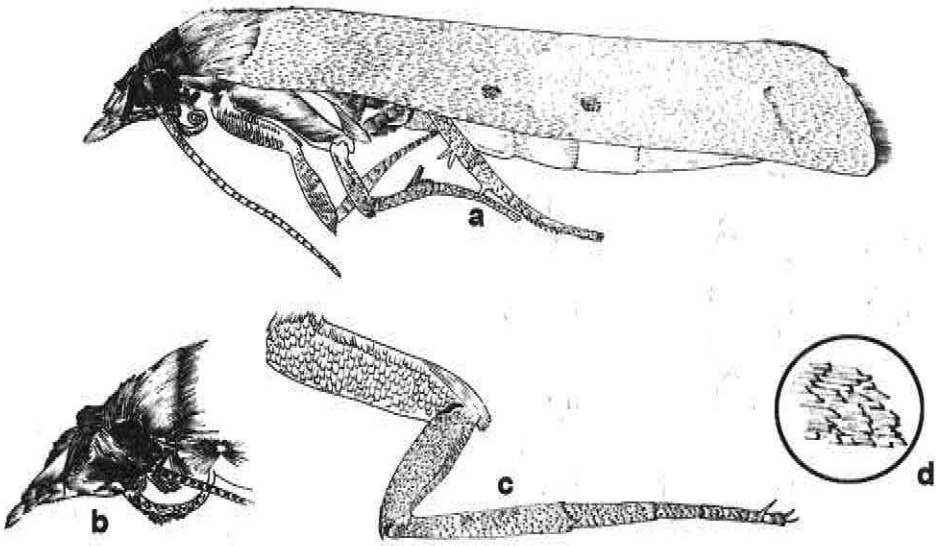

Figure 5 a–d. Adult *Eldana saccharina* Walker (a), head (b) and leg 1 (c) in lateral views, and closeup of hair scales (d)

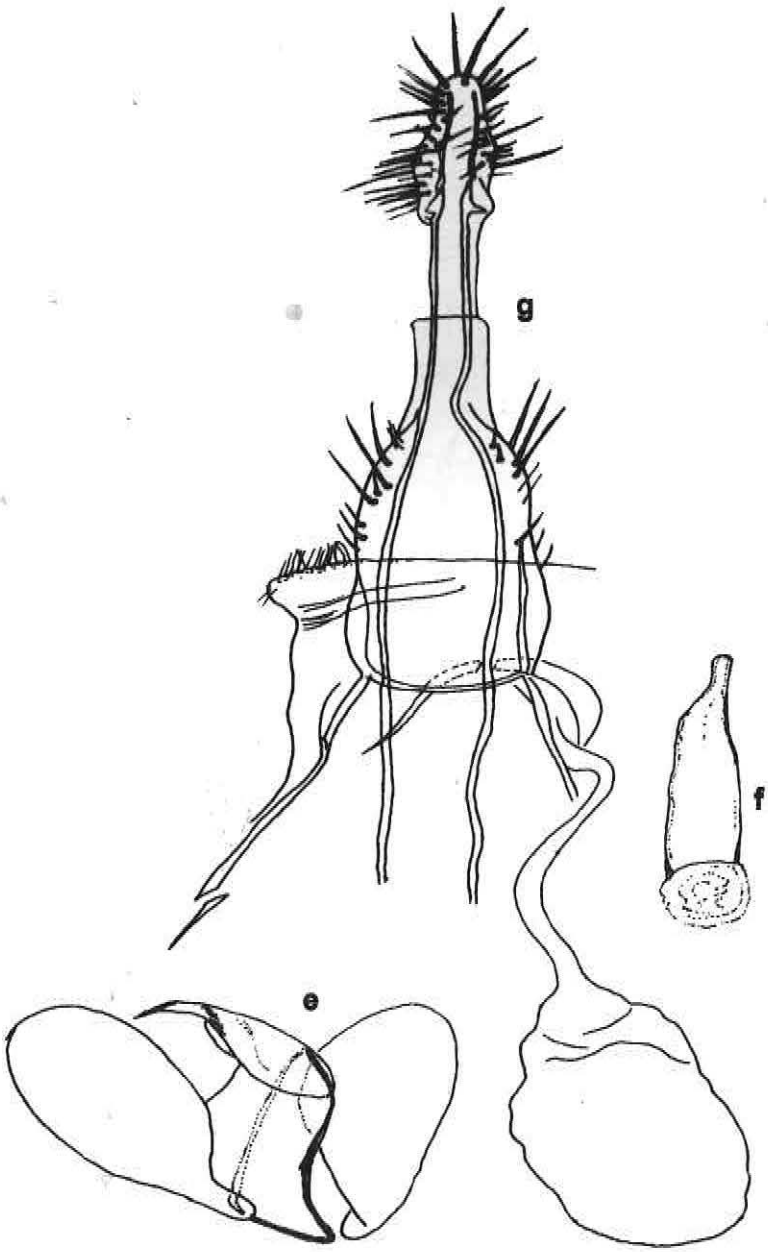

Figure 5 e–g. Genitalia of *E. saccharina* male (e) and its aedeagus (f) and female genitalia (g)

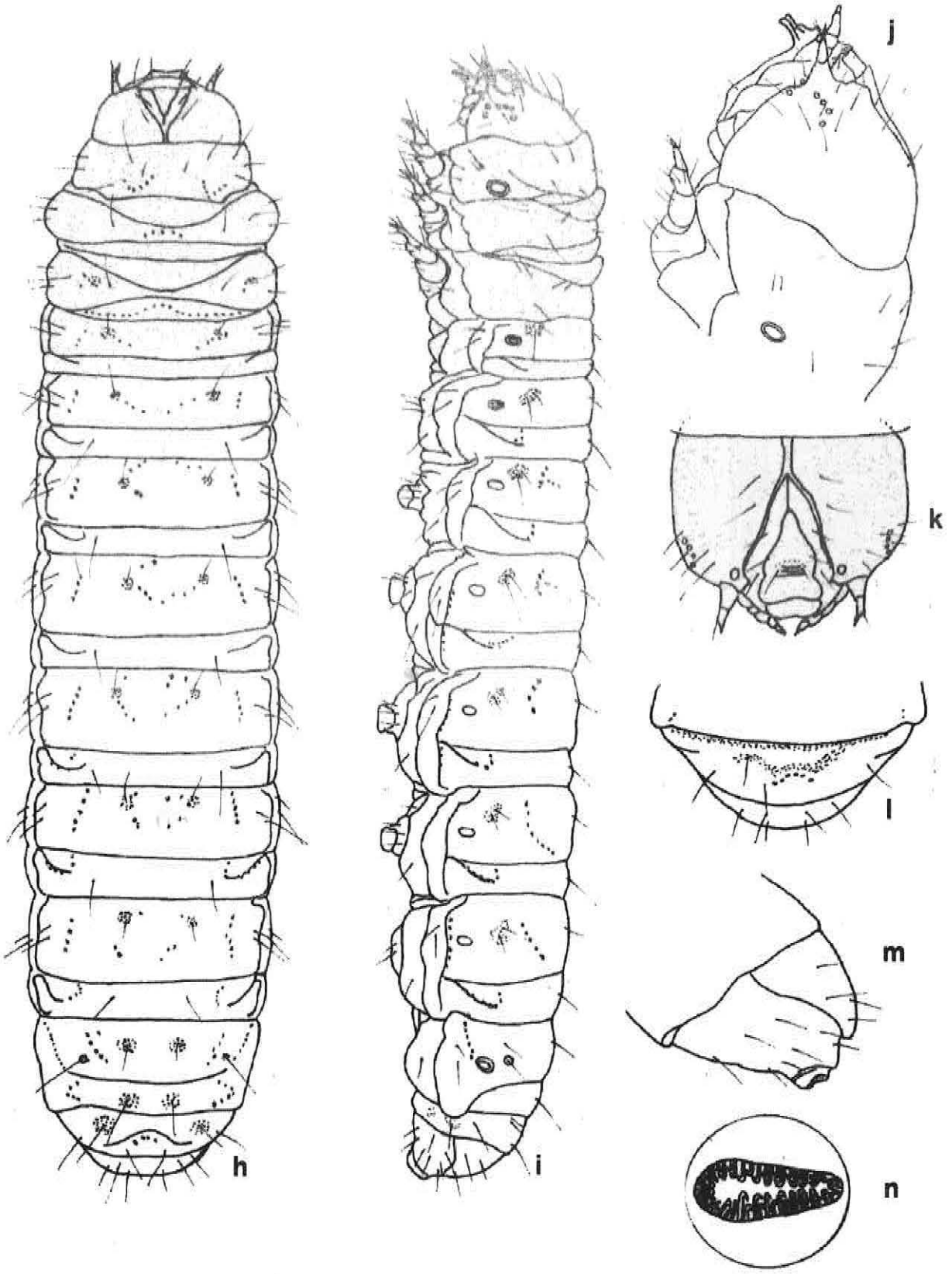

Figure 5 h–n. Dorsal (h) and lateral (i) views of *E. saccharina* larva, lateral (j) and frontal (k) views of head, dorsal (l) and lateral (m) views of anal plate and crochets (n)

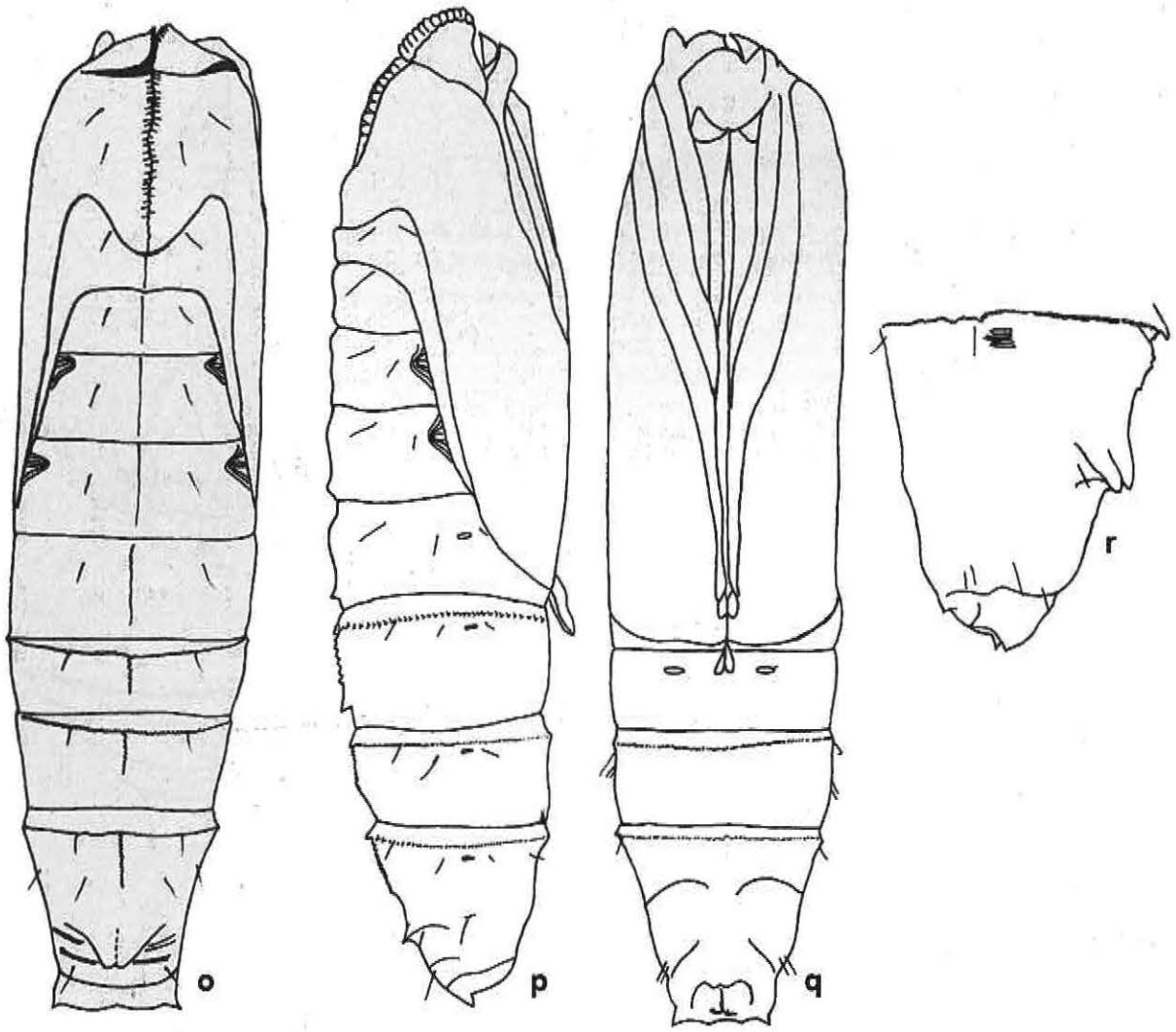

Figure 5 o–r. Pupa of *E. saccharina* in dorsal (o), lateral (p) and ventral (q) views and lateral view of cremaster and segments VIII–X (r)

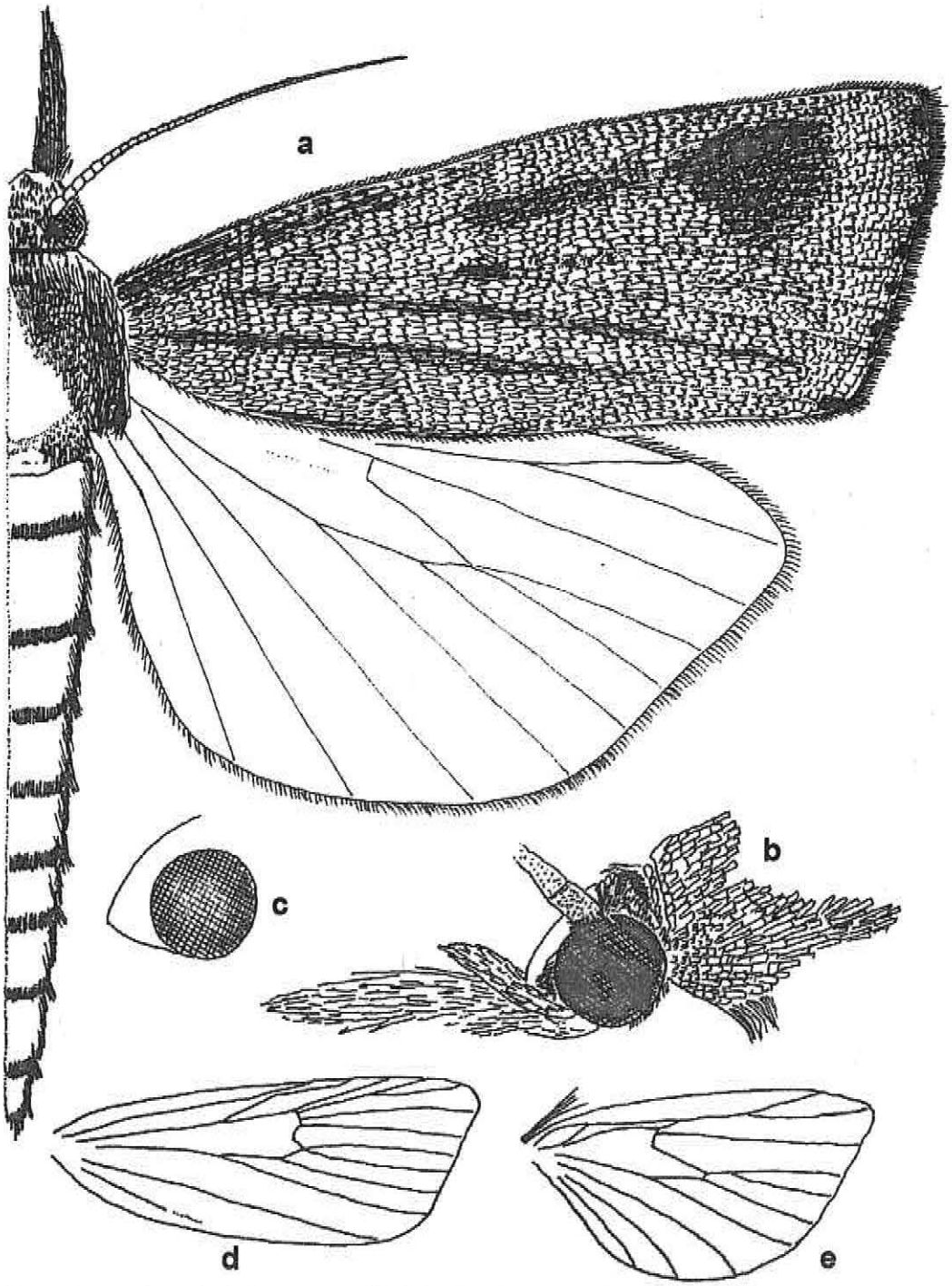

Figure 6 a–e. Female *Chilo partellus* (Swinhoe) with expanded wings (a), lateral views of head showing labial palp (b) and corneous point (c) and venation in the forewing (d) and hindwing (e)

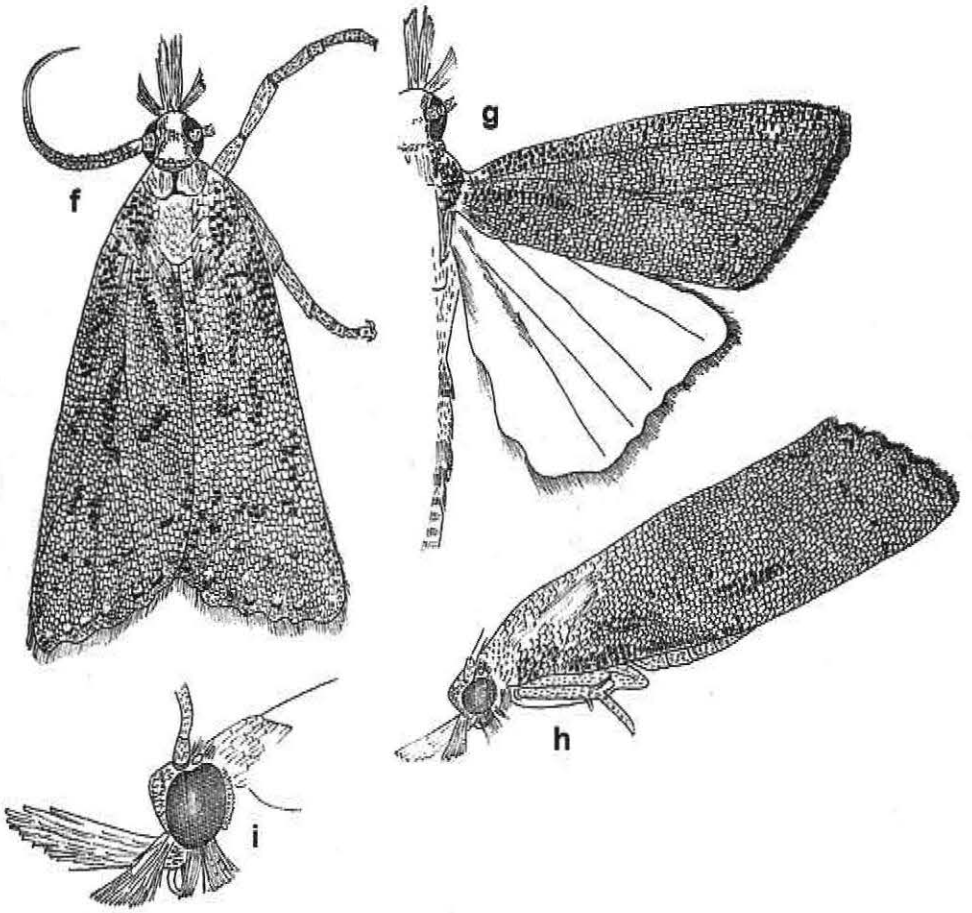

Figure 6 f–i. Male of *C. partellus* at rest (f), with expanded right forewing (g) lateral view (h), and head showing the ocelli, chaetosemata and labial palp (i)

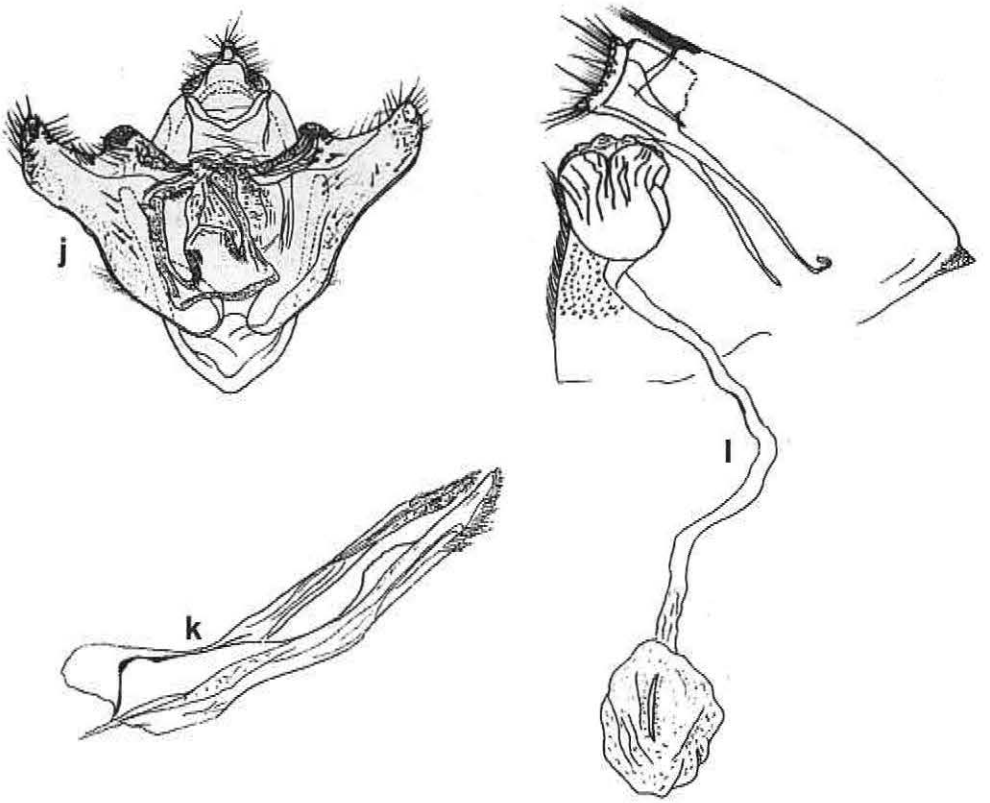

Figure 6 j–l. *C. partellus* male genitalia (j) and aedeagus (k), and female genitalia (l)

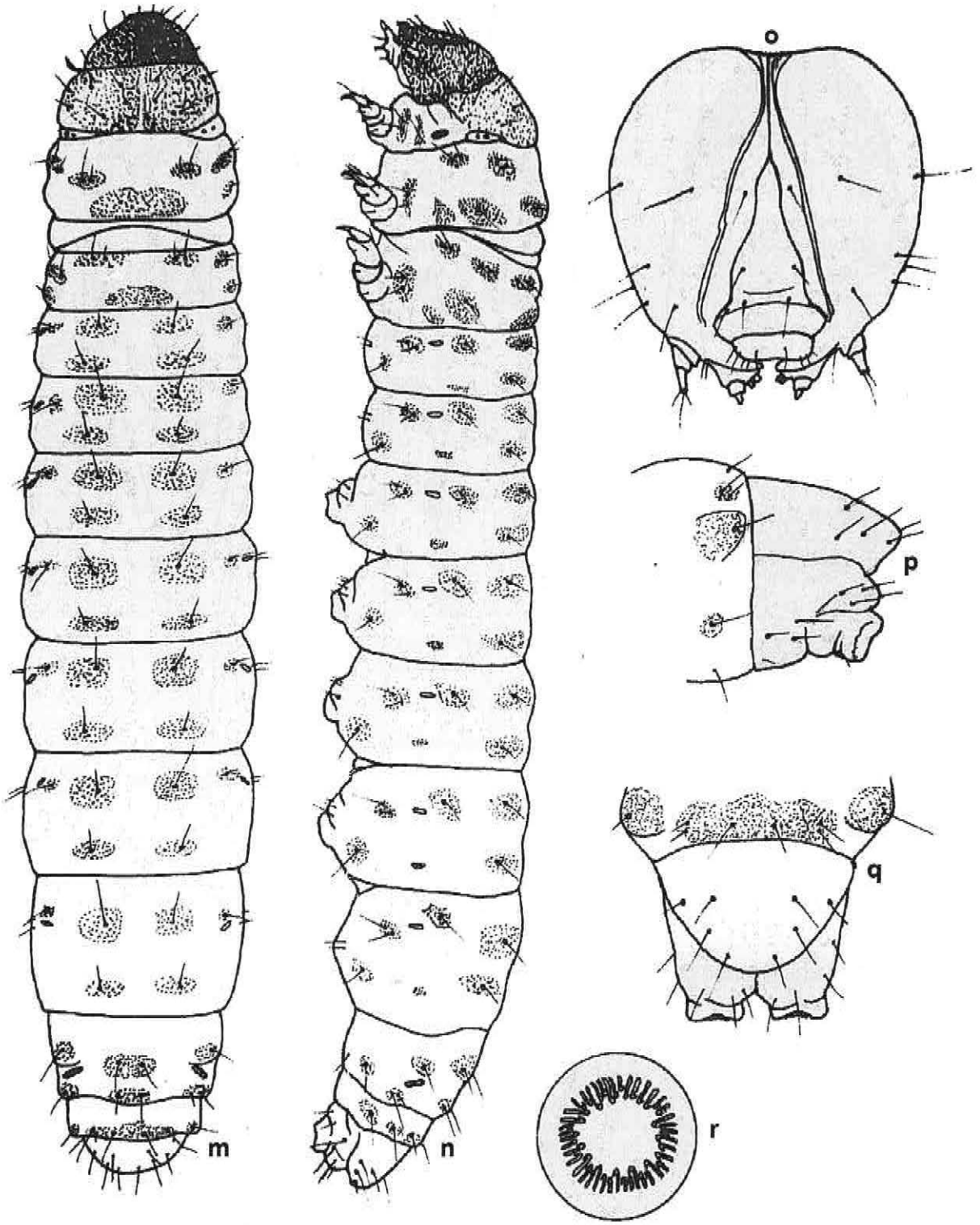

Figure 6 m–r. Larva of *C. partellus* in dorsal (m) and lateral (n) views, frontal view of head (o), lateral (p) and dorsal (q) views of anal plate, and crochets (r)

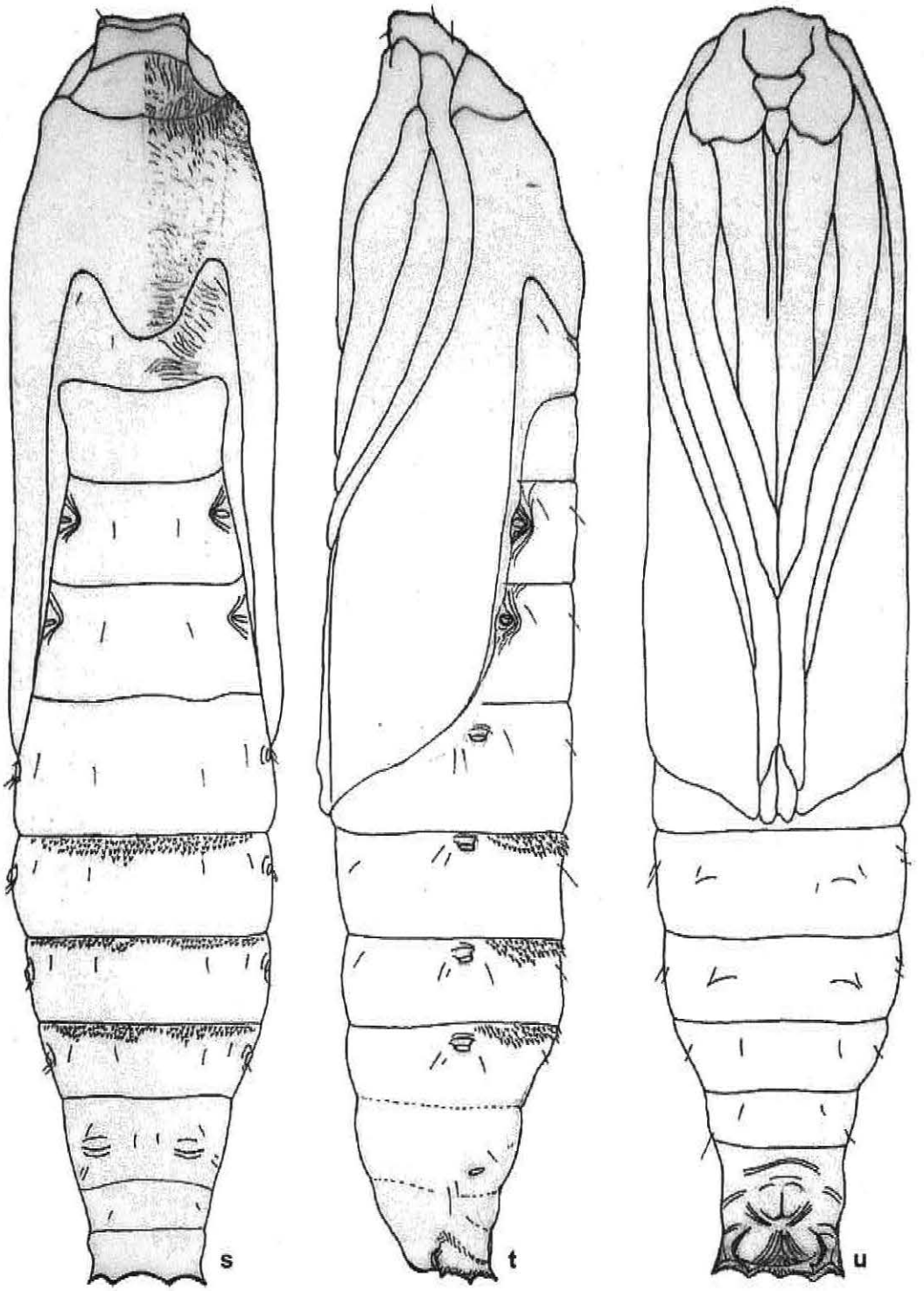

Figure 6 s–u. Dorsal (s), lateral (t) and ventral (u) views of *C. partellus* pupa

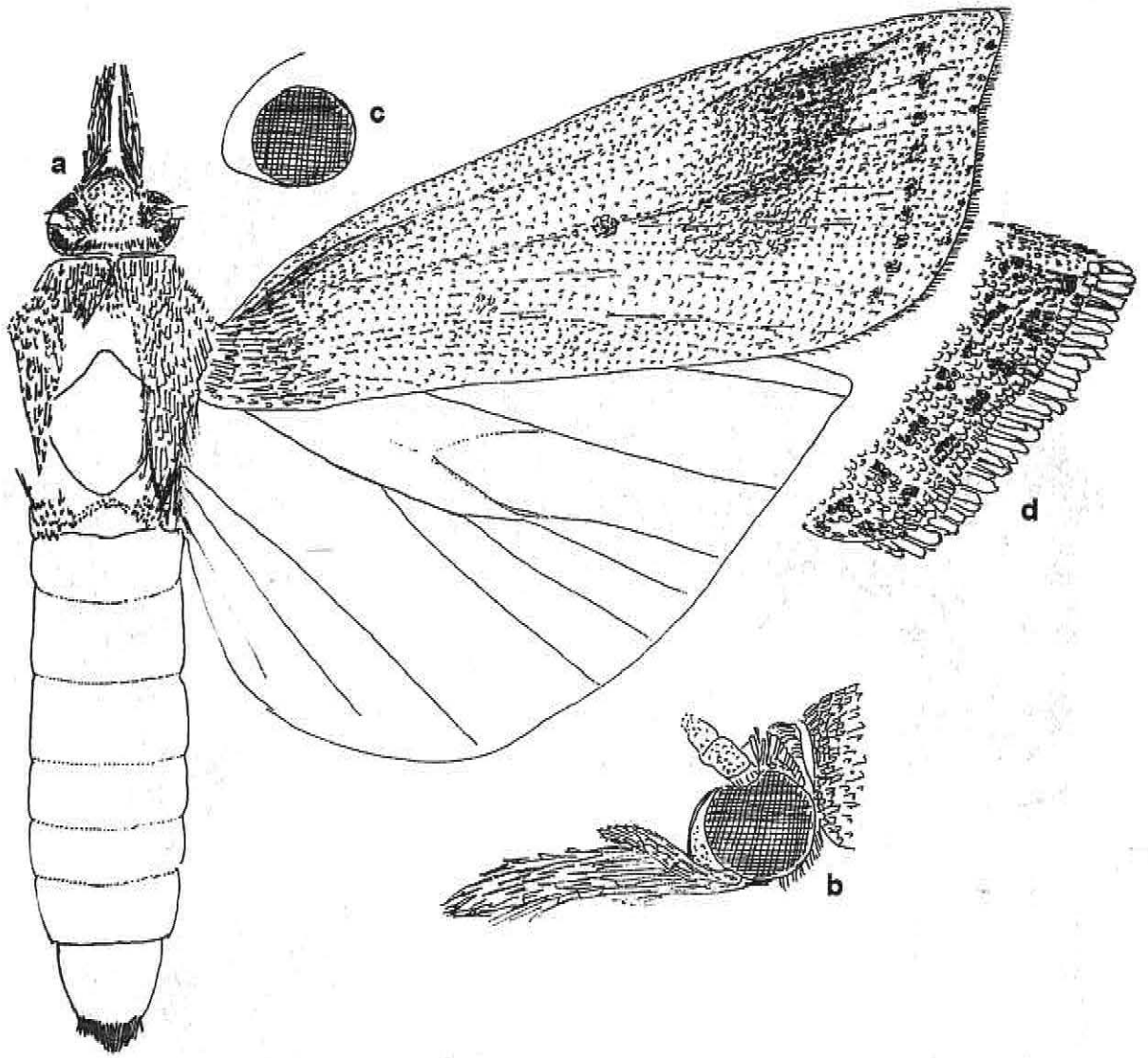

Figure 7 a–d. Adult of *Chilo orichalcociliellus* Strand (a), lateral view of head showing labial palp (b), head with rounded frons (c) and marking on the terminal margins of forewing (d)

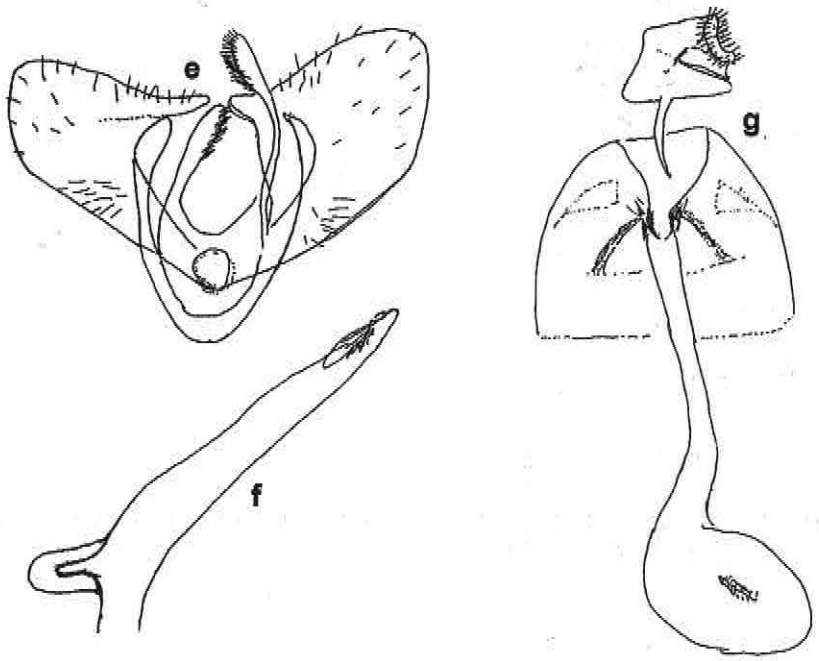

Figure 7 e–g. Genitalia of male (e) and aedeagus (f) and female genitalia (g) of *Chilo orichalcociliellus*

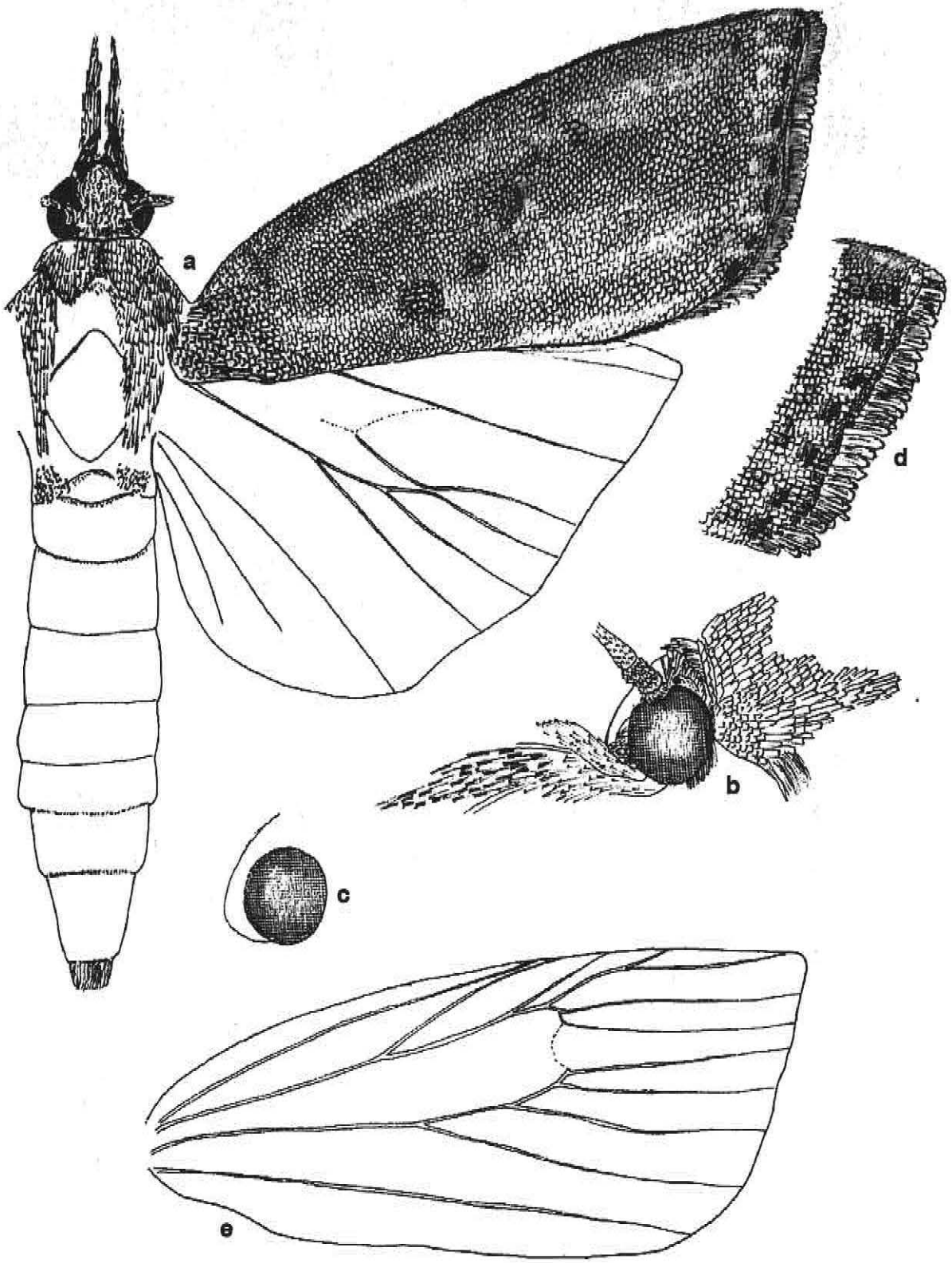

Figure 8 a–e. Adult of *Chilo thyrsis* Bleszynski (a), lateral view of head (b), head with rounded frons (c), markings on terminal margins of forewing (d) and forewing venation (e)

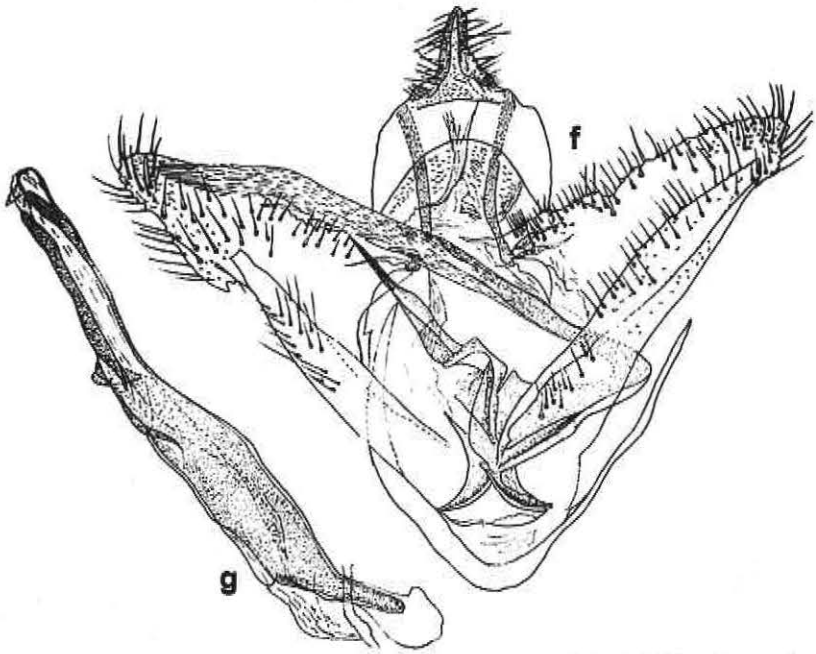

Figure 8 f–g. Male genitalia (f) and aedeagus (g) of *C. thrysis*

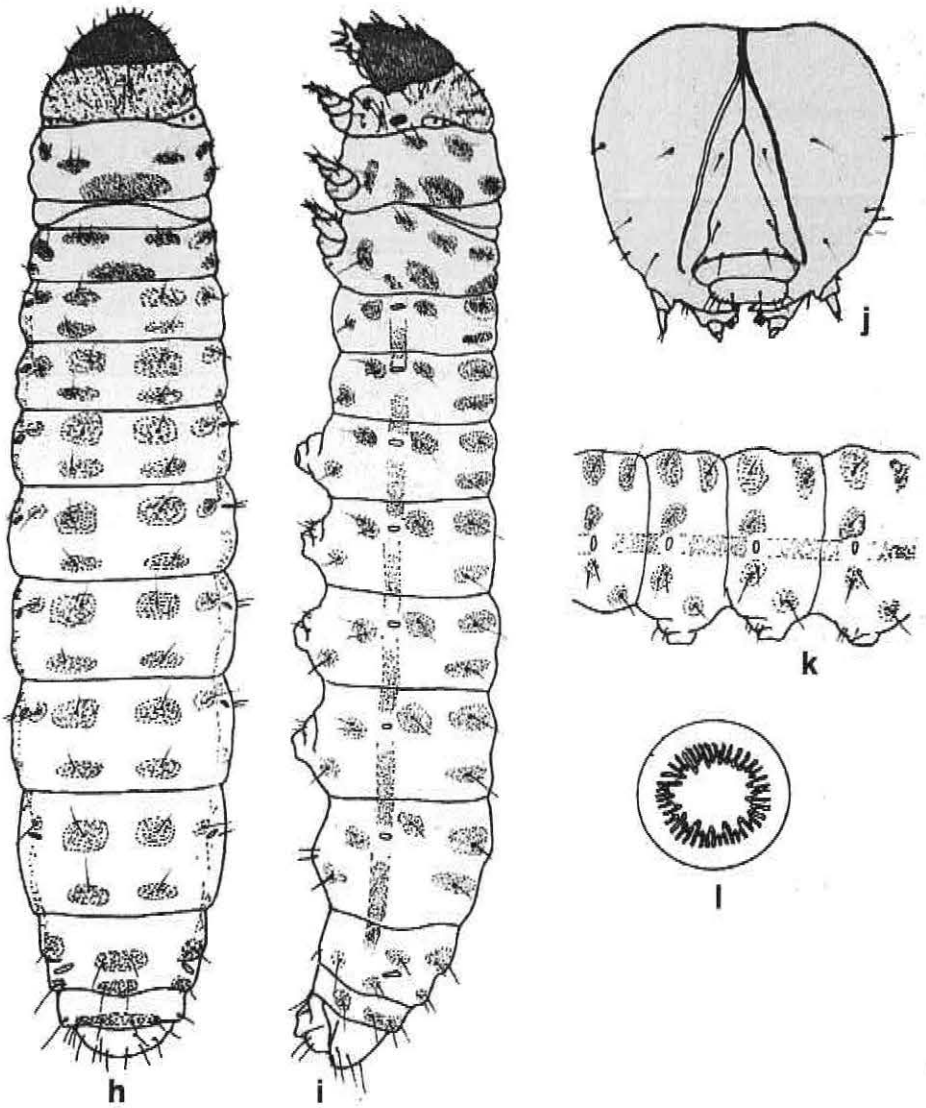

Figure 8 h–l. Dorsal (h) and lateral (i) views of *C. thrysis* larva, frontal view of head (j), abdominal prolegs (k) and crochets (l)

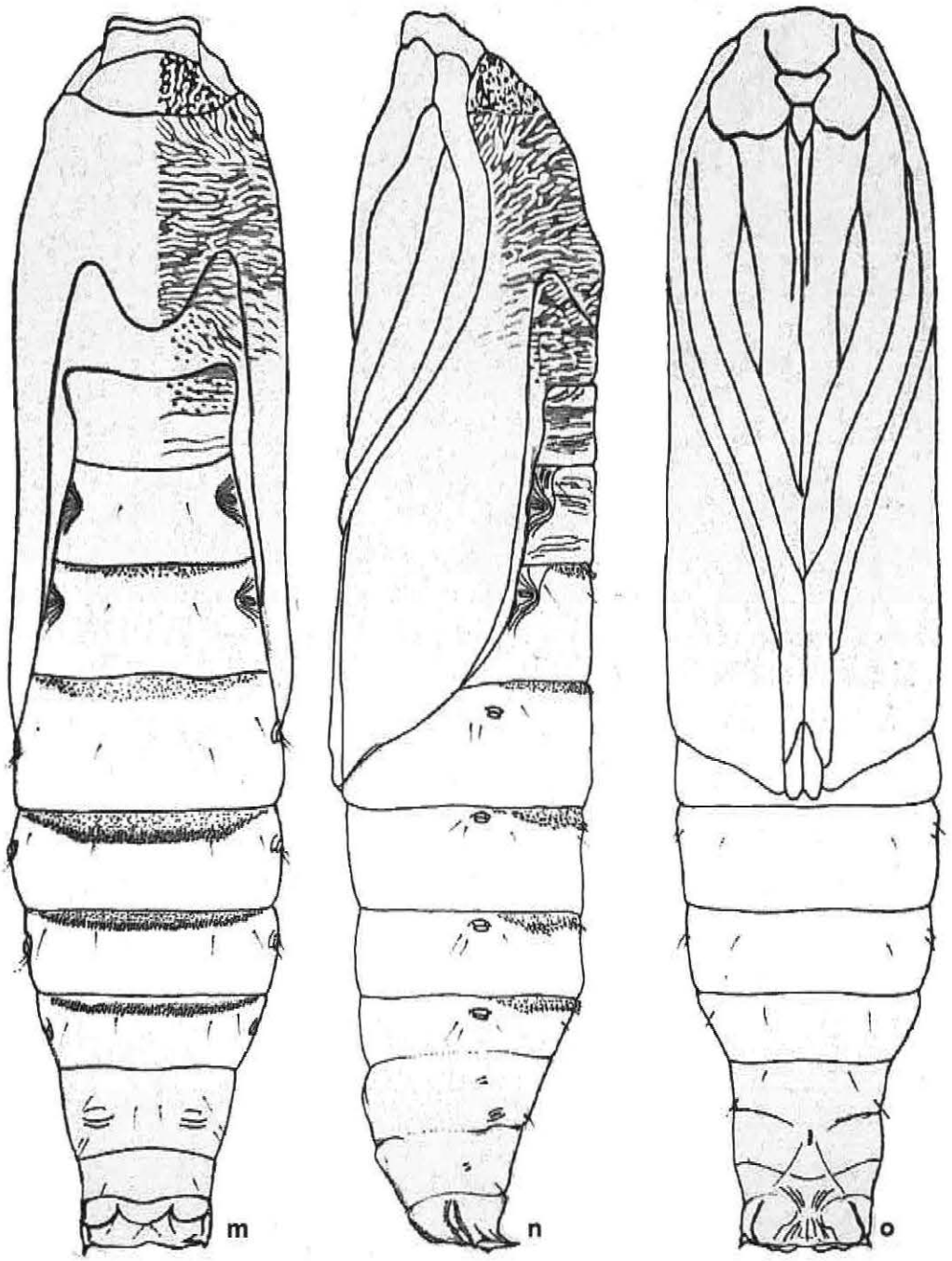

Figure 8 m–o. Dorsal (m), lateral (n) and ventral (o) views of *C. thrysis* pupa

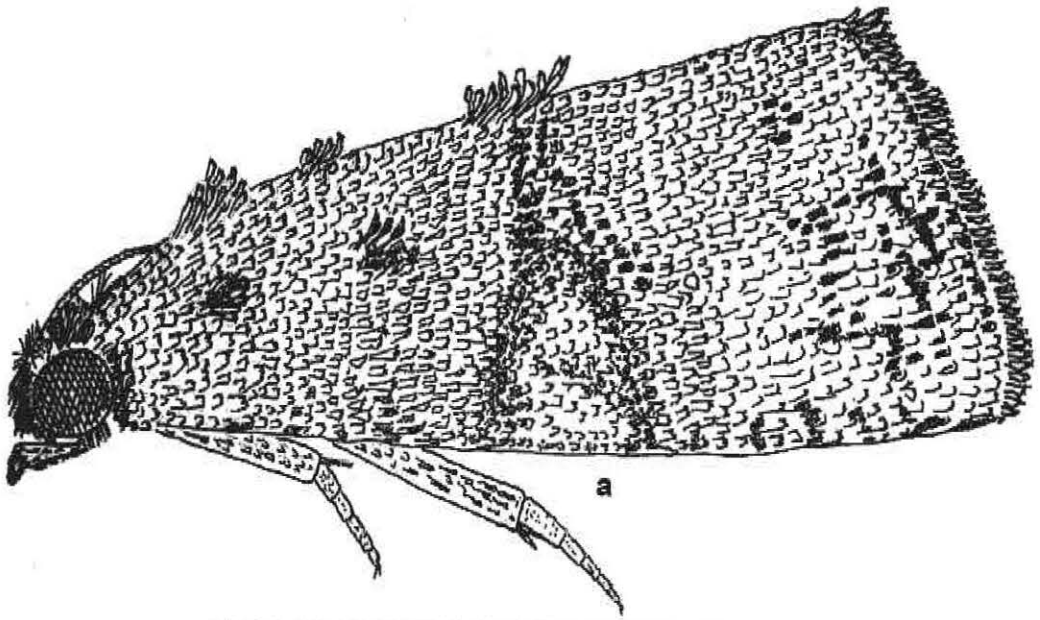

Figure 9 a. Adult of *Thaumatotibia leucotreta* (Meyrick) in lateral view

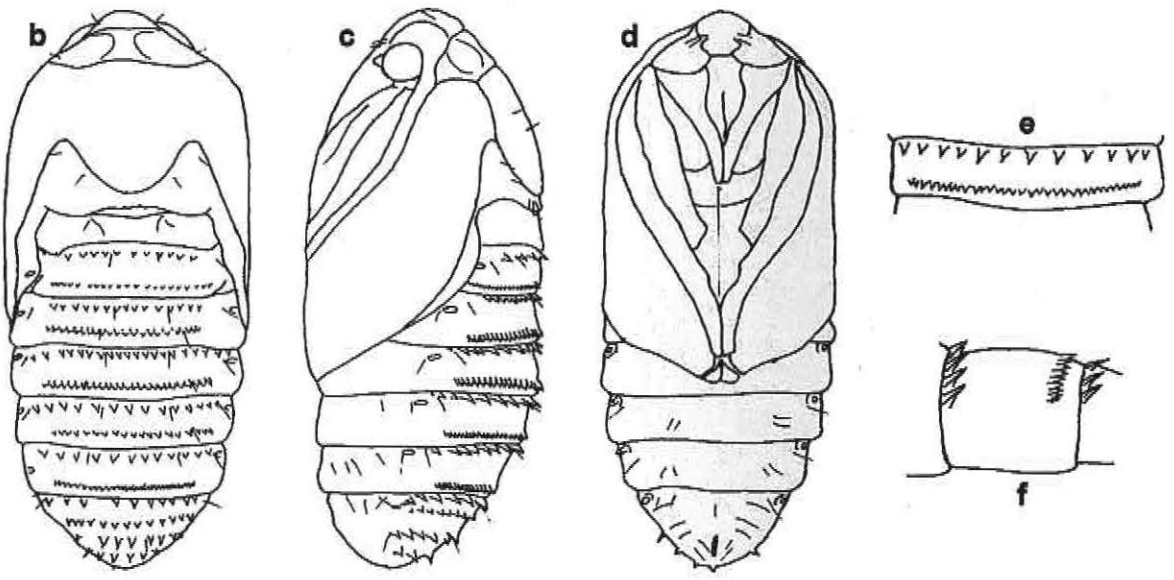

Figure 9 b–f. Pupa of *T. leucotreta* (Meyrick) in dorsal (b), lateral (c) and ventral (d) views and the abdominal spines in dorsal (e) and lateral (f) views

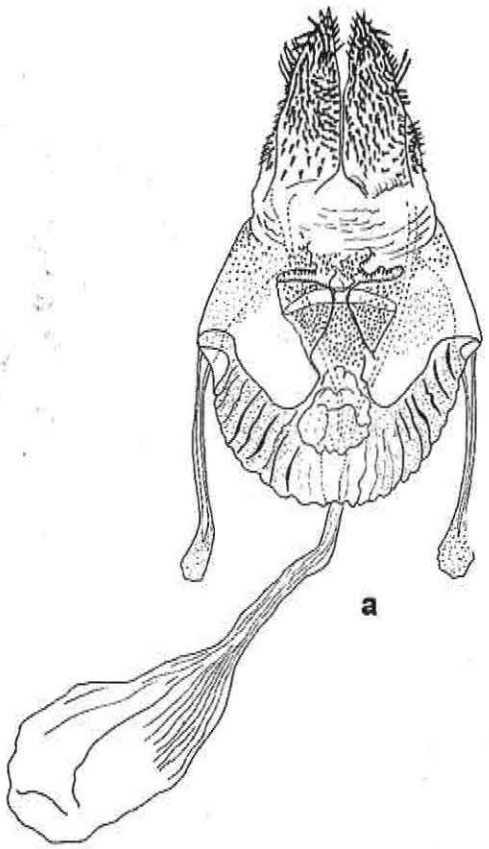

Figure 10 a. Female genitalia of *Sesamia nonagrioides botanephaga*

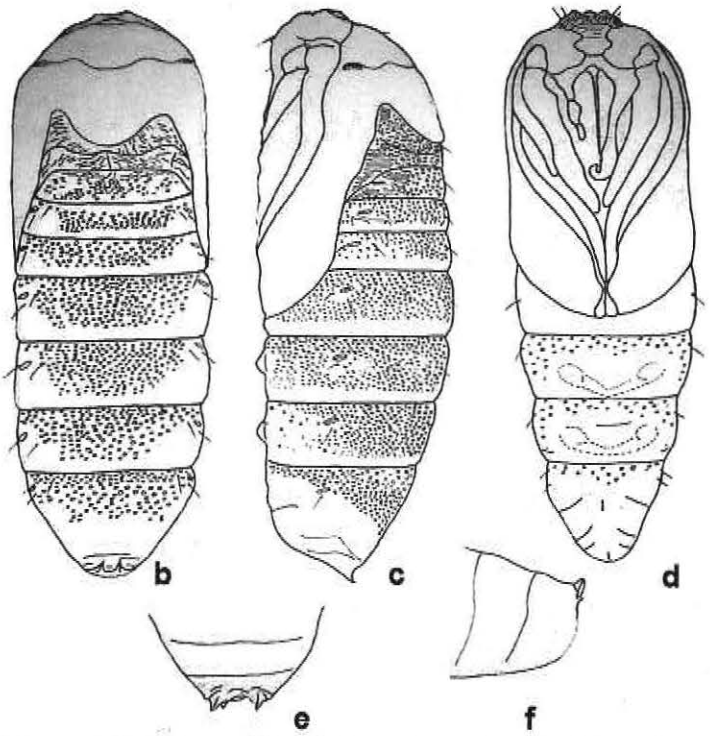

Figure 10 b–f. Pupa of *S. n. botanephaga* in dorsal (b), lateral (c) and ventral (d) views and cremaster in dorsal (e) and lateral (f) views

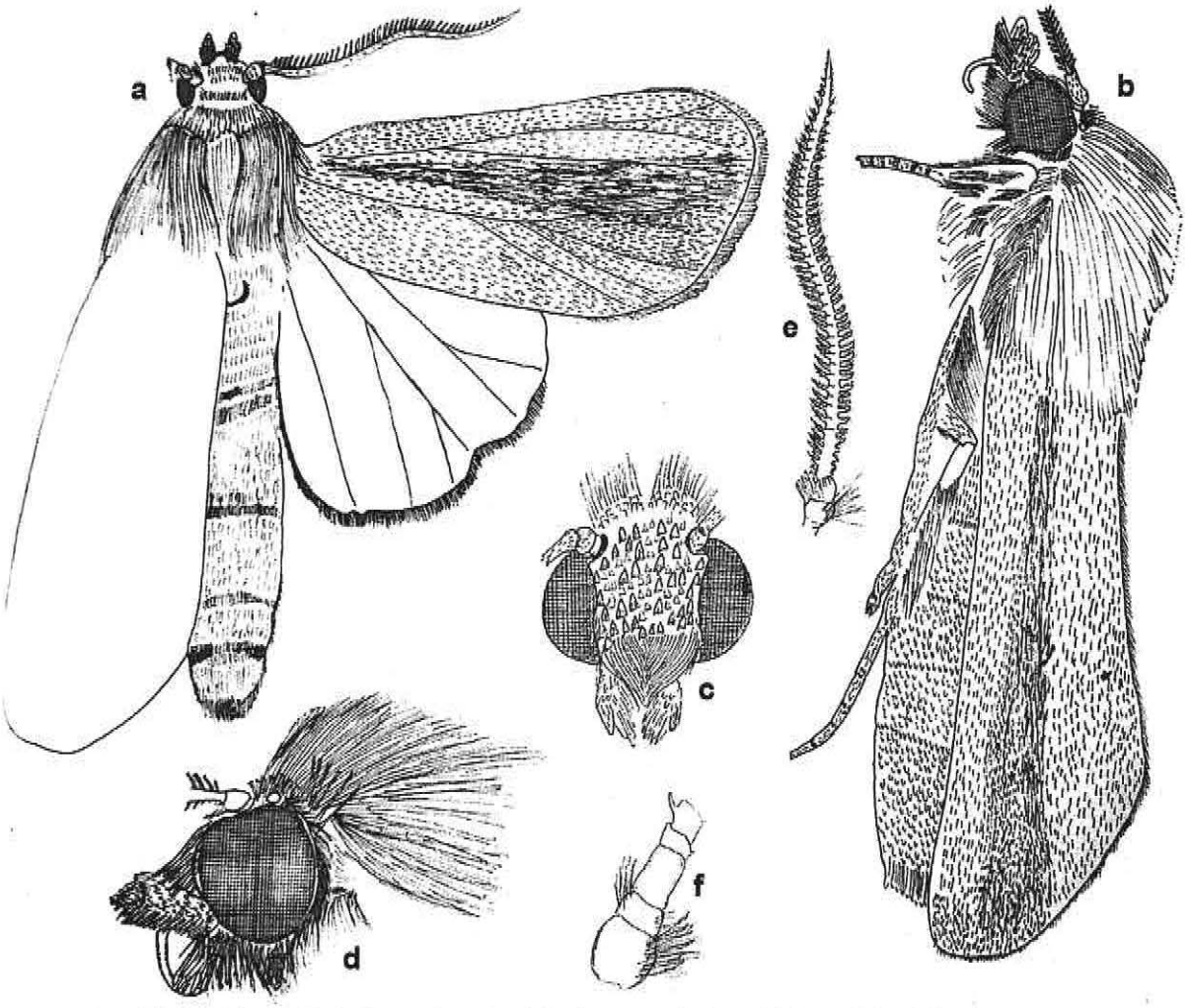

Figure 11 a–f. Male *Sesamia calamistis* Hampson in dorsal (a) and lateral (b) views, frontal (c) and lateral (d) views of head, antenna (e), and scape + pedicel + three funicles (f)

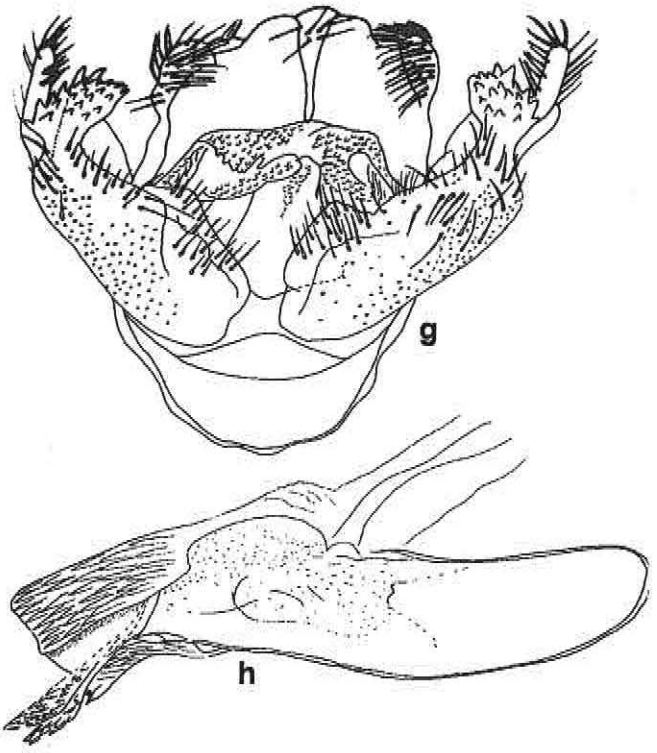

Figure 11 g–h. Male genitalia (g) and aedeagus (h) of *S. calamistis* Hampson

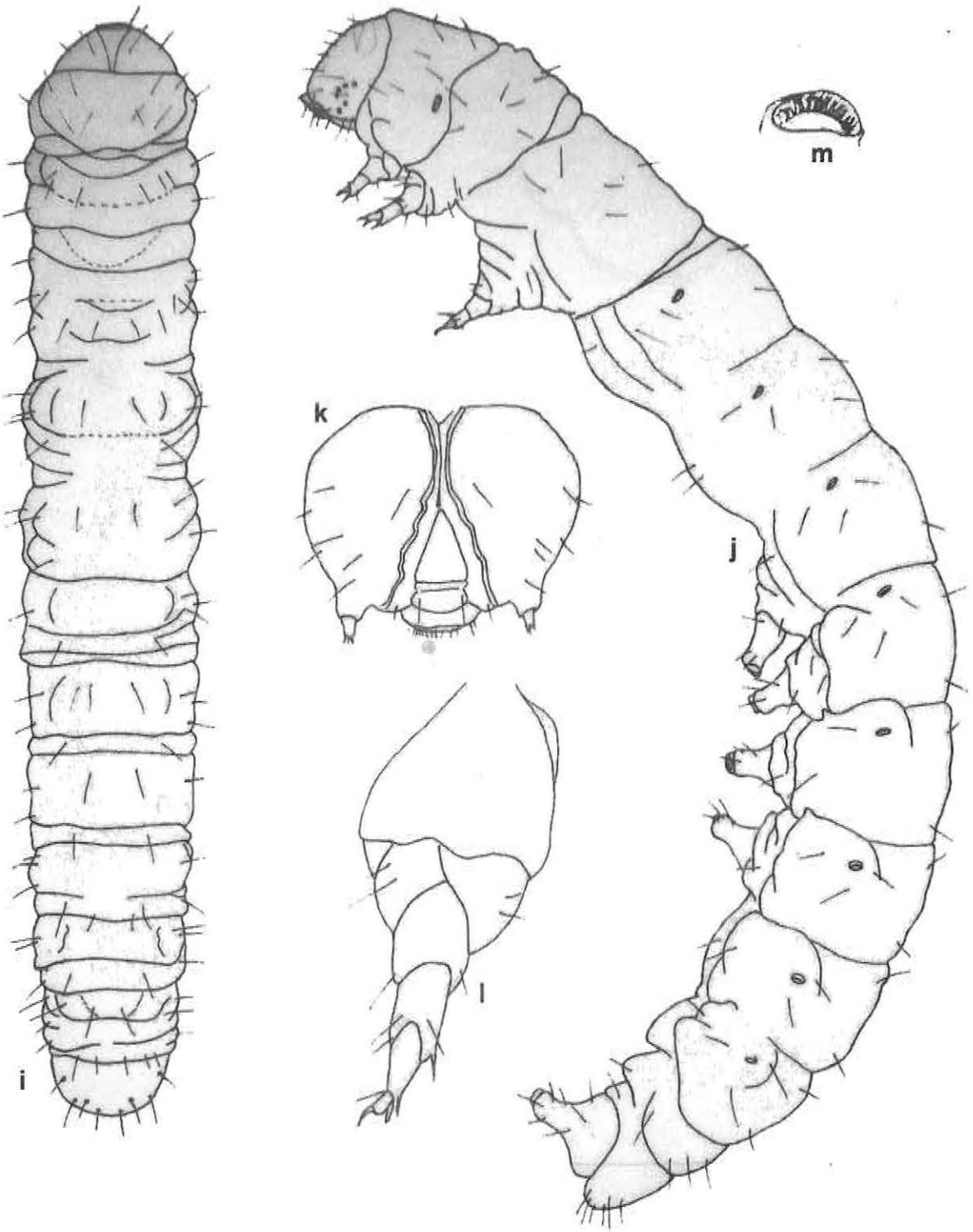

Figure 11 i–m. Larva of *S. calamistis* in dorsal (i), lateral (j) views, frontal view of head (k), leg I (l), and linear pattern of crochets (m)

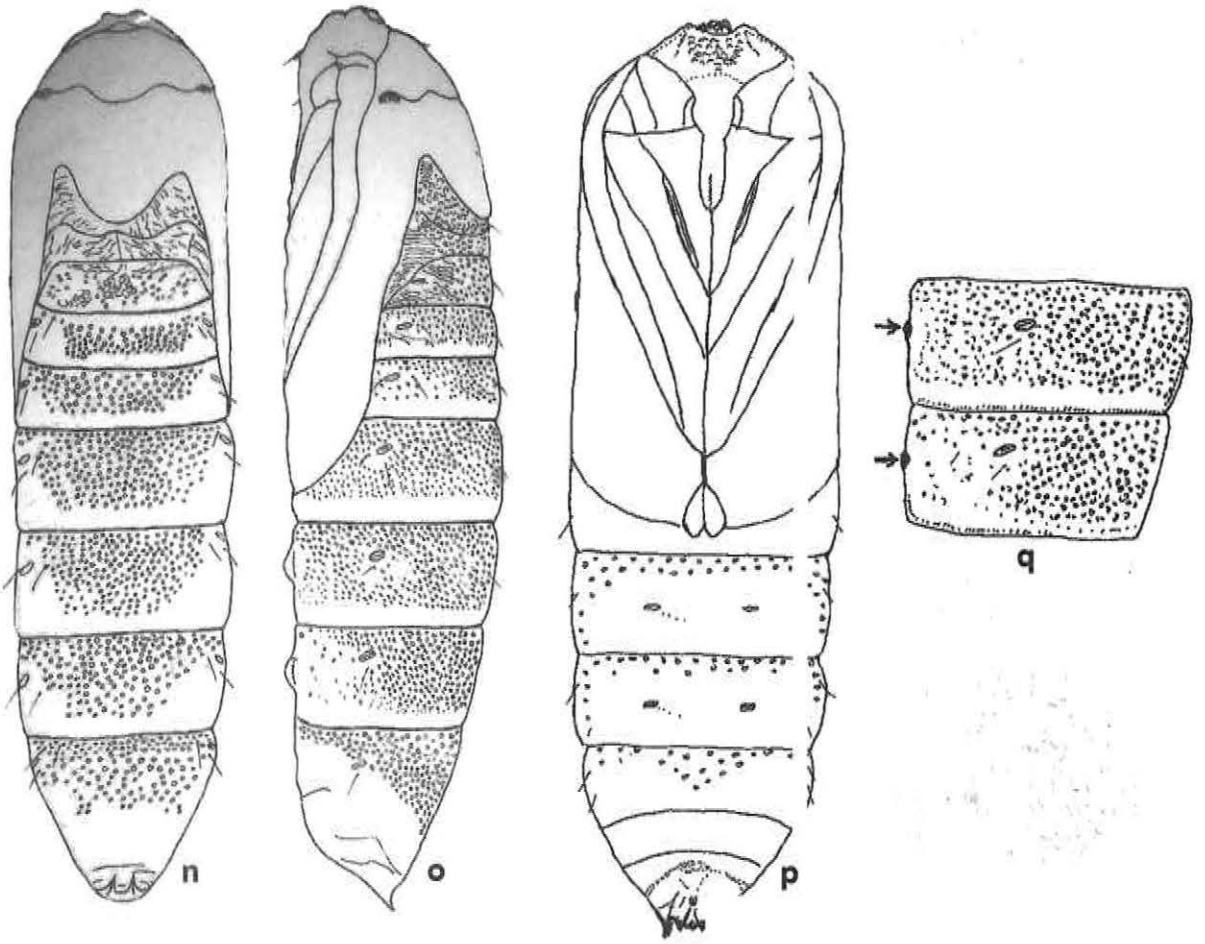

Figure 11 n–q. Dorsal (n), lateral (o) and ventral (p) views of the pupa of *S. calamistis,* lateral view of abdominal segments IV–V (q)

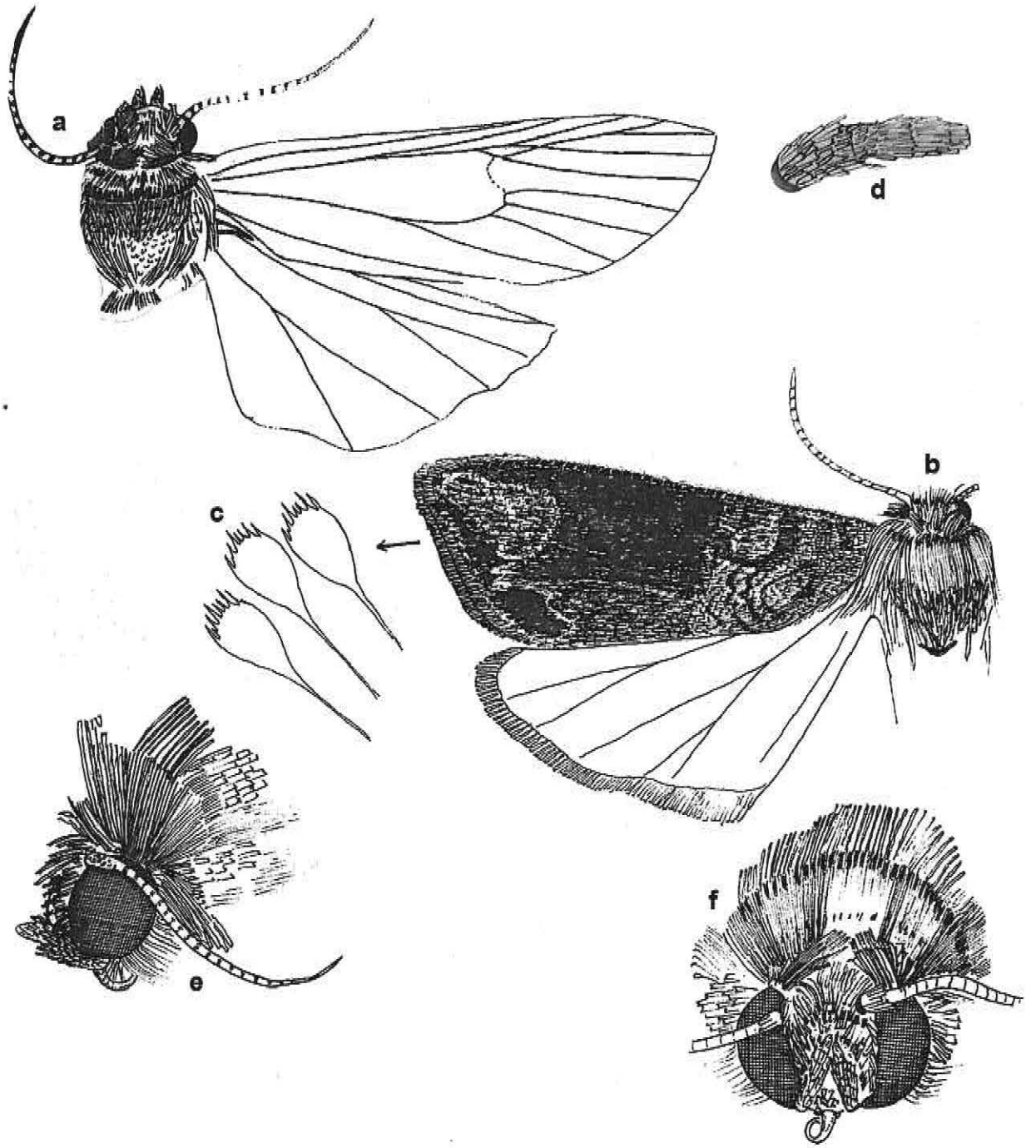

Figure 12 a–f. Adult of *Manga nubifera* (Hampson) showing the wing venation (a), wing pattern (b), hair scales on terminal fringes of wing (c), hairs on scape and pedicel of antenna (d), and lateral (e) and frontal (f) views of head

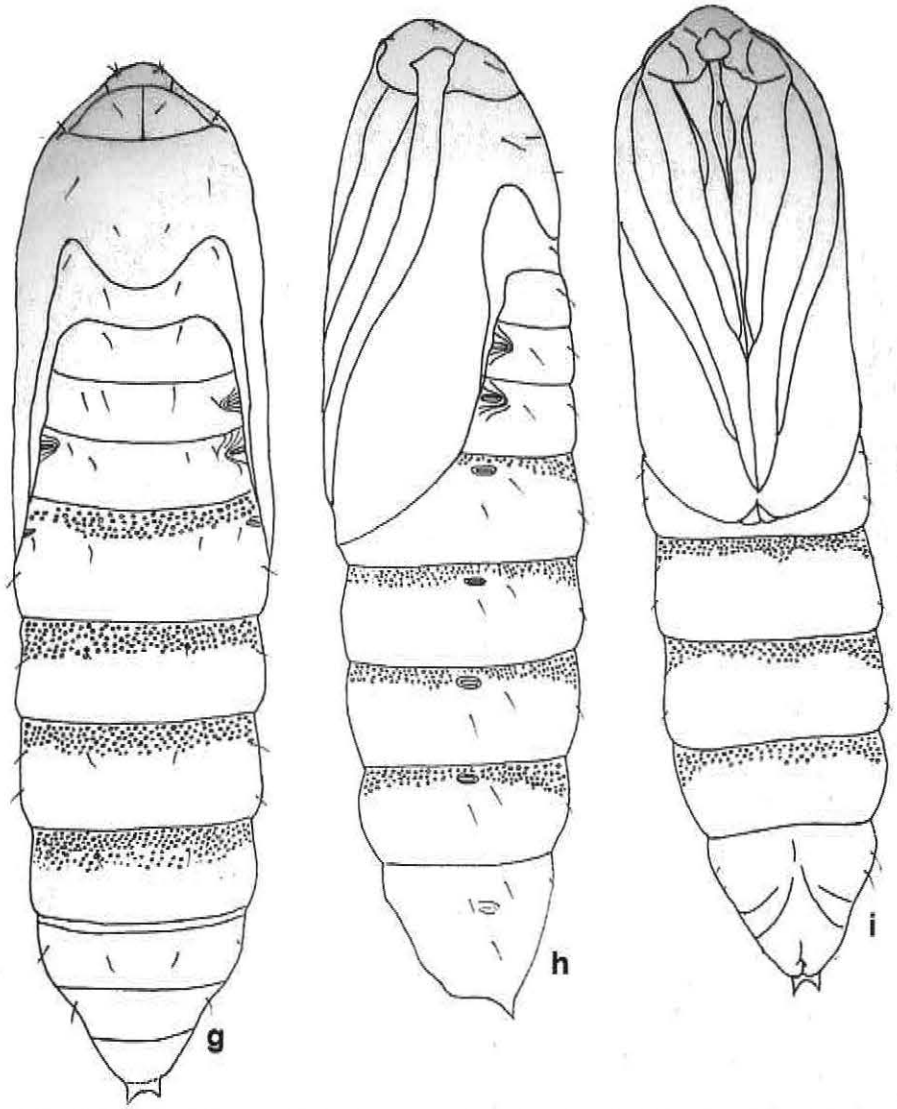

Figure 12 g–i. Pupa of *Manga nubifera* (Hampson) in dorsal (g), lateral (h) and ventral (i) views

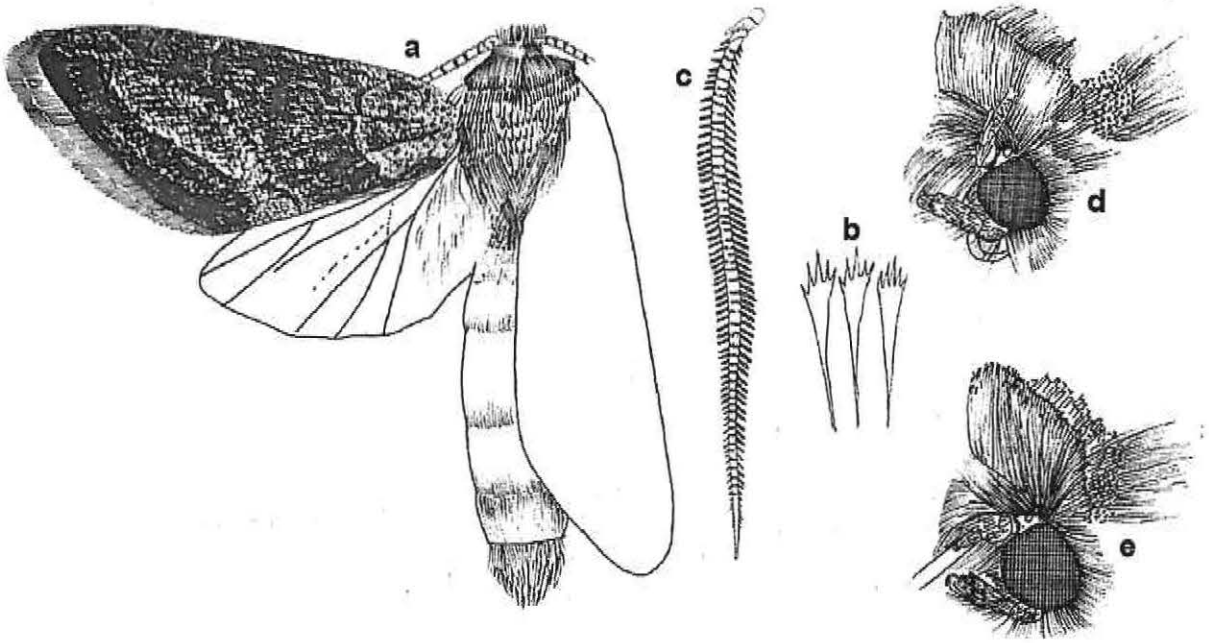

Figure 13 a–e. *Busseola fusca* (Fuller) female moth (a), hair scales on terminal fringes (b), male antenna (c), and lateral view of male (d) and female (e) heads

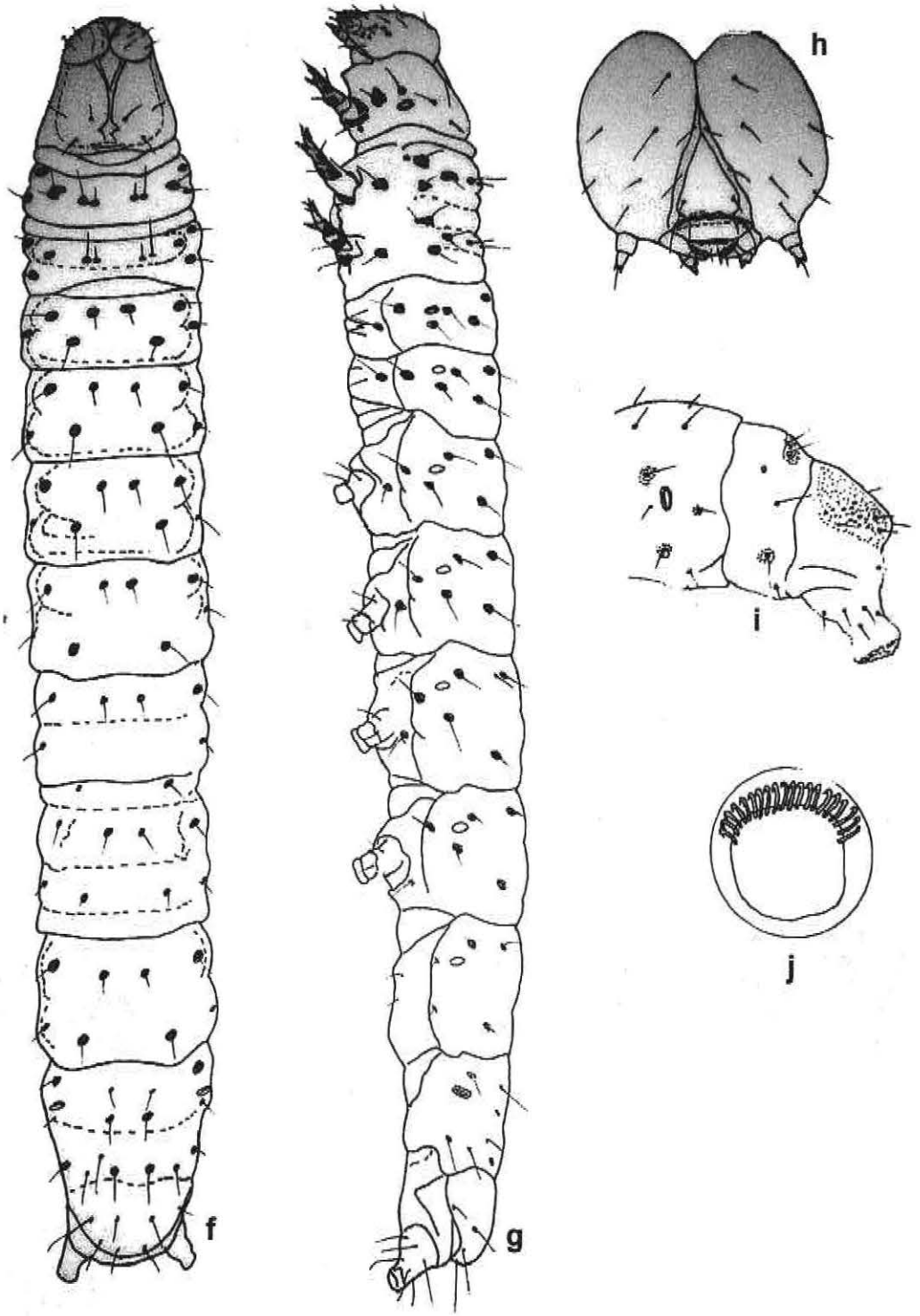

Figure 13 f–j. Dorsal (f) and lateral (g) views of *B. fusca* larva, frontal view of head (h), lateral view of anal plate and proleg (i) and the linear crochets (j)

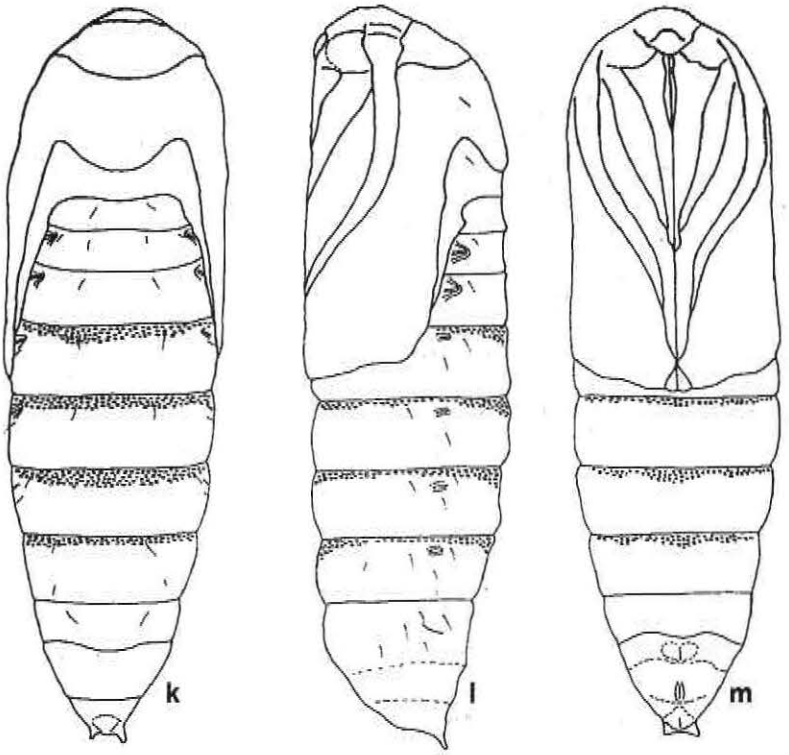

Figure 13 k–m. Dorsal (k), lateral (l) and ventral (m) views of *B. fusca* pupa

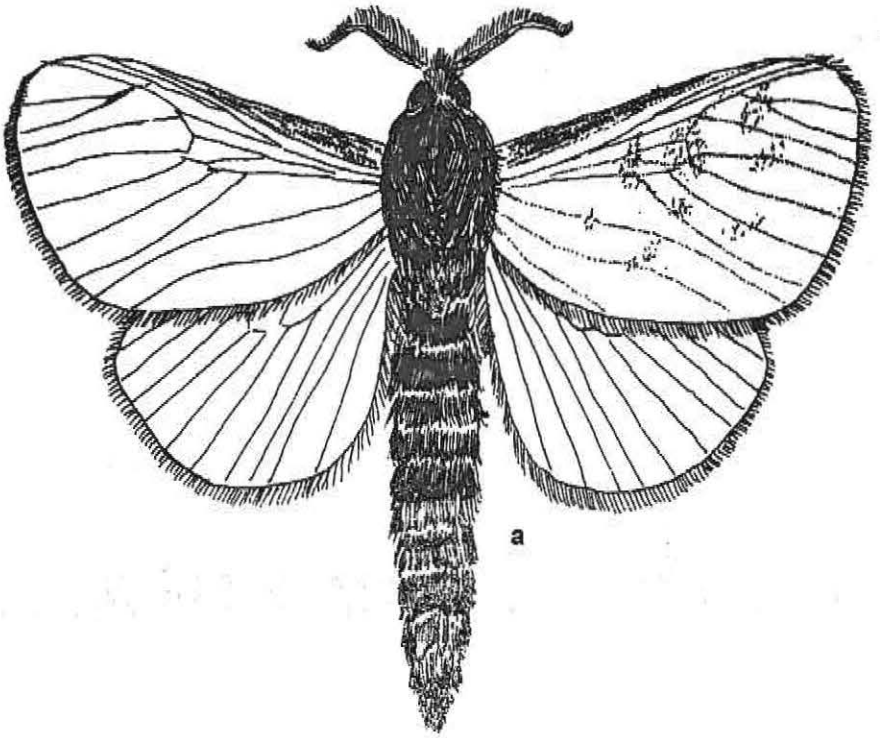

Figure 14 a. Moth of the cossid, *Phragmataecia boisduvalii* Herrich-Shäffer

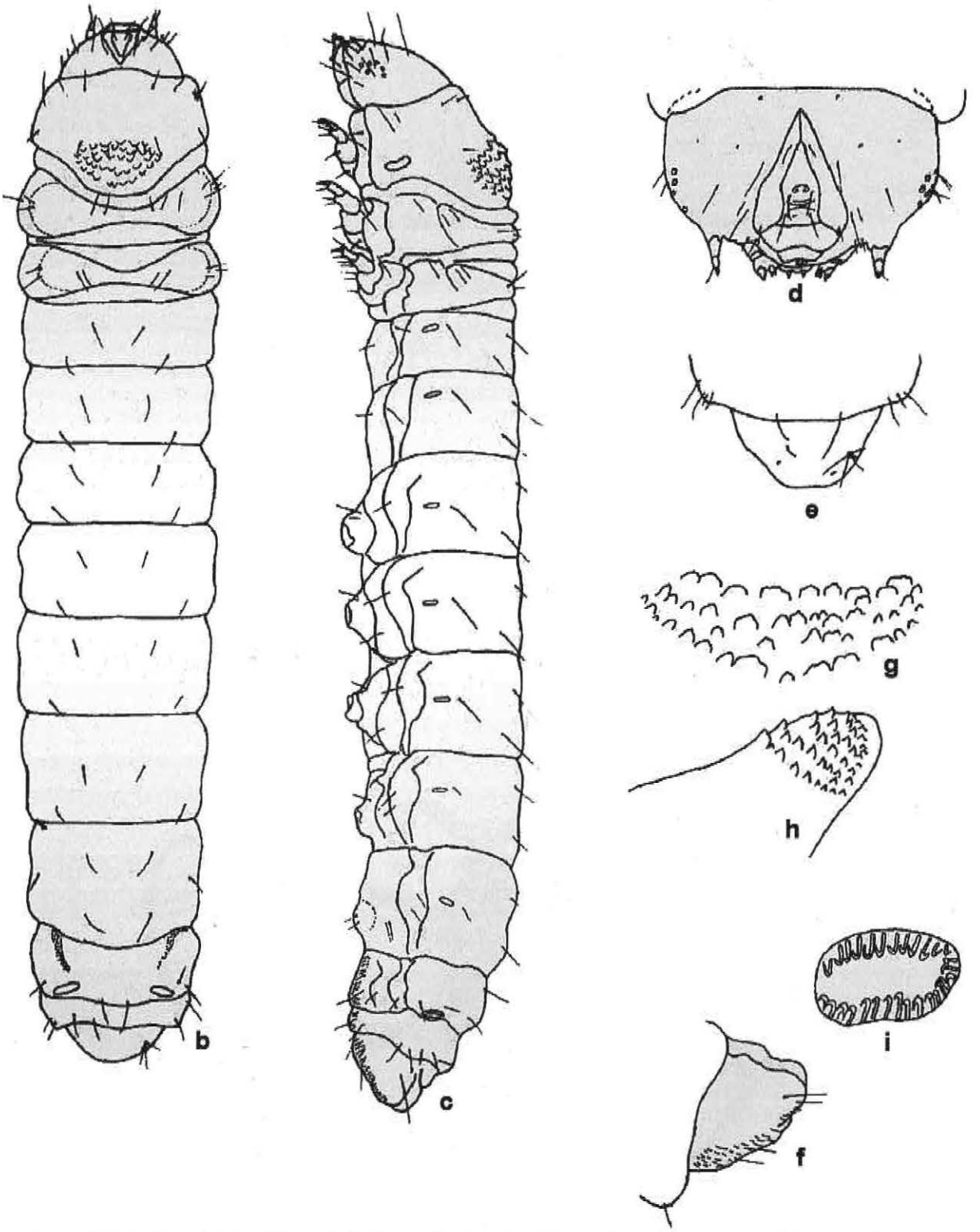

Figure 14 b–i. Dorsal (b) and lateral (c) views of *P. boisduvalii* larva, frontal view of head (d), dorsal (e) and lateral (f) views of anal plate, blunt spikes on the pronotum in dorsal (g) and lateral (h) views and crochets (i)

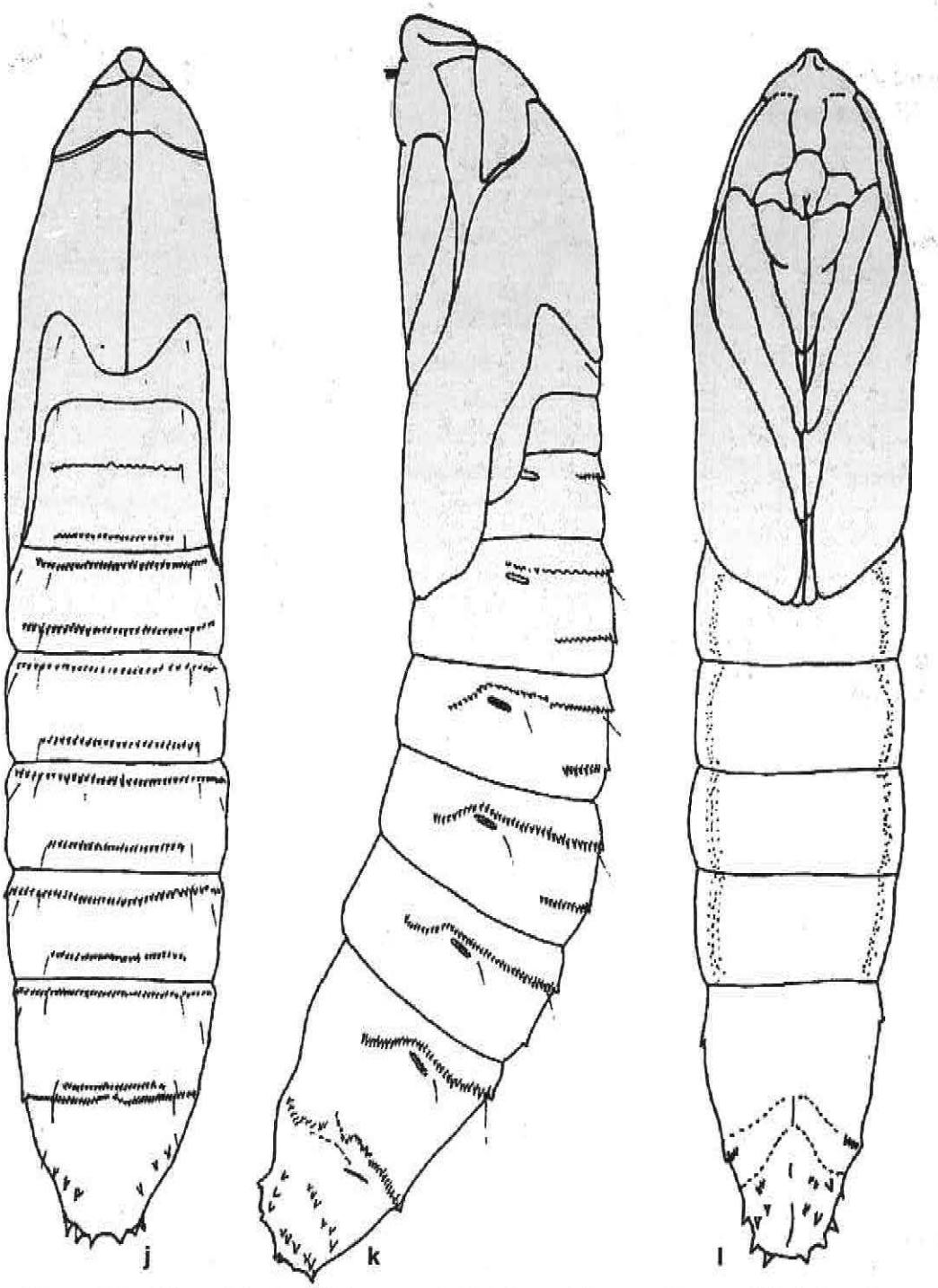

Figure 14 j–l. Dorsal (j), lateral (k) and ventral (l) views of the cossid pupa, *P. boisduvalii*

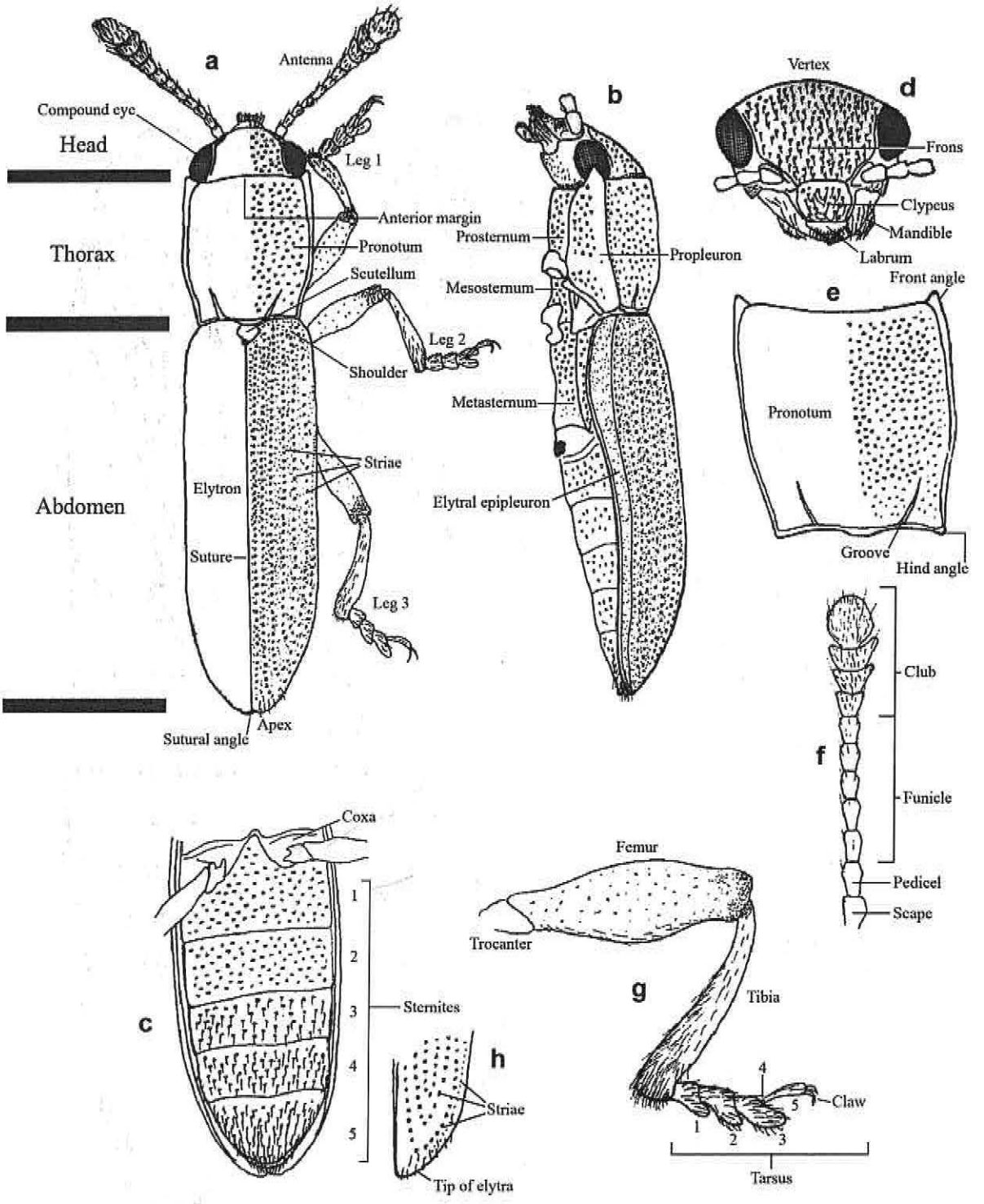

Figure 15 a–h. Morphology of a beetle showing the dorsal (a) and lateral (b) views, abdominal venter (c), frontal view of head (d), pronotum (e), antenna (f), leg III (g) and tip of elytra (h)

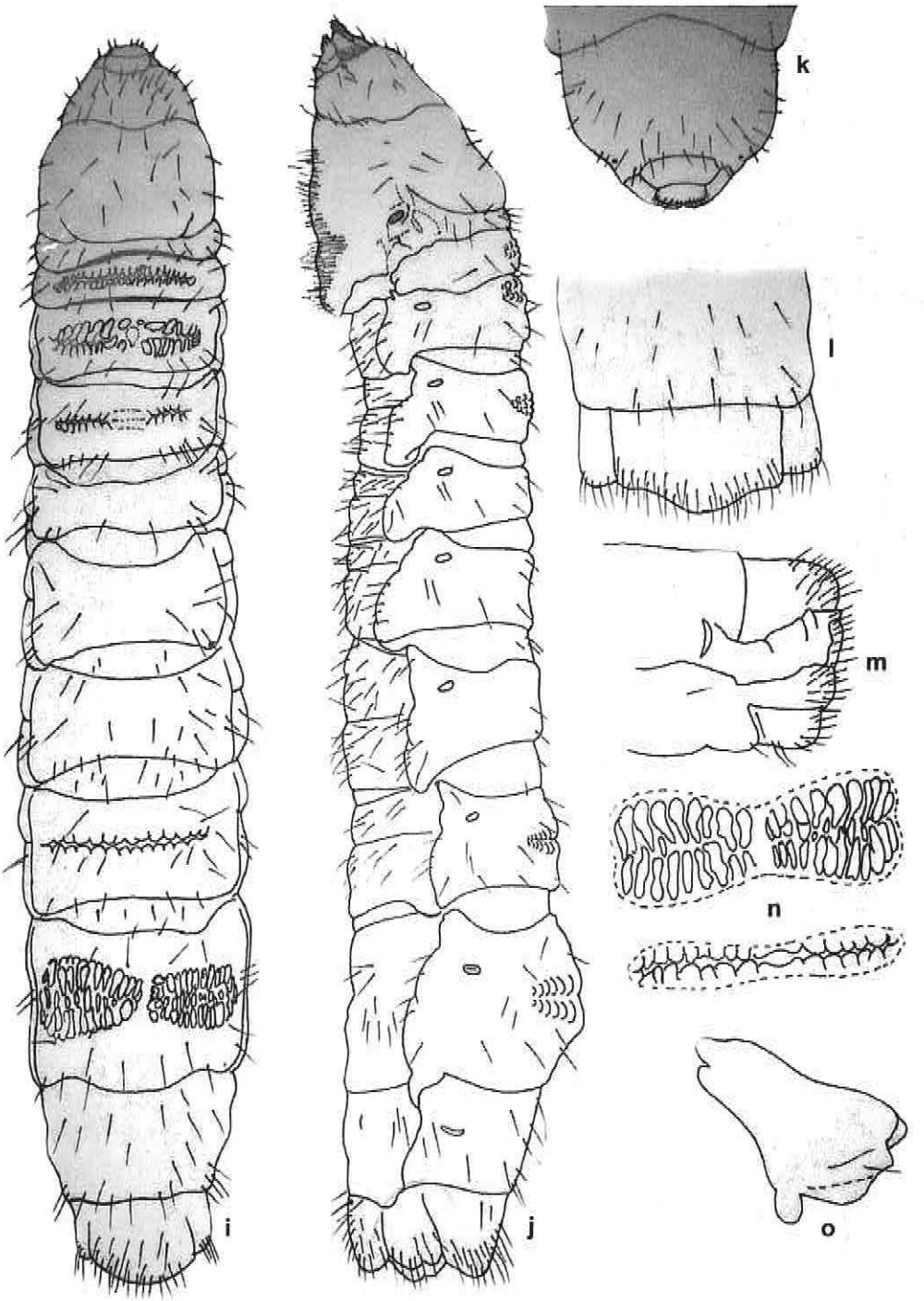

Figure 15 i–o. Dorsal (i) and lateral (j) views of coleopteran larva, head (k), dorsal (l) and lateral (m) views of anal plate, two forms of ampullae (n) and mandible (o)

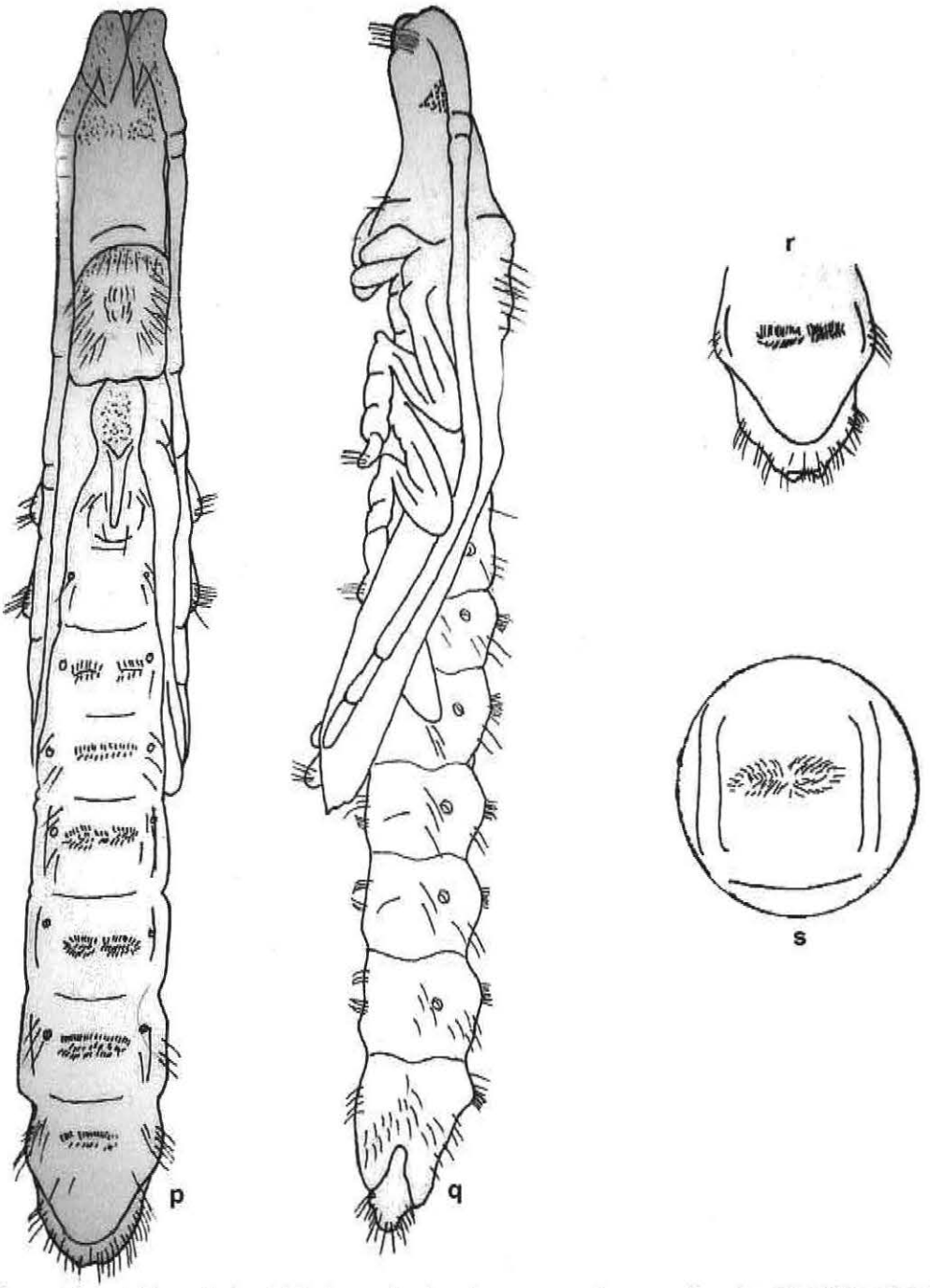

Figure 15 p–s. Dorsal (p) and lateral (q) views of coleopteran pupa, dorsum of tergites IX–X (r) and ampulla (s)

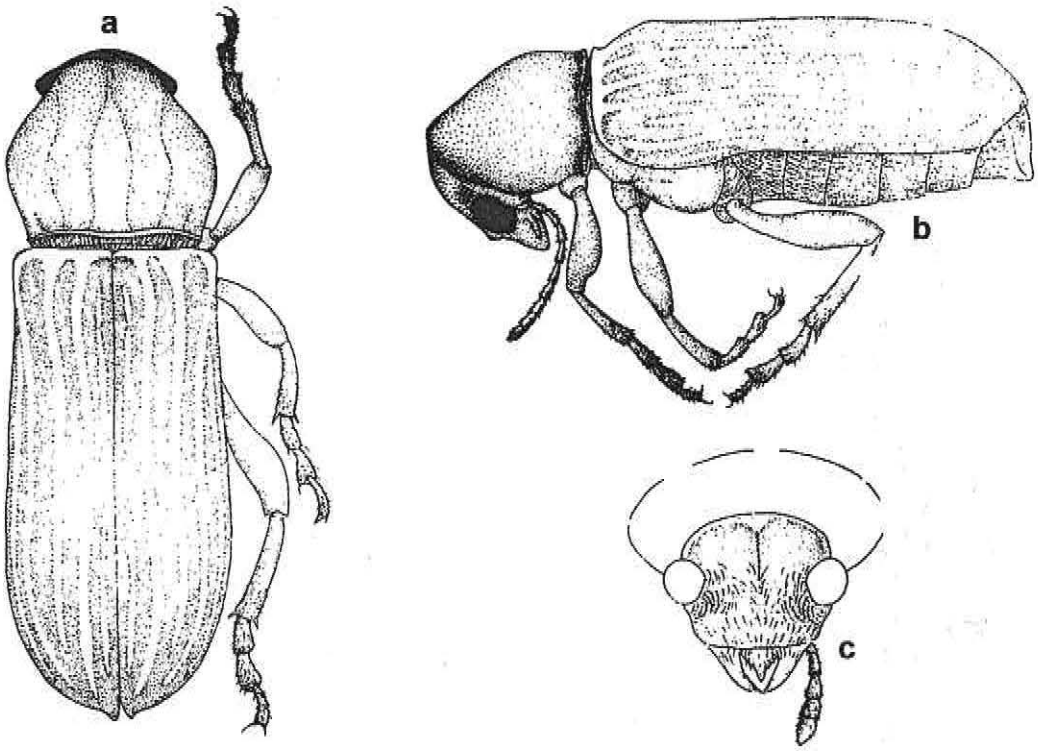

Figure 16 a–c. Dorsal (a), lateral (b) and head frontal views (c) of the anthribid beetle, *Phloebius* sp. A

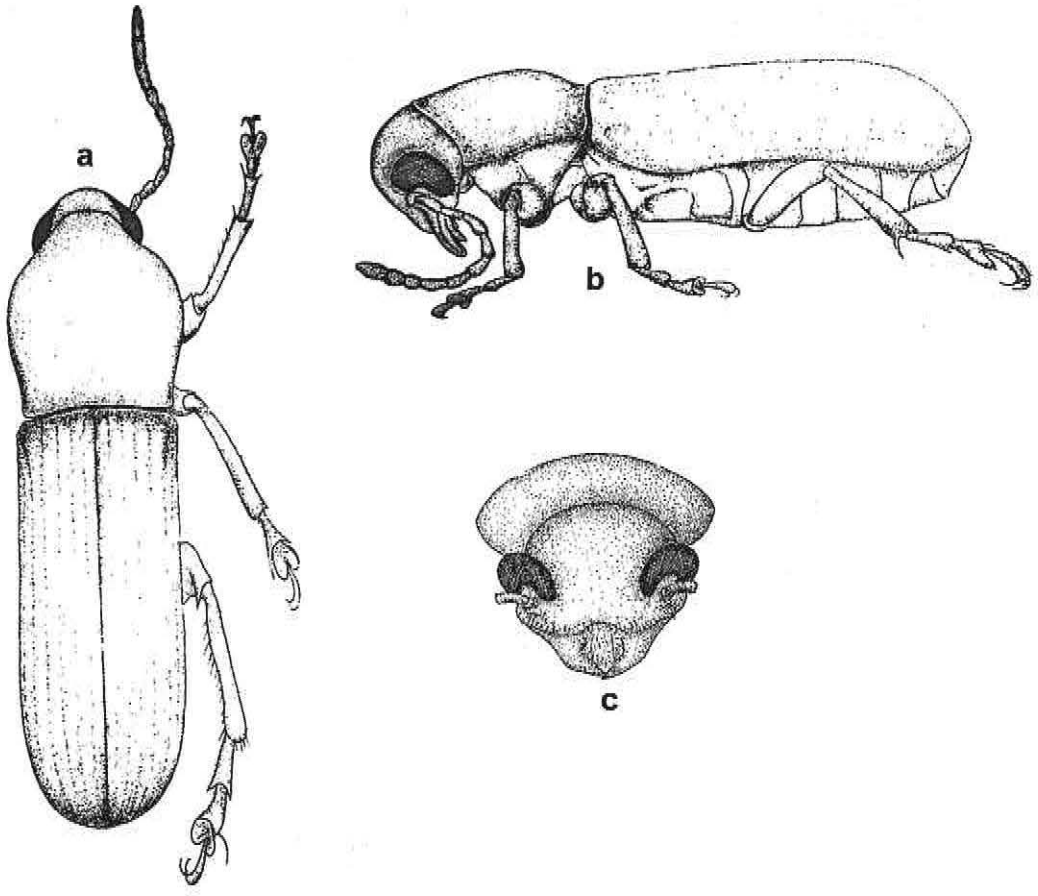

Figure 17 a–c. *Phloebius* sp. B dorsal (a), lateral (b) and frontal (c) views of head

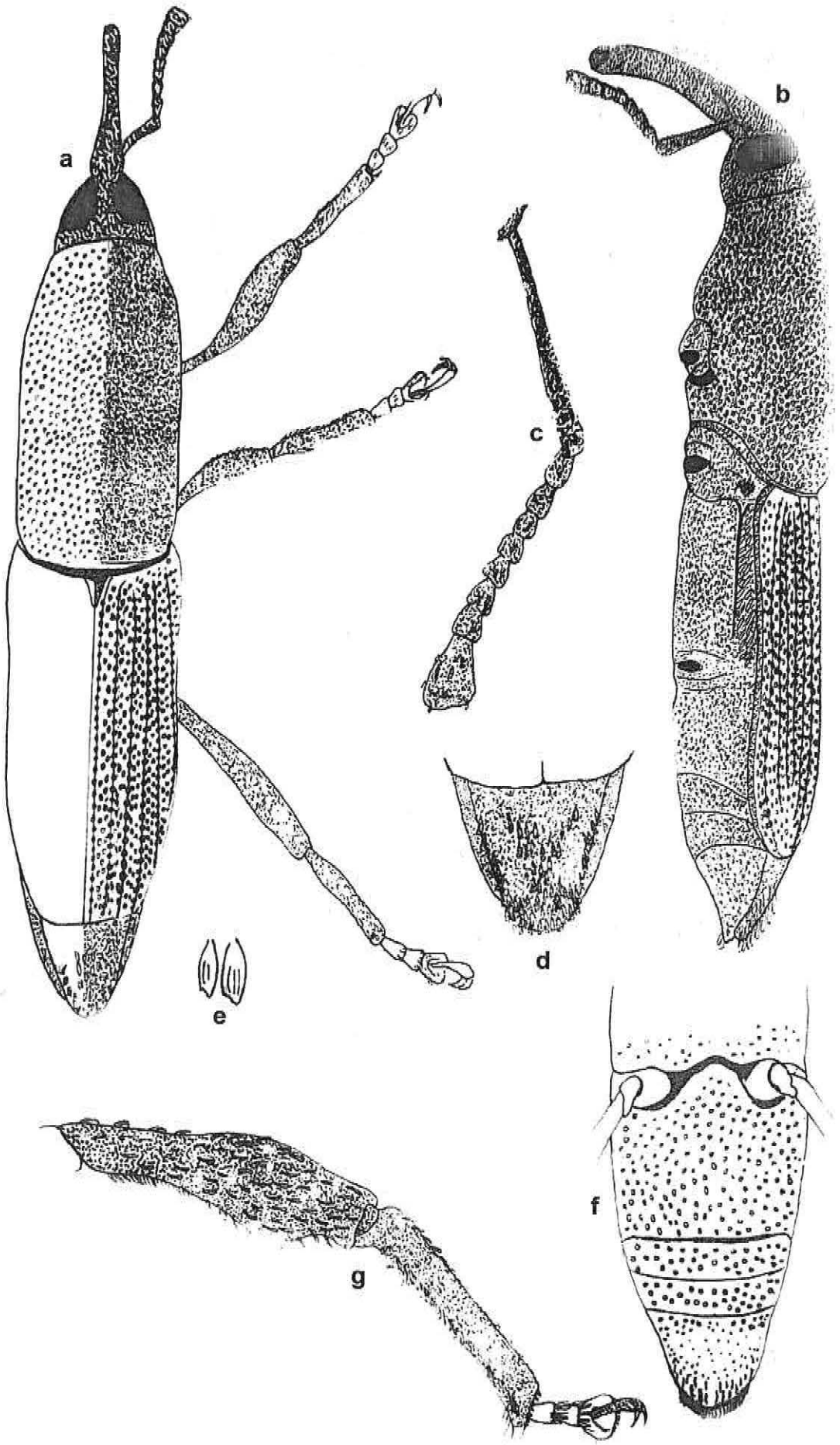

Figure 18 a–g. Dorsal (a) and lateral (b) views of ?*Odioporus* sp., antenna (c), hairs on the exposed abdominal tergite (d), closeup of hairs (e), abdominal venter (f) and leg I (g)

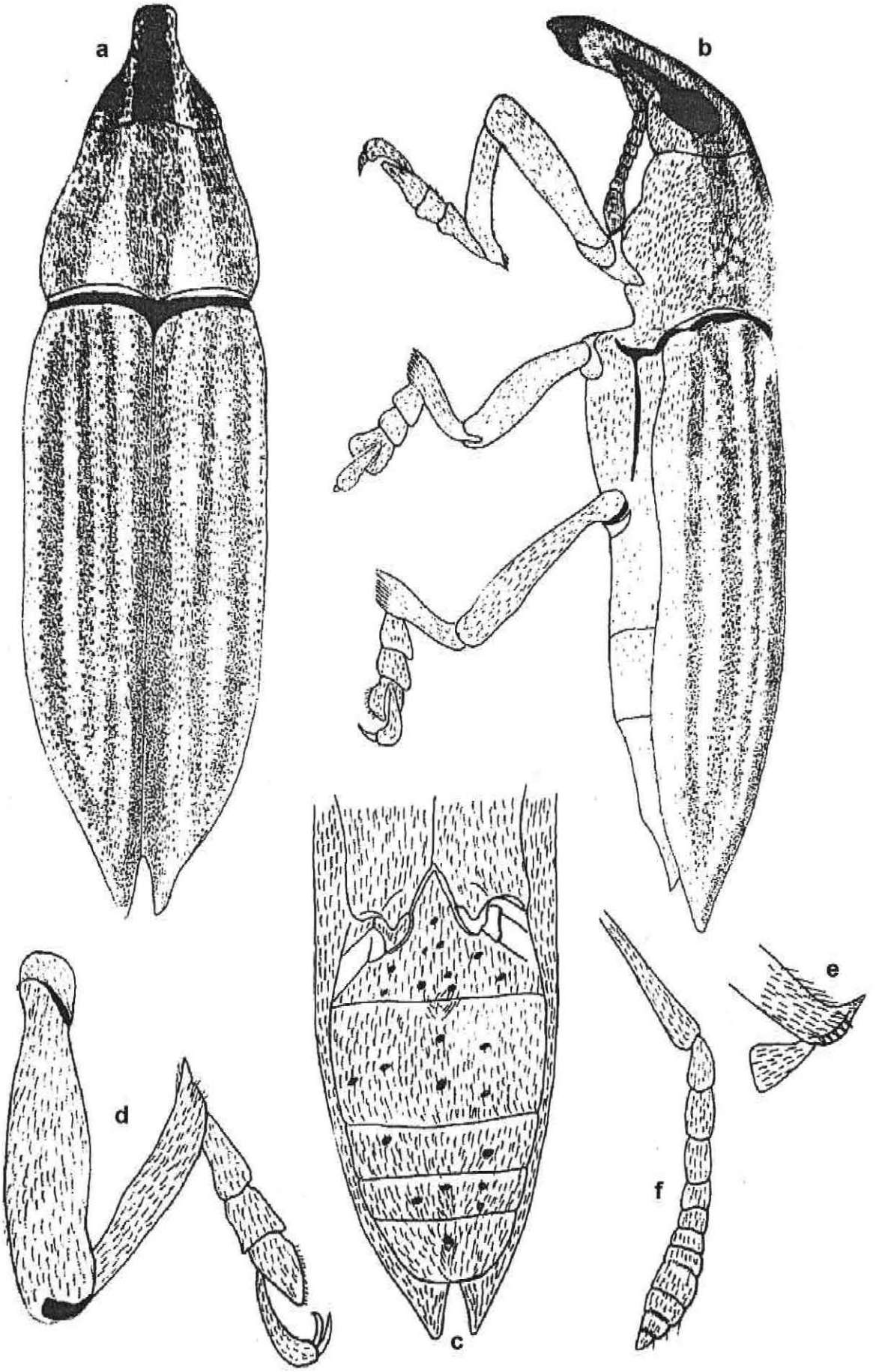

Figure 19 a–f. Dorsal (a) and lateral (b) views of *Lixus* sp. A, sternites (c), leg I (d), tip of tibia (e) and antenna (f)

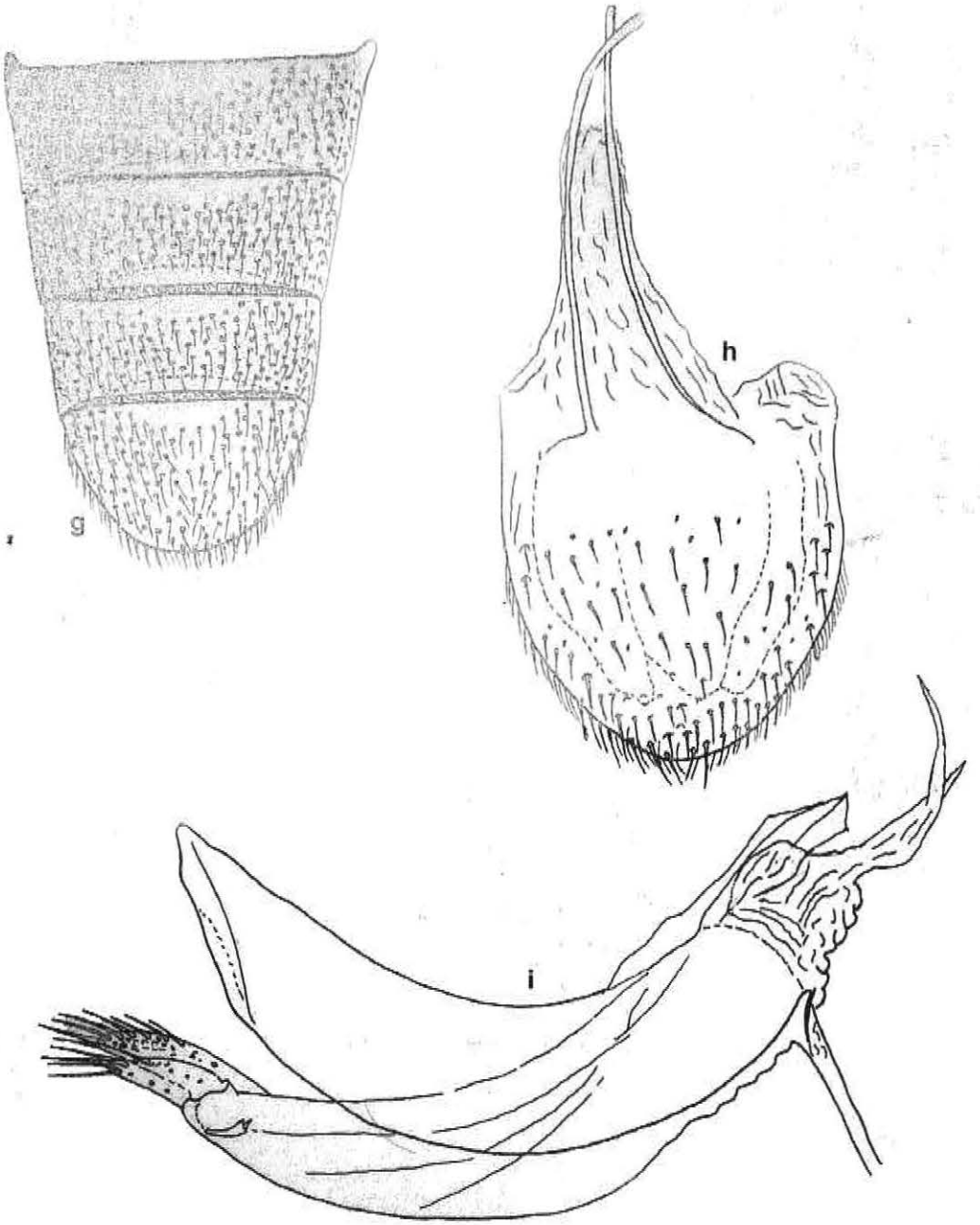

Figure 19 g–i. Sternites (g), abdominal sternite IX of male (h) and aedeagus (i) of *Lixus* sp. A

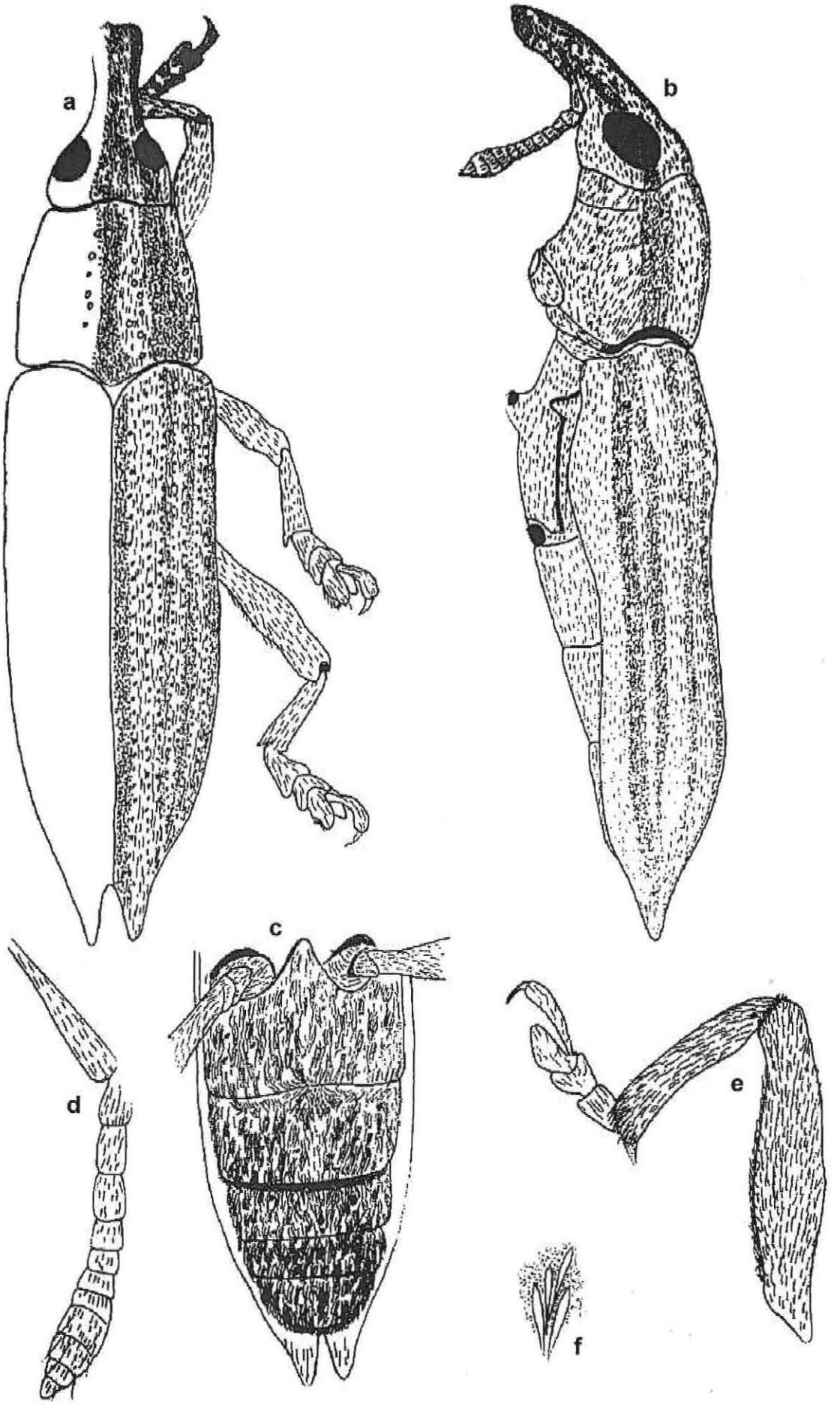

Figure 20 a–f. Dorsal (a) and lateral (b) views of *Lixus* near *germaini* Hustache, abdominal sternites (c), antenna (d) leg I (e) and hairs on abdominal venter (f)

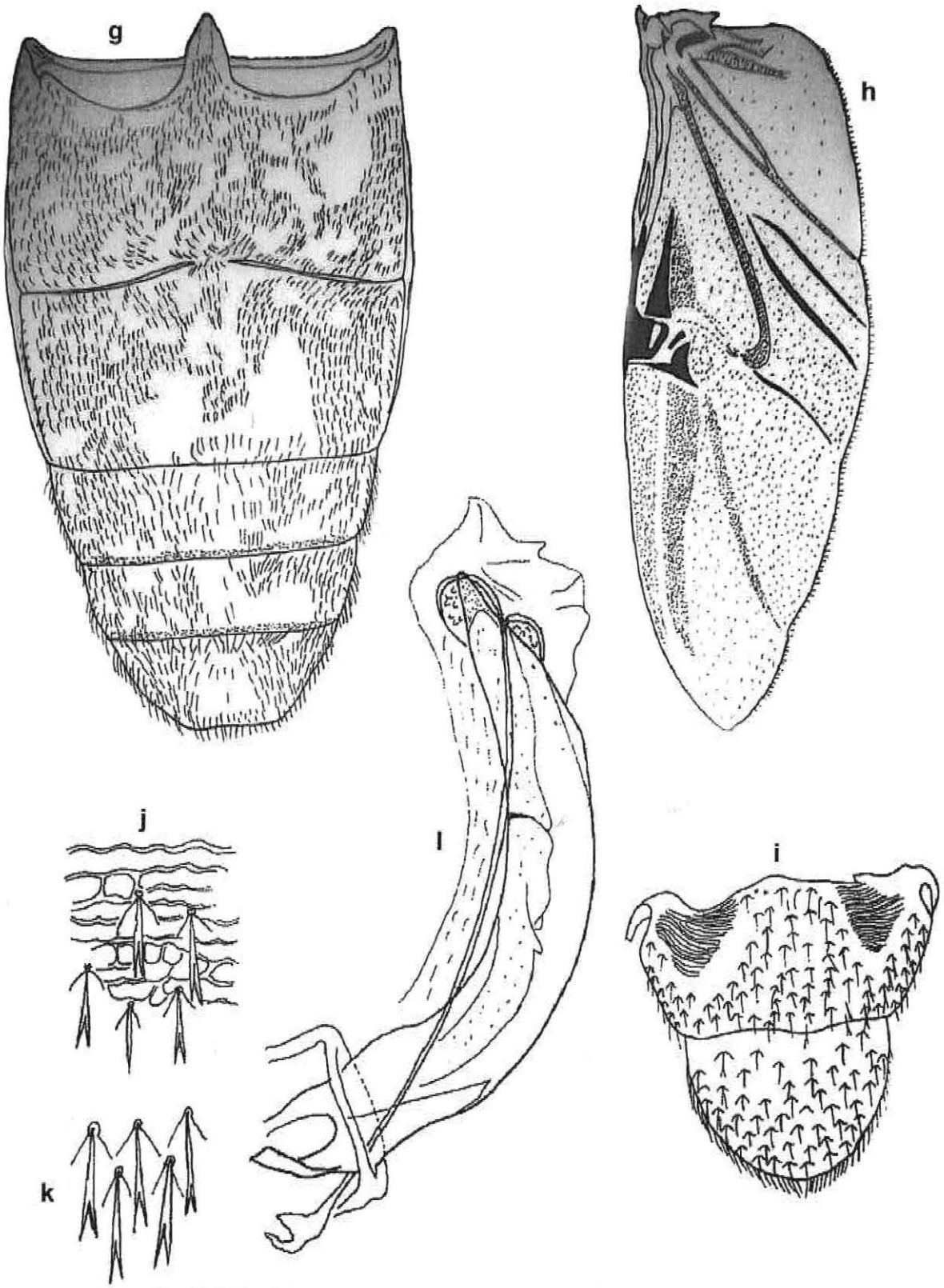

Figure 20 g–l. Male abdominal venter of *Lixus* near *germaini* Hustache (g), hindwing (h), sternites VIII–IX (i), sculpture (j) and hairs (k) in terminal sternite, and aedeagus (l)

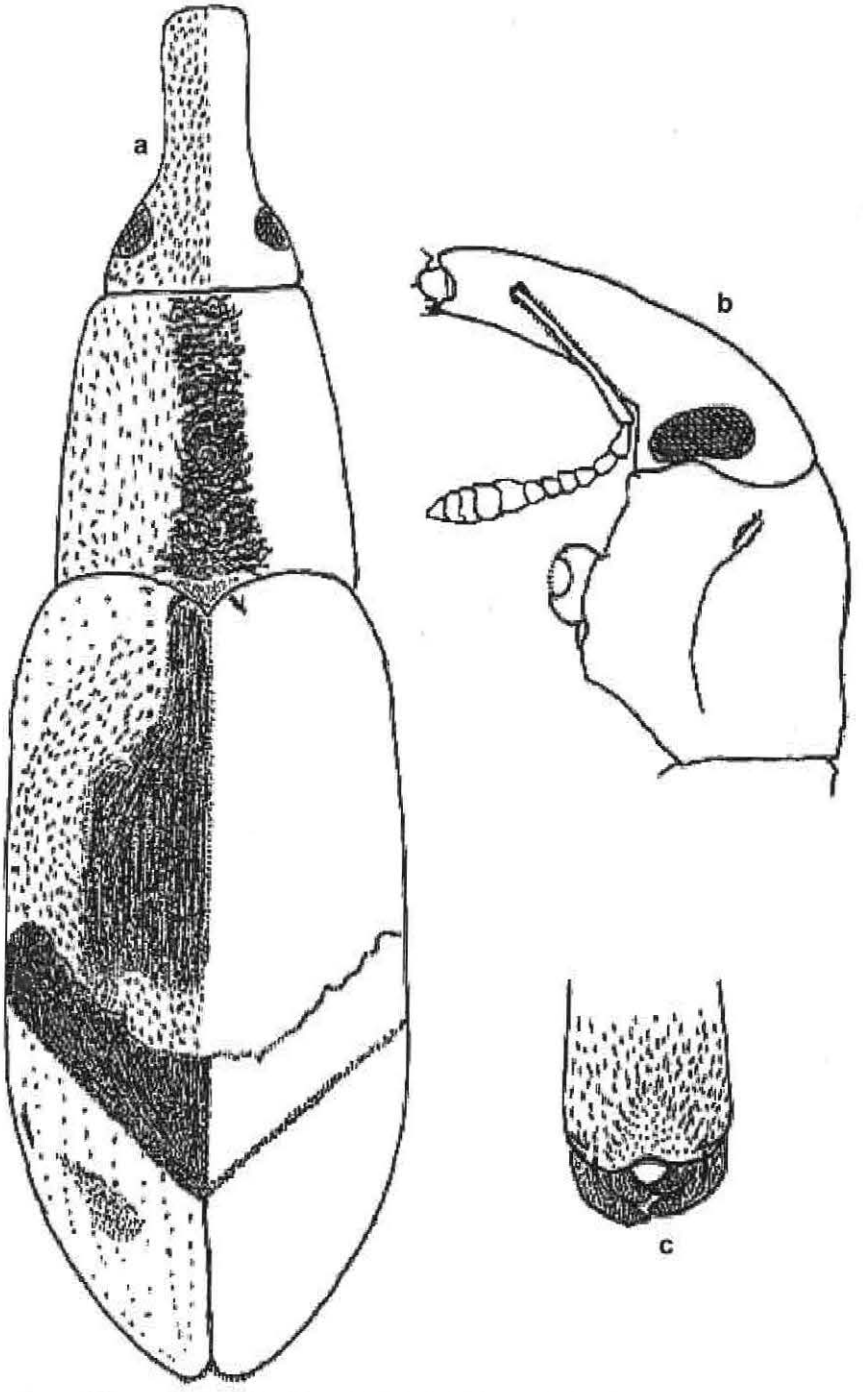

Figure 21 a–c. Dorsal (a) view of adult *Tanymecus* near *dilaticollis* Gyllenhal, lateral view of head (b) and mandible (c)

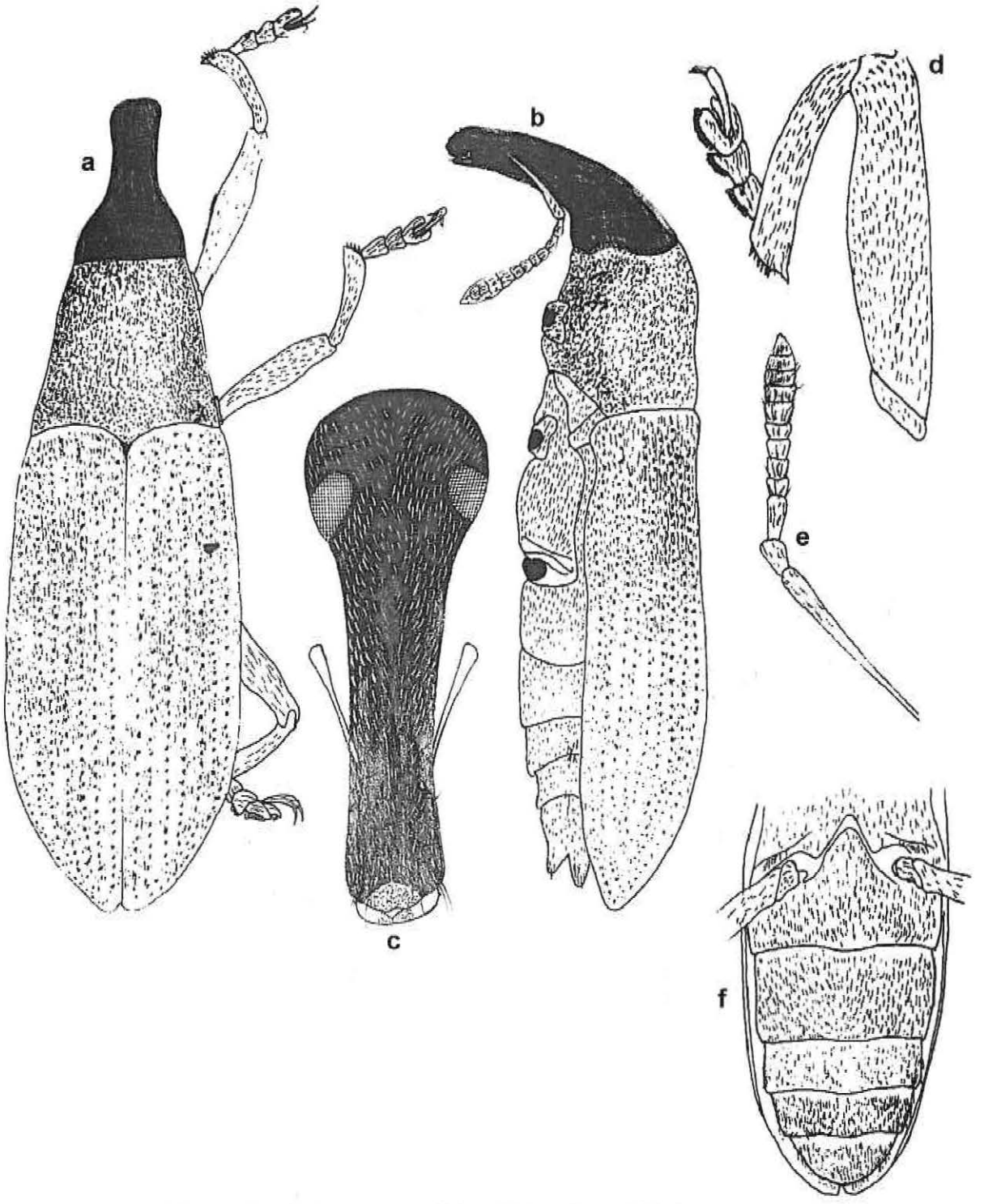

Figure 22 a–f. *Tanymecus* sp. A dorsal (a) and lateral (b) views, rostrum and head (c), leg I (d), antenna (e) and abdominal sternite (f)

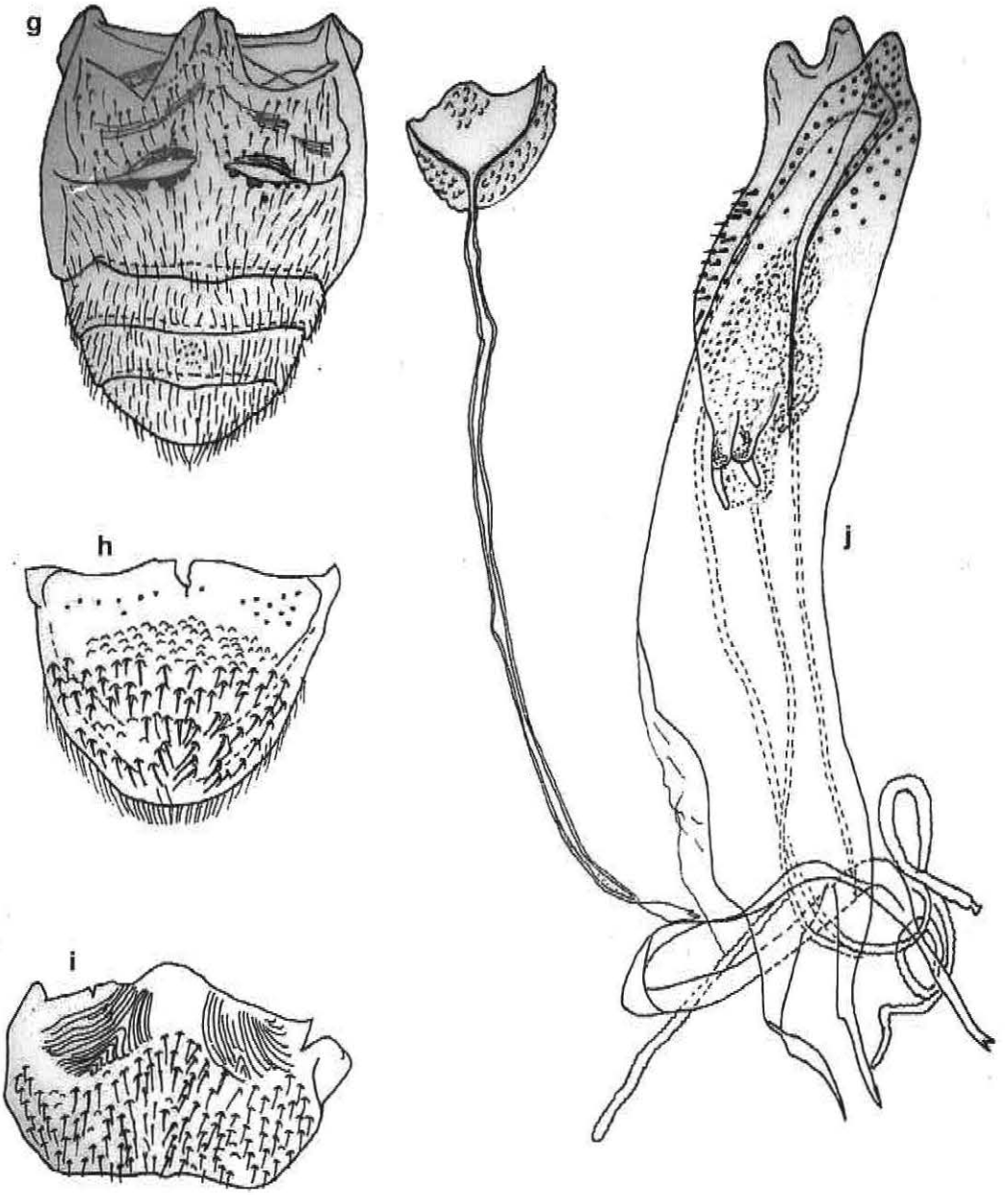

Figure 22 g–j. Ventral abdomen of *Tanymecus* sp. A male (g), sternites VIII (h) and IX (i) and aedeagus (j)

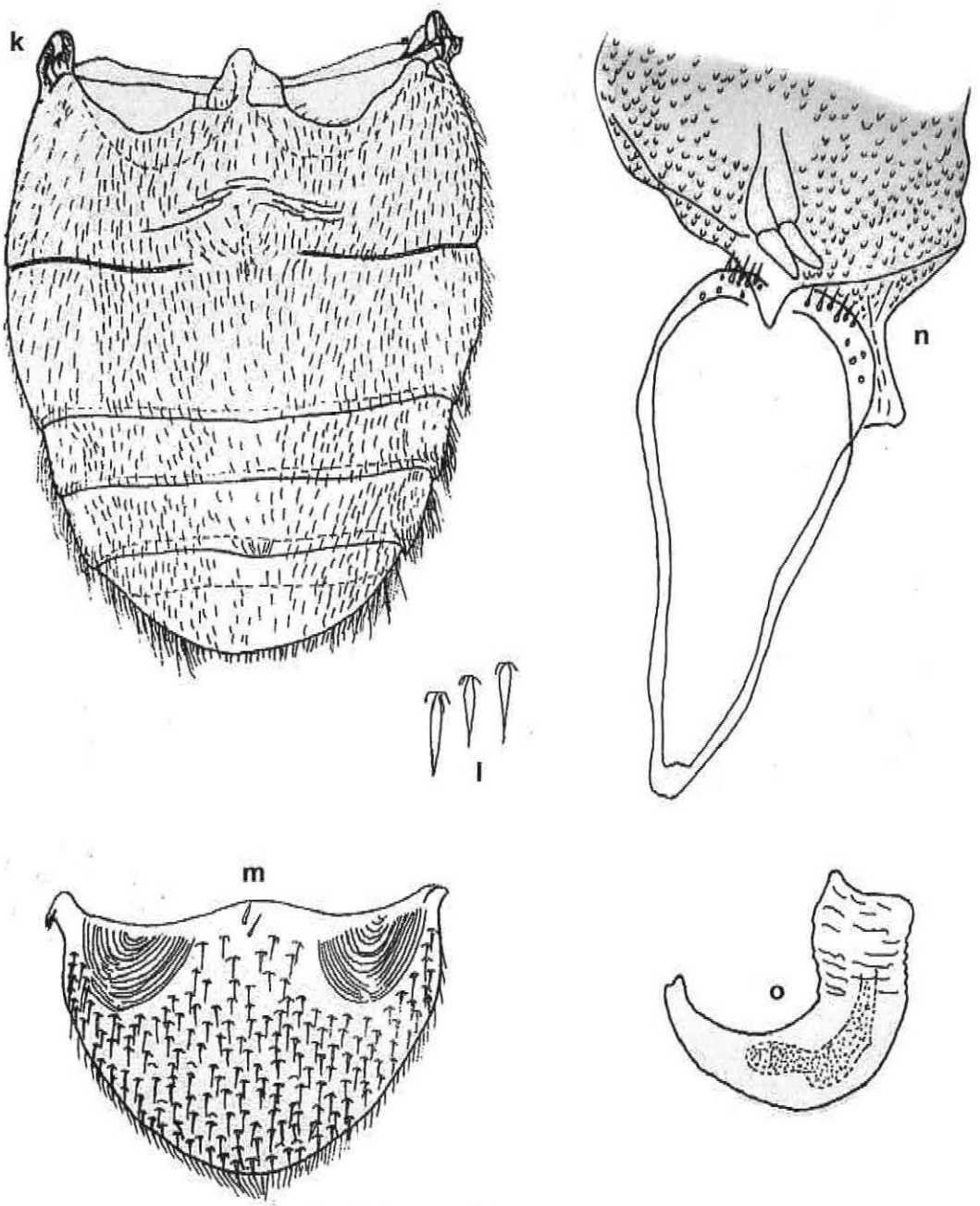

Figure 22 k–o. Female abdominal venter (k) of *Tanymecus* sp. A, abdominal hairs (l), sternite VIII (m), part of female genitalia (n) and spermatheca (o)

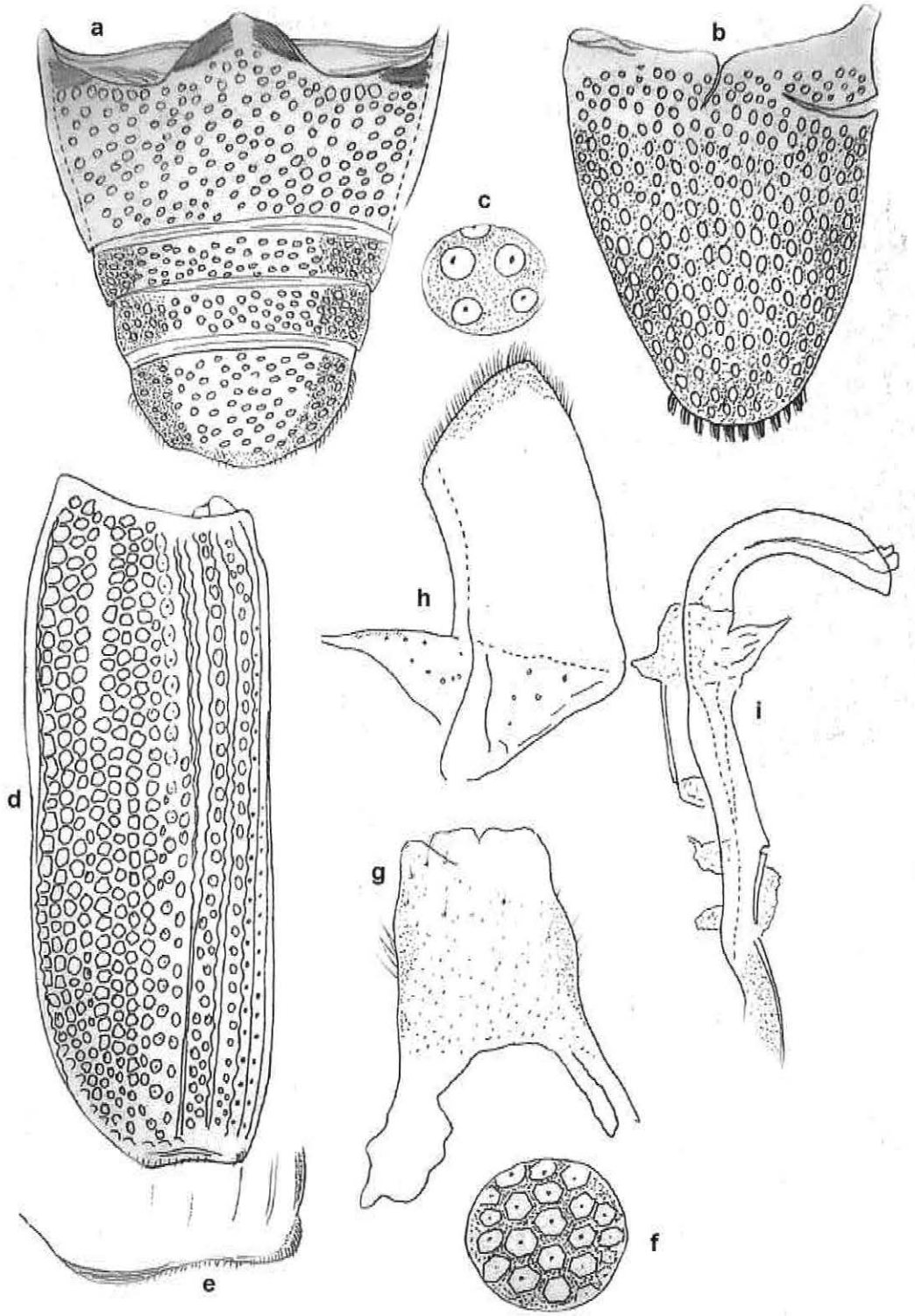

Figure 23 a–i. Abdominal venter (a) and dorsum (b) of ?*Tanymecus* sp., sculpture in sternite (c), left elytron (d) and its tip (e), sculpture of elytron (f), portions of male genitalia (g, h) and aedeagus (i)

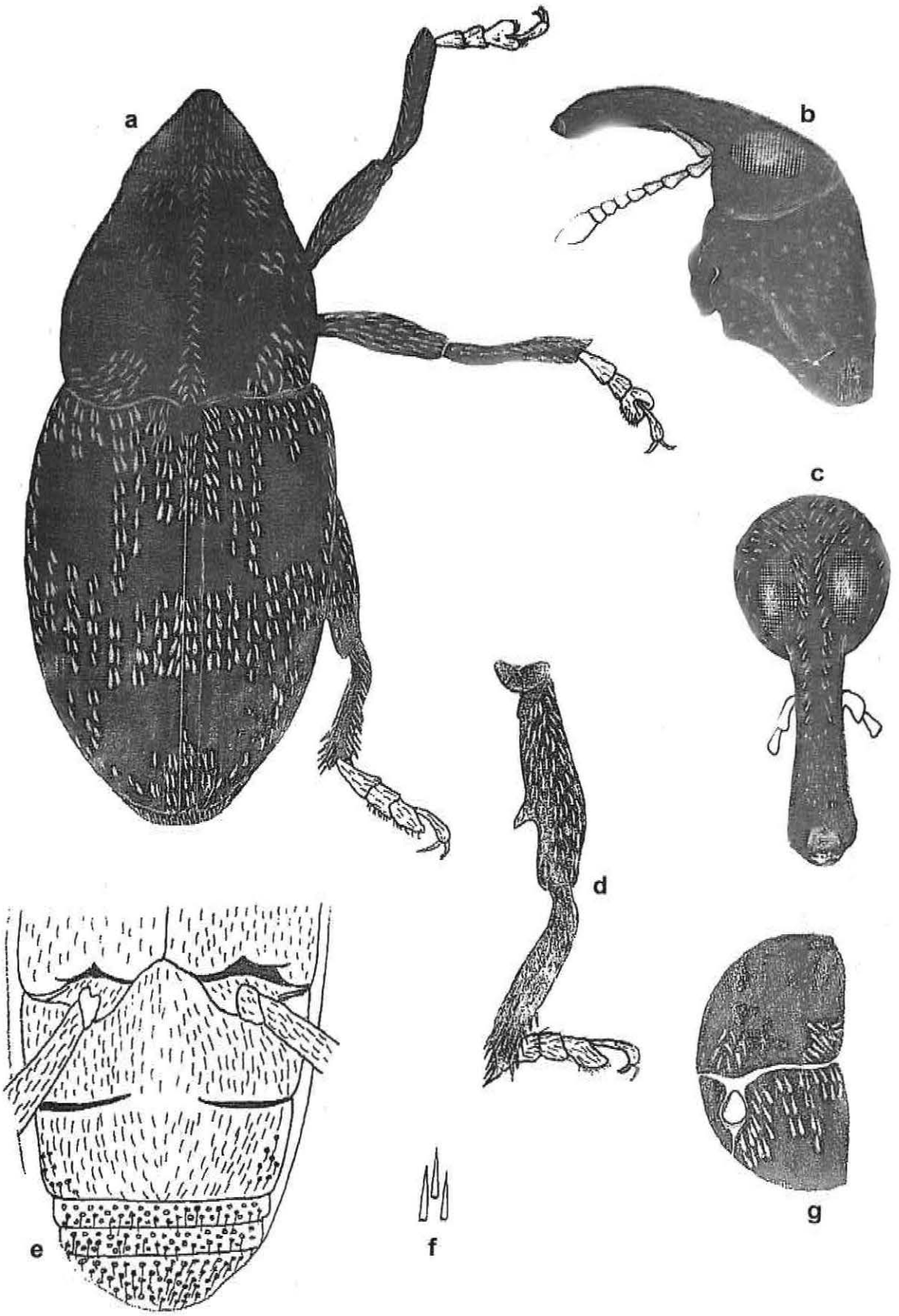

Figure 24 a–g. Dorsal (a) view of unknown genus sp. A, lateral (b) and frontal (c) views of head, leg III (d), abdominal venter (e) and its hairs (f) and the junction of posterolateral pronotum and shoulder (g)

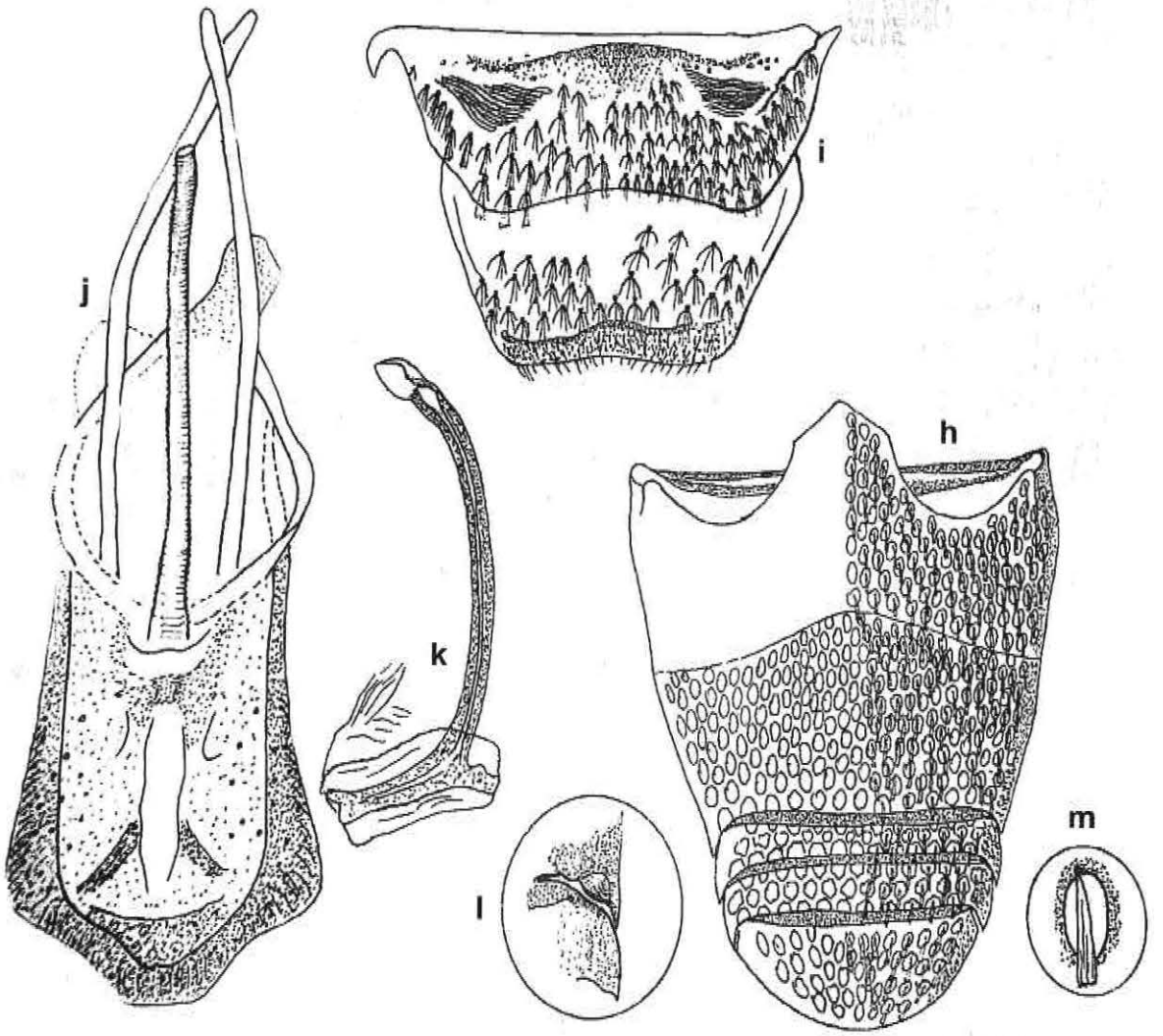

Figure 24 h–m. Abdominal venter (h) of male of unknown genus sp. A, sternites VIII–IX (i), male genitalia (j), siphon (k), lateral junction of two sternites (l) and hair in each puncture (m)

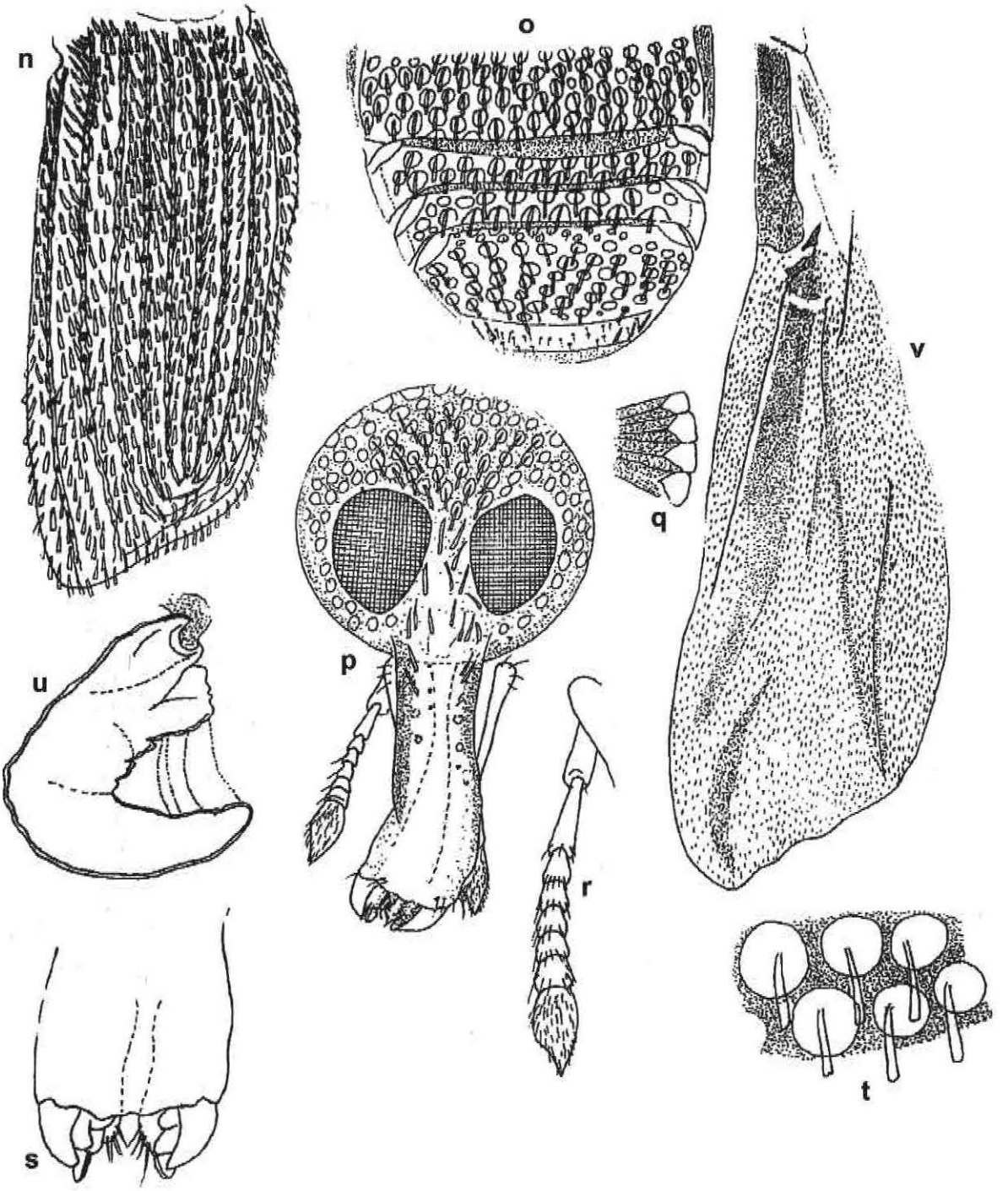

Figure 24 n–v. Female right elytron (n) of unknown genus sp. A, abdominal venter (o), frontal view of head (p), ommatidia (q), antenna (r), tip of rostrum showing the mandible (s), hairs in abdominal punctures (t), spermatheca (u) and hindwing (v)

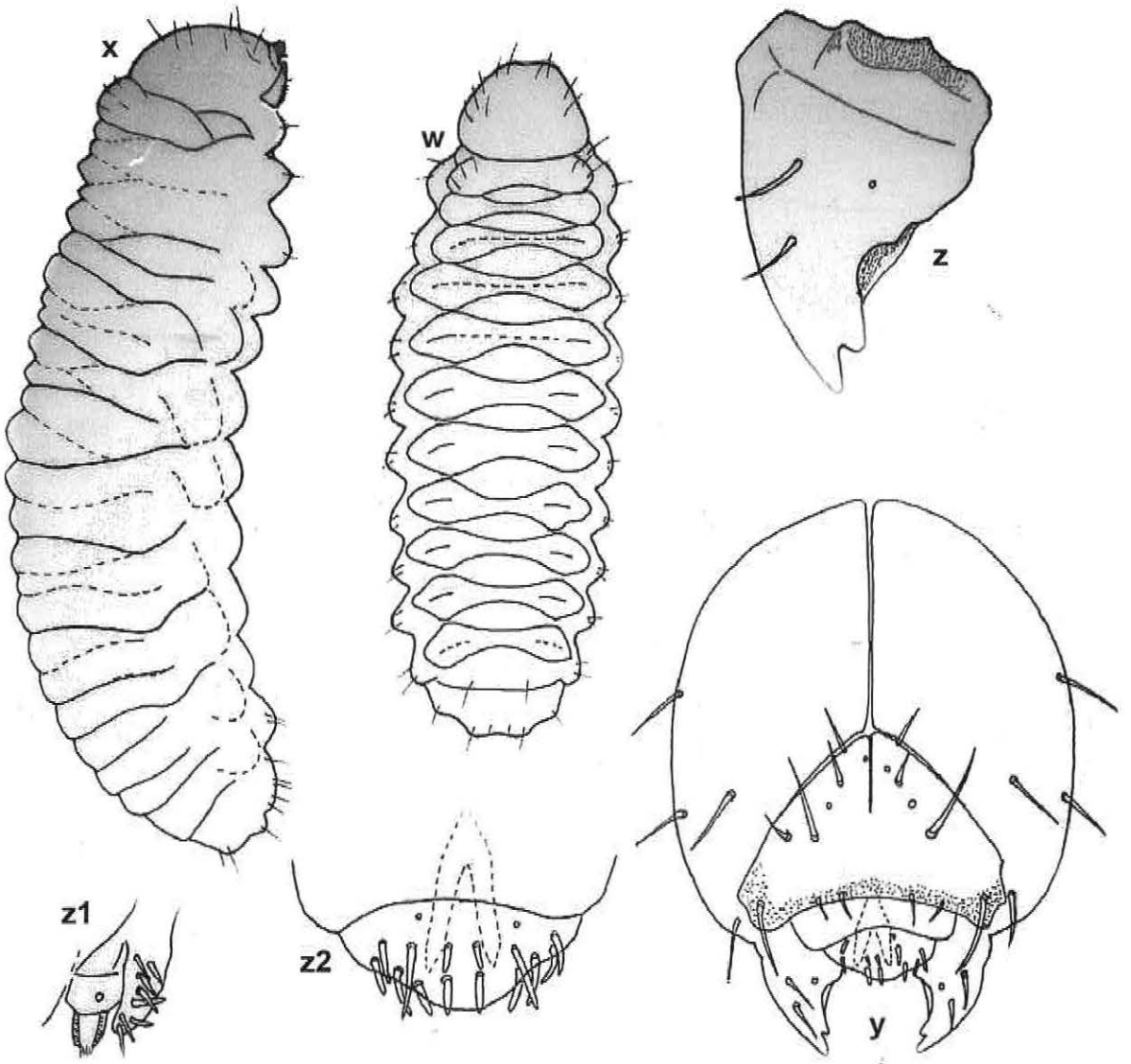

Figure 24 w–z2. Dorsal (w) and lateral (x) view of unknown genus sp. A larva, head (y), mandible (z), maxilla (z1) and setae on epipharynx (z2)

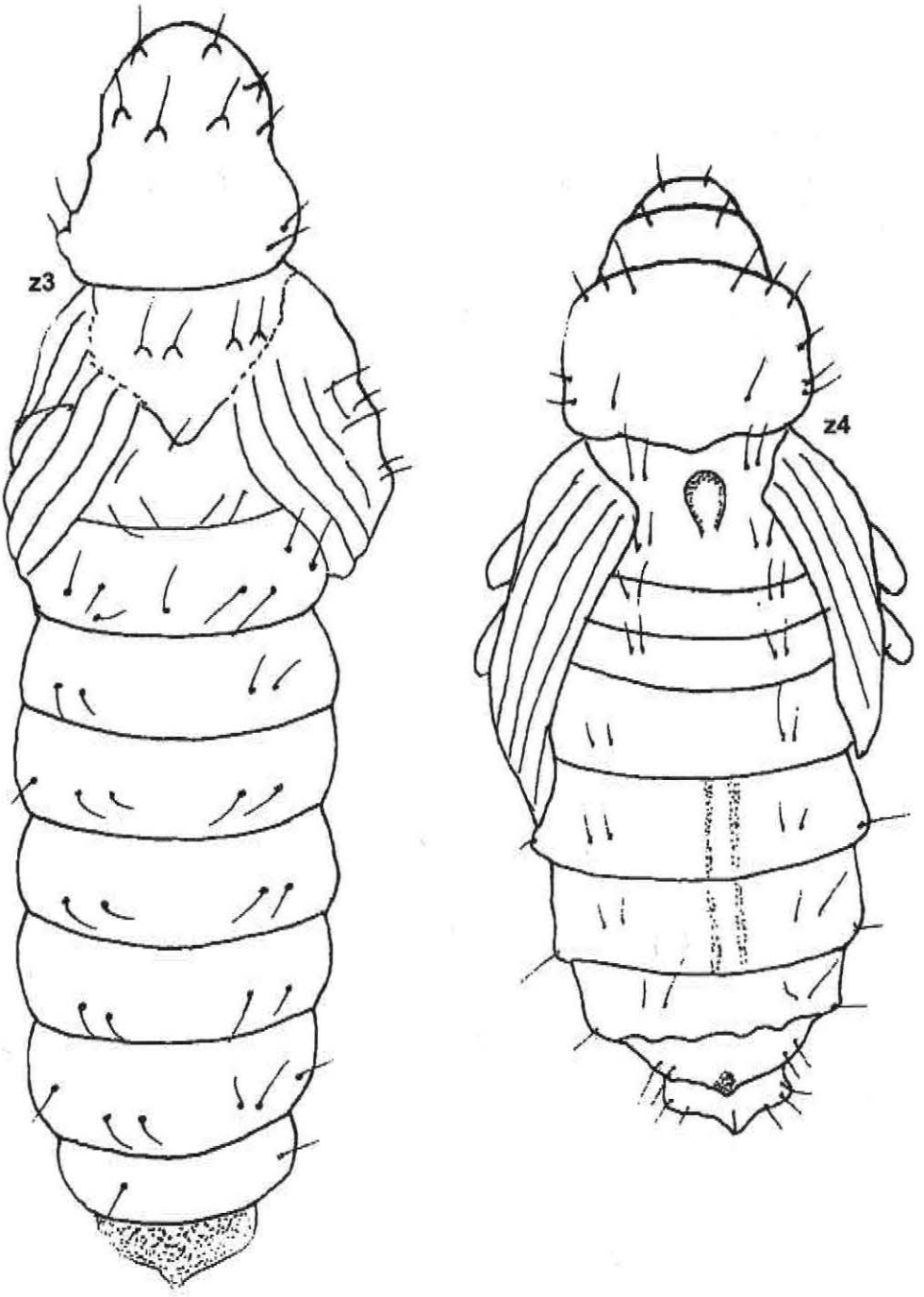

Figure 24 z3–z4. Dorsal (z3, z4) views of unknown genus sp. A pupa

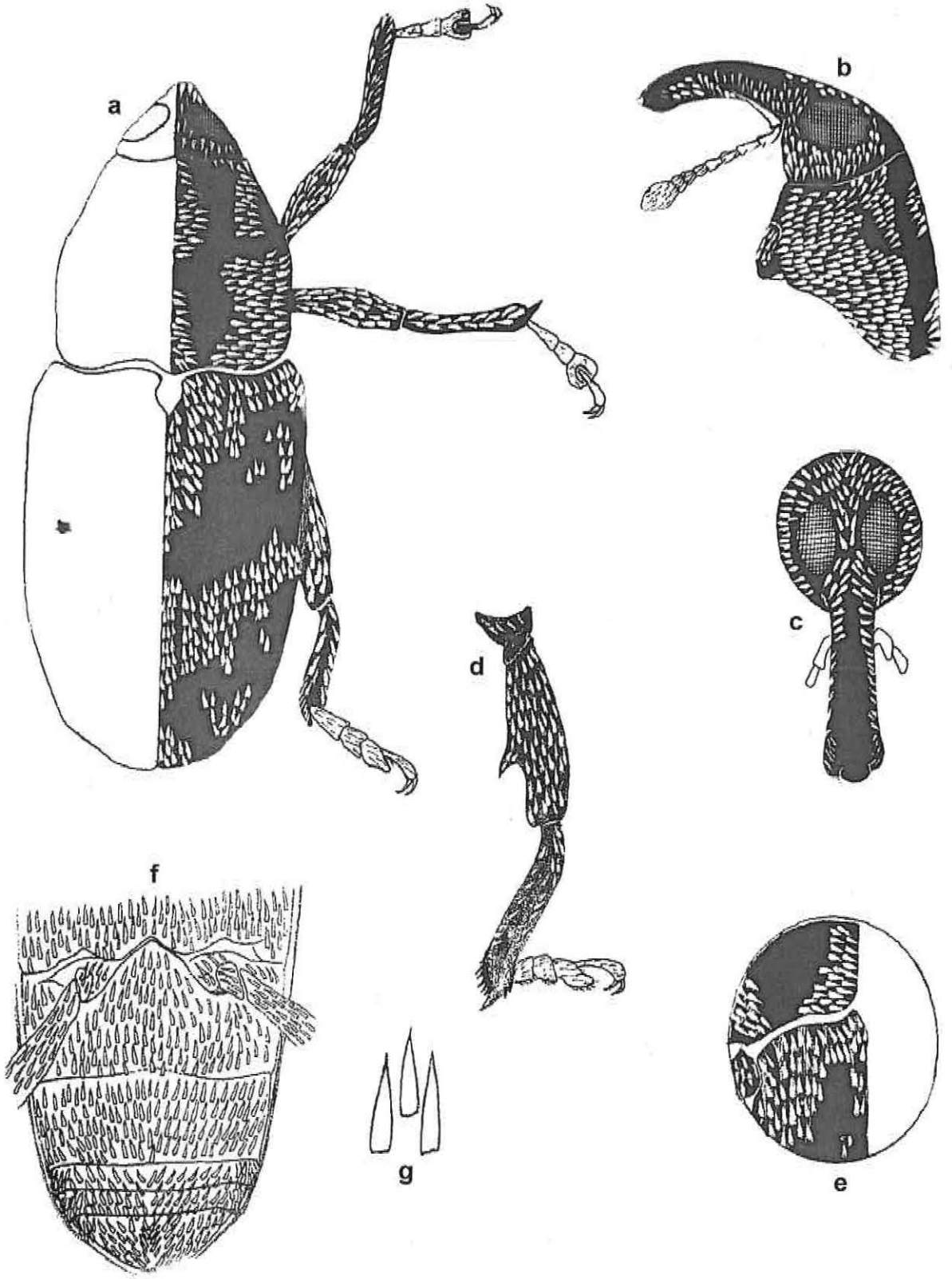

Figure 25 a–g. Dorsal (a) view of unknown genus sp. B, lateral (b) and frontal (c) views of head, leg III (d), pronotal and humeral hairs (e), abdominal venter (f) and abdominal hairs (g)

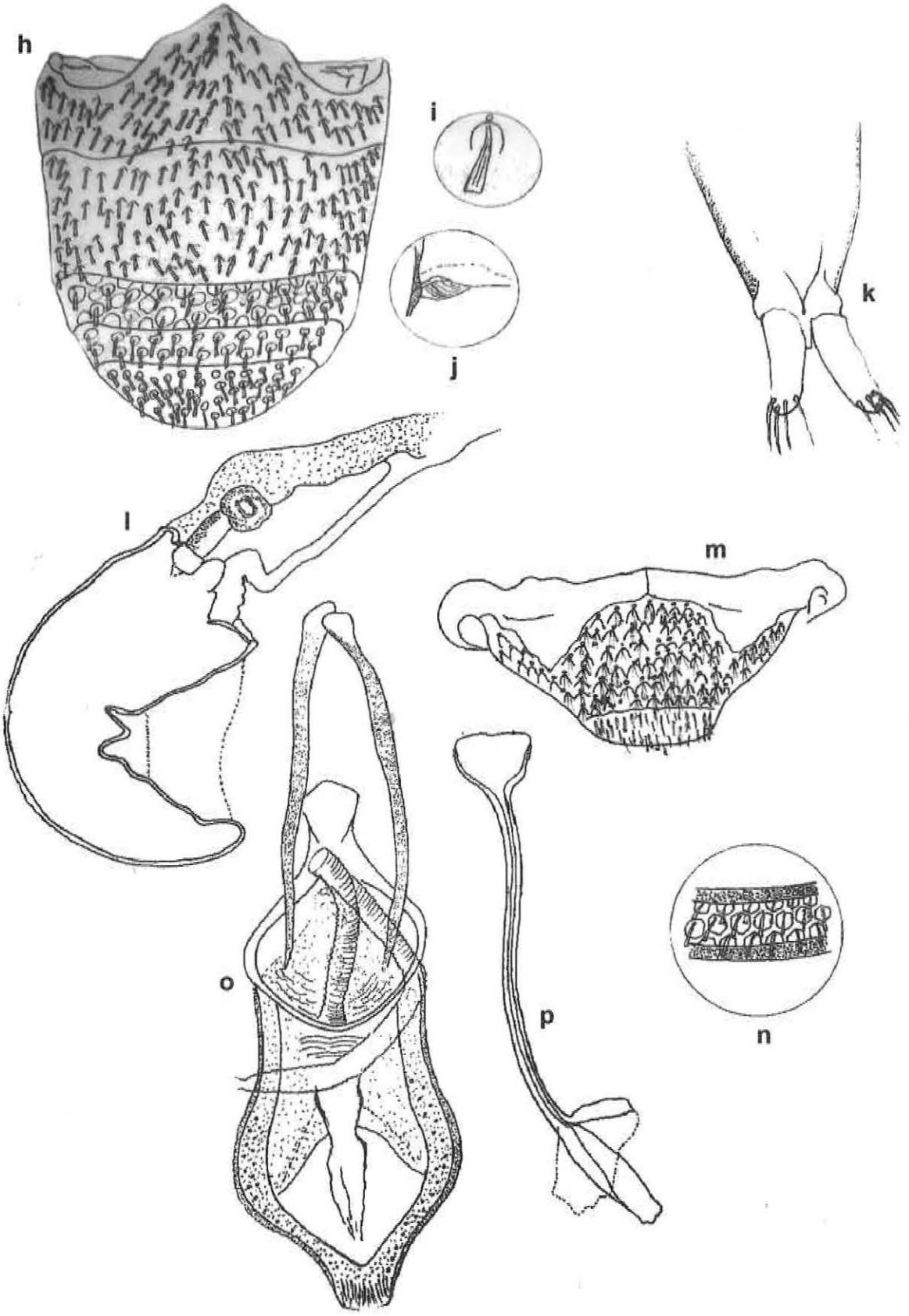

Figure 25 h–p. Abdominal venter (h) of unknown genus sp. B, hair on abdominal venter (i), separation of two sternites (j), female genitalia (k), spermatheca (l), male sternite VIII (m), sculpture and hairs on sternite V in female (n), male genitalia (o) and siphon (p)

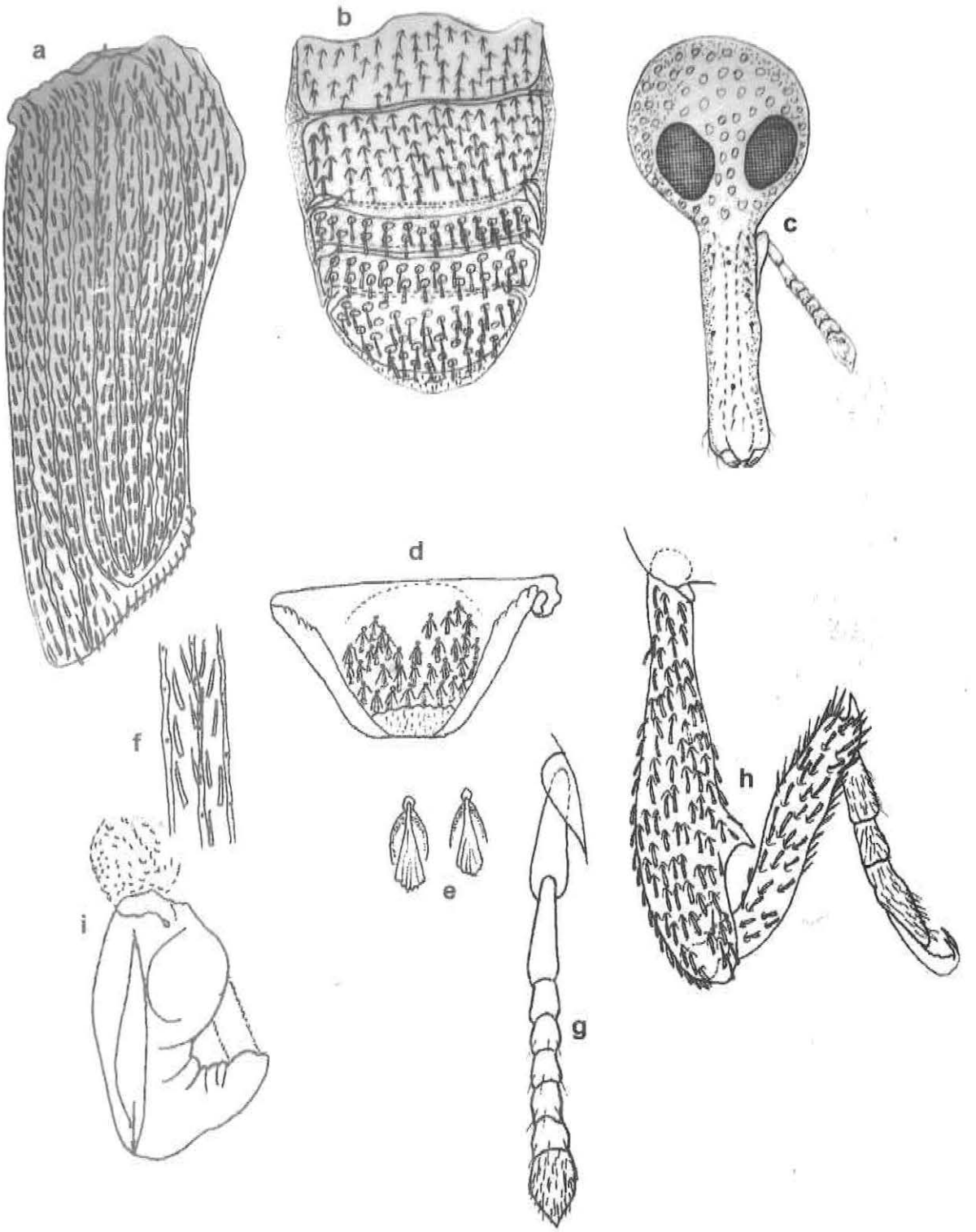

Figure 26 a–i. Right elytron (a) of unknown genus sp. C, abdominal venter (b), frontal view of head (c), last sternite (d), hairs on sternites (e), elytral hairs (f), antenna (g), leg III (h) and spermatheca (i)

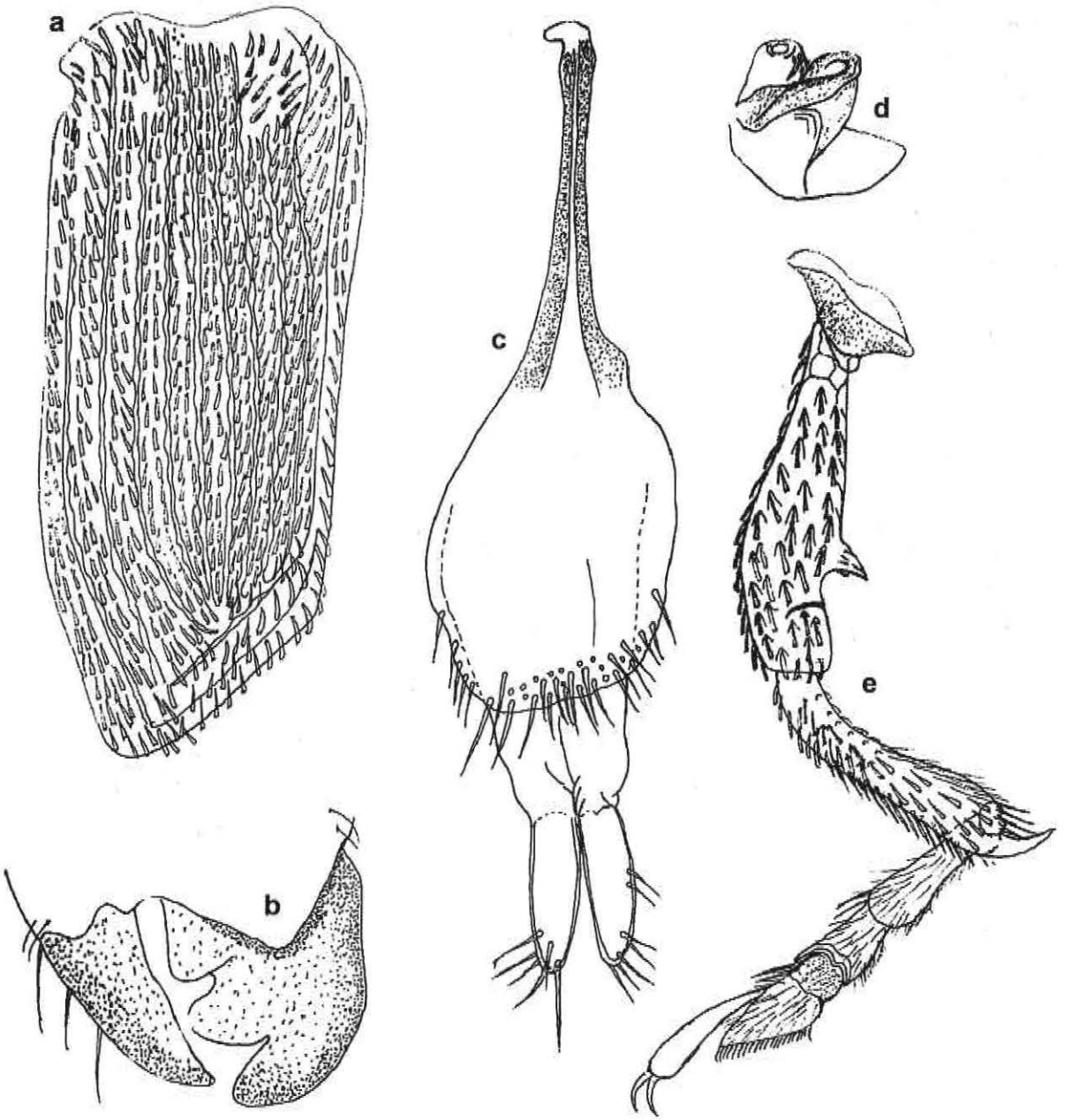

Figure 27 a–e. Right elytron (a) of unknown genus sp. D, mandible (b), portion of female genitalia (c), spermatheca (d) and leg III (e)

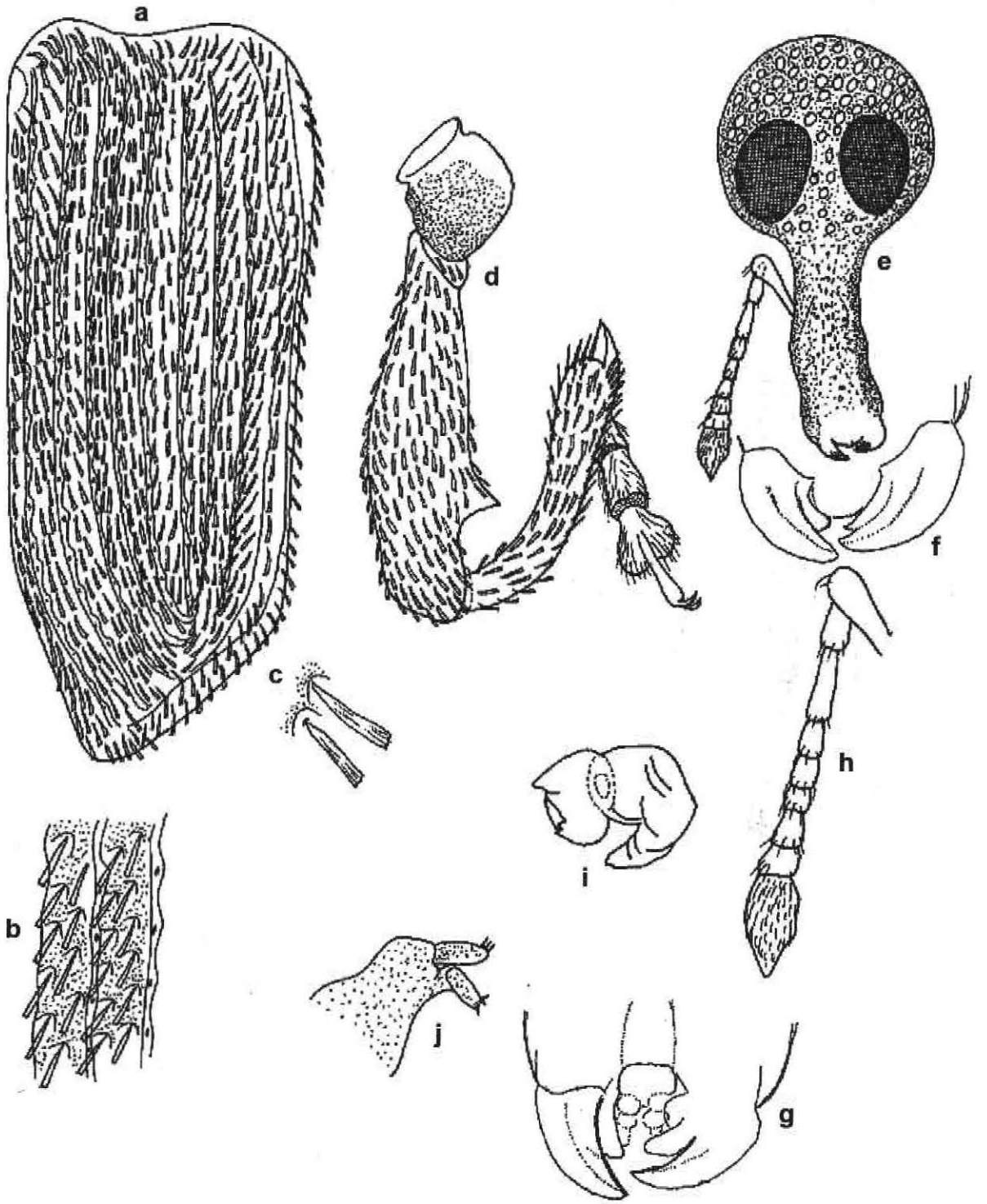

Figure 28 a–j. Right elytron (a) of unknown genus sp. E, hairs on elytron (b), closeup of hairs (c), leg III (d), frontal view of head (e), two types of mandibles (f, g), antenna (h), spermatheca (i) and part of female genitalia (j)

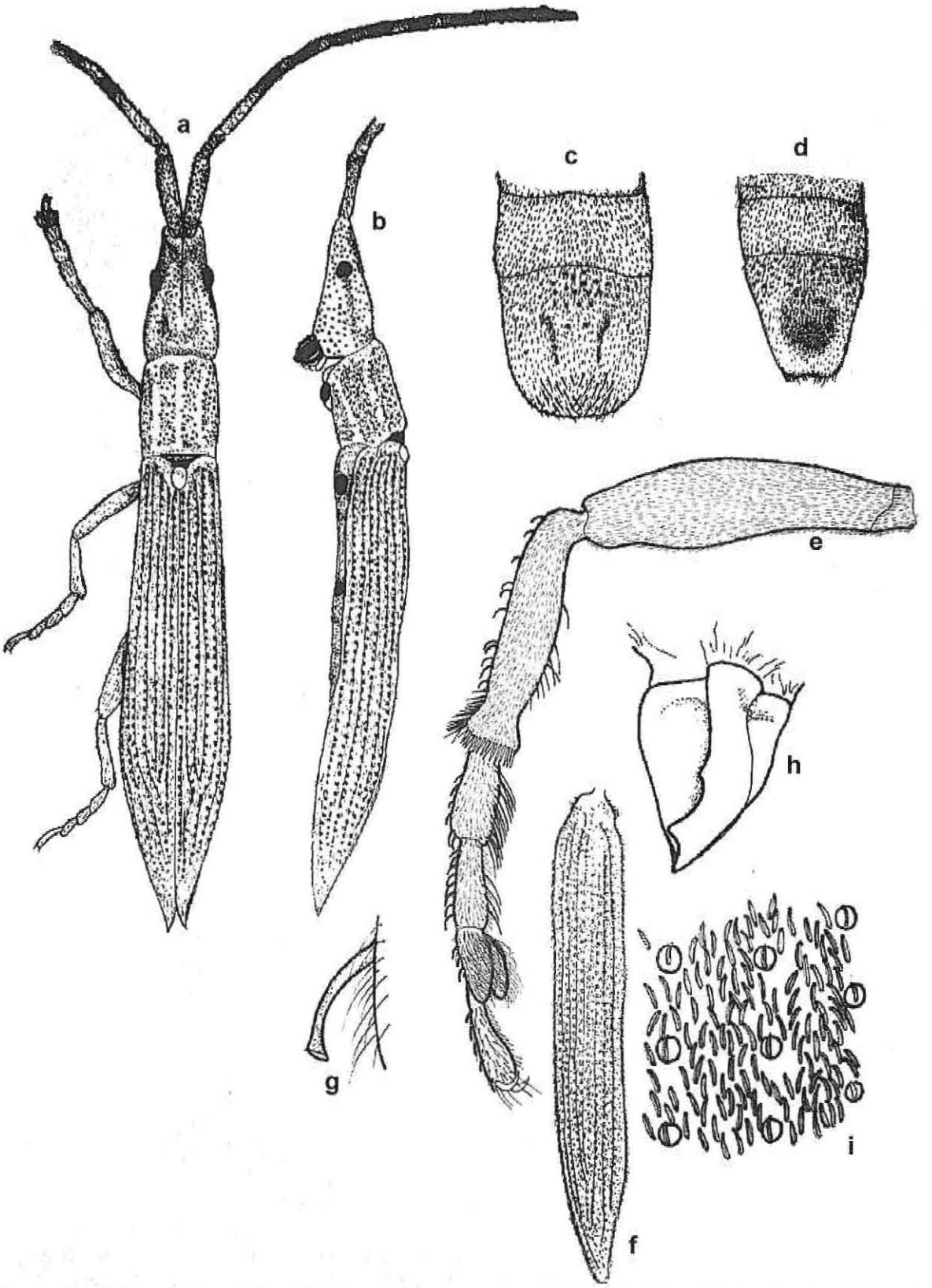

Figure 29 a–i. Dorsal (a) and lateral (b) views of *Hypamazso pauli* (Fairmaire), female (c) and male (d) tips of abdomen, leg III (e), left elytron (f), sensory hair on the leg (g), mandible (h) and pattern of elytral hairs (i)

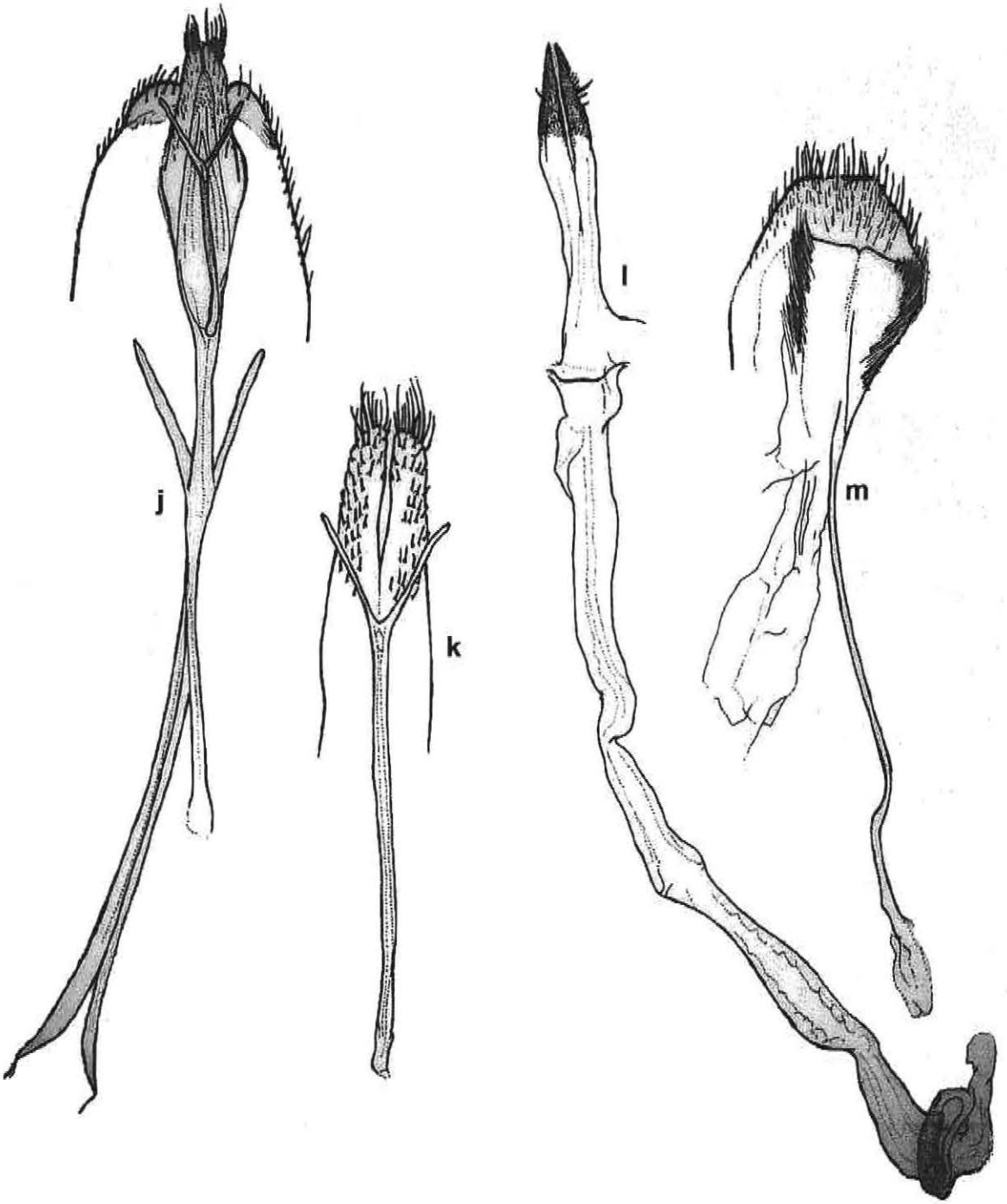

Figure 29 j–m. Genitalia (j) of male *H. pauli*, siphon (k), aedeagus (l) and sternite IX (m)

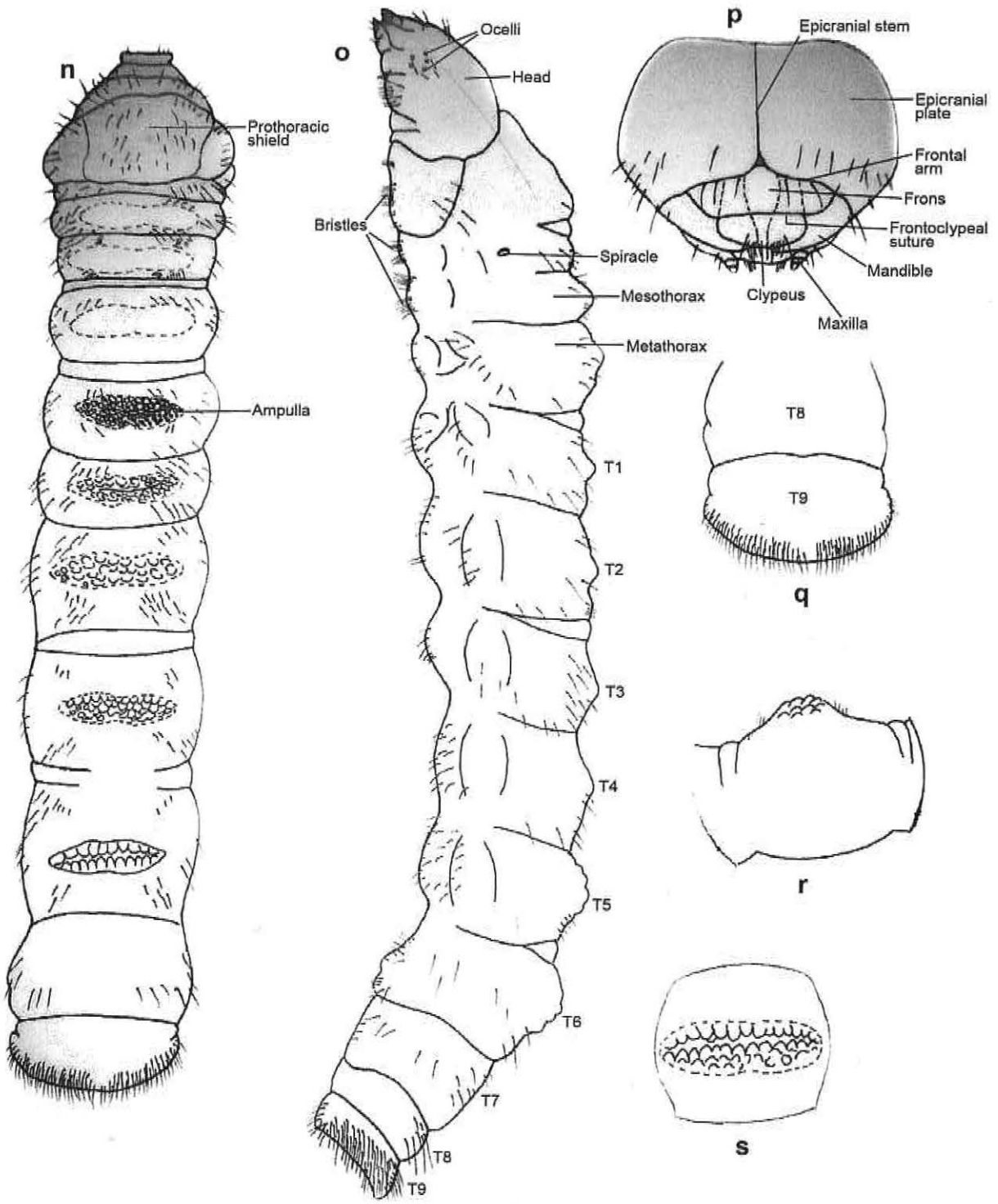

Figure 29 n–s. Dorsal (n) and lateral (o) views of *H. pauli* larva, frontal view of head (p), anal segment (q) lateral (r) and dorsal (s) views of ampulla

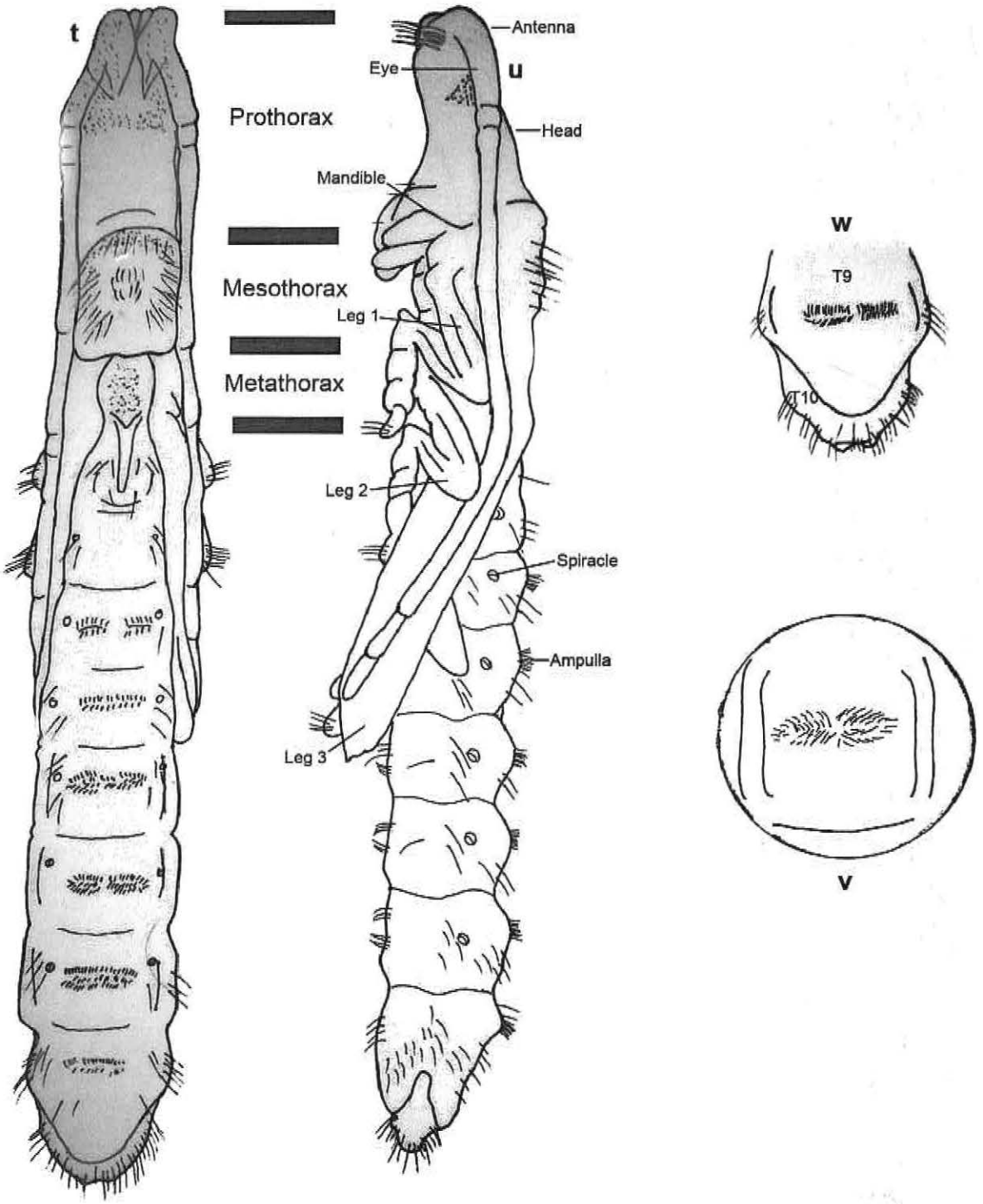

Figure 29 t–w. Dorsal (t) and lateral (u) views of *H. pauli* pupa, ampulla on anal plate (v) and on abdominal dorsum (w)

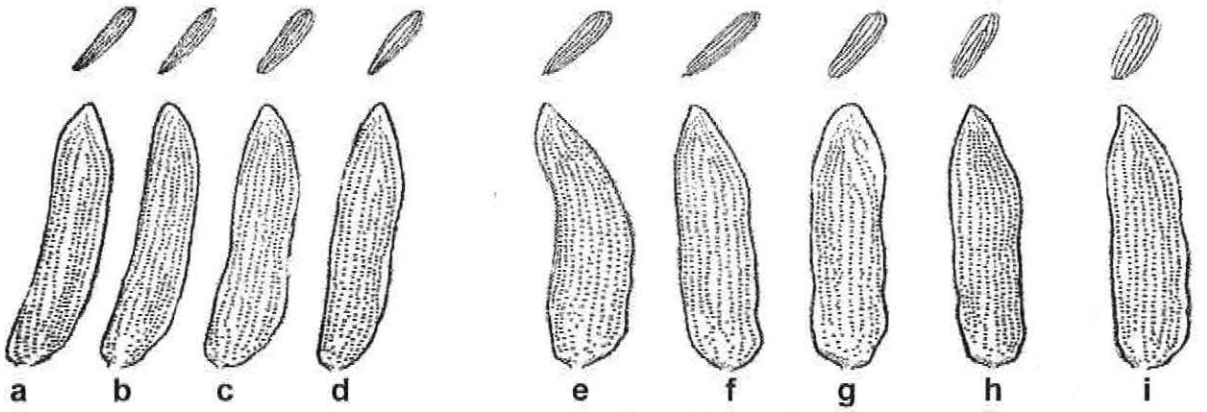

Figure 30 a–i. Wing patterns and form of elytral hairs in the adults of *H. pauli*

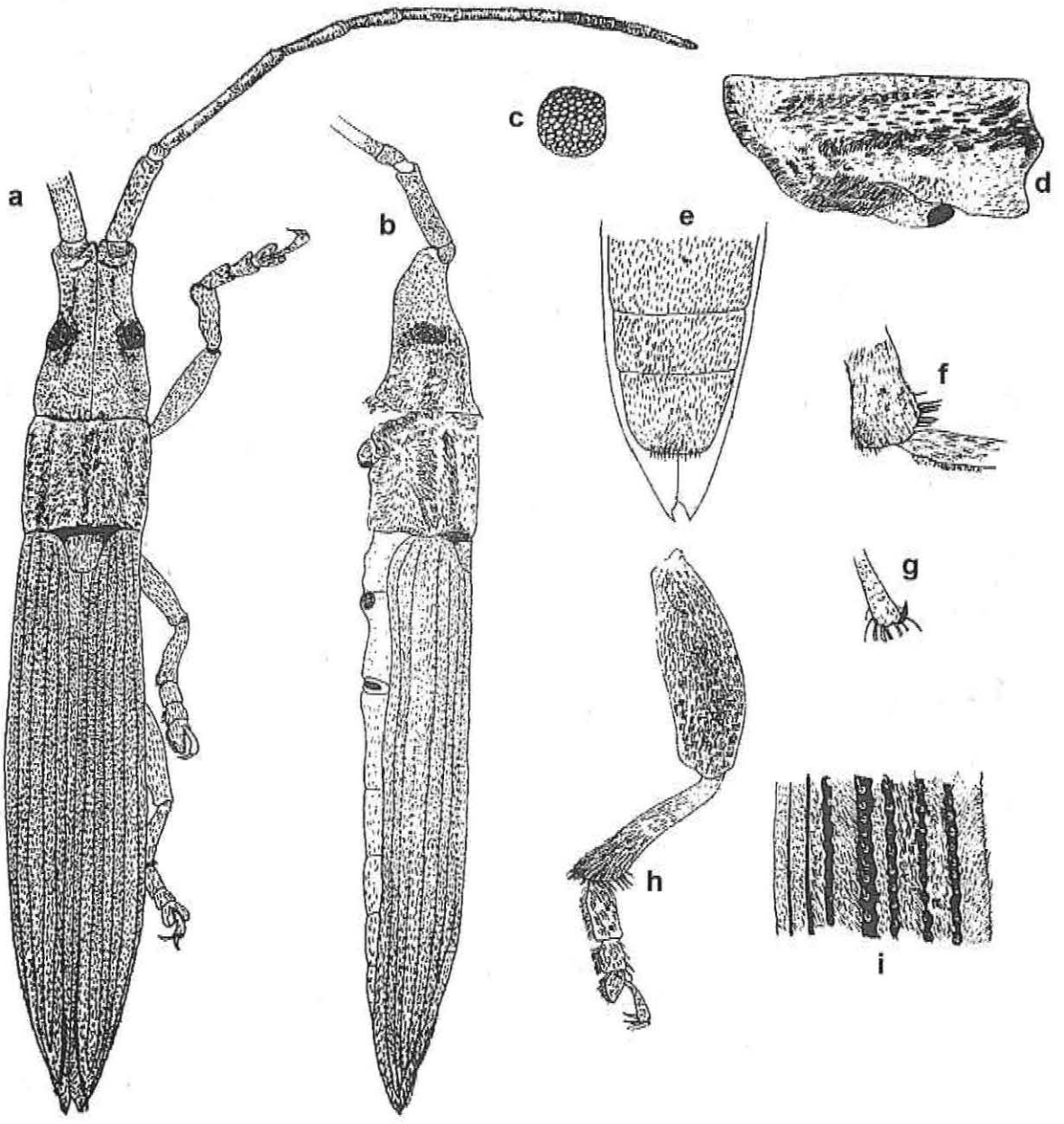

Figure 31 a–i. Dorsal (a) and lateral (b) views of *Hypamazso* sp. B adult, eye (c), side of pronotum (d), last three sternites of female (e), apex of tibia III (f), tip of claw (g), leg III (h) and sculpture on the dorso-lateral side of elytra (i)

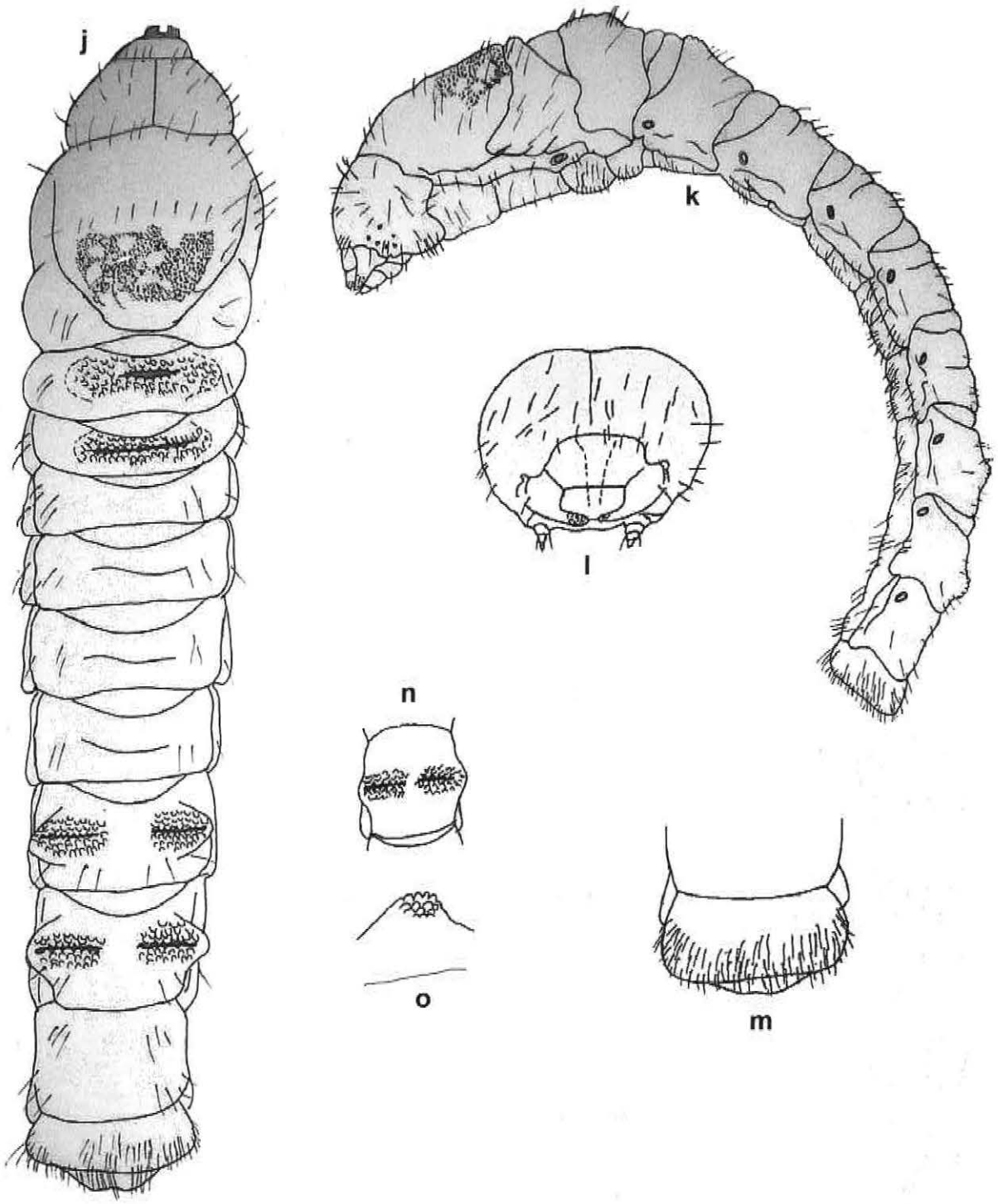

Figure 31 j–o. Dorsal (j) and lateral (k) views of the *Hypamazso* sp. B larva, frontal view of head (l), anal plate (m), paired ampulla on abdominal dorsum (n) and lateral (o) view of ampulla

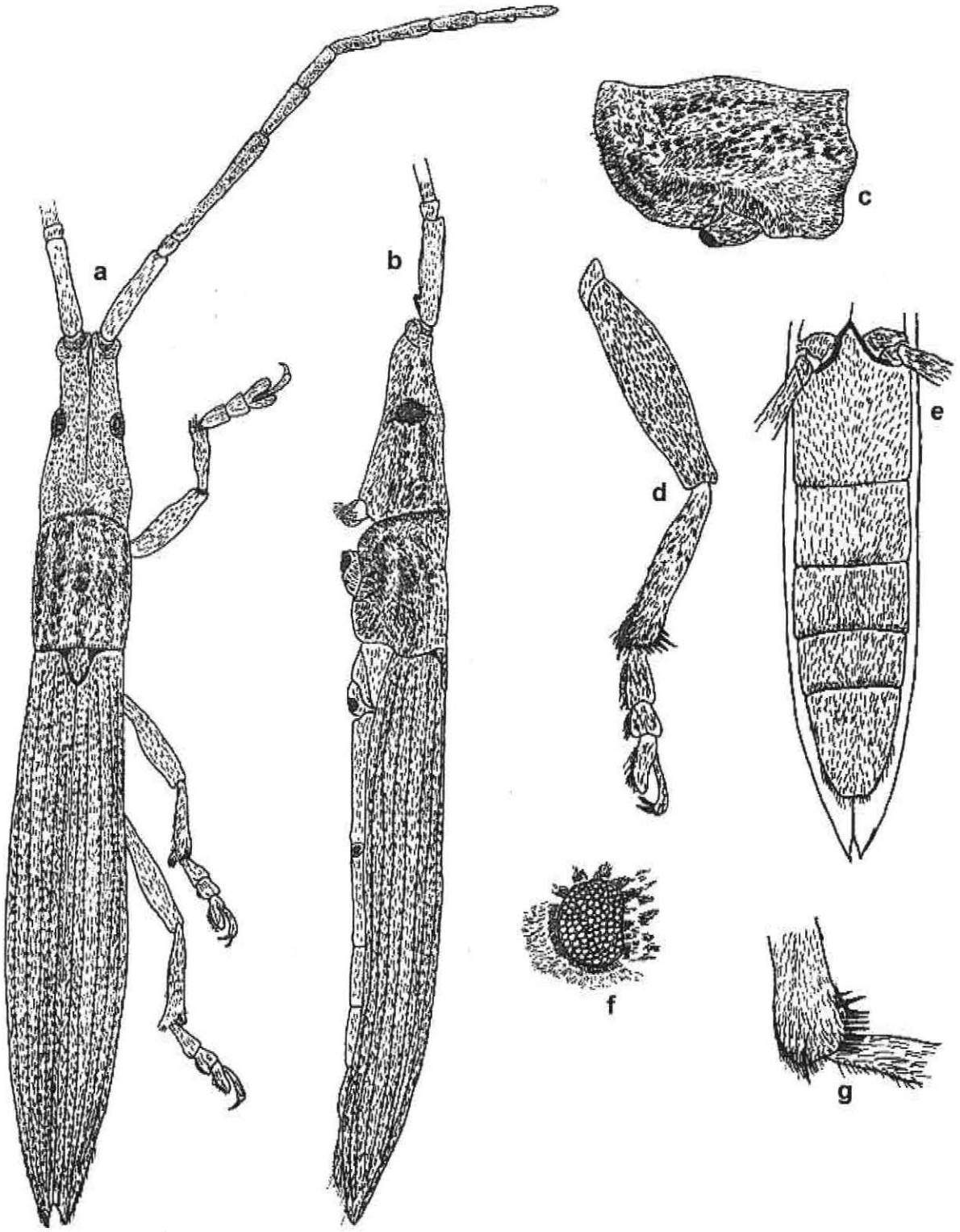

Figure 32 a–g. Dorsal (a) and lateral (b) views of *Hypamazso* sp. C adult, propleuron (c), leg III (d), abdominal venter (e), eye (f) and tip of tibia III (g)

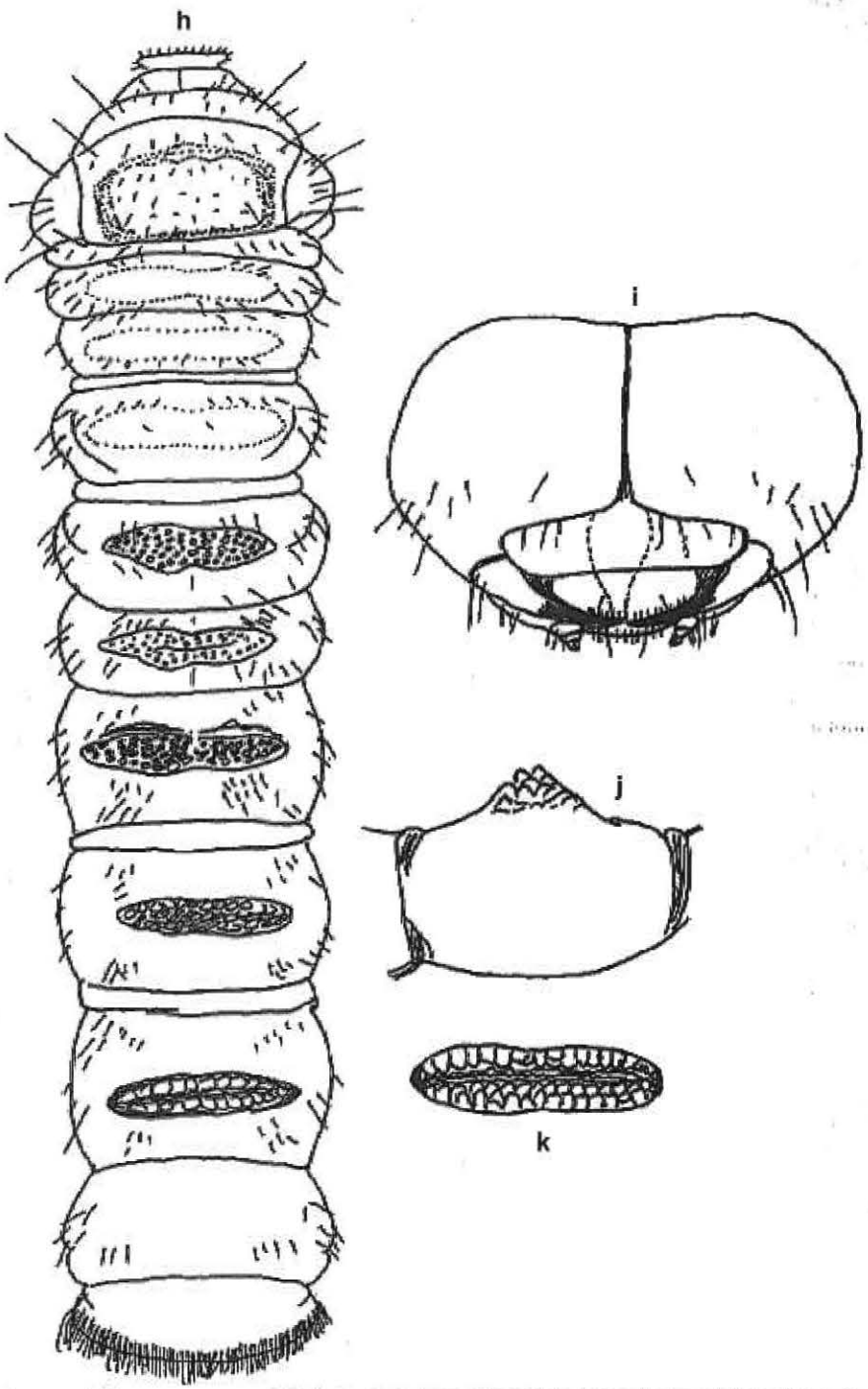

Figure 32 h–k. Larva of *Hypamazso* sp. C (h), frontal view of head (i), lateral (j) and dorsal (k) views of ampulla

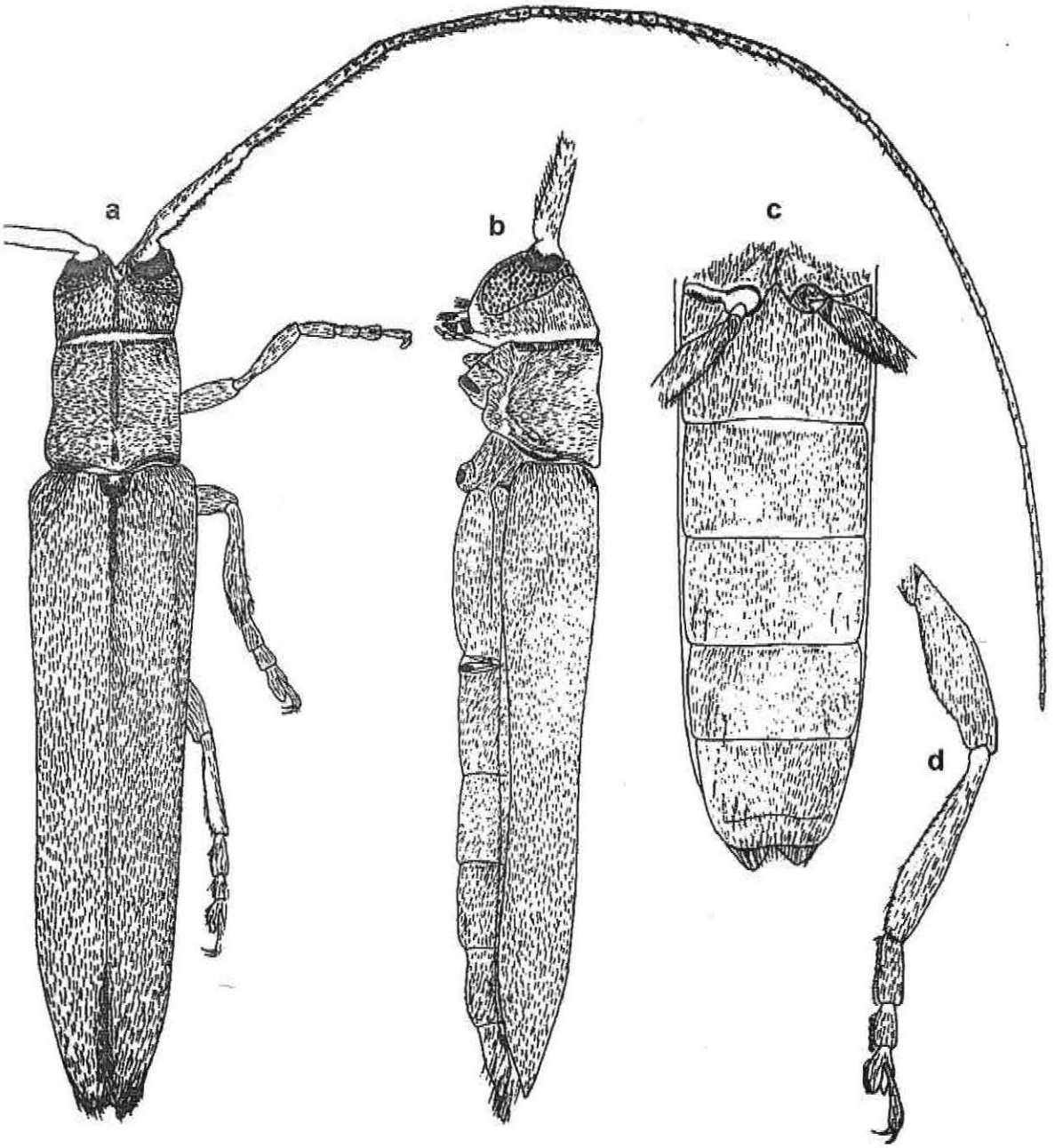

Figure 33 a–d. Dorsal (a) and lateral (b) views of *Obeneopsis* sp. adult, sternites I–V (c) and leg III (d)

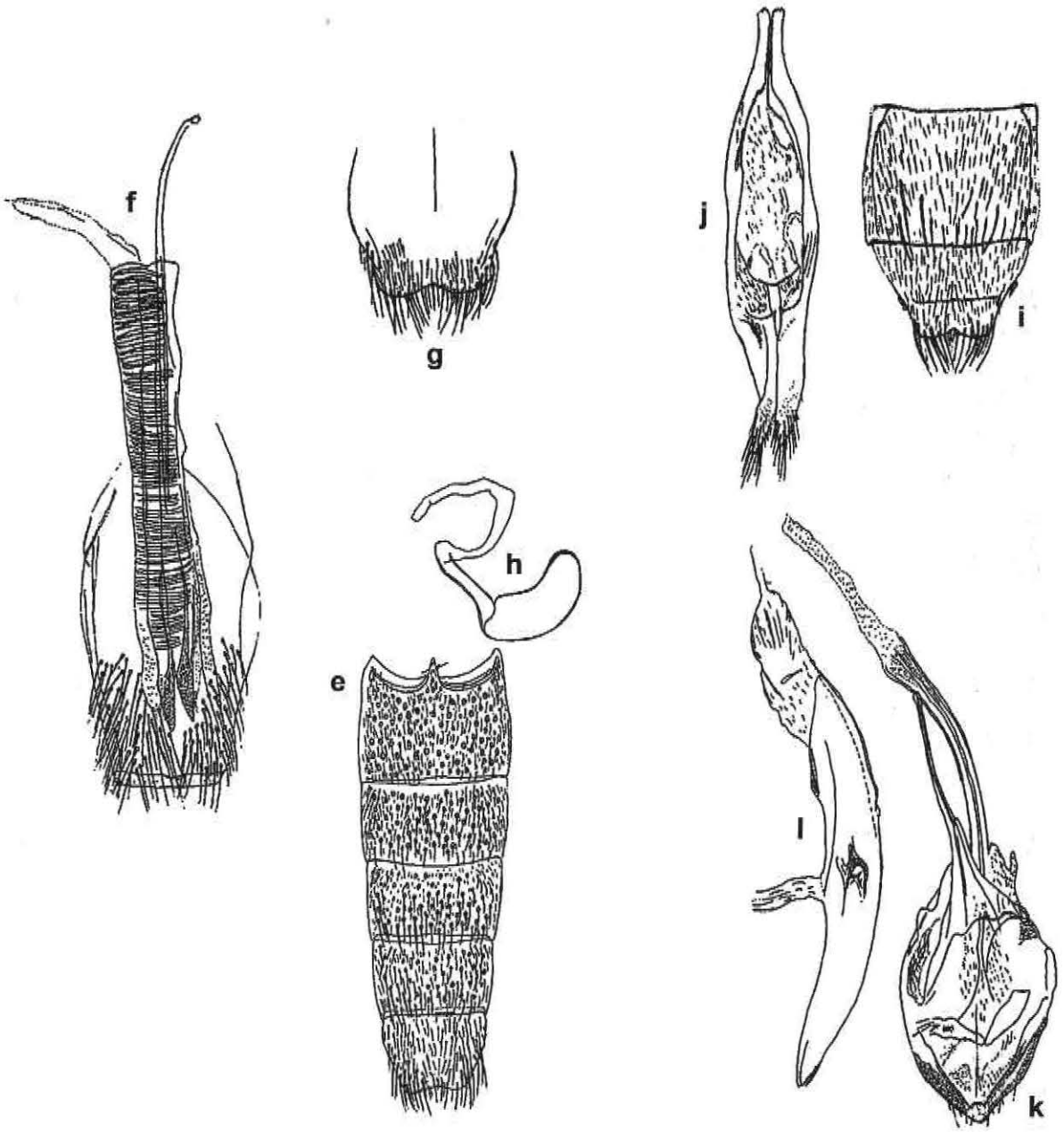

Figure 33 e–l. Female abdominal venter of *Obeneopsis* sp. (e), genitalia (f), sternite V (g), spermatheca (h) and male sternites IV–V (i), part of male genitalia (j), aedeagus (k) and tegmen (l)

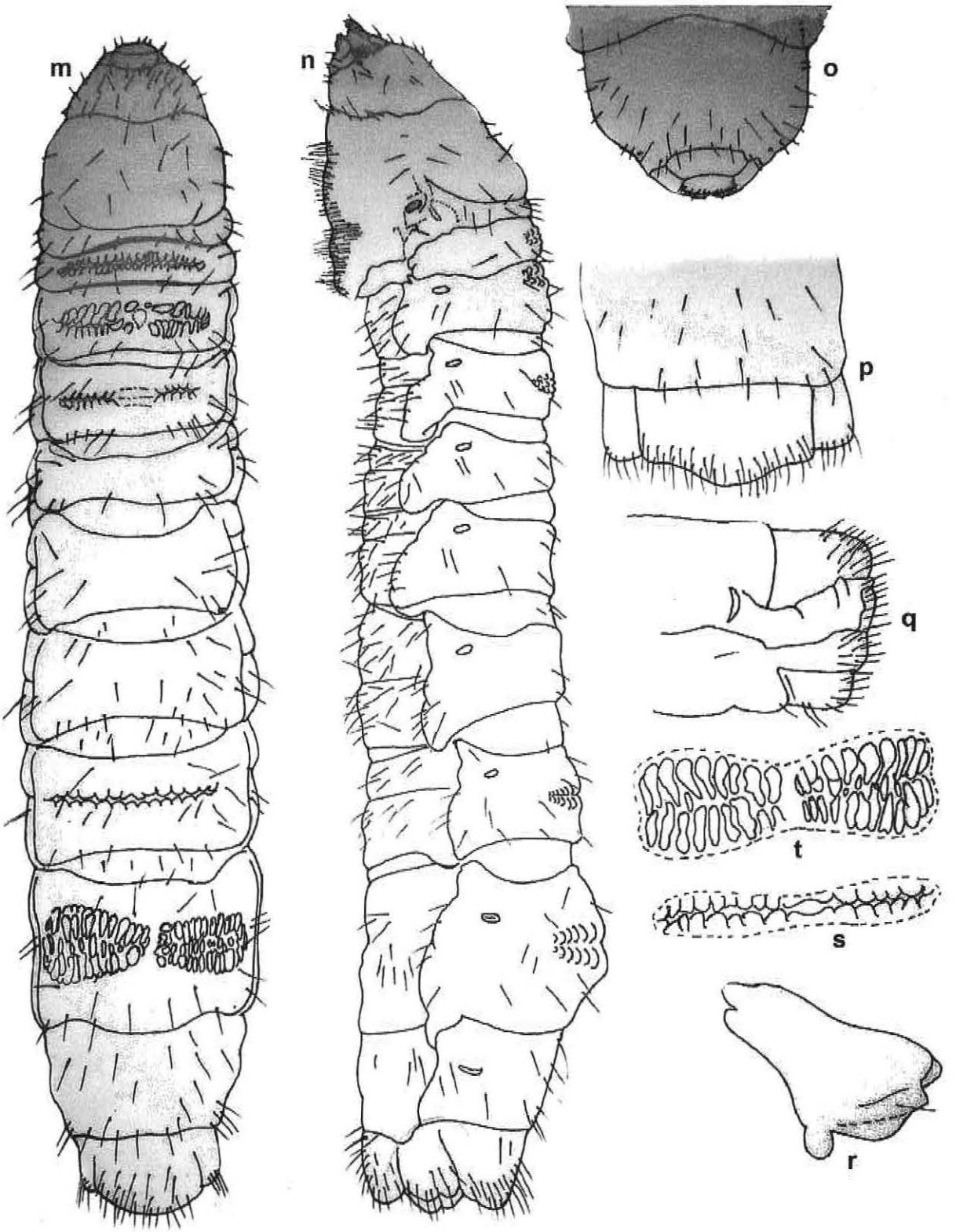

Figure 33 m–t. Dorsal (m) and lateral (n) views of *Obeneopsis* larva, head (o), dorsal (p) and lateral (q) views of segment IX, mandible (r) and ampulla on segment VII (s) and segment VI (t)

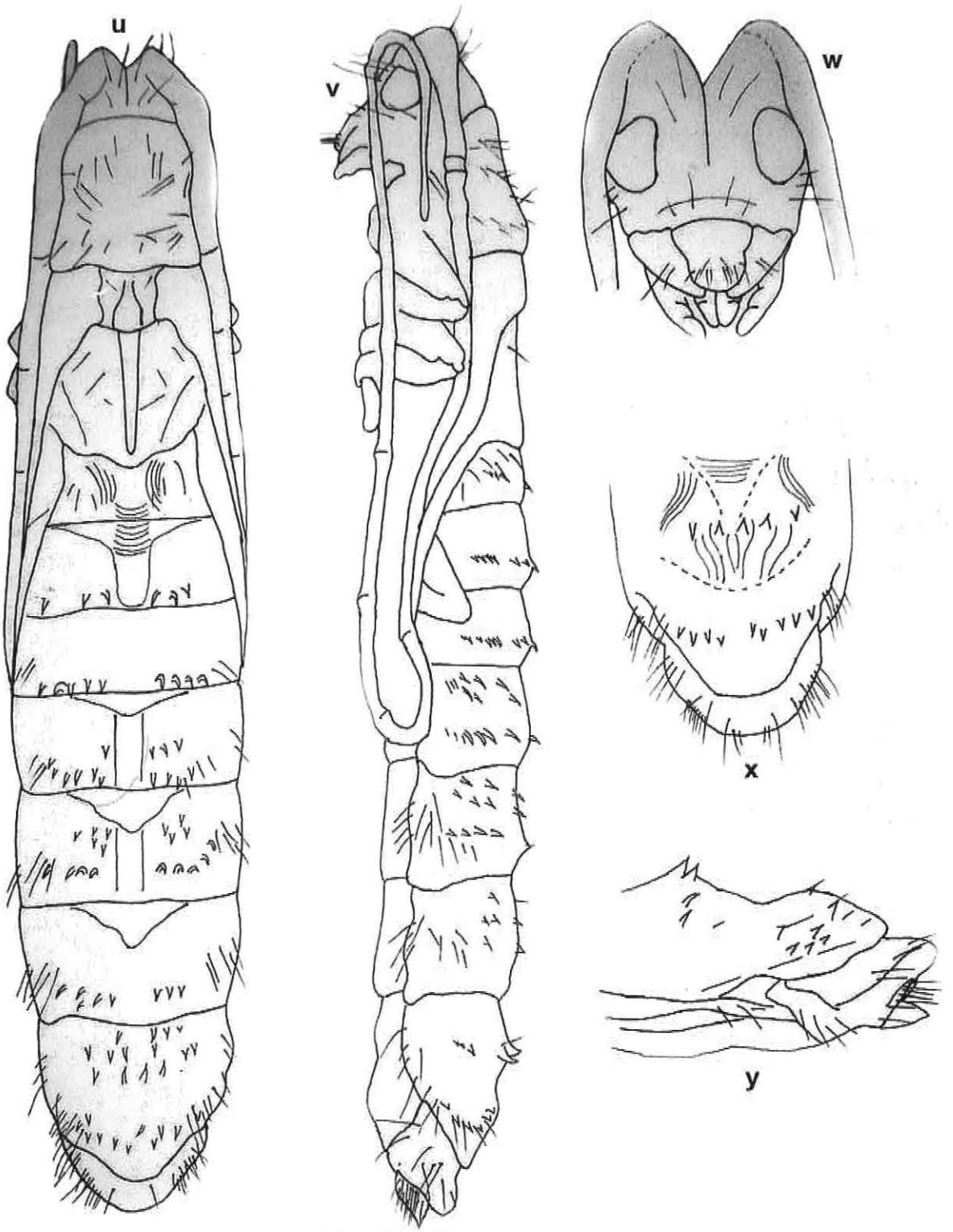

Figure 33 u–y. Dorsal (u) and lateral (v) views of *Obeneopsis* sp. pupa, frontal view of head (w), spines on the dorsal (x) and lateral (y) portions of abdominal tip

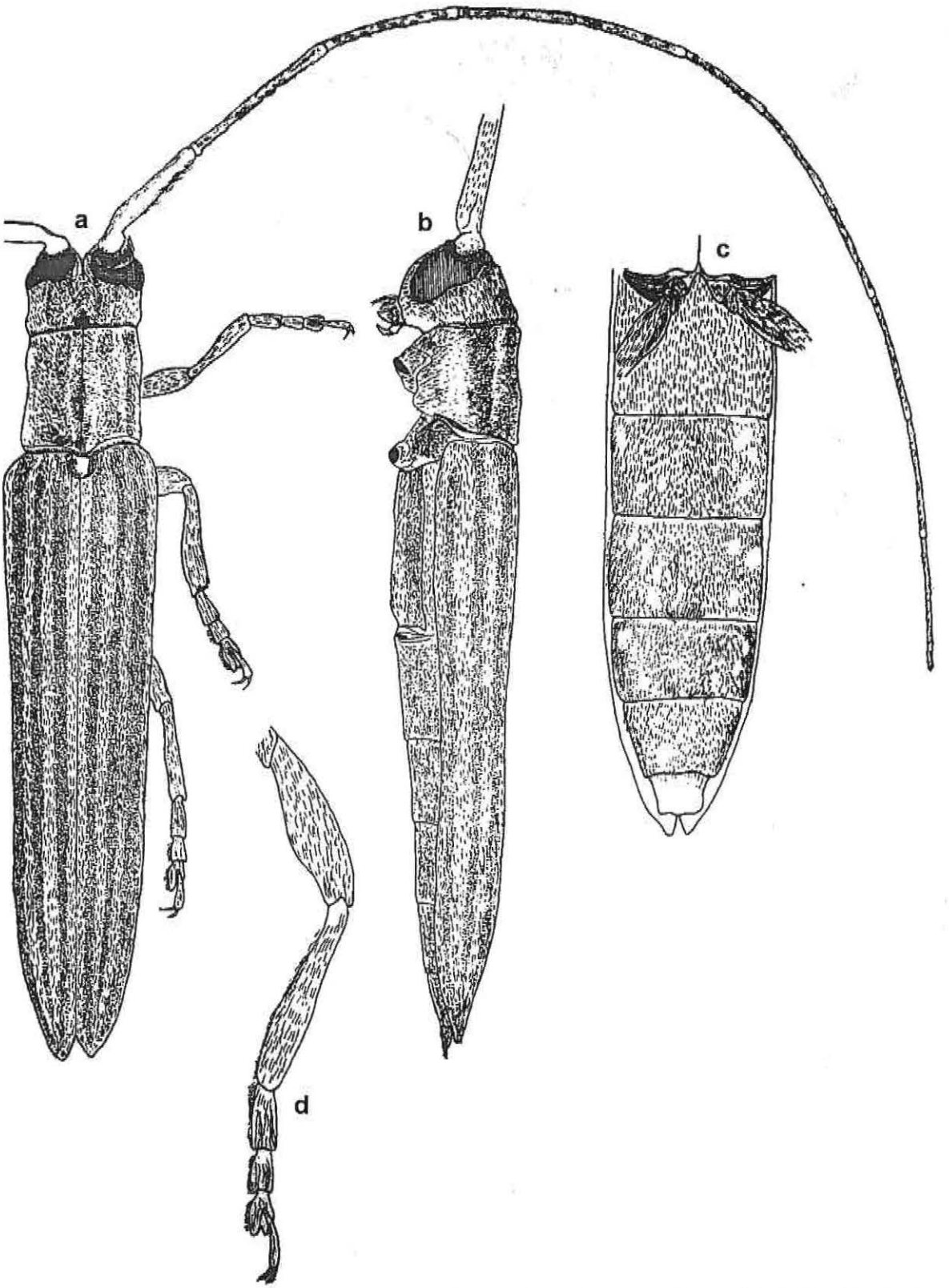

Figure 34 a–d. Dorsal (a) and lateral (b) views of *Hyllisia* near *vittata* Fåhraeus, sternites I–VI (c) and leg III (d)

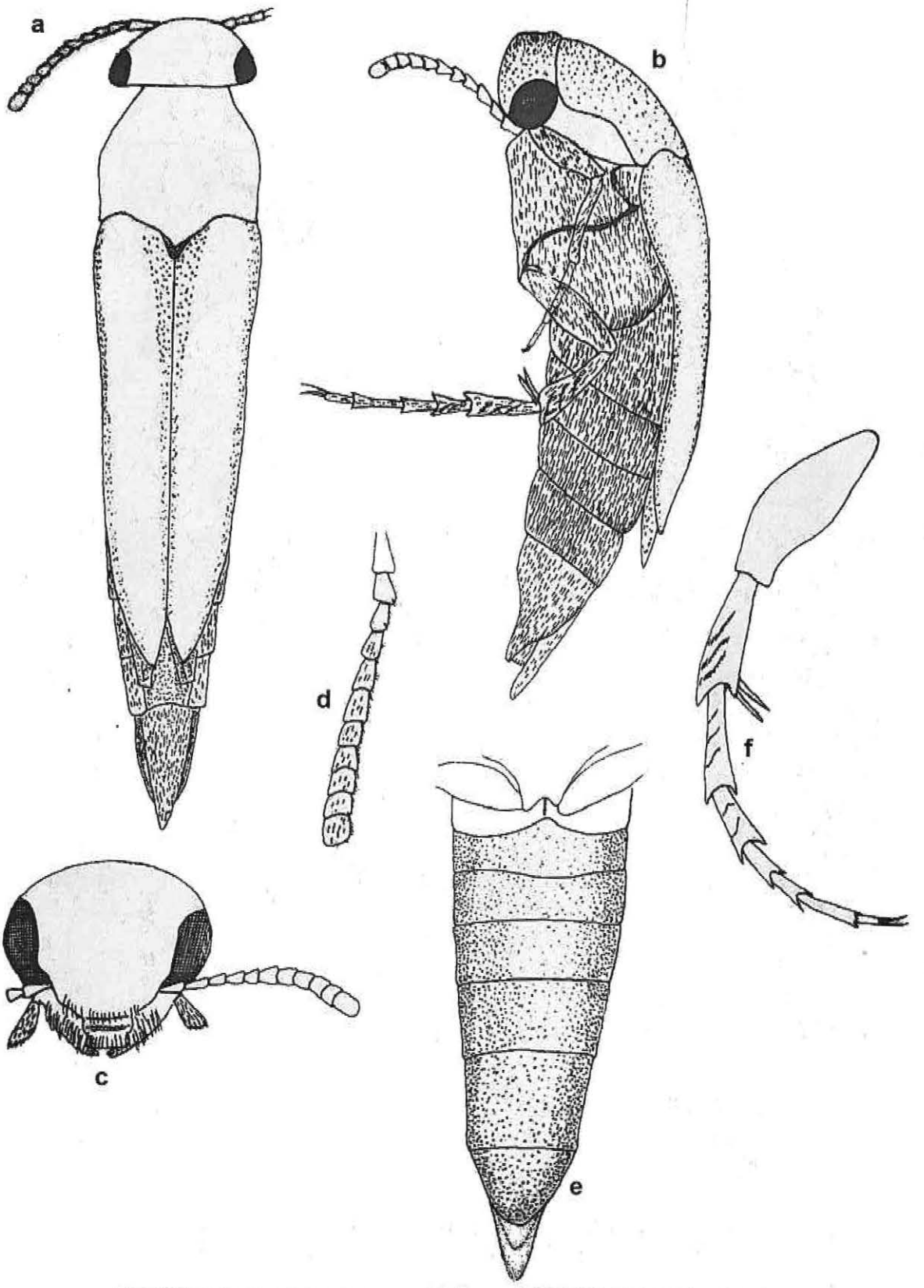

Figure 35 a–f. Dorsal (a) and lateral (b) views of *Stenalia* near *occidentalis* Pic, frontal view of head (c), antenna (d), abdominal venter (e) and leg III (f)

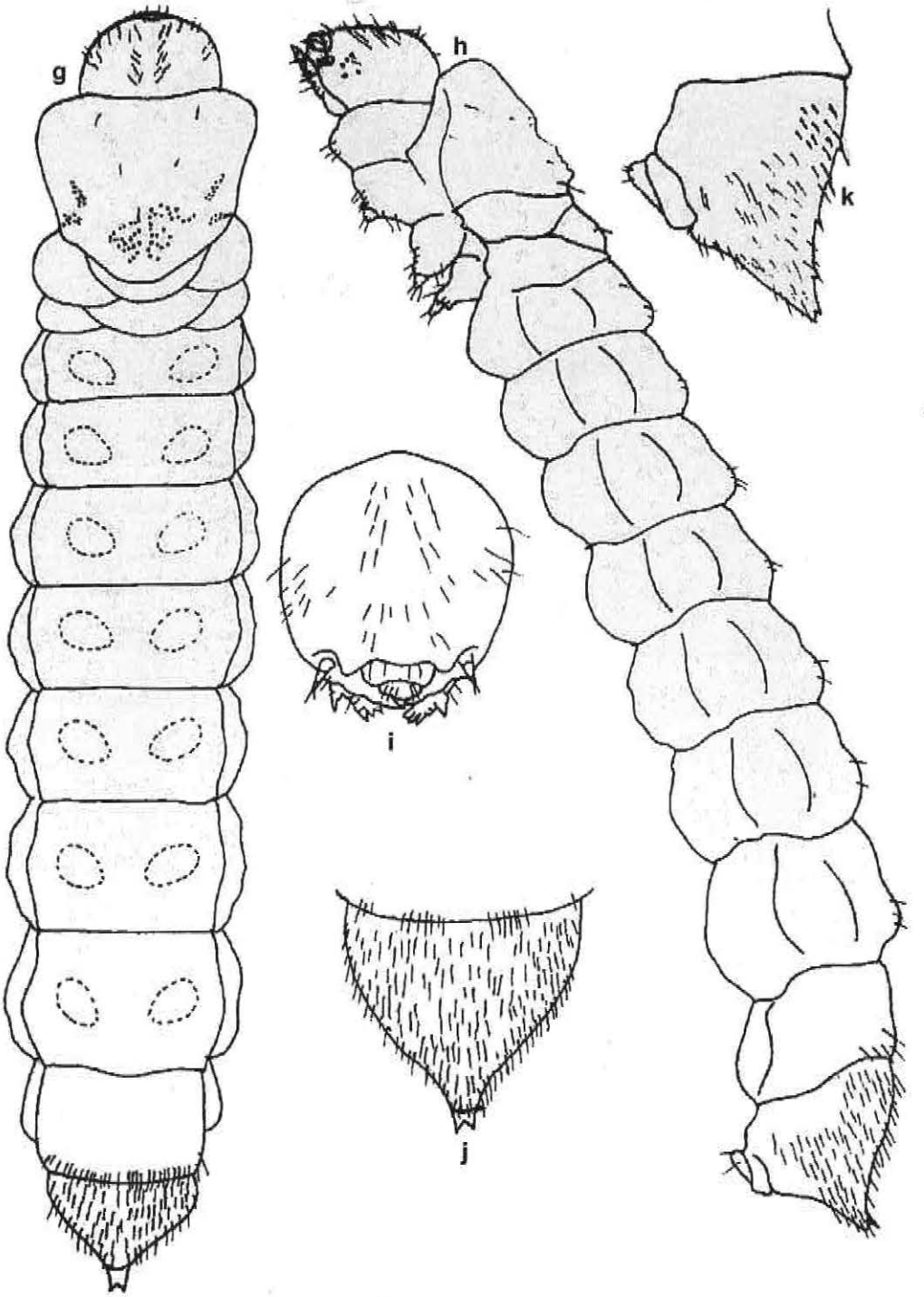

Figure 35 g–k. Dorsal (g) and lateral (h) views of *S.* near *occidentalis* larva, frontal view of head (i), dorsal (j) and lateral (k) views of urogomphi

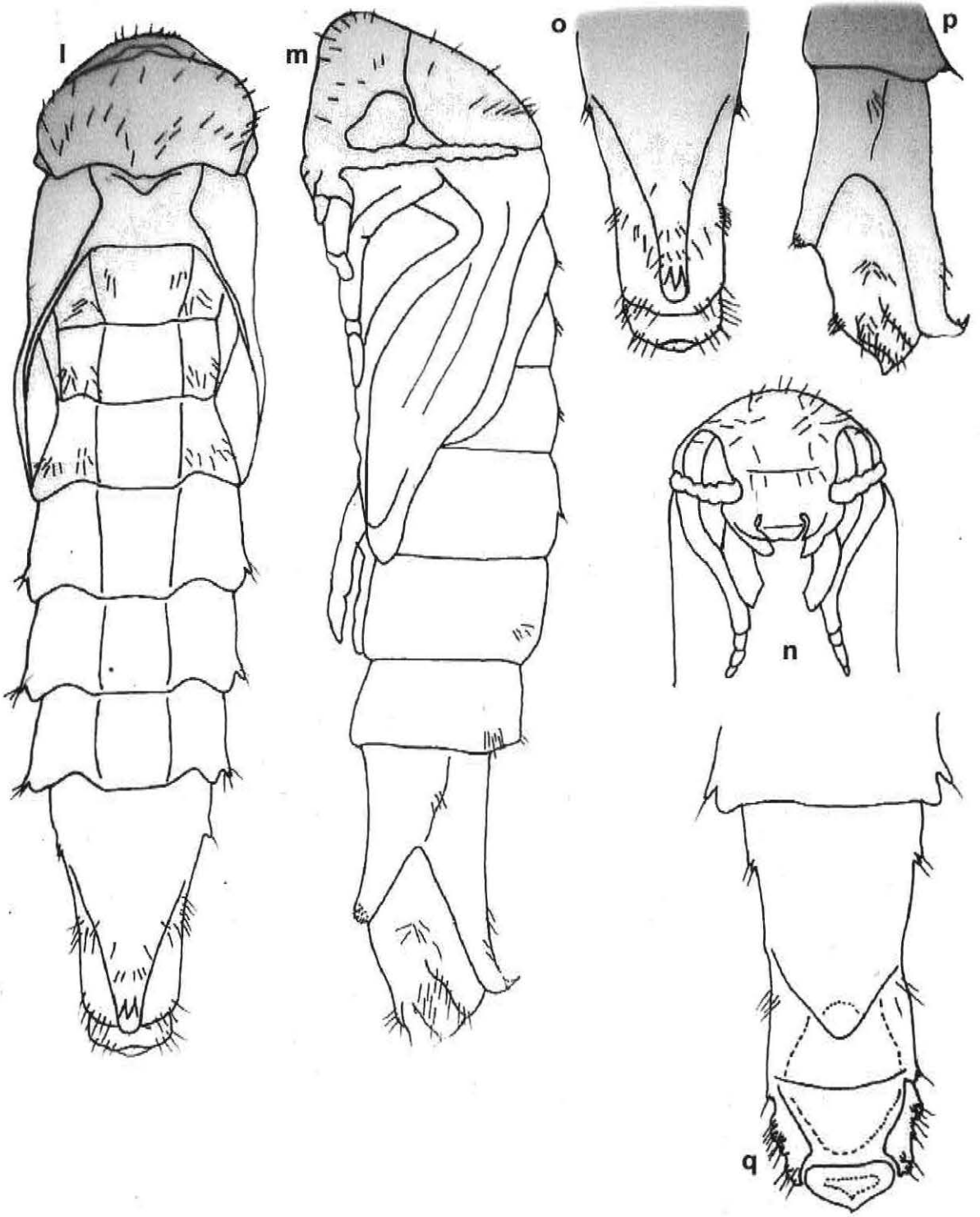

Figure 35 l–q. Dorsal (l) and lateral (m) views of *S.* near *occidentalis* pupa, frontal view of head (n), dorsal (o), lateral (p) and ventral (q) views of urogomphi

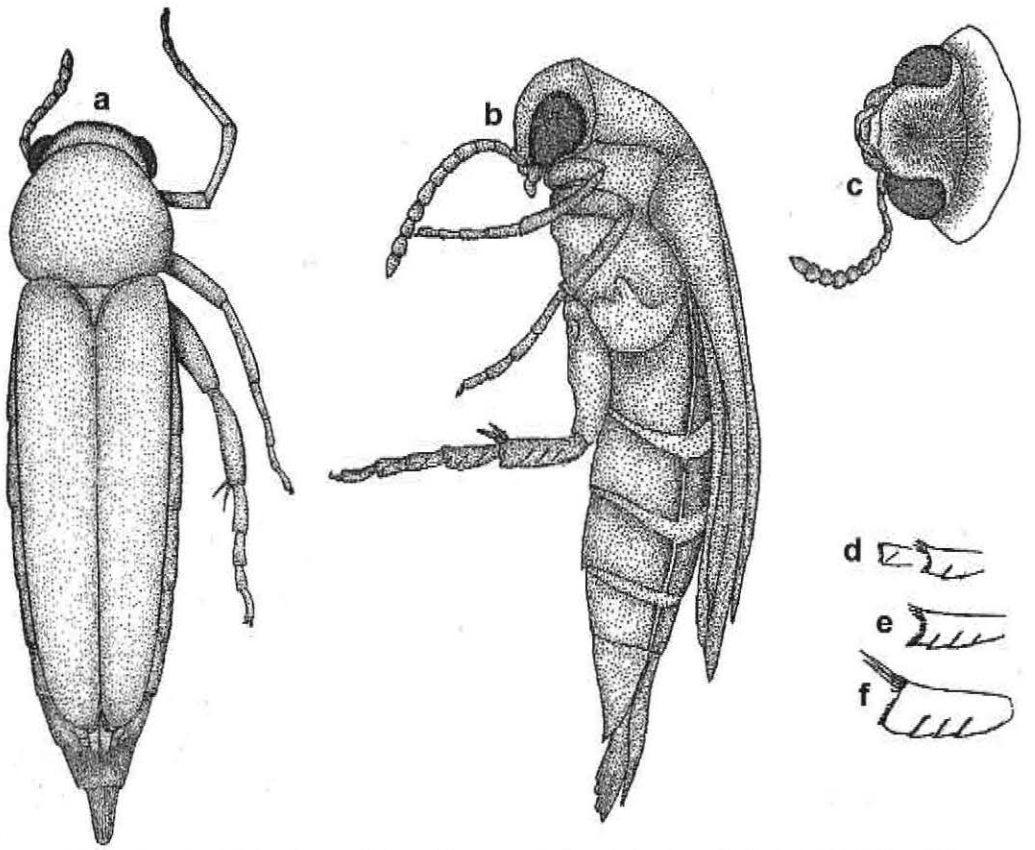

Figure 36 a–f. Dorsal (a) and lateral (b) views of *Stenalia* sp. B, frontal view of head (c), oblique serrated spines on leg III in tarsal segment II and III (d), tarsus I (e) and tibia III (f)

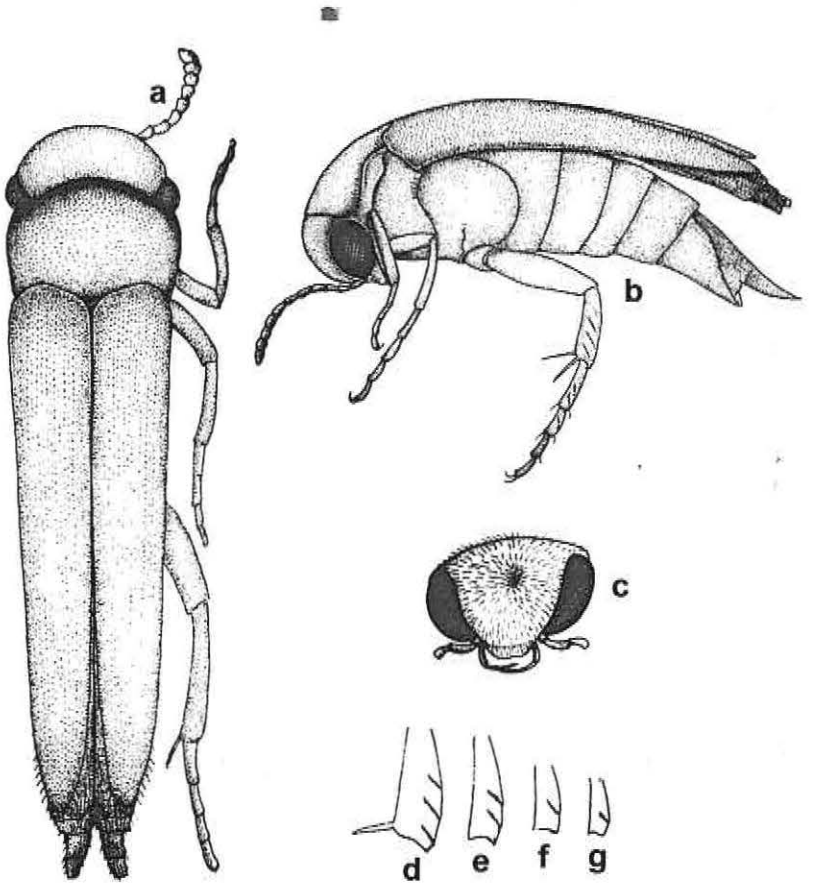

Figure 37 a–g. Dorsal (a) and lateral (b) views of *Stenalia* sp. C, frontal view of head (c), oblique serrated spines in tibia III (d), basitarsus (e), tarsal segment II (f), and III (g) of leg III

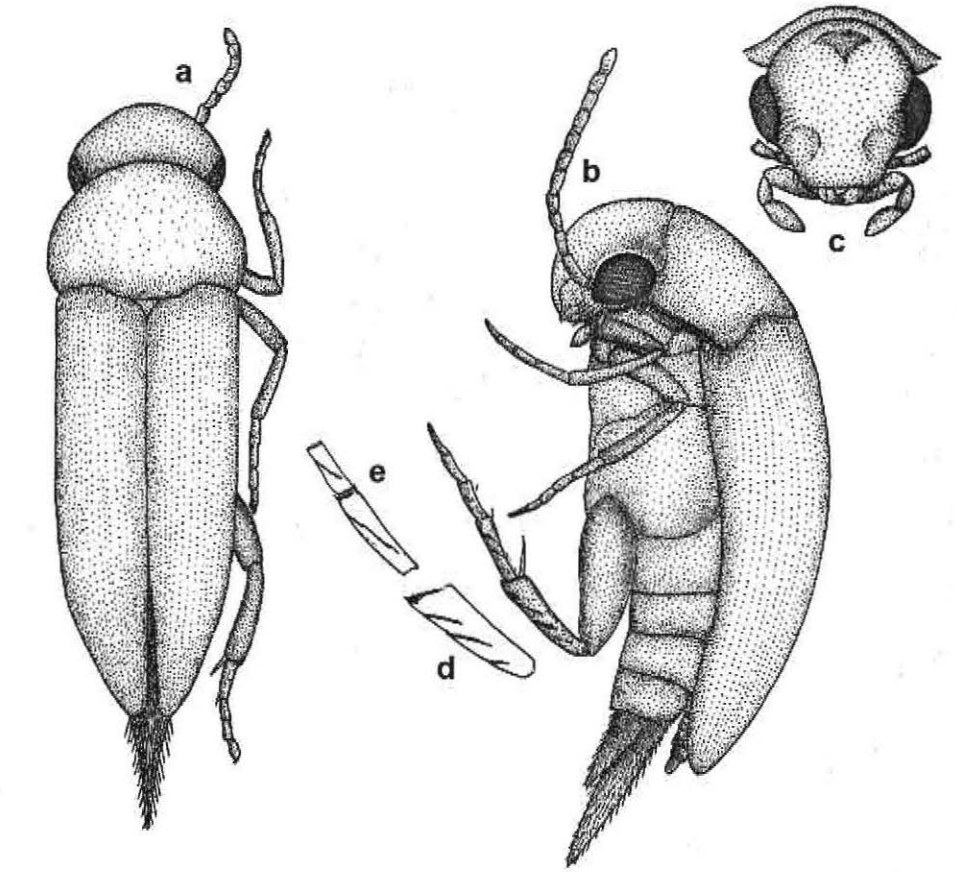

Figure 38 a–e. Dorsal (a) and lateral (b) views of *Stenalia* sp. D, frontal view of head (c), tibia III (d), and basal two segments of tarsus (e)

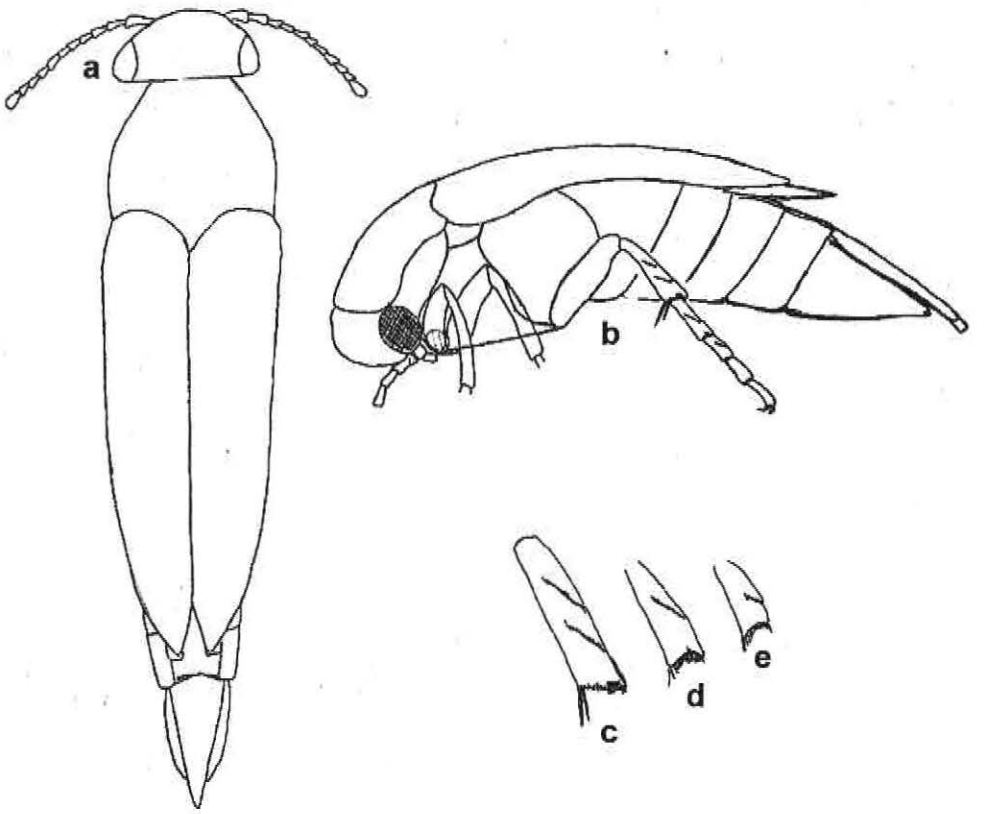

Figure 39 a–e. Dorsal (a) and lateral (b) views of *Stenalia* sp. E and oblique spines of tibia III (c), basitarsus (d), and second tarsal segment (e) of leg III

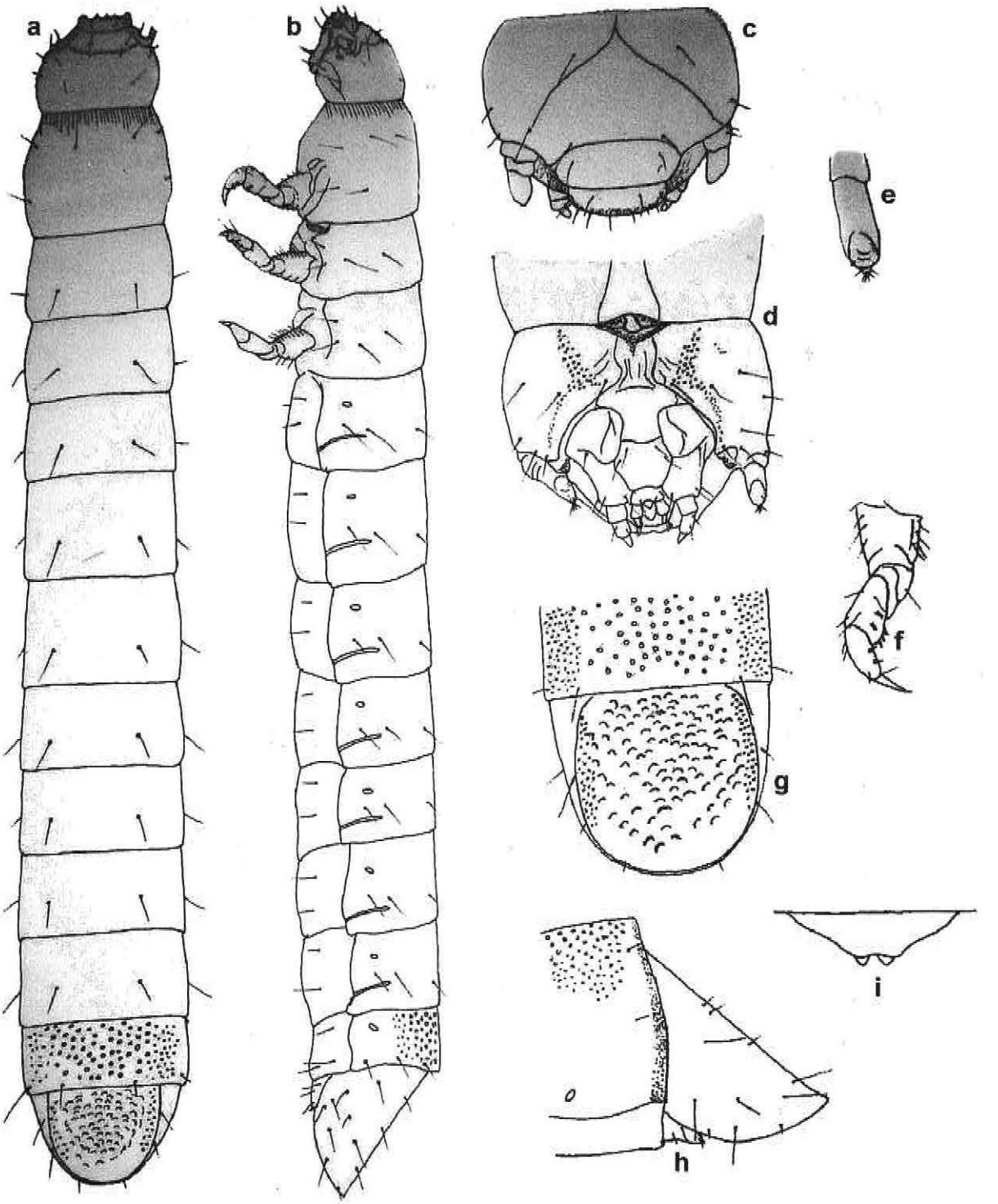

Figure 40 a–i. Dorsal (a) and lateral (b) views of *Paramarygmus* sp. larva, frontal (c) and ventral (d) views of head, antenna (e), proleg I (f), dorsal (g) and lateral (h) views of segments VIII–IX and ventral view of sternite X (i)

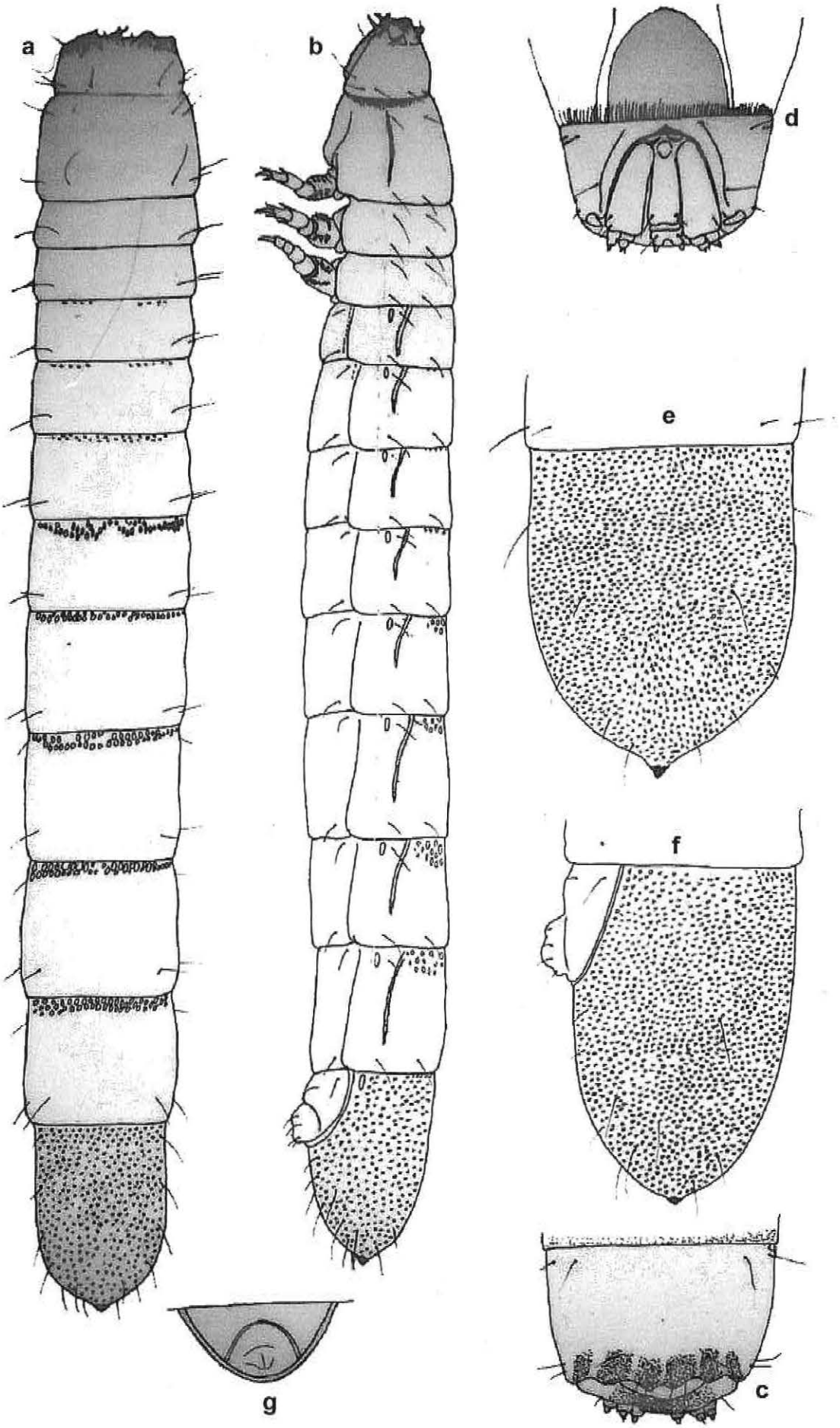

Figure 41 a–g. Dorsal (a) and lateral (b) views of *Zophodes* sp. larva, frontal (c) and ventral (d) views of head, dorsum of abdominal segment IX (e), lateral view of segment IX–X (f) and ventral view of segment X (g)

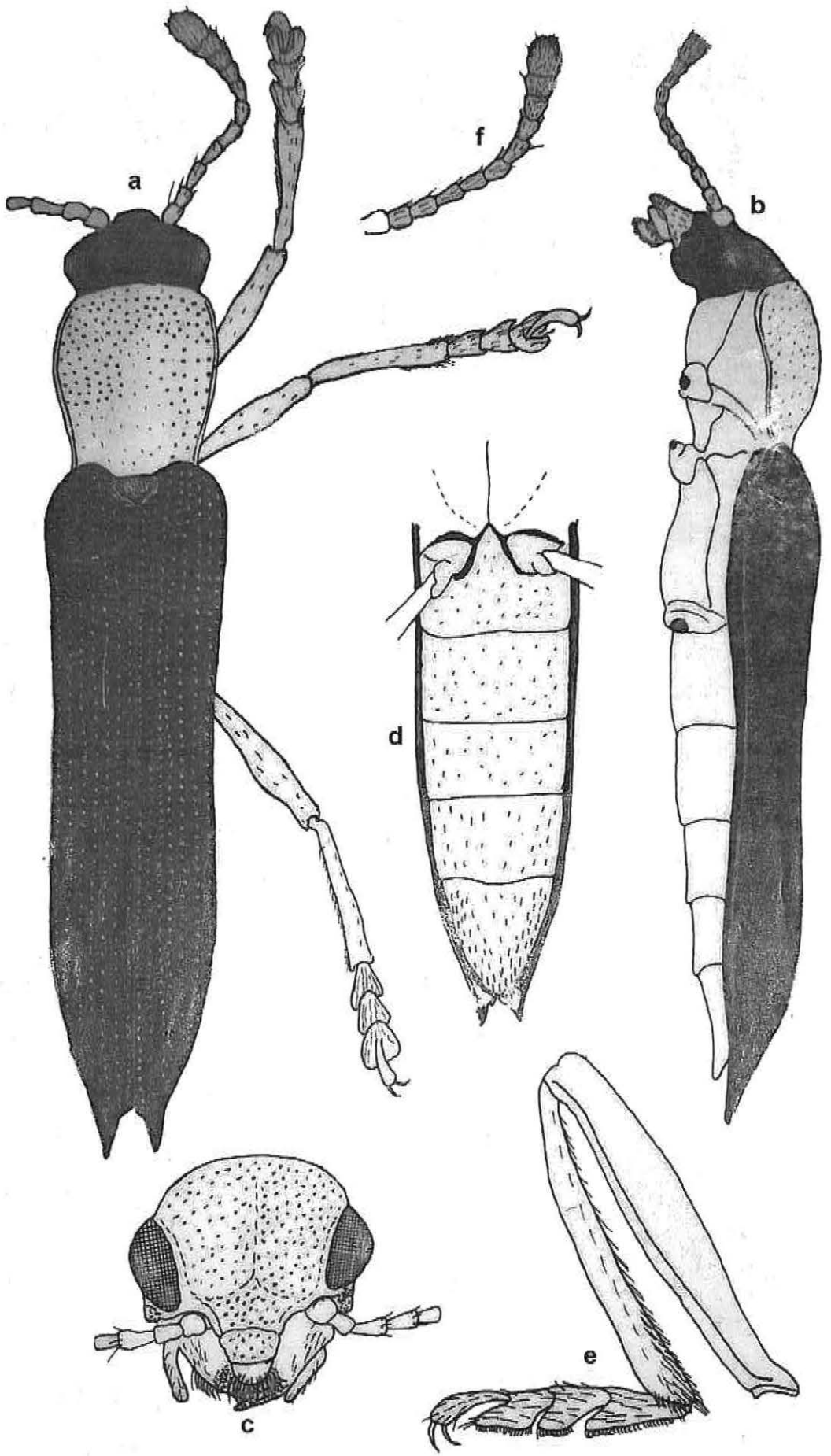

Figure 42 a–f. Dorsal (a) and lateral (b) views of *Stenolanguria caudata*, frontal view of head (c), abdominal venter (d), leg III (e) and antenna (f)

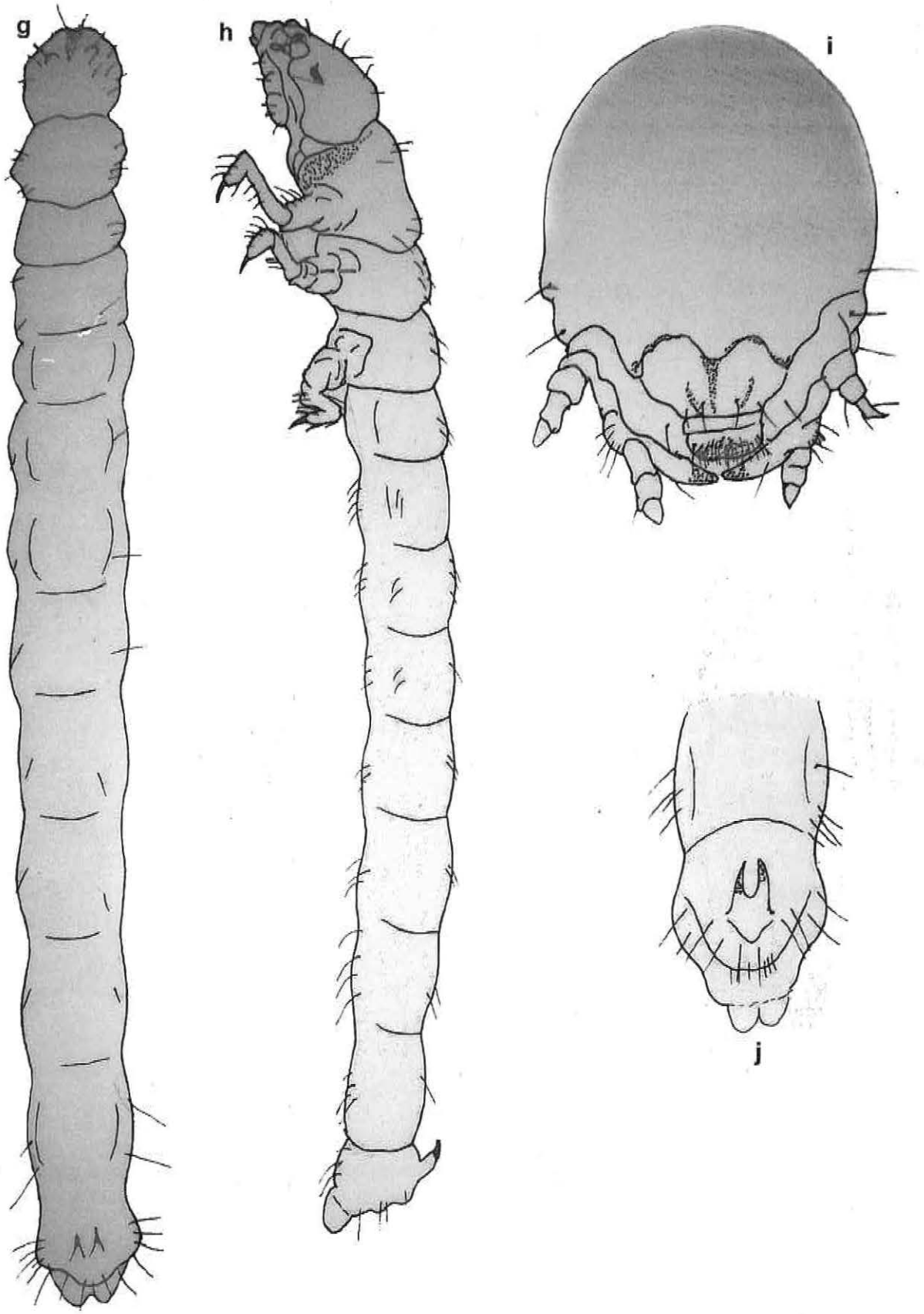

Figure 42 g–j. Dorsal (g) and lateral (h) views of *S. caudata* larva, frontal view of head (i), and dorsal view of urogomphi (j)

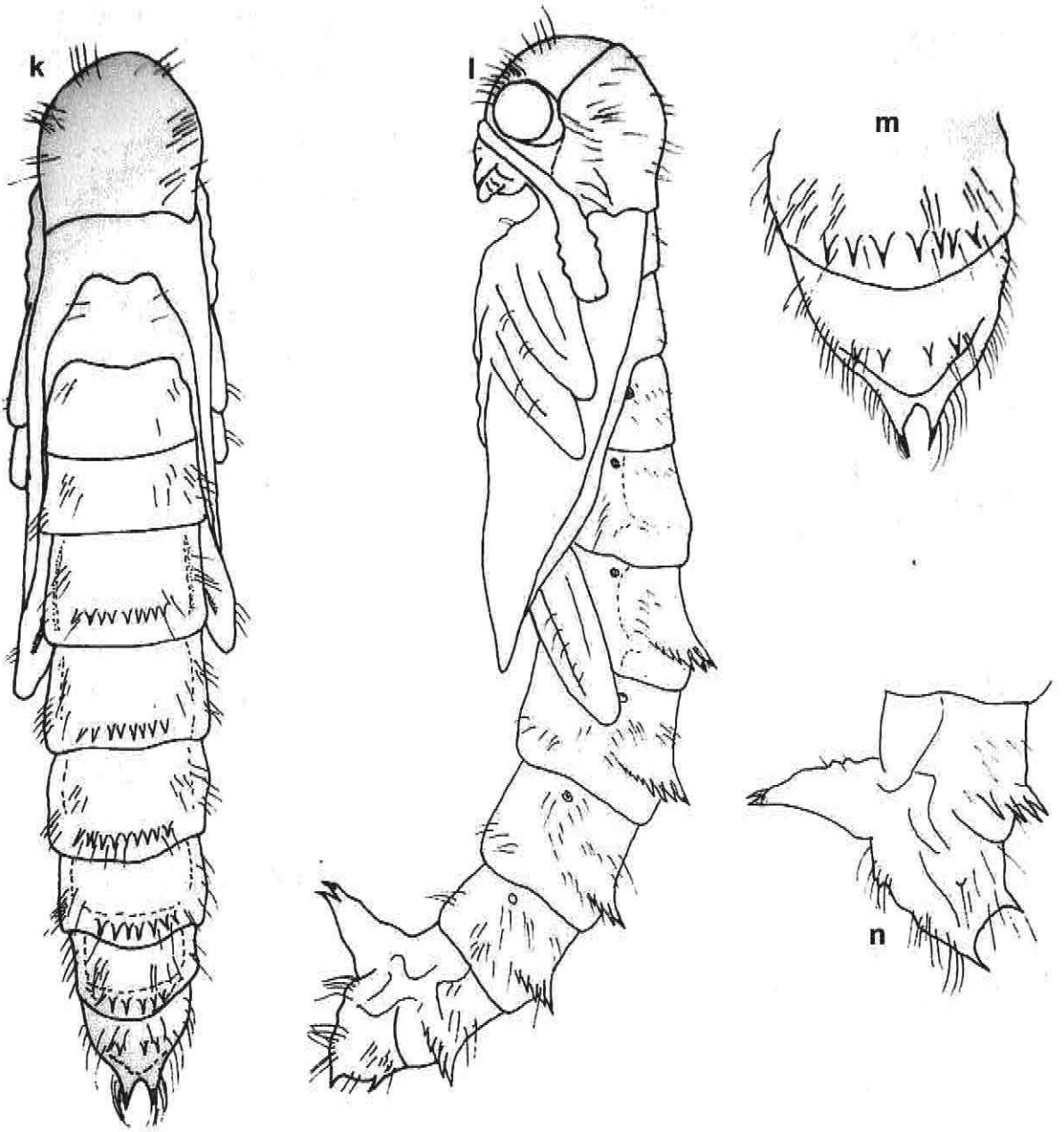

Figure 42 k–n. Dorsal (k) and lateral (l) views of *S. caudata* pupa, dorsal (m) and lateral (n) views of urogomphi

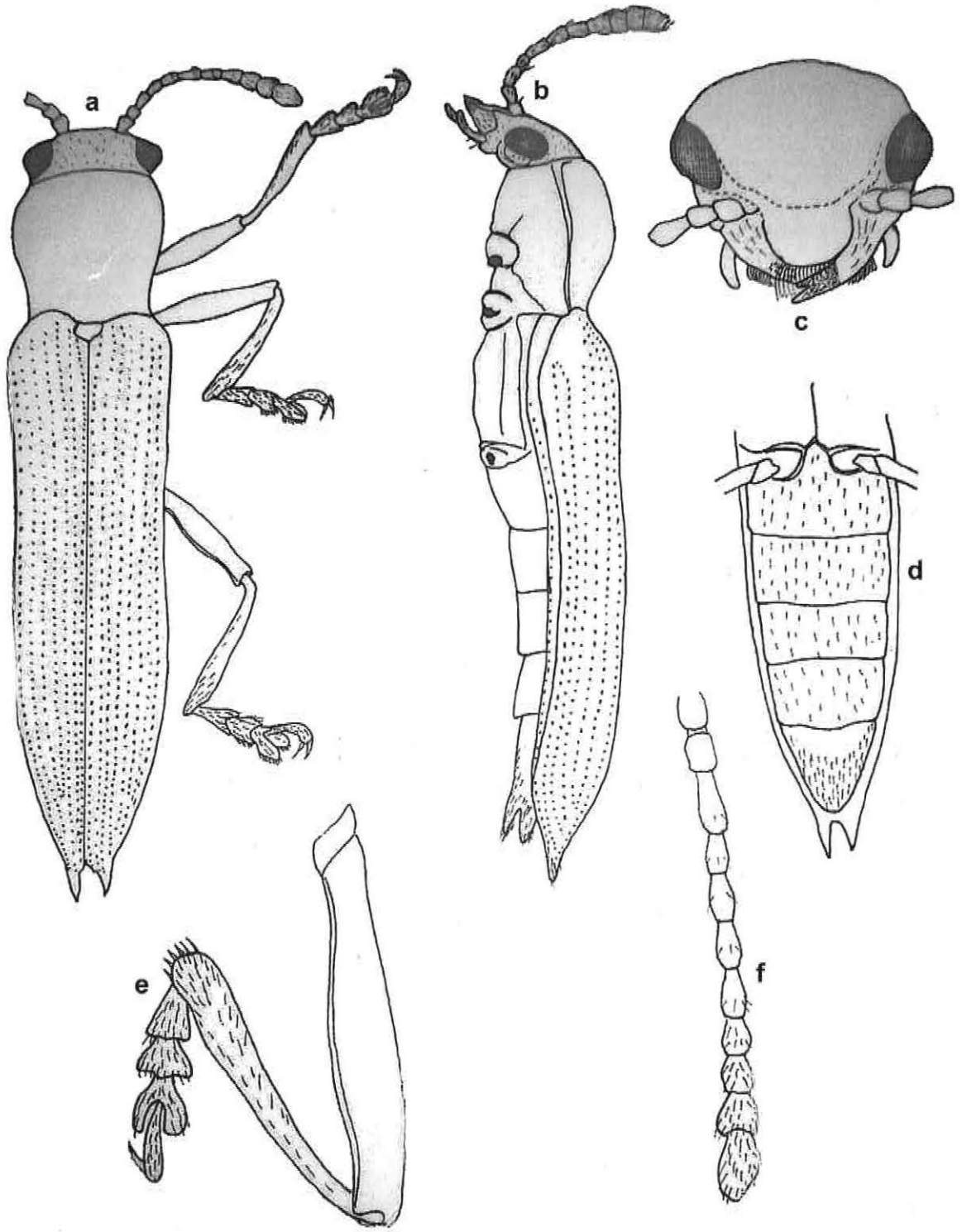

Figure 43 a–f. Dorsal (a) and lateral (b) views of *Stenolanguria* sp., frontal view of head (c), abdominal venter (d), leg III (e) and antenna (f)

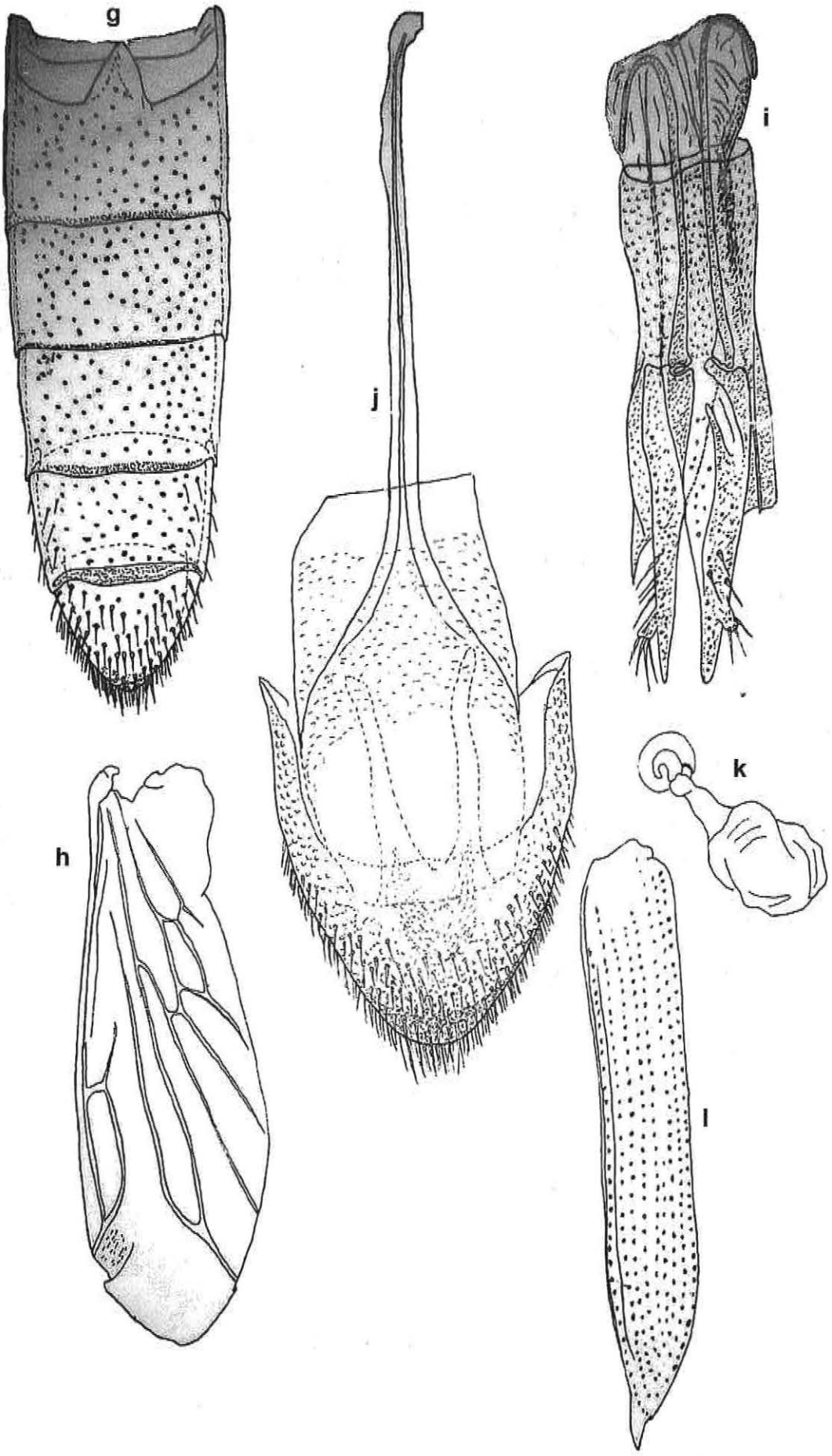

Figure 43 g–l. *Stenolanguria* sp. abdominal venter (g), hindwing (h), female genitalia (i, j), spermatheca (k) and right elytron (l)

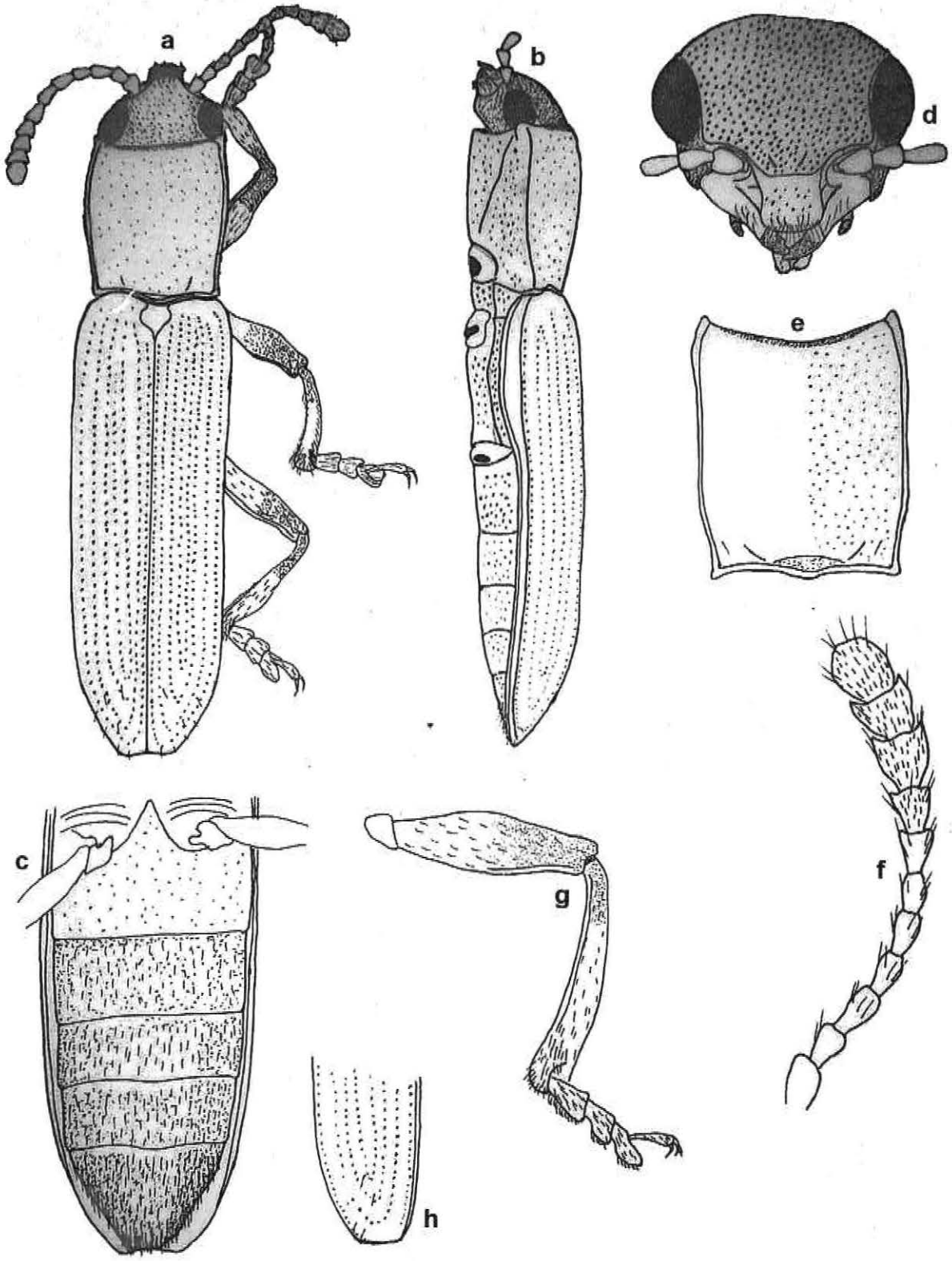

Figure 44 a–h. Dorsal (a) and lateral (b) views of *Barbaropus* near *olseni* Pic, venter of abdomen (c), frontal view of head (d), pronotum (e), antenna (f), leg I (g) and tip of elytron (h)

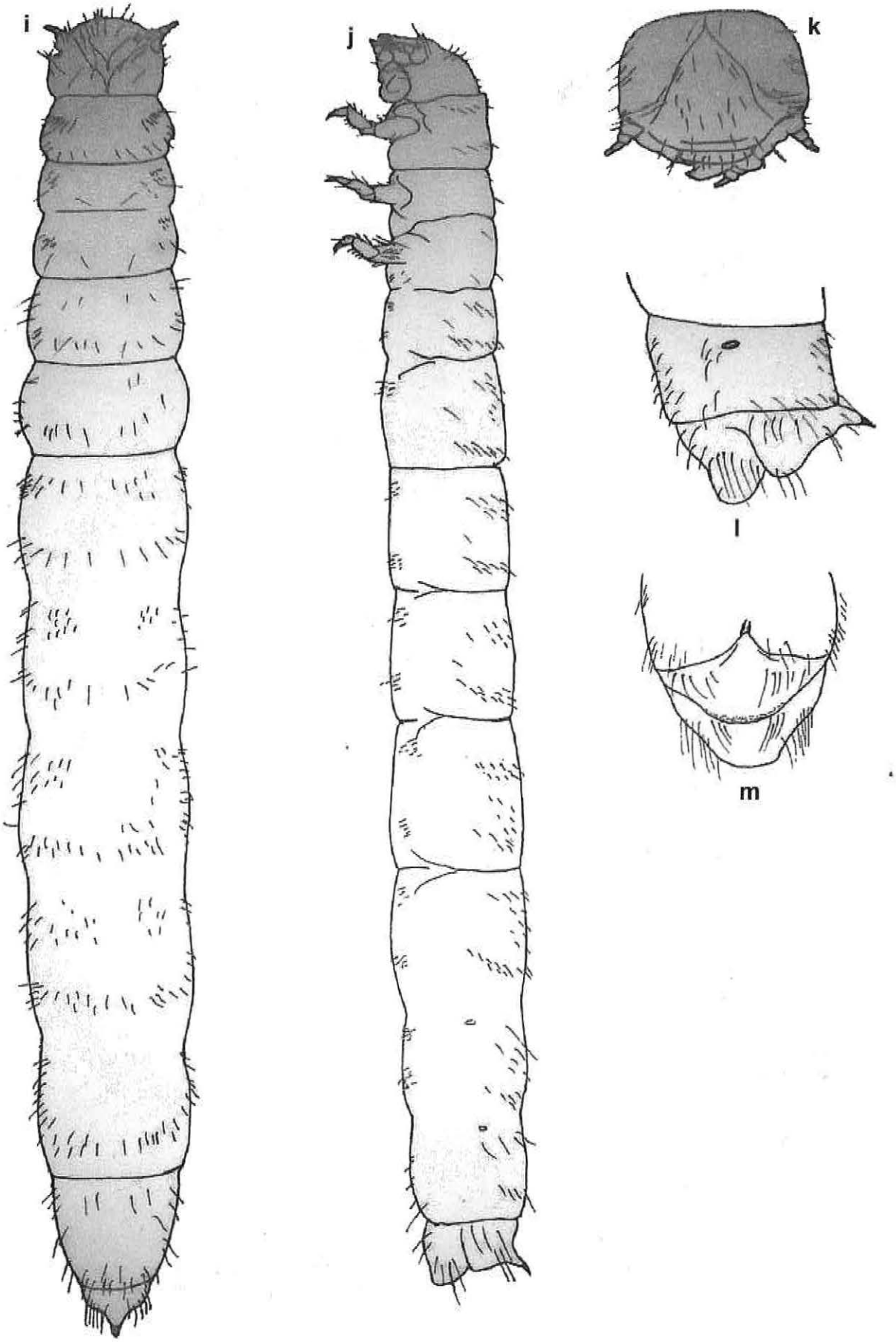

Figure 44 i–m. Dorsal (i) and lateral (j) views of *Barbaropus* near *olseni* Pic larva, frontal view of head (k), lateral (l) and dorsal (m) views of urogomphi

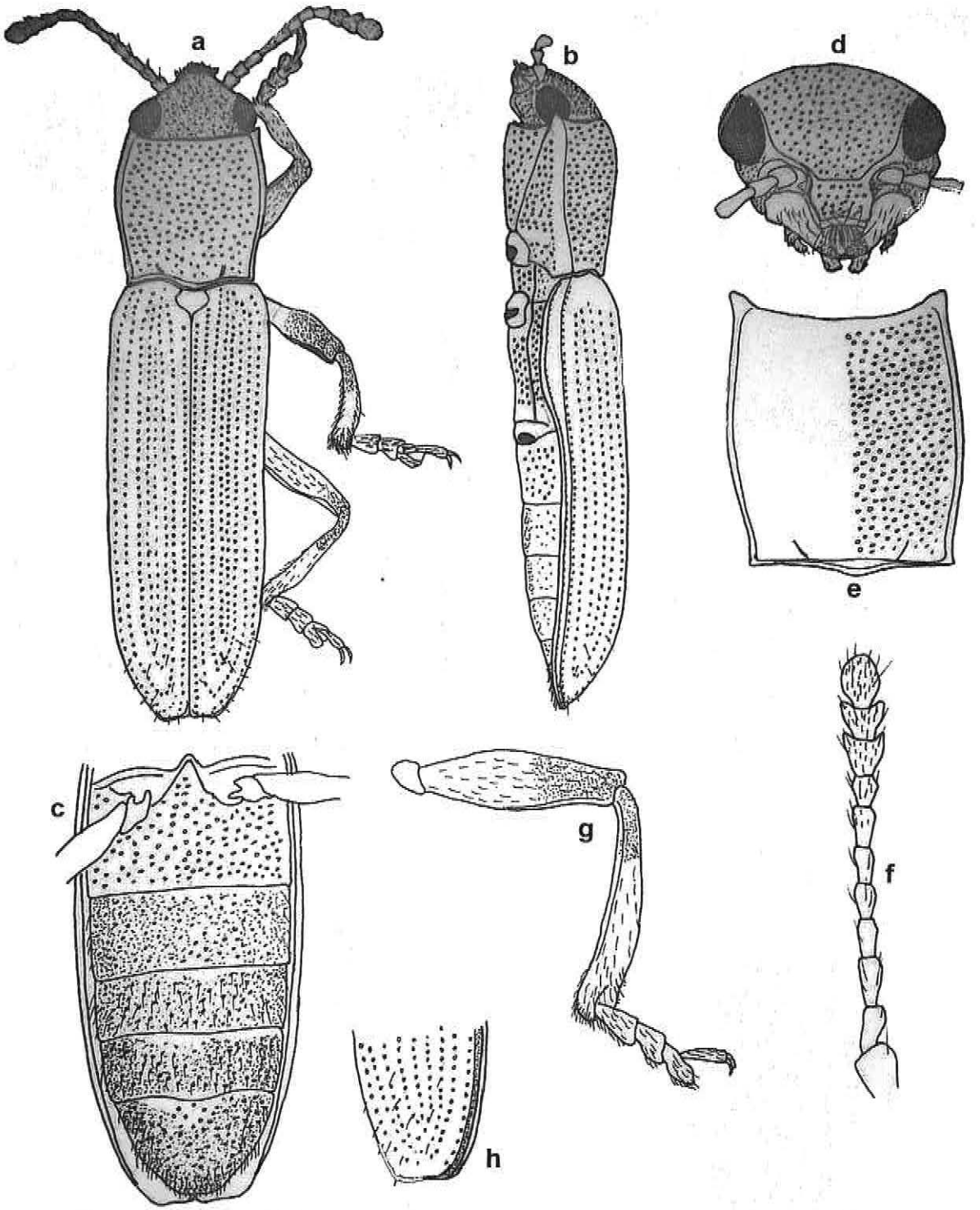

Figure 45 a–h. Dorsal (a) and lateral (b) views of *Barbaropus* sp. C, venter of abdomen (c), frontal view of head (d), pronotum (e), antenna (f), leg I (g) and tip of elytron (h)

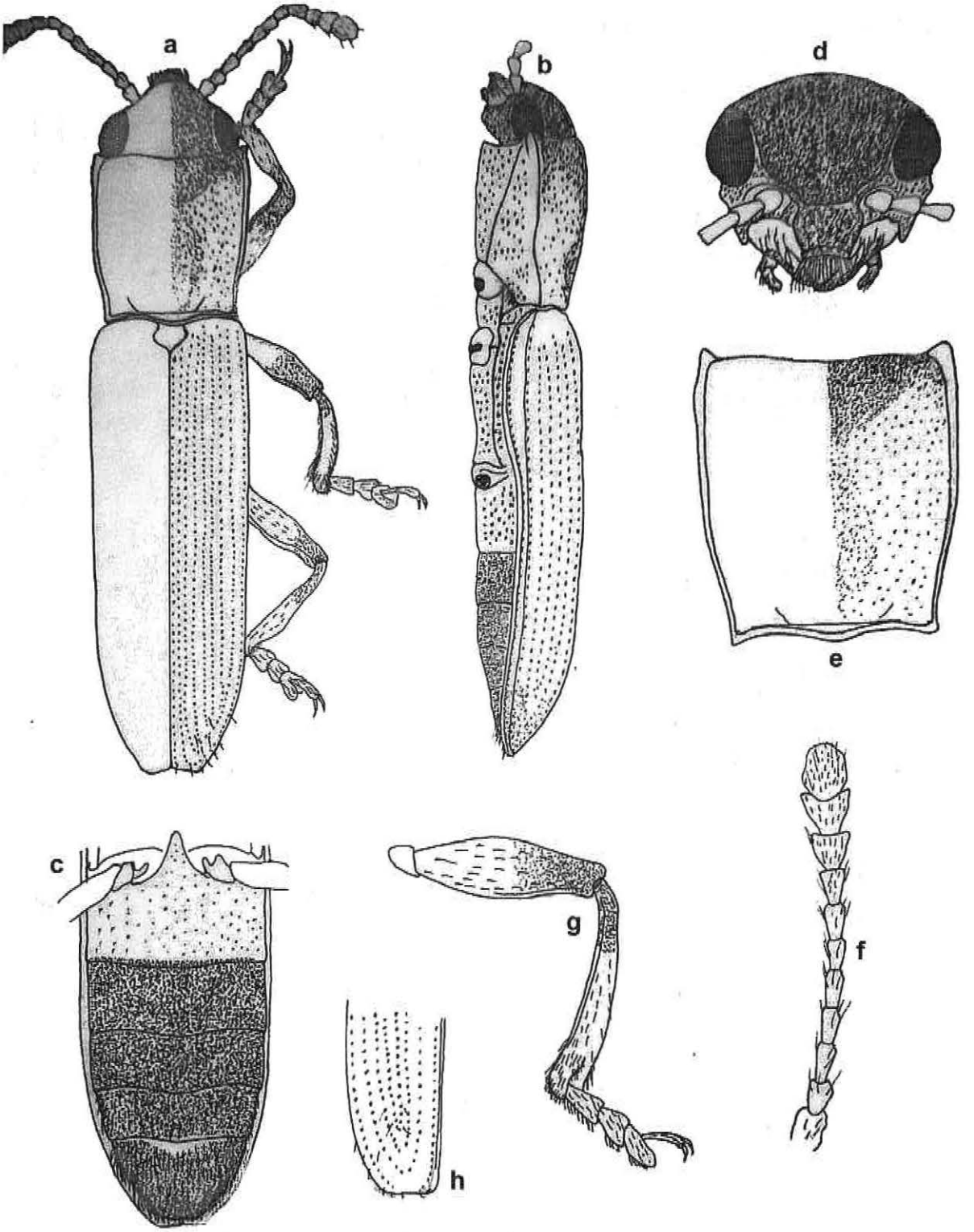

Figure 46 a–h. Dorsal (a) and lateral (b) views of *Barbaropus* sp. B, venter of abdomen (c), frontal view of head (d), pronotum (e), antenna (f), leg I (g) and tip of elytra (h)

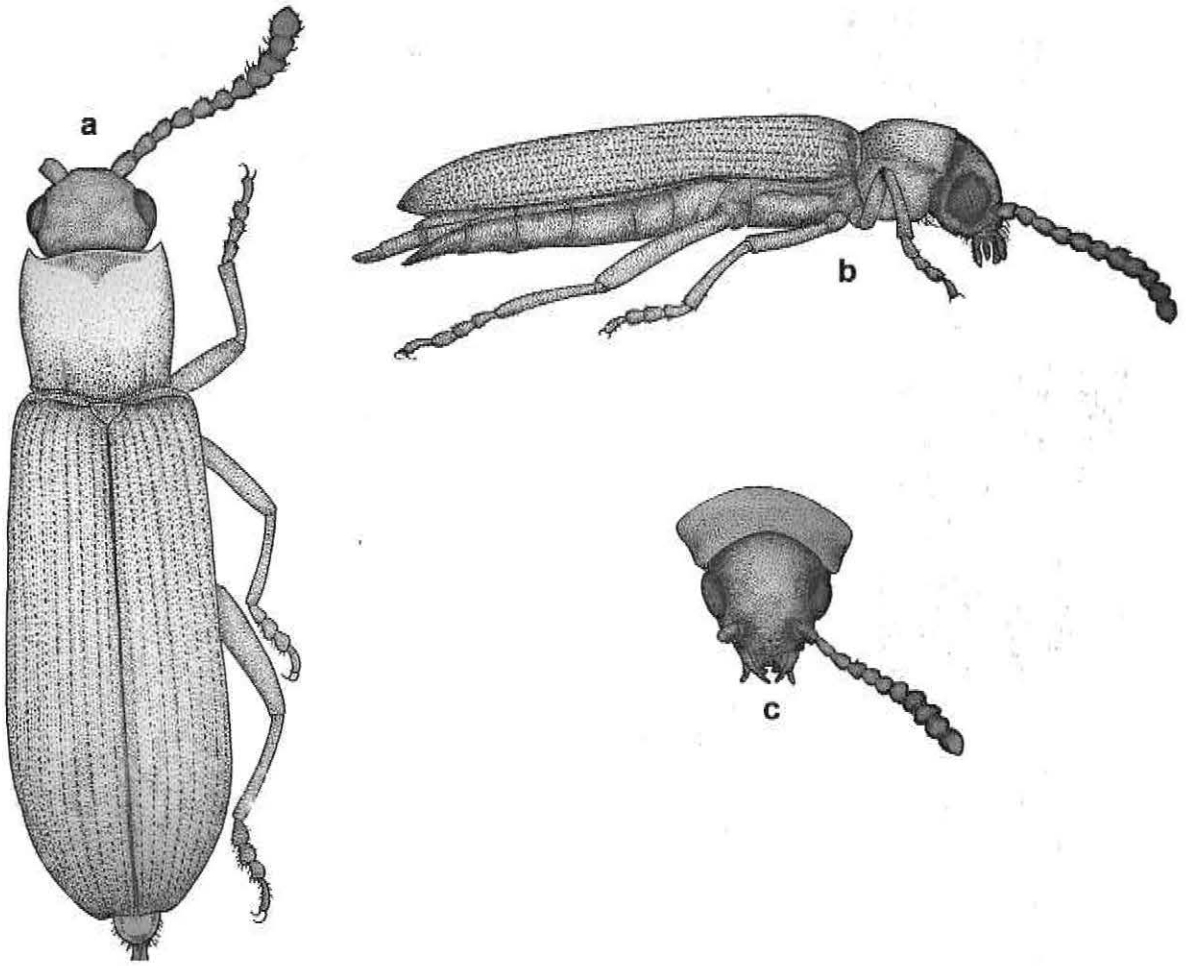

Figure 47 a–c. Dorsal (a) and lateral (b) views of *Barbaropus* sp. D and frontal view of head (c)

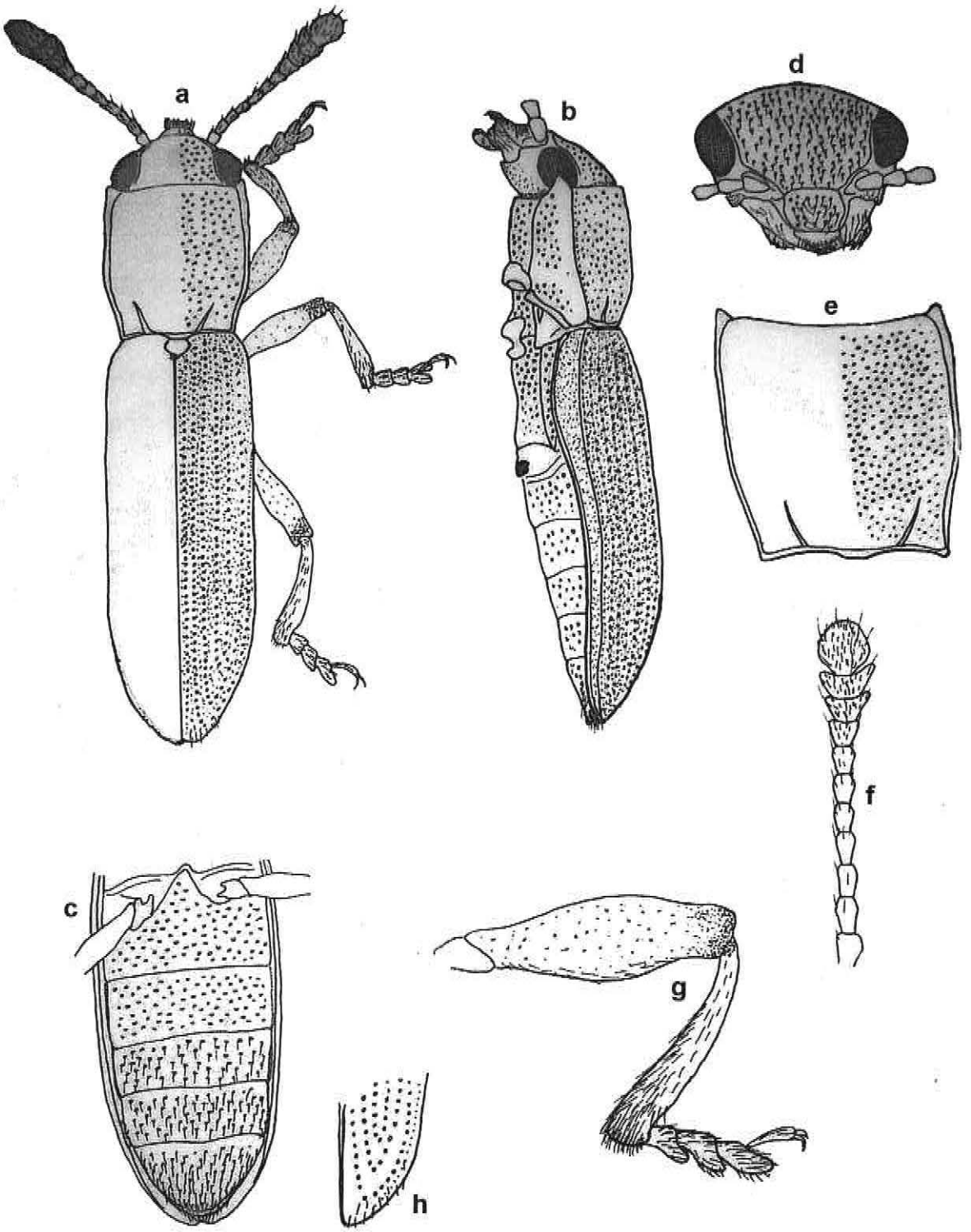

Figure 48 a–h. Dorsal (a) and lateral (b) views of *Barbaropus* sp. E, venter of abdomen (c), frontal view of head (d), pronotum (e), antenna (f), leg I (g) and tip of elytron (h)

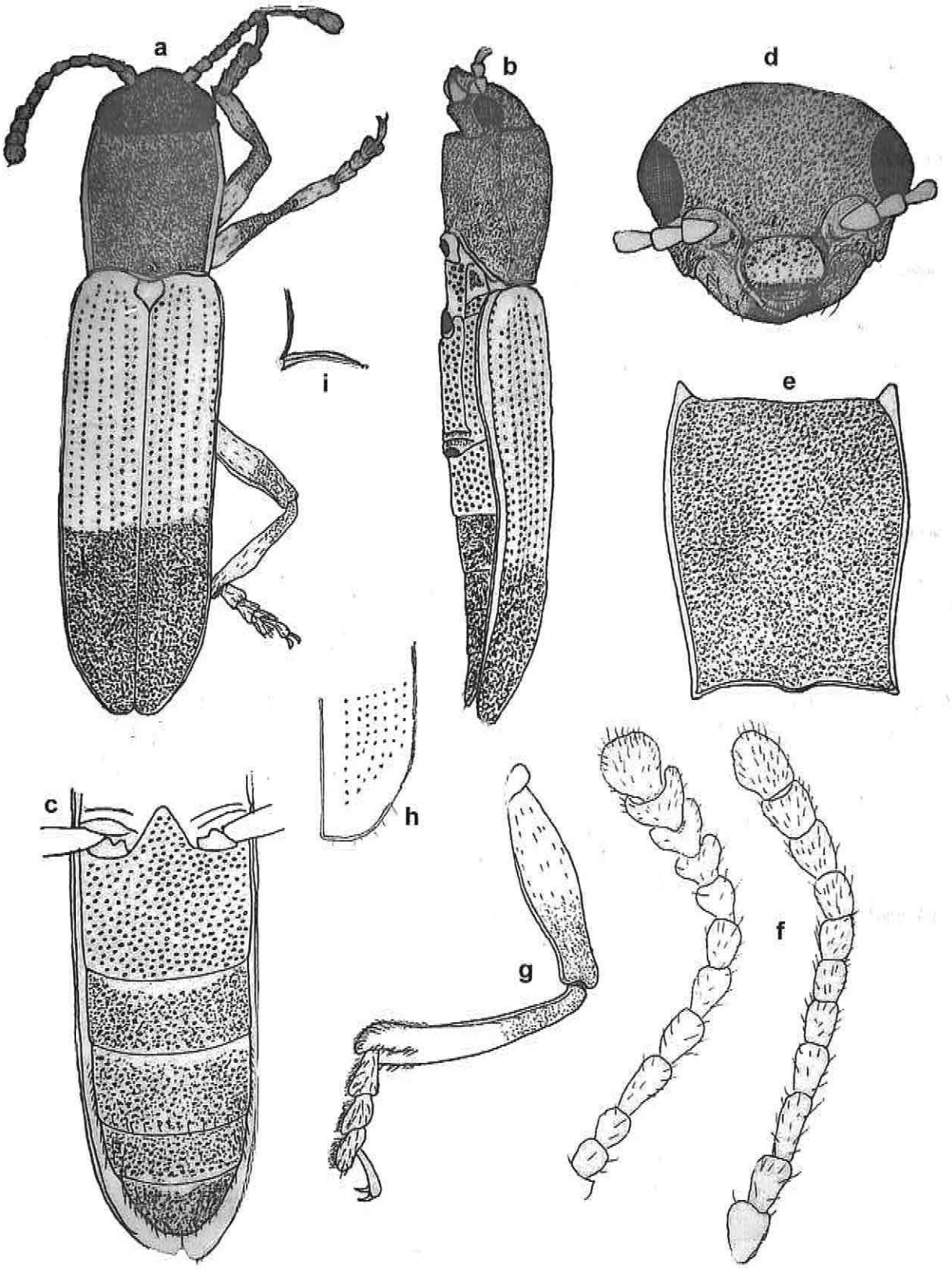

Figure 49 a–i. Dorsal (a) and lateral (b) views of *Promecolanguria rufocephala*, venter of abdomen (c), frontal view of head (d), pronotum (e), two forms of antenna (f), leg I (g), tip of elytron (h) and posterior lateral angle of pronotum (i)

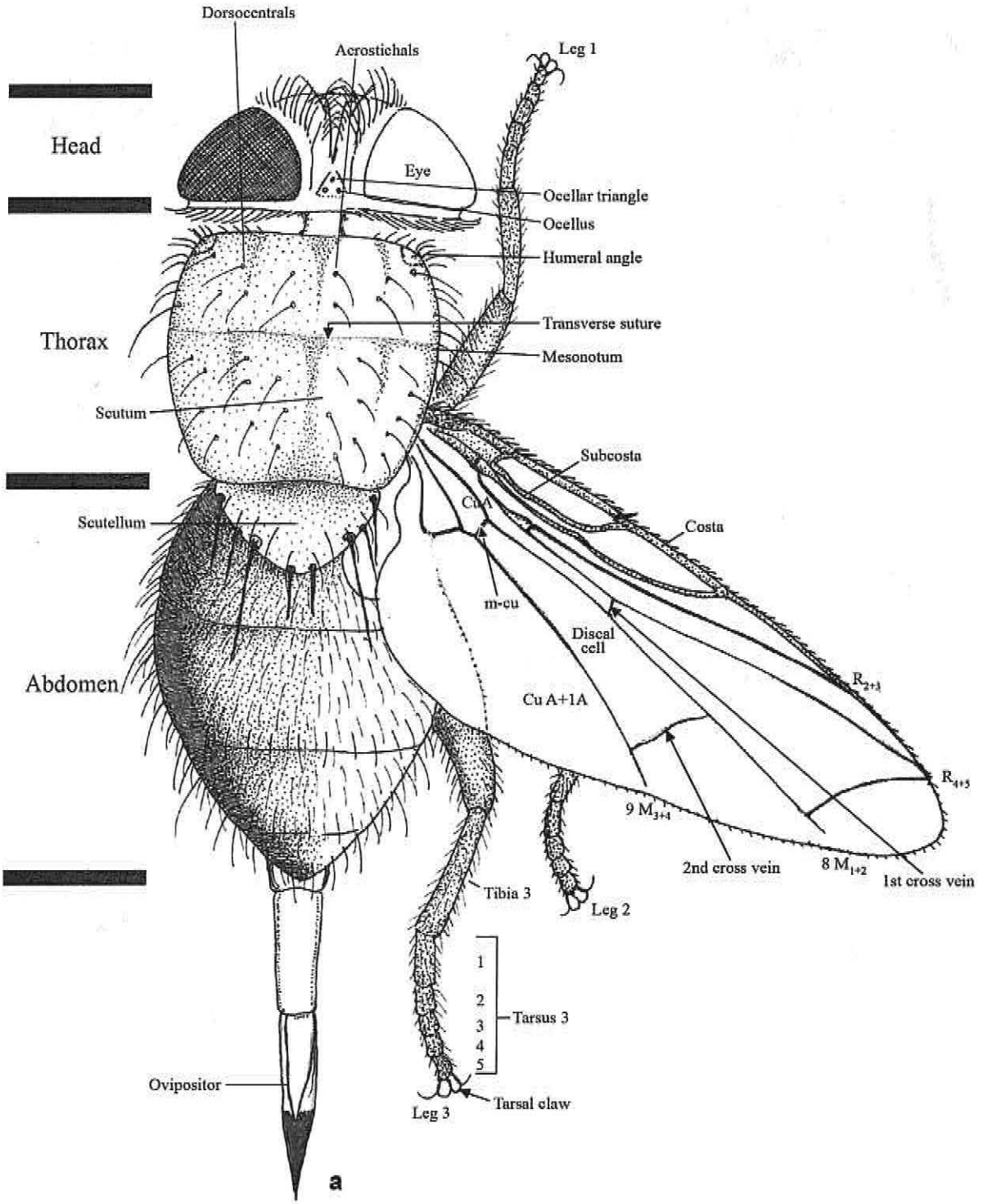

Figure 50 a. Dorsal view of a hypothetical fly

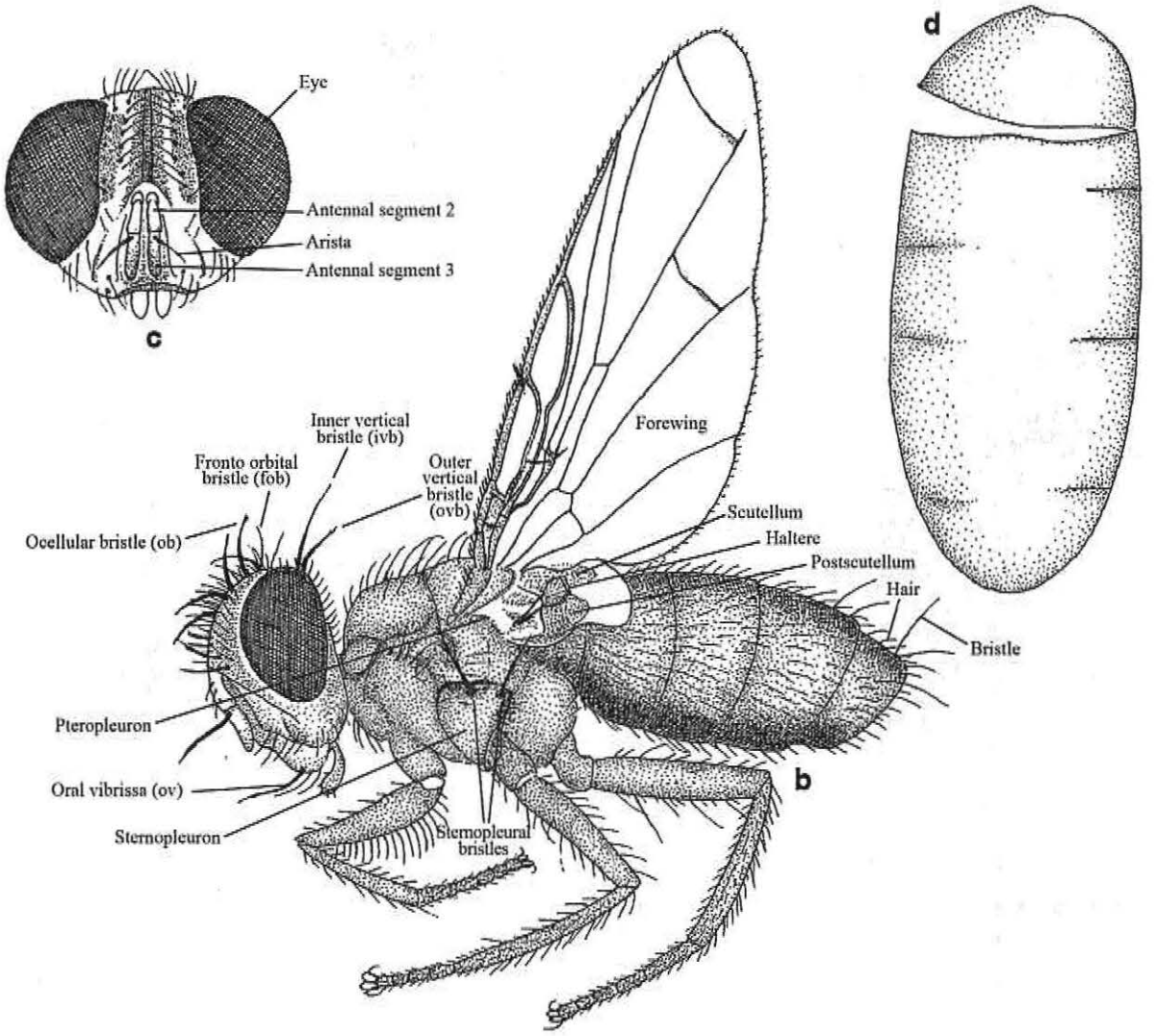

Figure 50 b–d. Lateral view of a hypothetical fly (b), frontal view of head (c) and pupa (d)

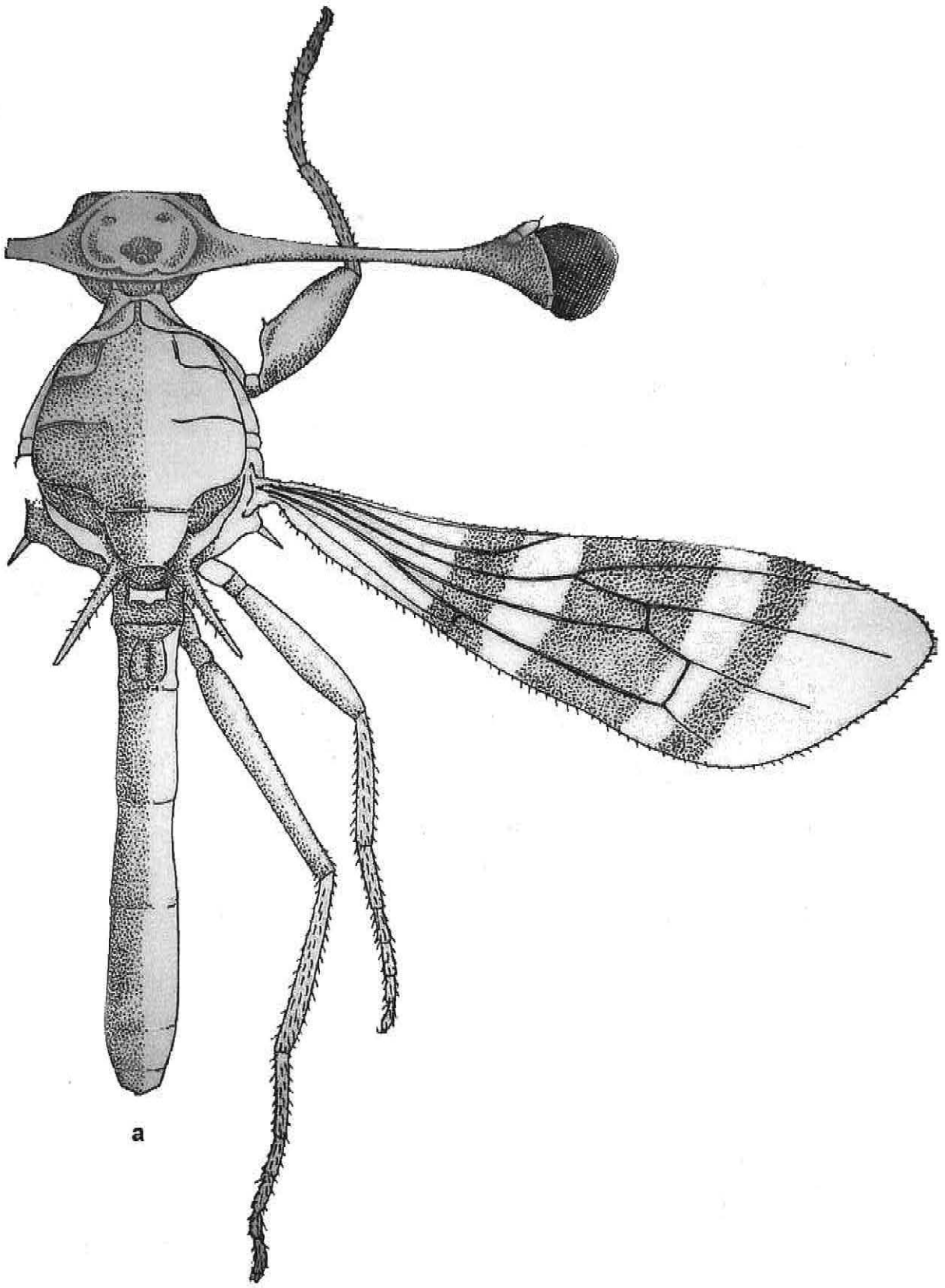

Figure 51 a. Dorsal view of *Diopsina* sp.

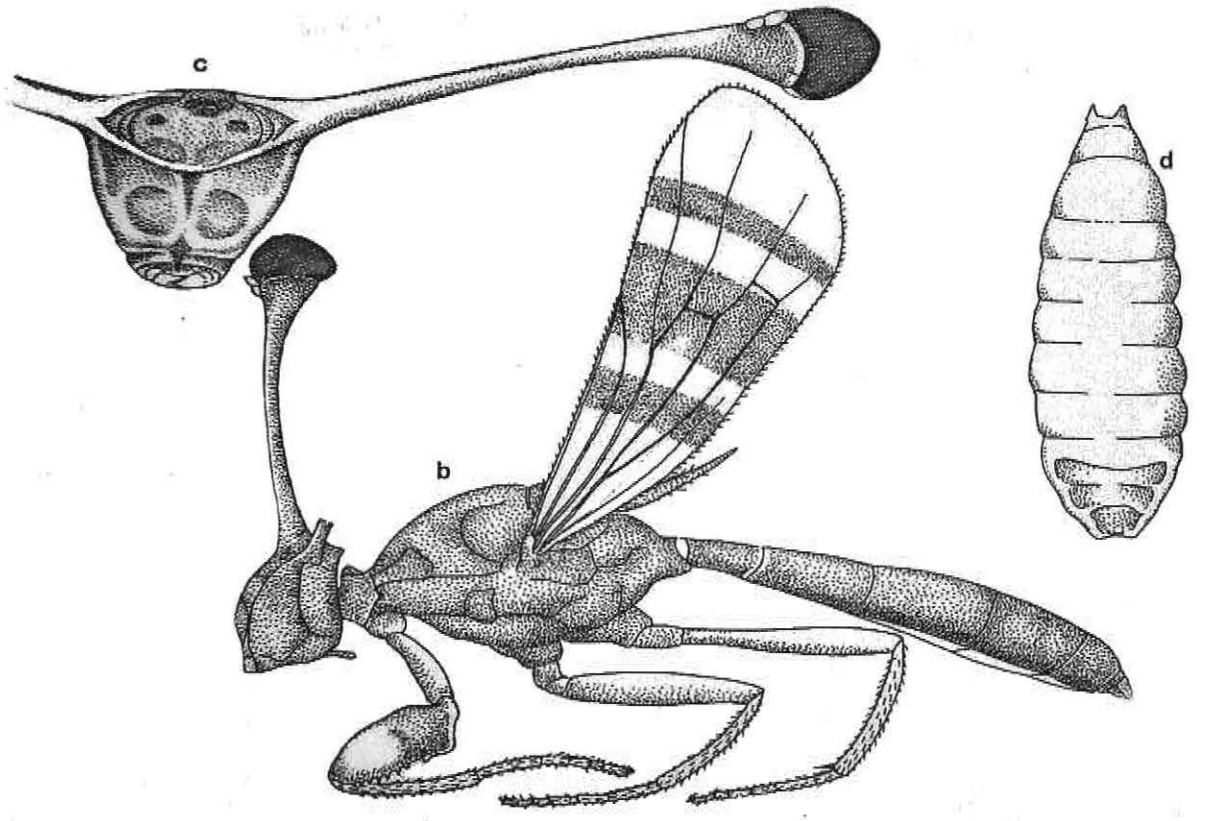

Figure 51 b–d. Lateral view of *Diopsina* sp. (b), frontal view of head (c) and pupa (d)

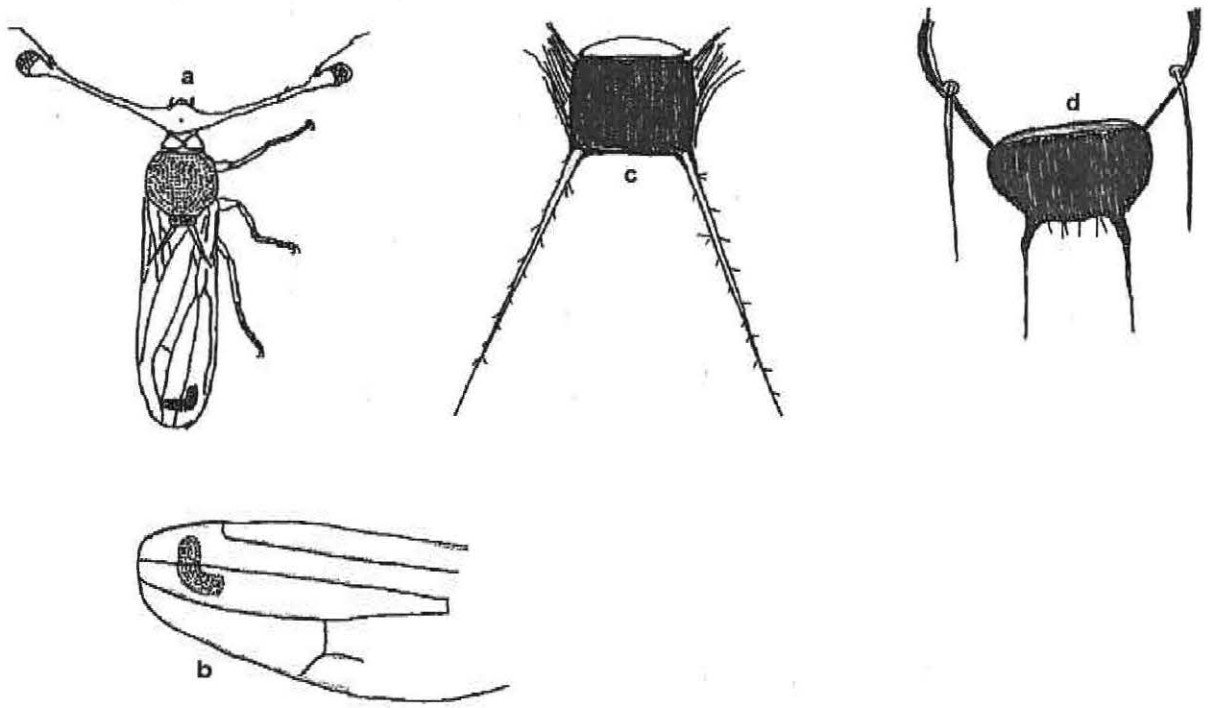

Figure 52 a–d. Dorsal view of *Diopsis* near *lindneri* Feijen (a), spot on forewing (b), scutellum (c) and scutellum of *Diopsis* sp. B (d)

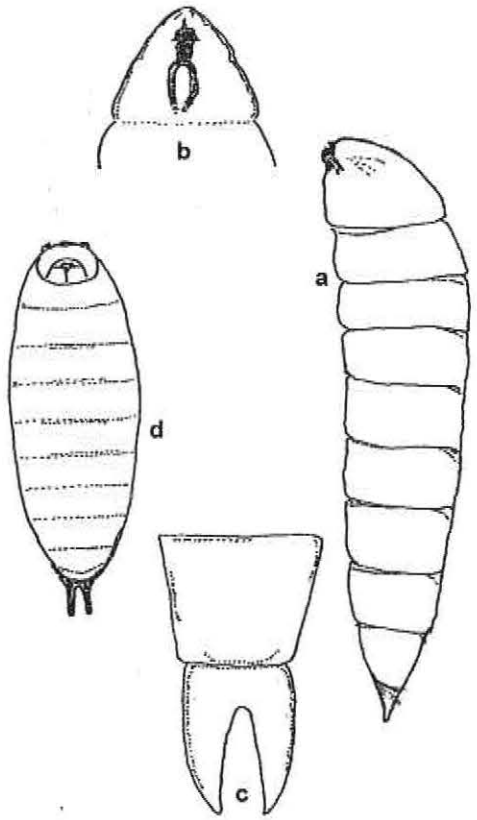

Figure 53 a–d. Lateral view of *Mepachymerus* sp. larva (a), dorsal view of head (b), posterior end (c) and dorsal view of pupa (d)

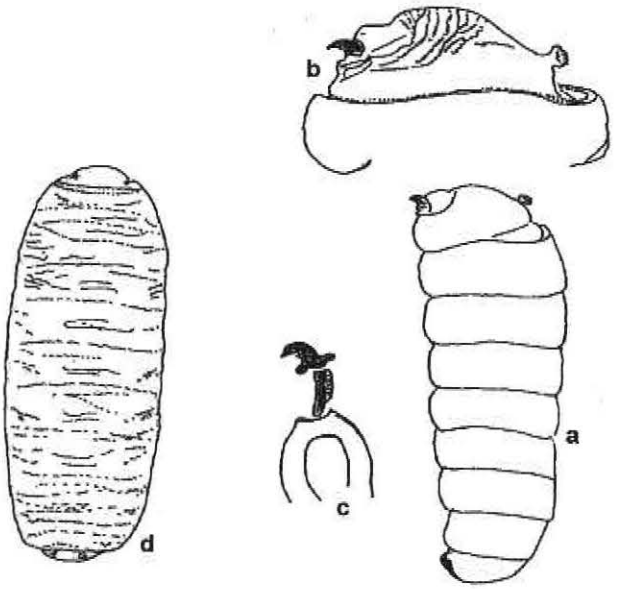

Figure 54 a–d. Lateral view of *Elachiptereicus abessynicus* Becker larva (a), head (b), cephalopharyngeal skeleton (c) and pupa (d)

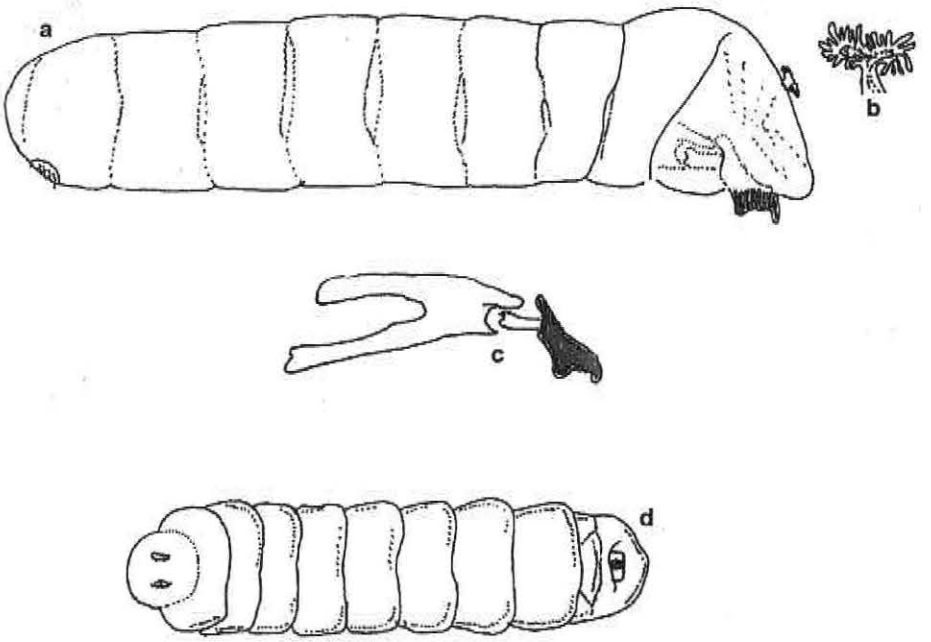

Figure 55 a–d. Lateral view of *Pachylophus* sp. larva (a), anterior spiracle (b), cephalopharyngeal skeleton (c) and pupa (d)

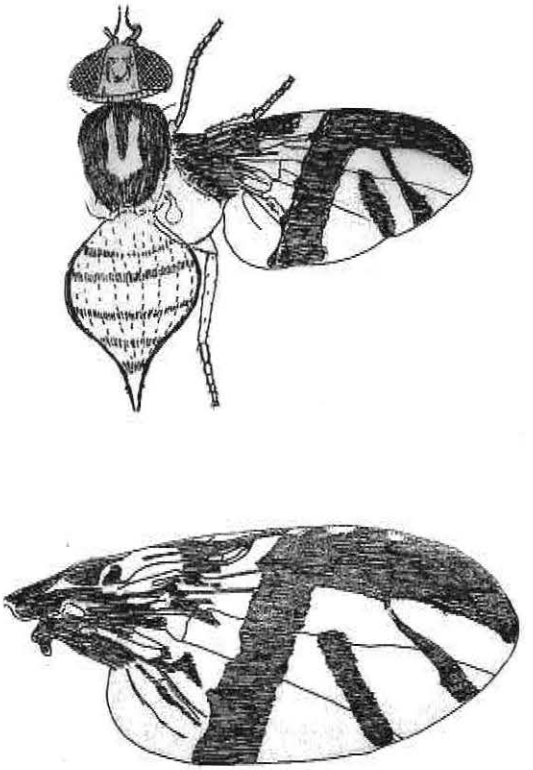

Figure 56 a–b. Dorsal view of *Bistrispinaria fortis* (Speiser) adult (a) and wing (b)

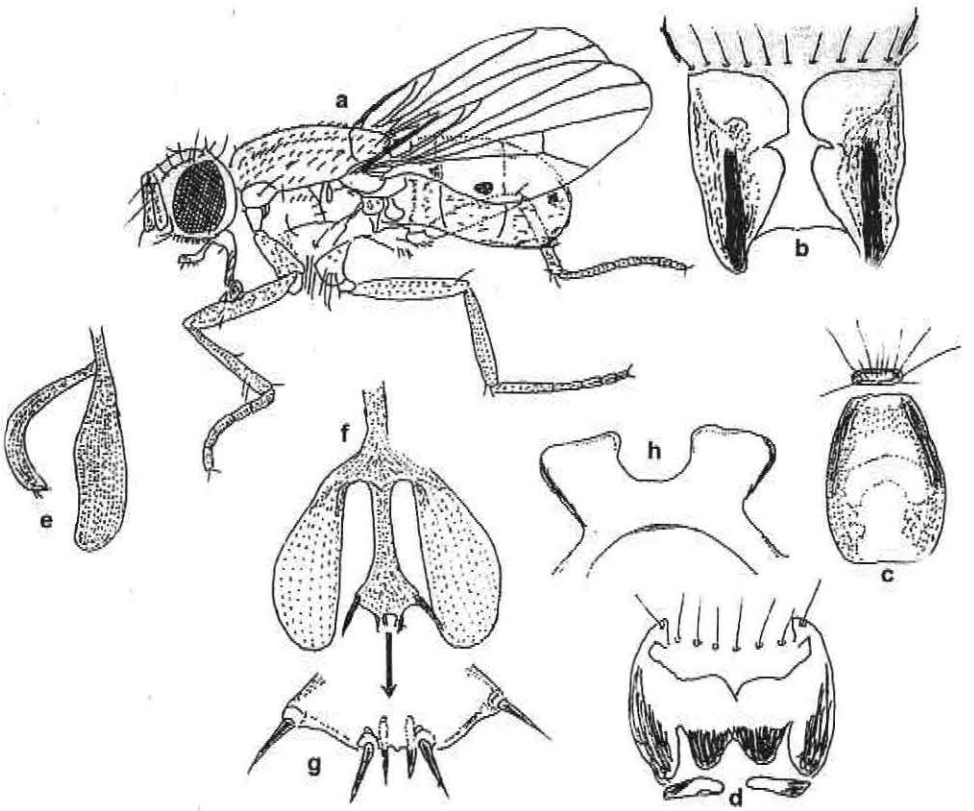

Figure 57 a–h. Lateral view of adult *Atherigona soccata* Rondani (a), tergite VII (b) and VIII (c), sternite VII (d), lateral (e) and dorsal (f) views of trifoliate process, tip of median process (g) and hypopygial prominence (h)

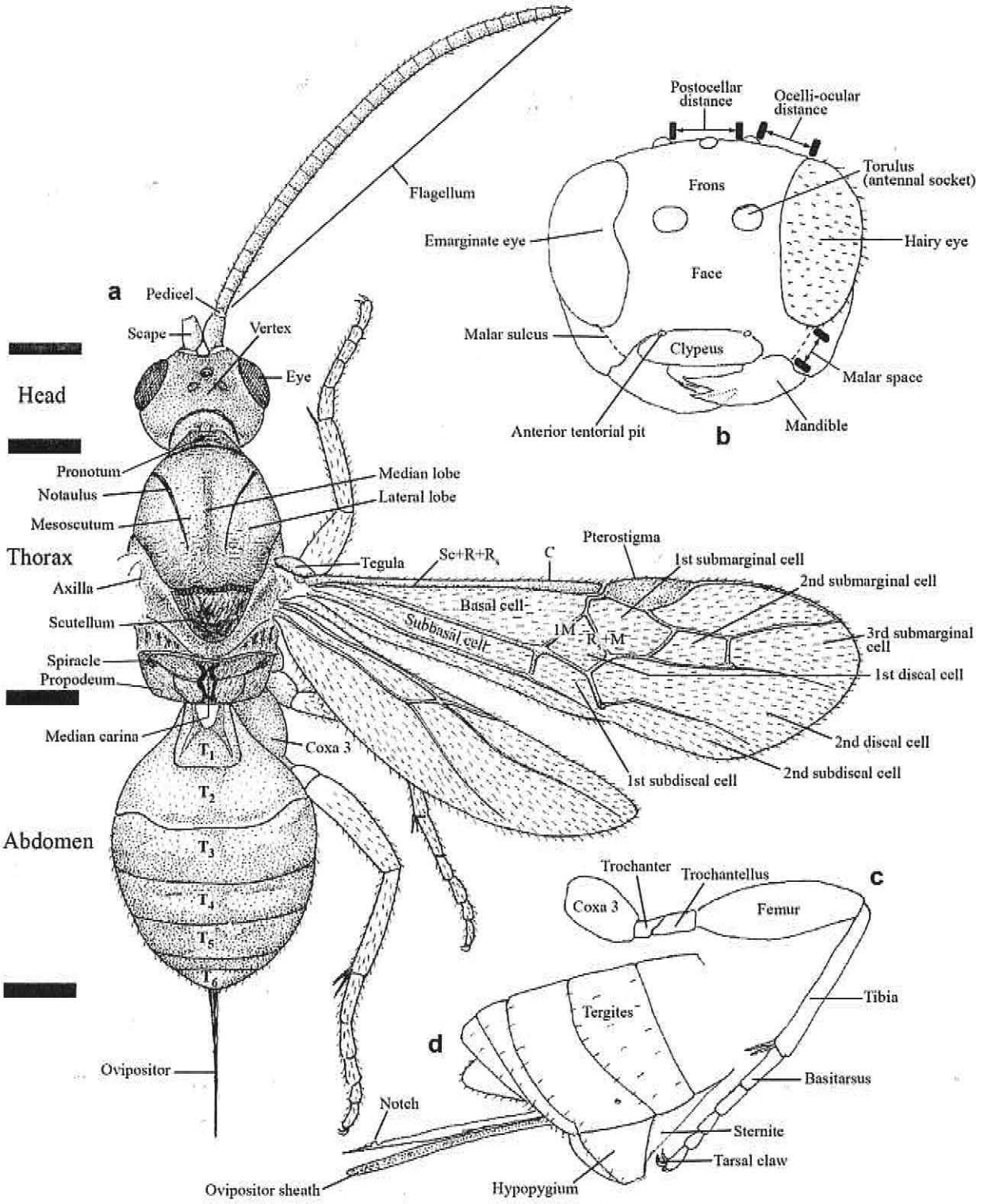

Figure 58 a–d. Dorsal view of a parasitic hymenoptera (a), frontal view of head (b), leg III (c) and posterior abdomen showing ovipositor (d)

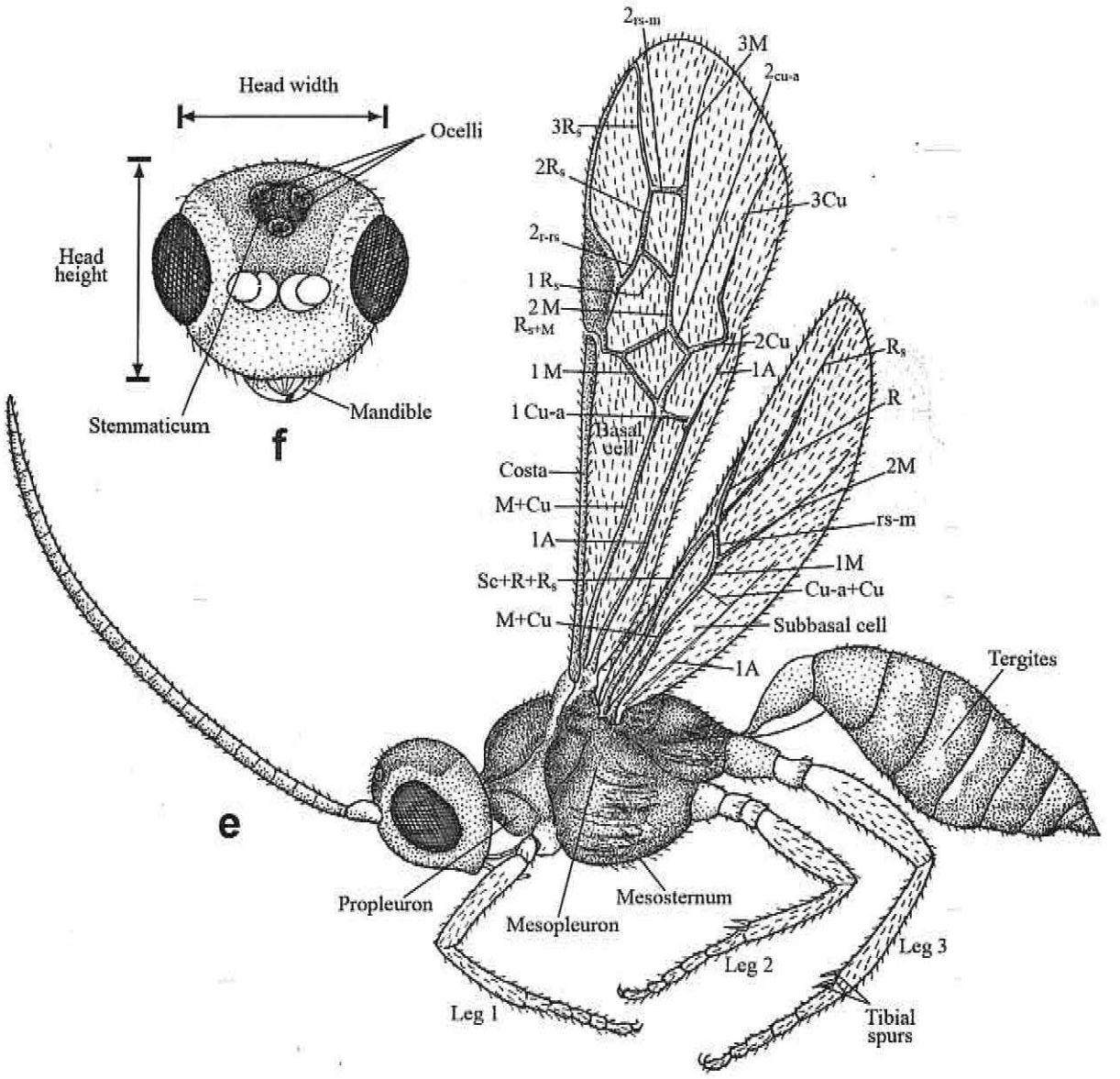

Figure 58 e–f. Lateral view of a parasitic hymenopteran (e) and frontal view of head (f)

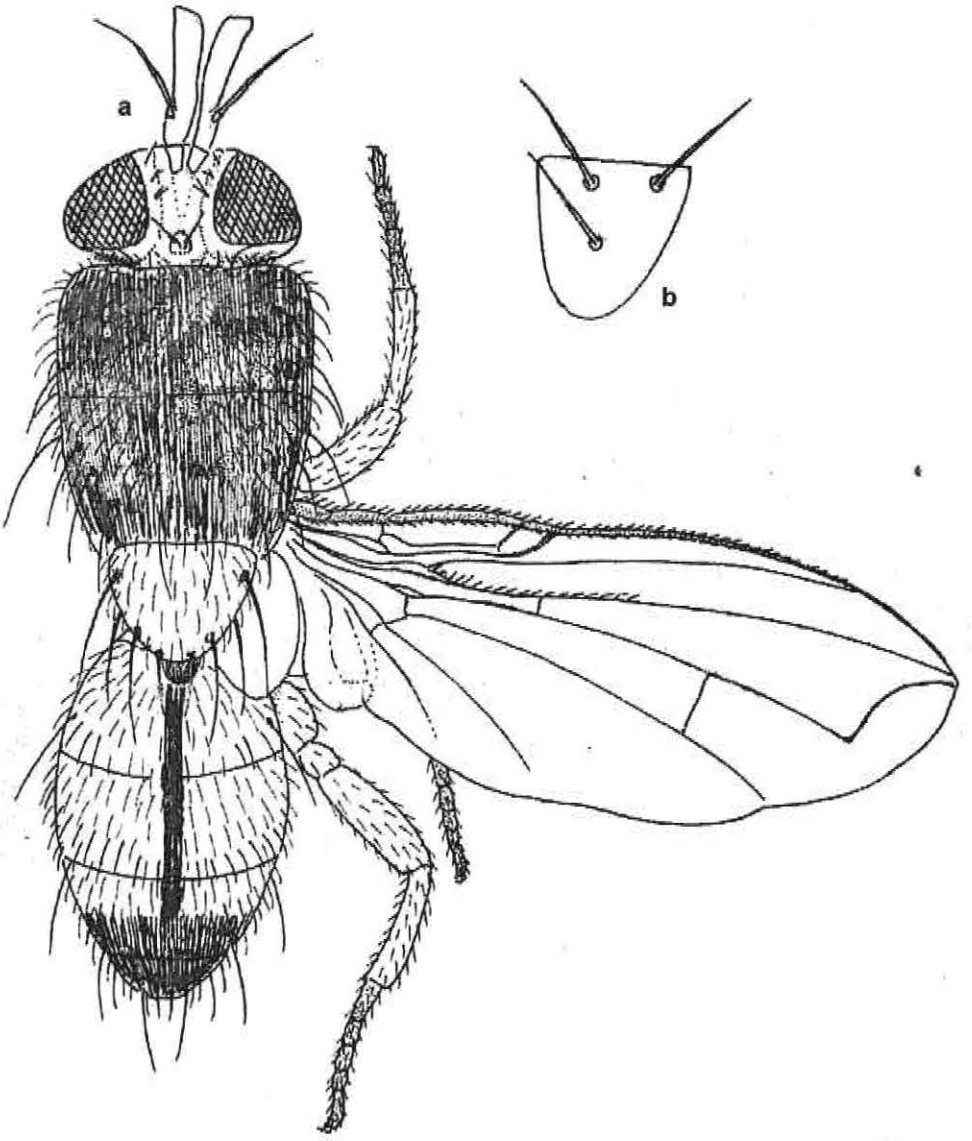

Figure 59 a–b. Dorsal view of adult *Siphona* sp. A (a) and sternopleural setae (b)

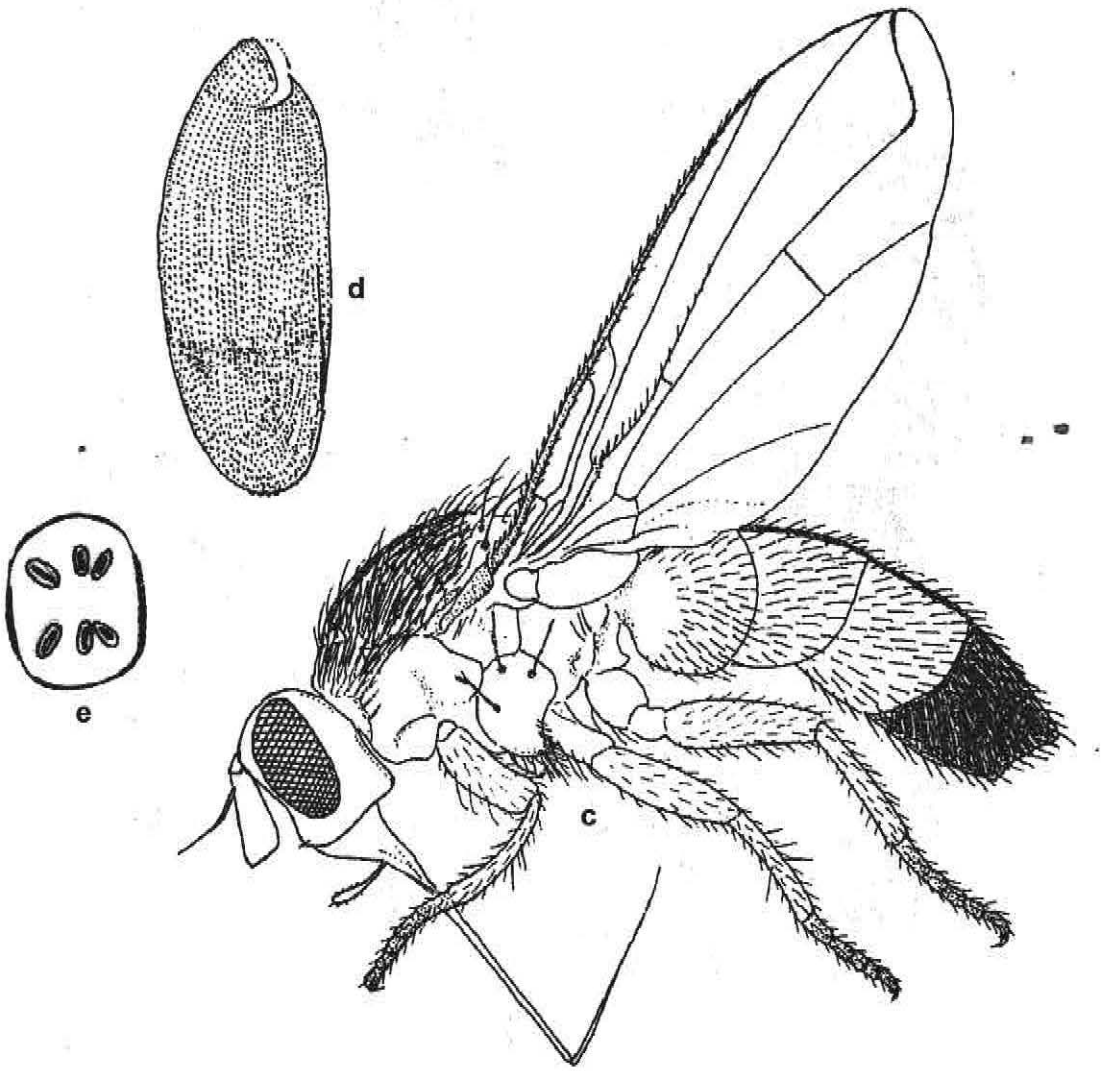

Figure 59 c–e. Lateral view of *Siphona* sp. A (c), pupa (d) and spiracle (e)

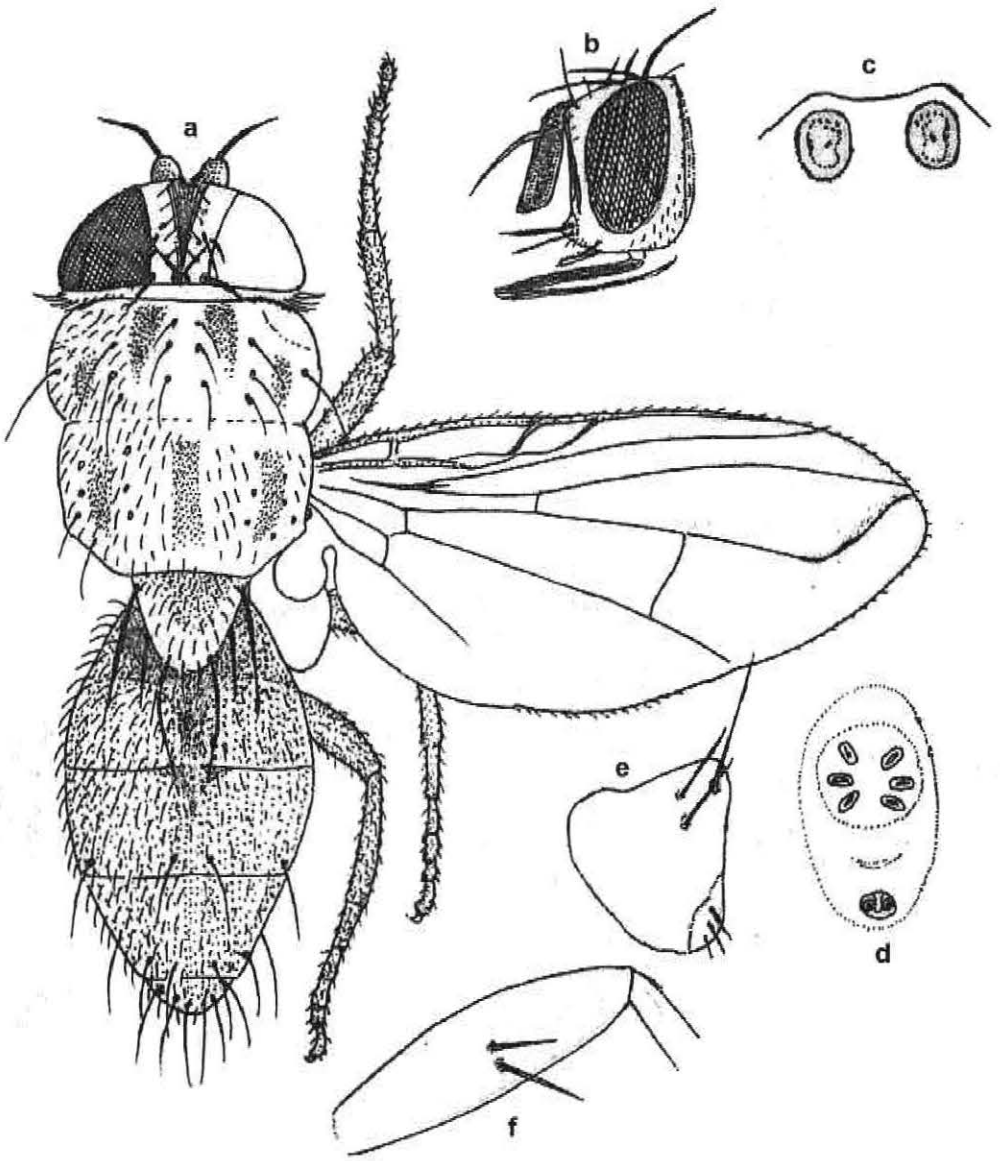

Figure 60 a–f. Dorsal view of *Siphona* sp. B (a), lateral view of head (b), anterior spiracle (c) and enlarged view (d), sternopleural setae (e) and spines on femur III (f)

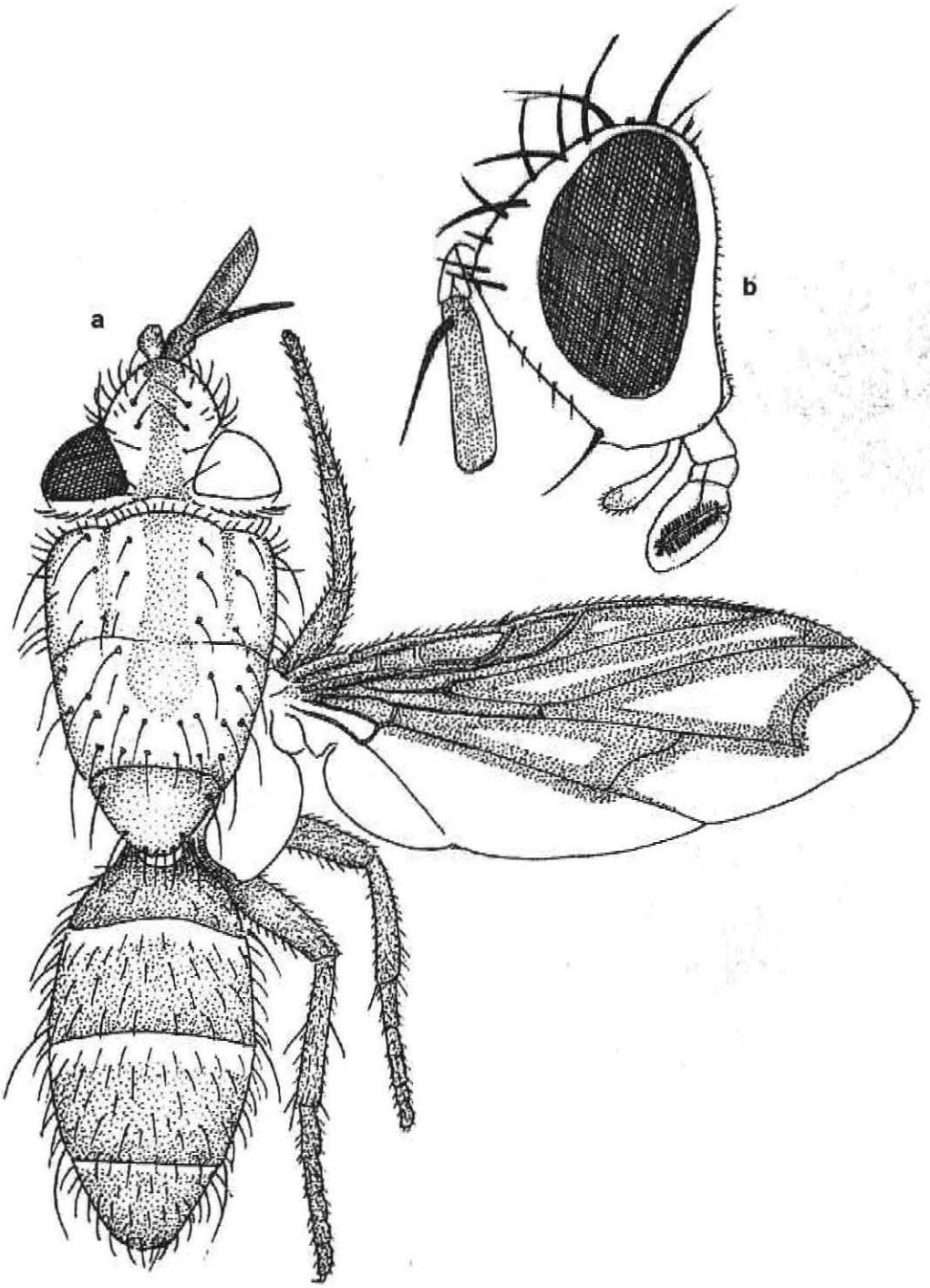

Figure 61 a–b. Dorsal view of *Lydella* near *sesamiae* Mesnil (a) and lateral view of head (b)

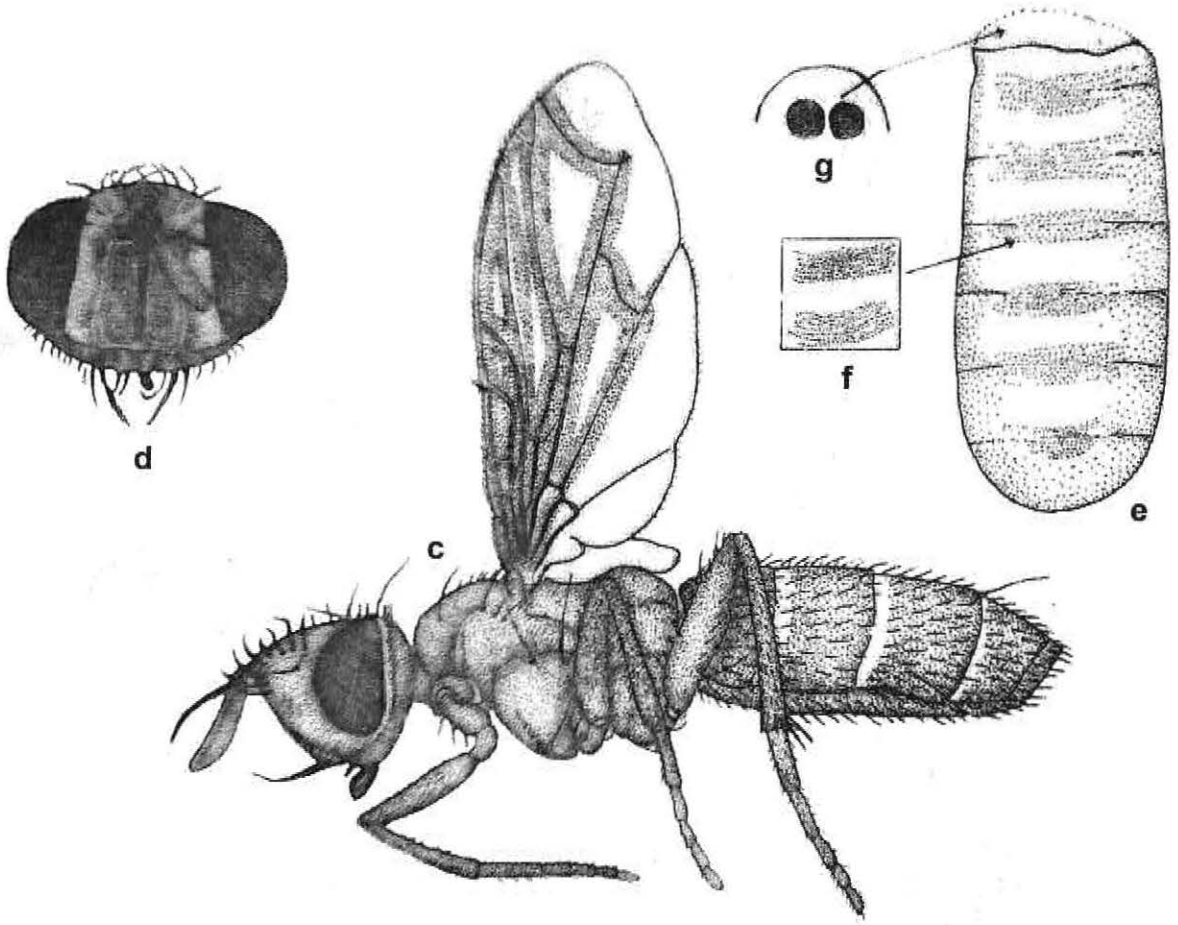

Figure 61 c–g. Lateral view of *L.* near *sesamiae* (c), frontal view of head (d), pupa (e), sculpture on pupal surface (f) and spiracle (g)

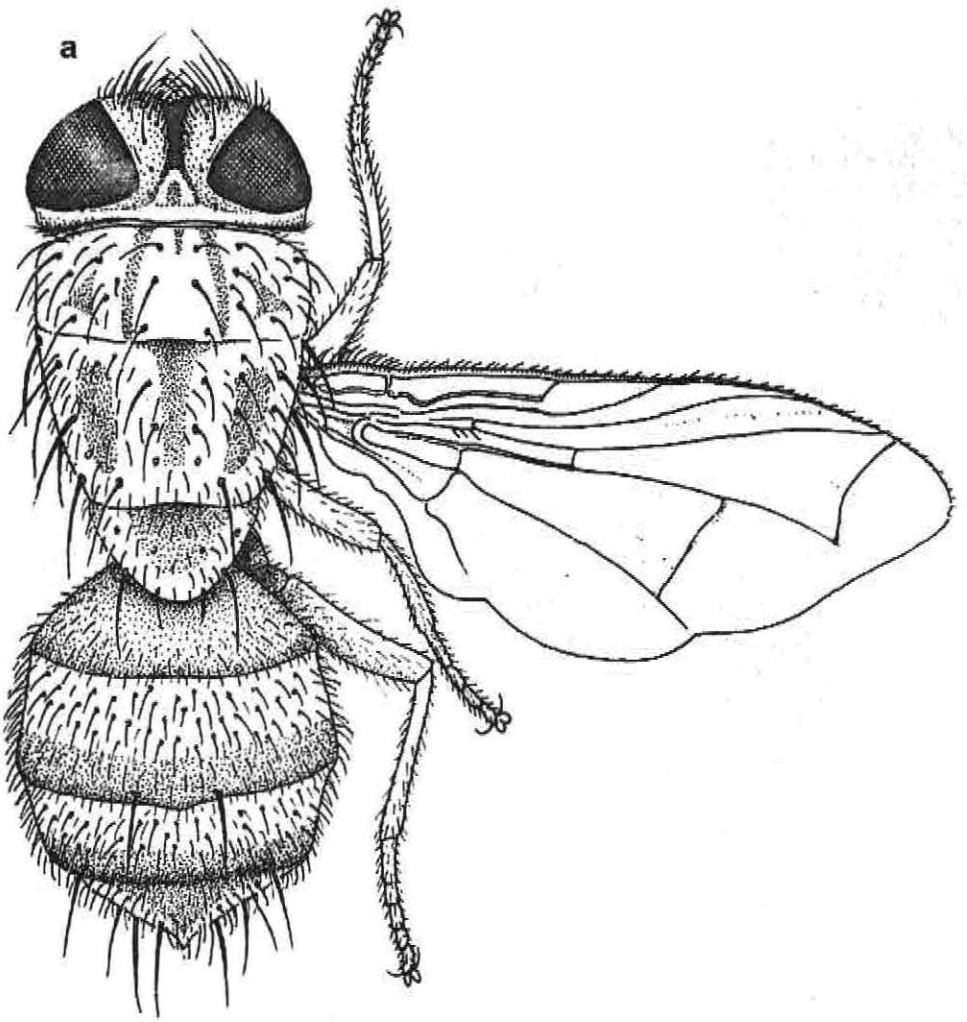

Figure 62 a. Dorsal view of *Descampsina sesamiae* Mesnil

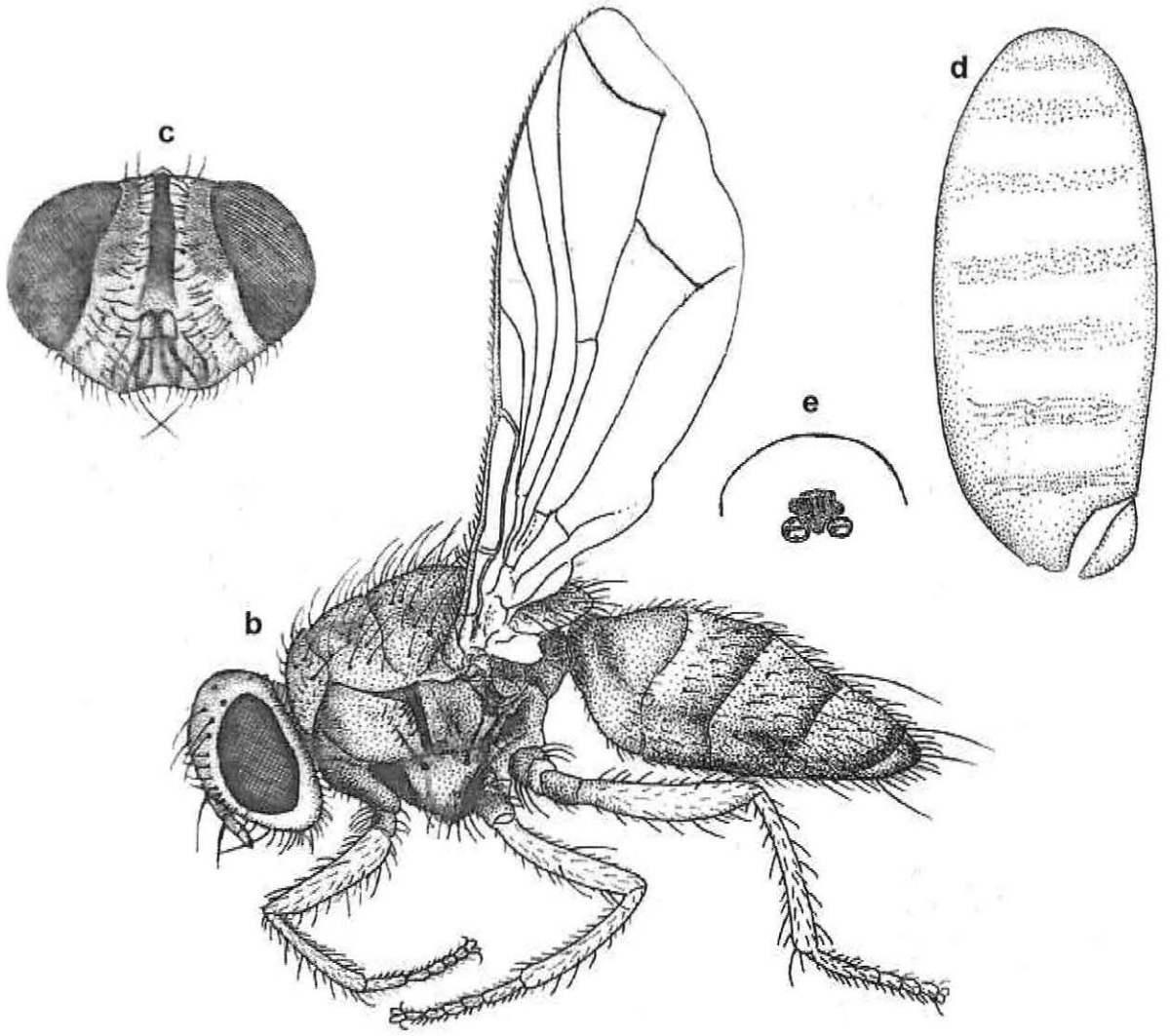

Figure 62 b–e. Lateral view of *D. sesamiae* (b), frontal view of head (c), pupa (d) and spiracle (e)

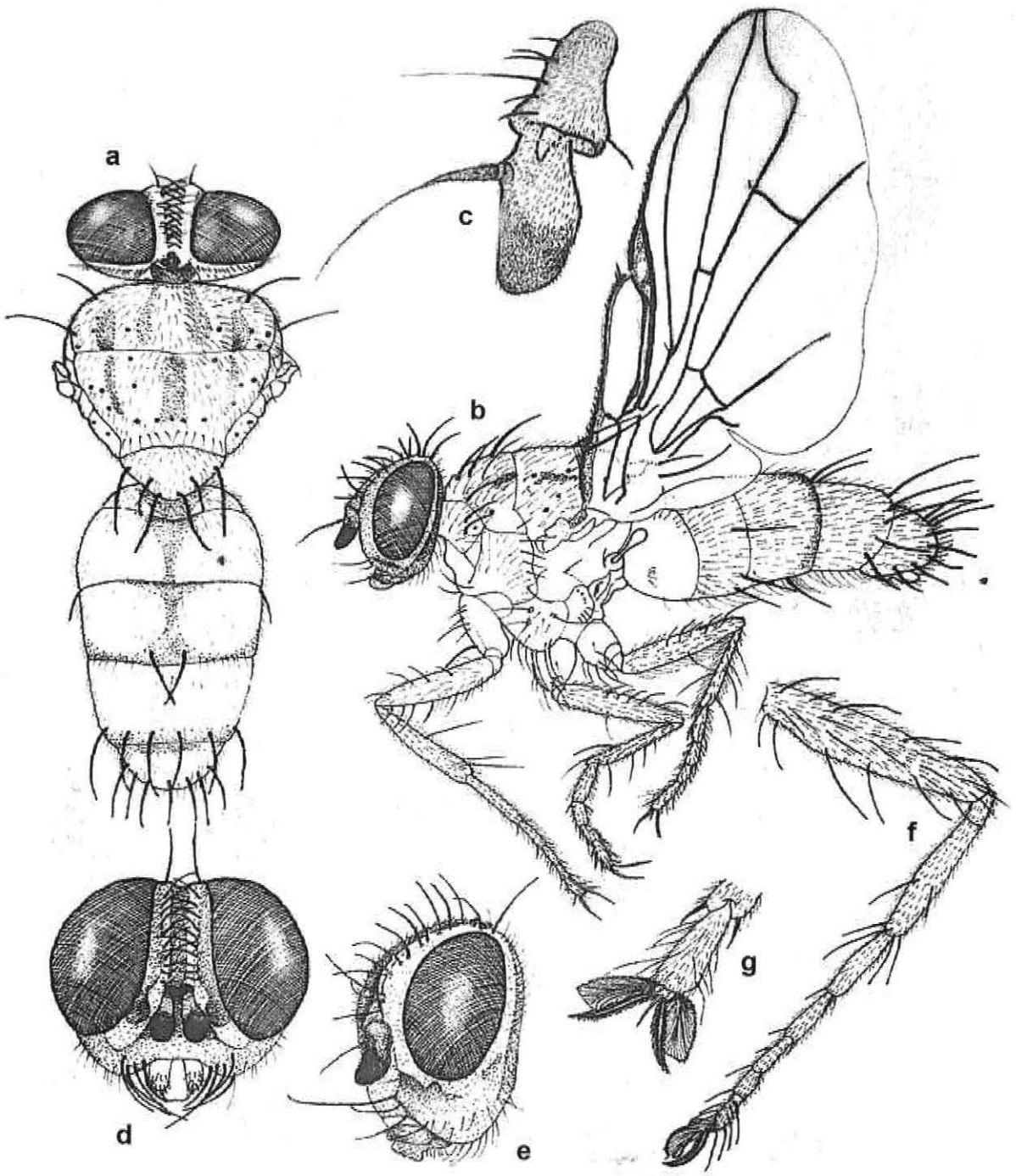

Figure 63 a–g. *Leskia* sp. dorsal (a) and lateral (b) views, antenna (c), frontal (d) and lateral (e) views of head, leg III (f) and tarsal claw (g)

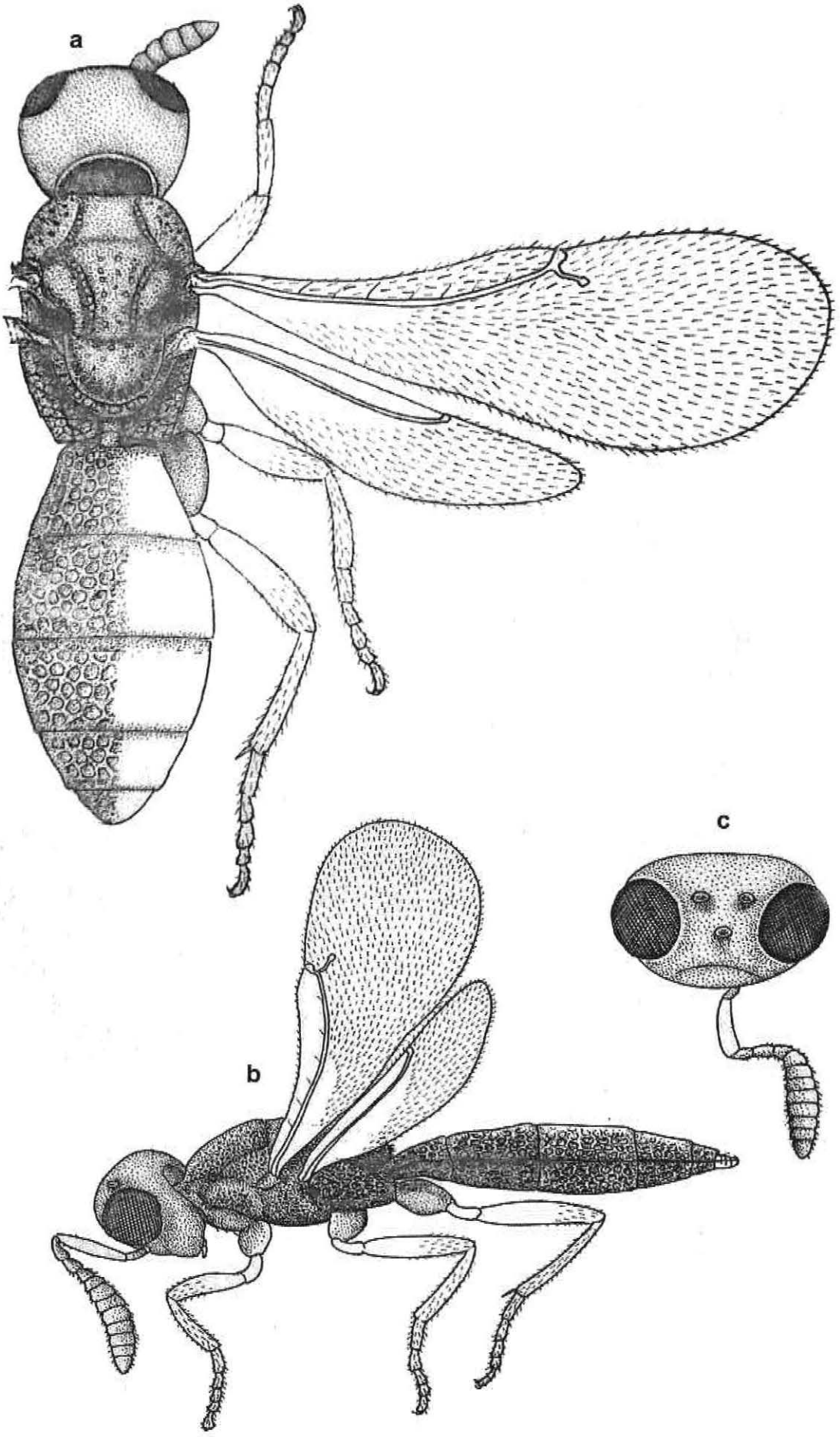

Figure 64 a–c. Dorsal (a) and lateral (b) views of *Scelio* sp. and frontal view of head (c)

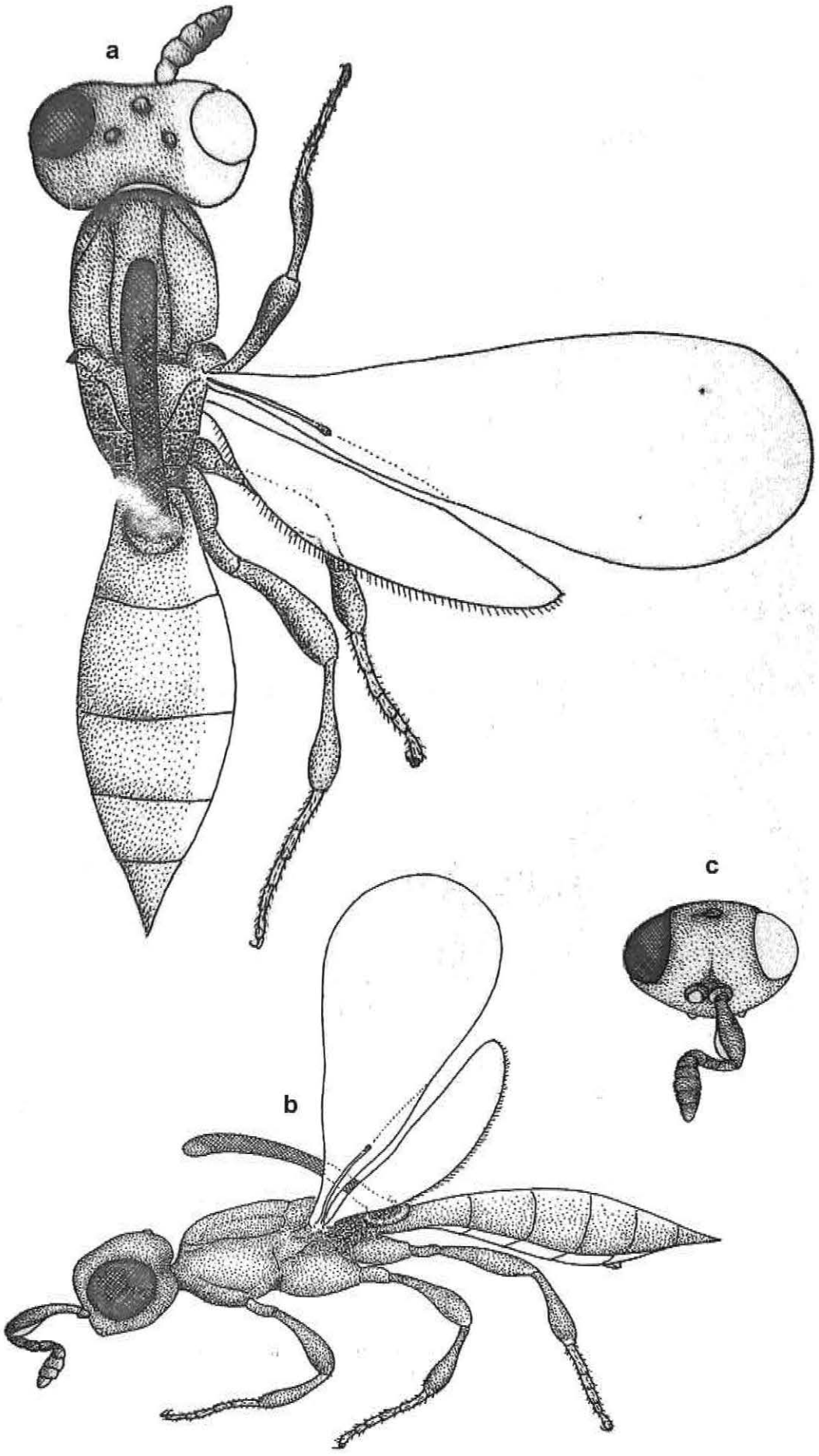

Figure 65 a–c. Dorsal (a) and lateral (b) views of *Inostemma* sp. and frontal view of head (c)

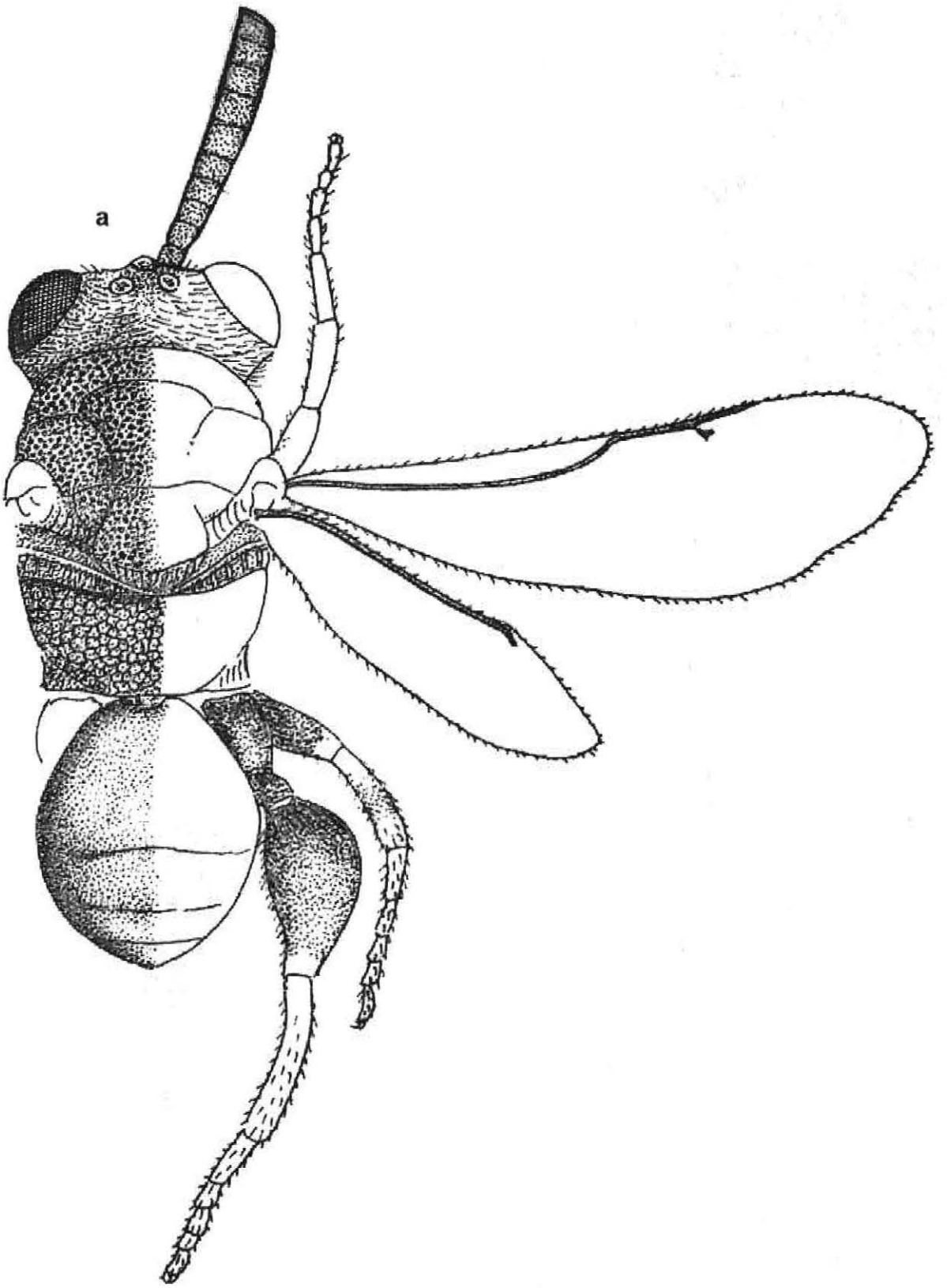

Figure 66 a. Dorsal view of *Brachymeria kassalensis* (Kirby)

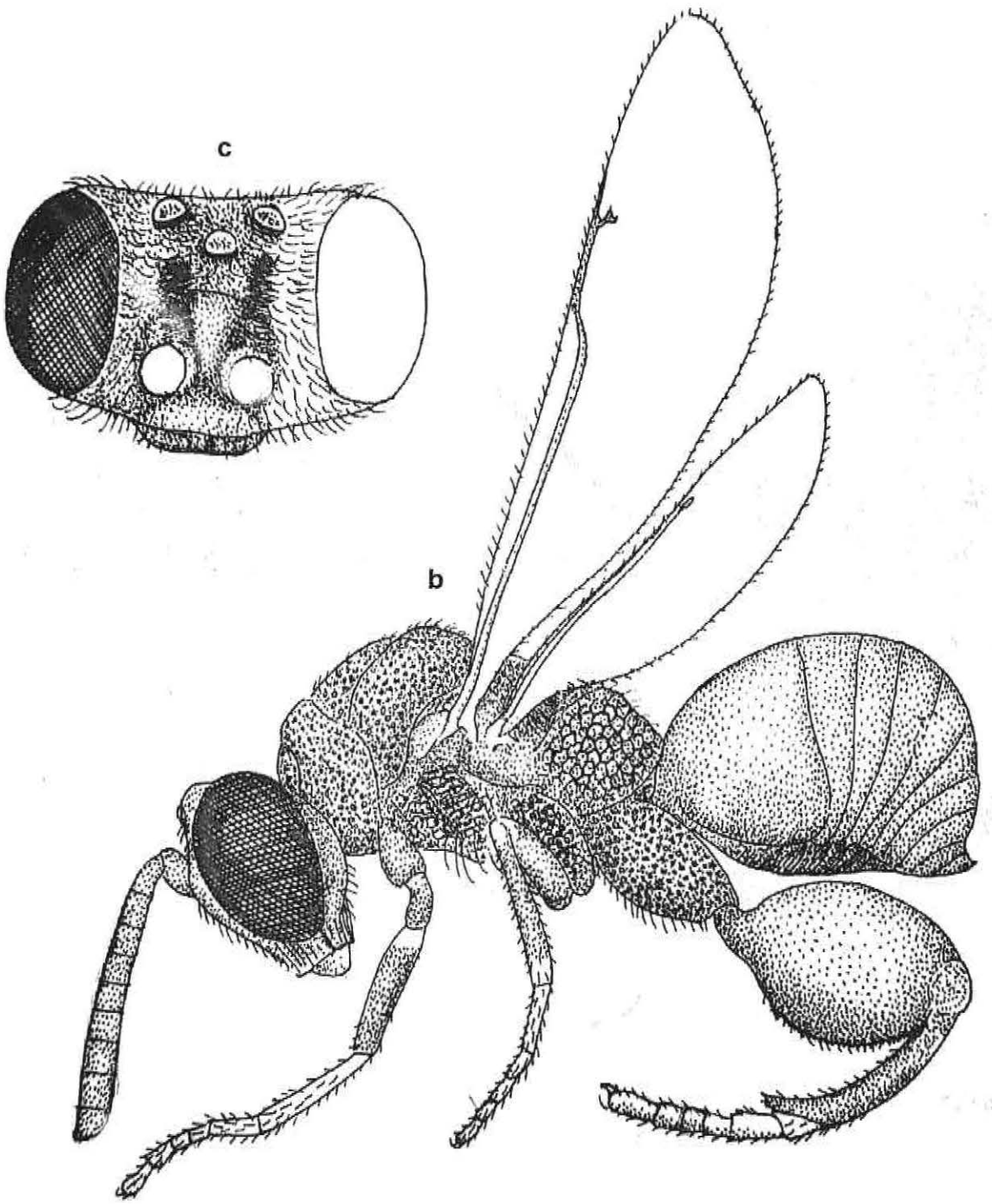

Figure 66 b–c. Lateral view of *B. kassalensis* (b) and frontal view of head (c)

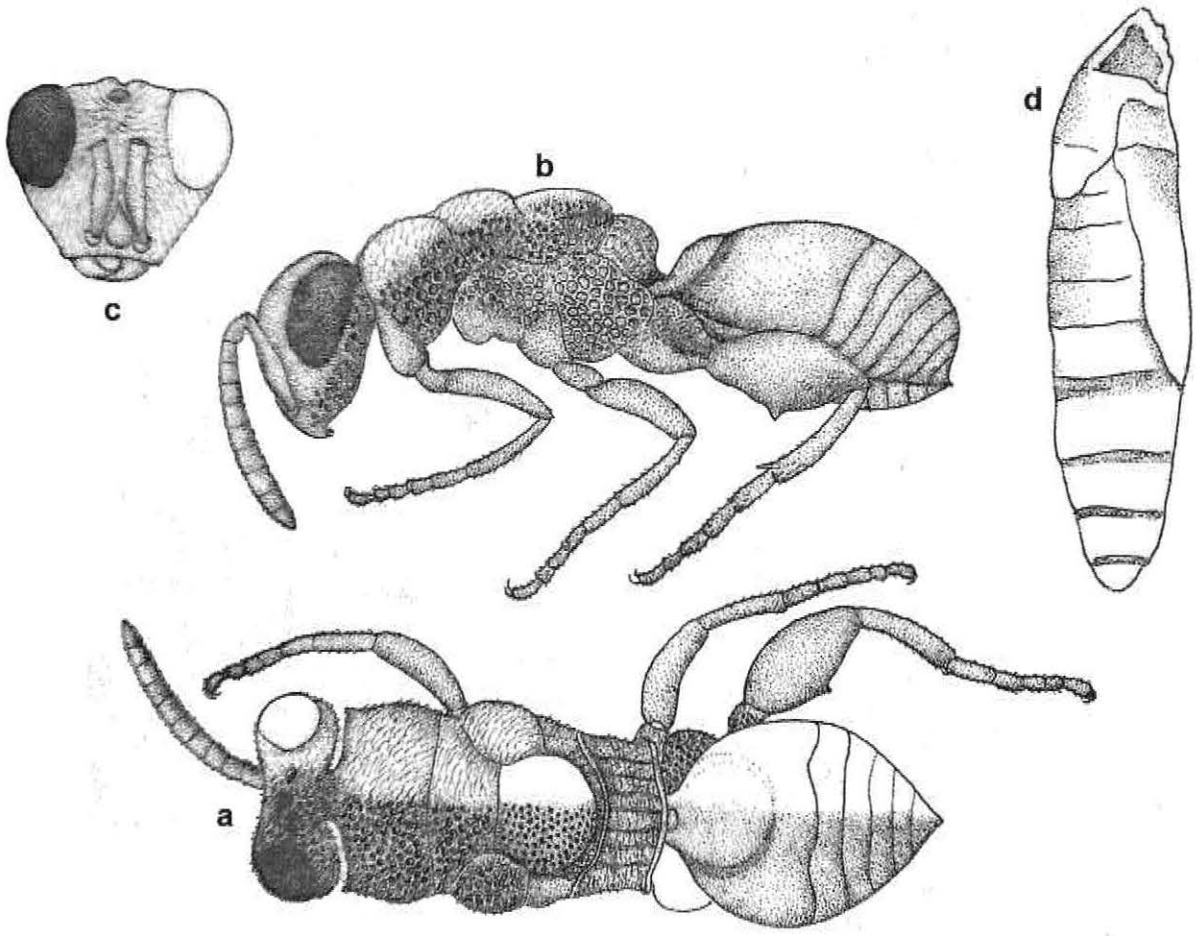

Figure 67 a–d. Dorsal (a) and lateral (b) views of *Hockeria* sp., frontal view of head (c) and pupa of host (d)

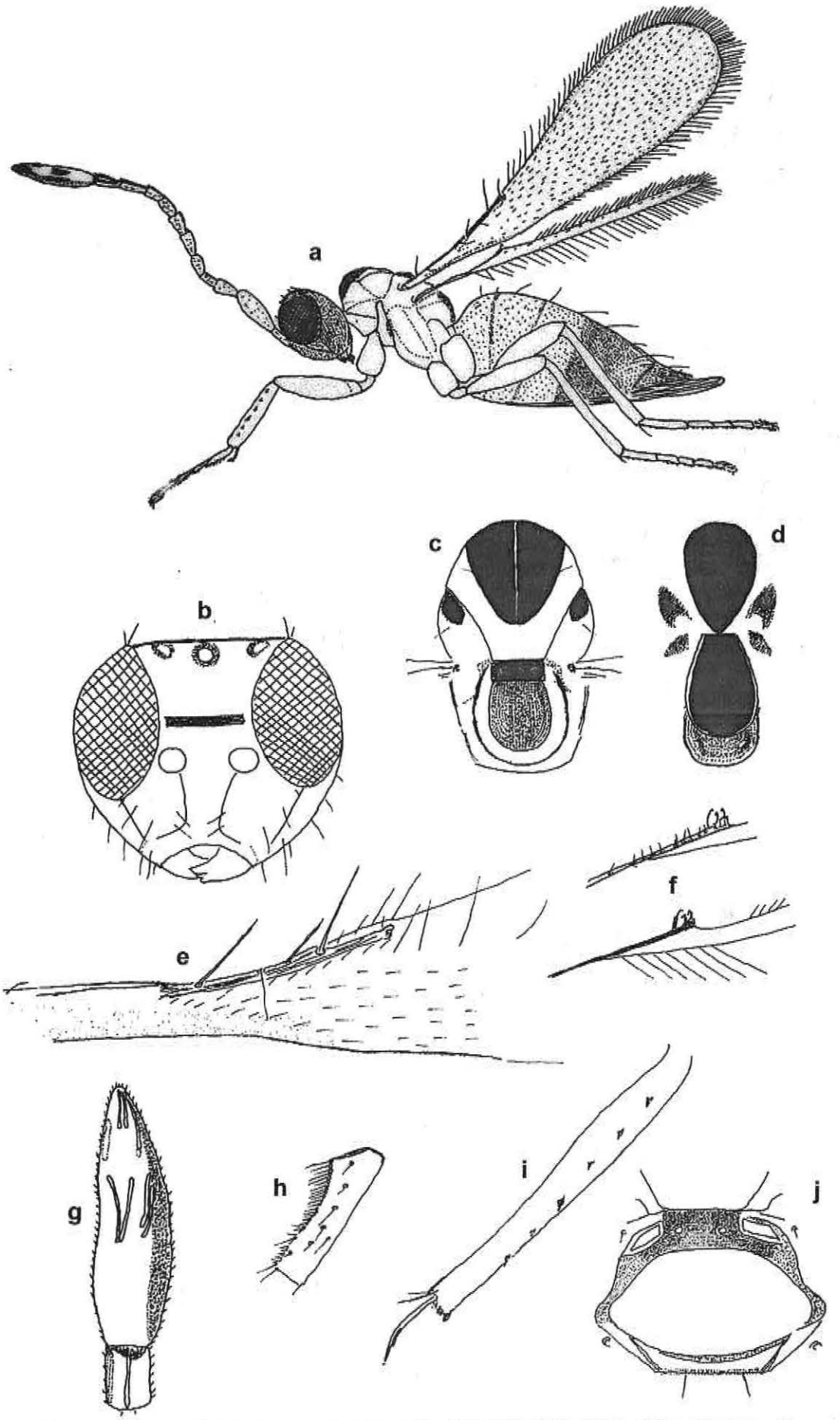

Figure 68 a–j. Lateral view of *Gonatocerus* sp. (a), frontal view of head (b), meso- and metanotum of female (c) and male (d), wing venation (e), hindwing (f), antennal club (g), tarsal bristles (h), tibia I (i) and propodeum (j)

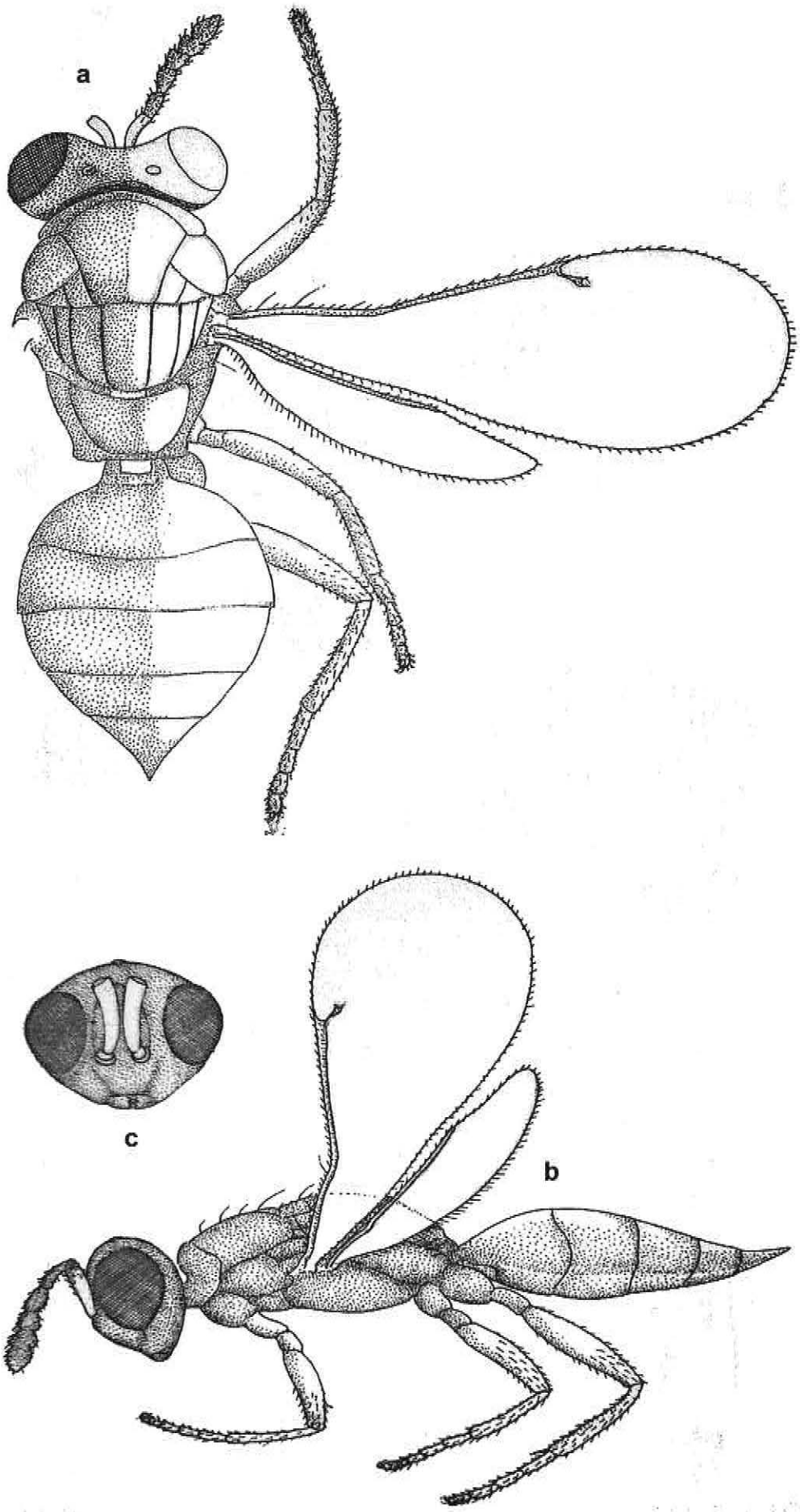

Figure 69 a–c. Dorsal (a) and lateral (b) views of *Tetrastichus* sp. and frontal view of head (c)

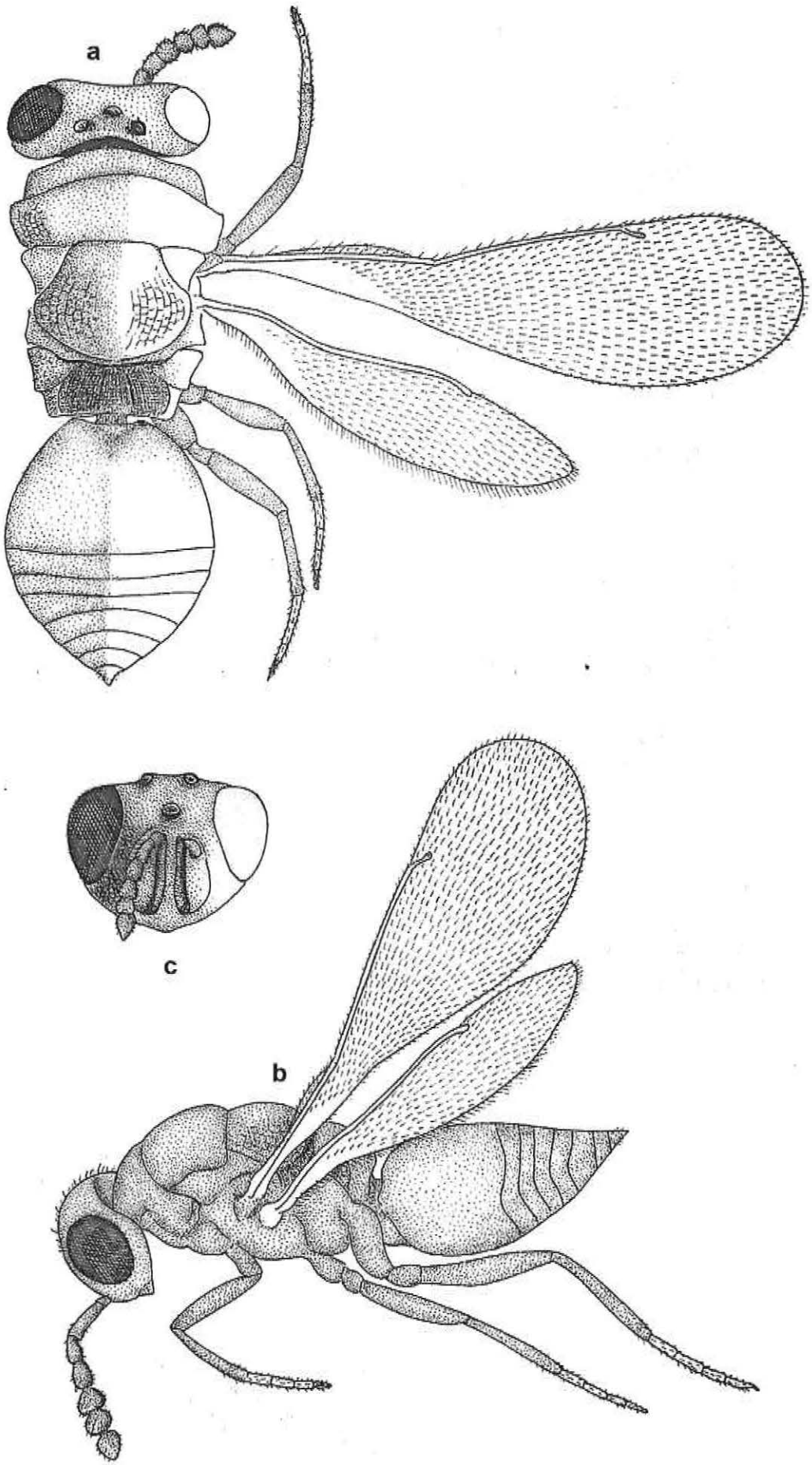

Figure 70 a–c. *Pediobius homoeus* (Waterston) dorsal (a) and lateral (b) views and frontal view of head (c)

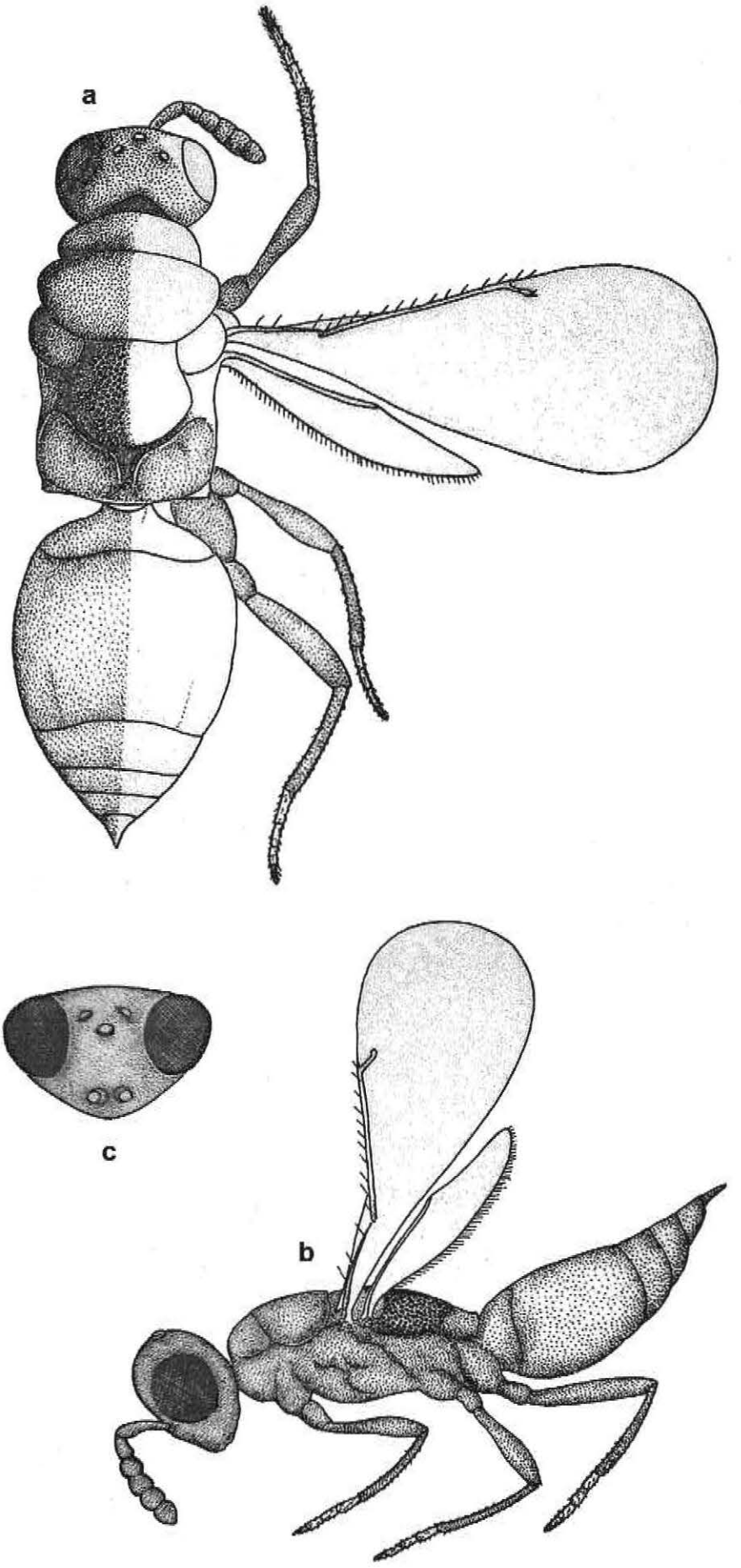

Figure 71 a–c. Dorsal (a) and lateral (b) views and frontal view of head (c) of *Pediobius furvus* (Gahan)

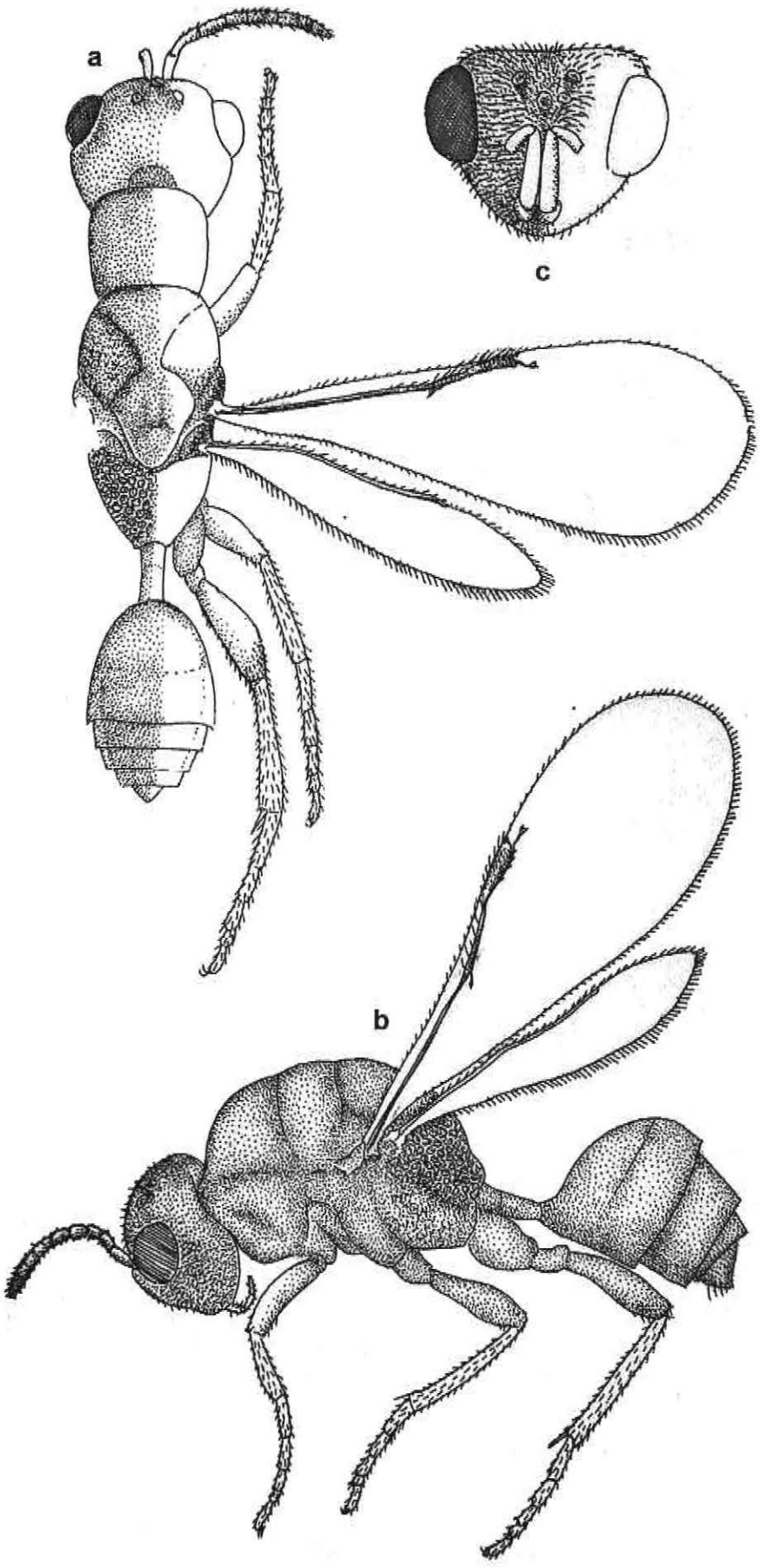

Figure 72 a–c. Dorsal (a), lateral (b) views and head (c) of *Sycophila* sp.

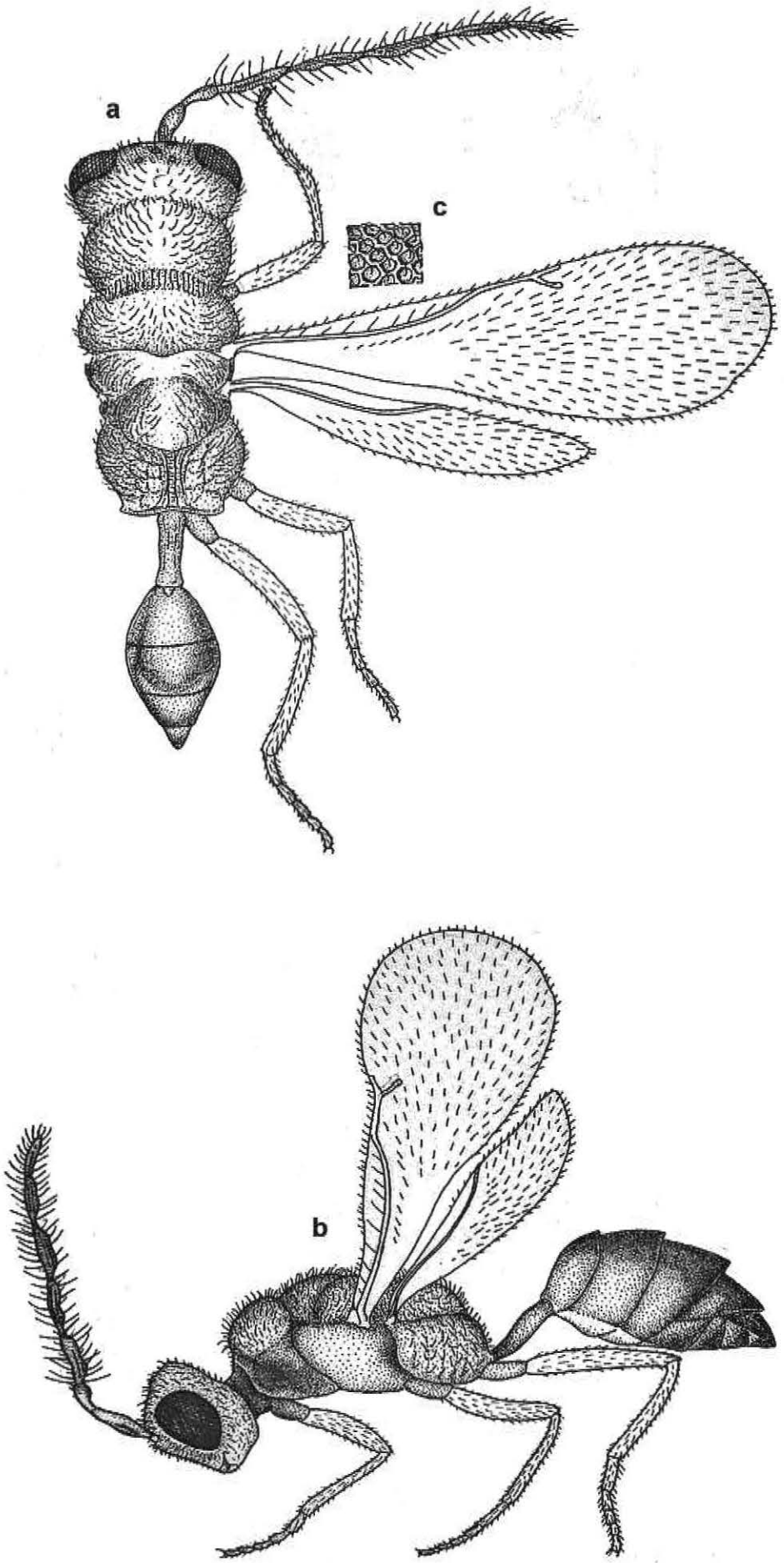

Figure 73 a–c. Dorsal (a) and lateral (b) views and body sculpture (c) of *Eurytoma oryzivora* Delvare

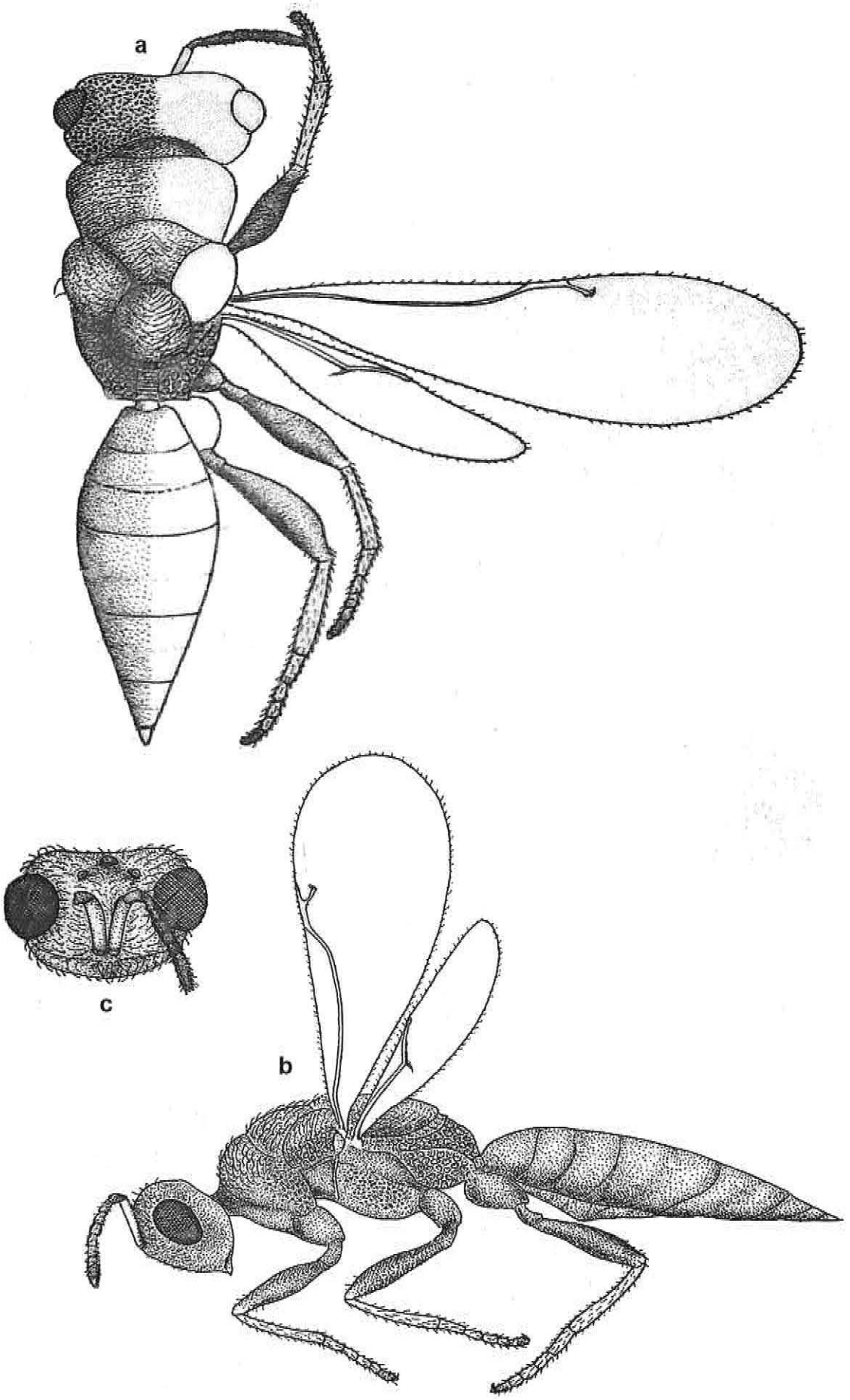

Figure 74 a–c. Dorsal (a) and lateral (b) views and head (c) of *Eurytoma* sp. A

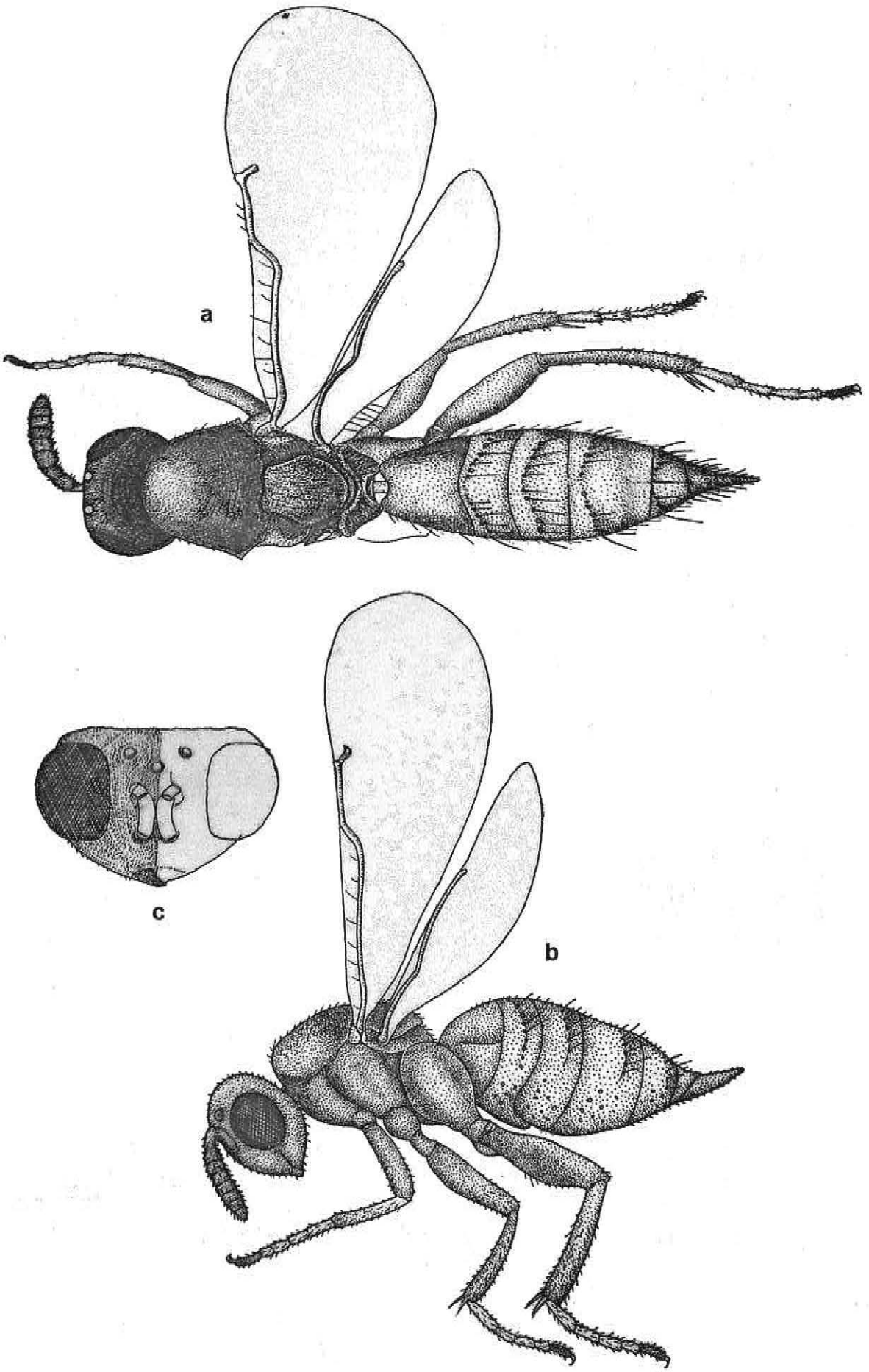

Figure 75 a–c. Dorsal (a) and lateral (b) views and head (c) of ?*Eurytoma* sp. C

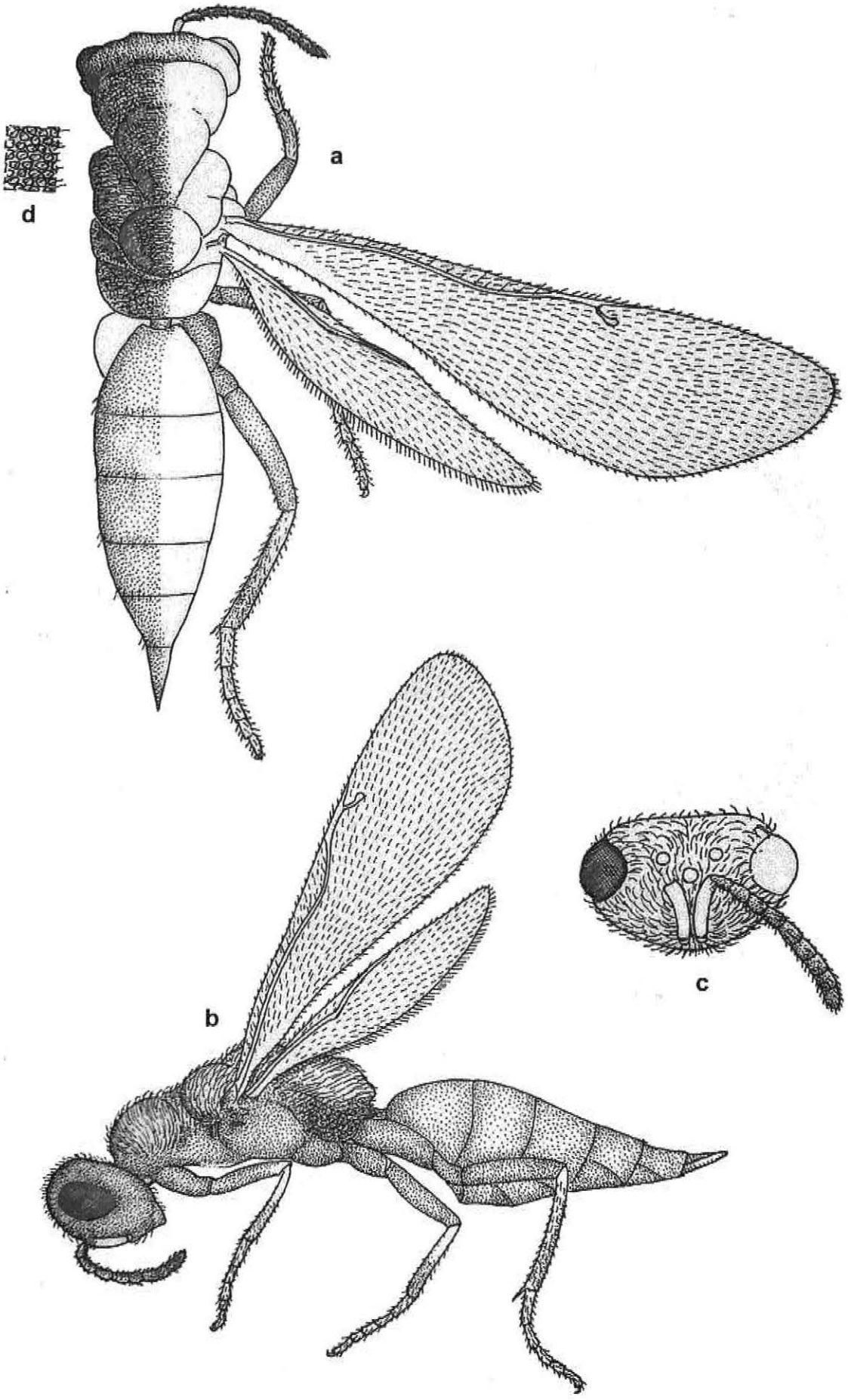

Figure 76 a–d. Dorsal (a) and lateral (b) views, head (c) and body sculpture (d) of *Eurytoma* sp. D

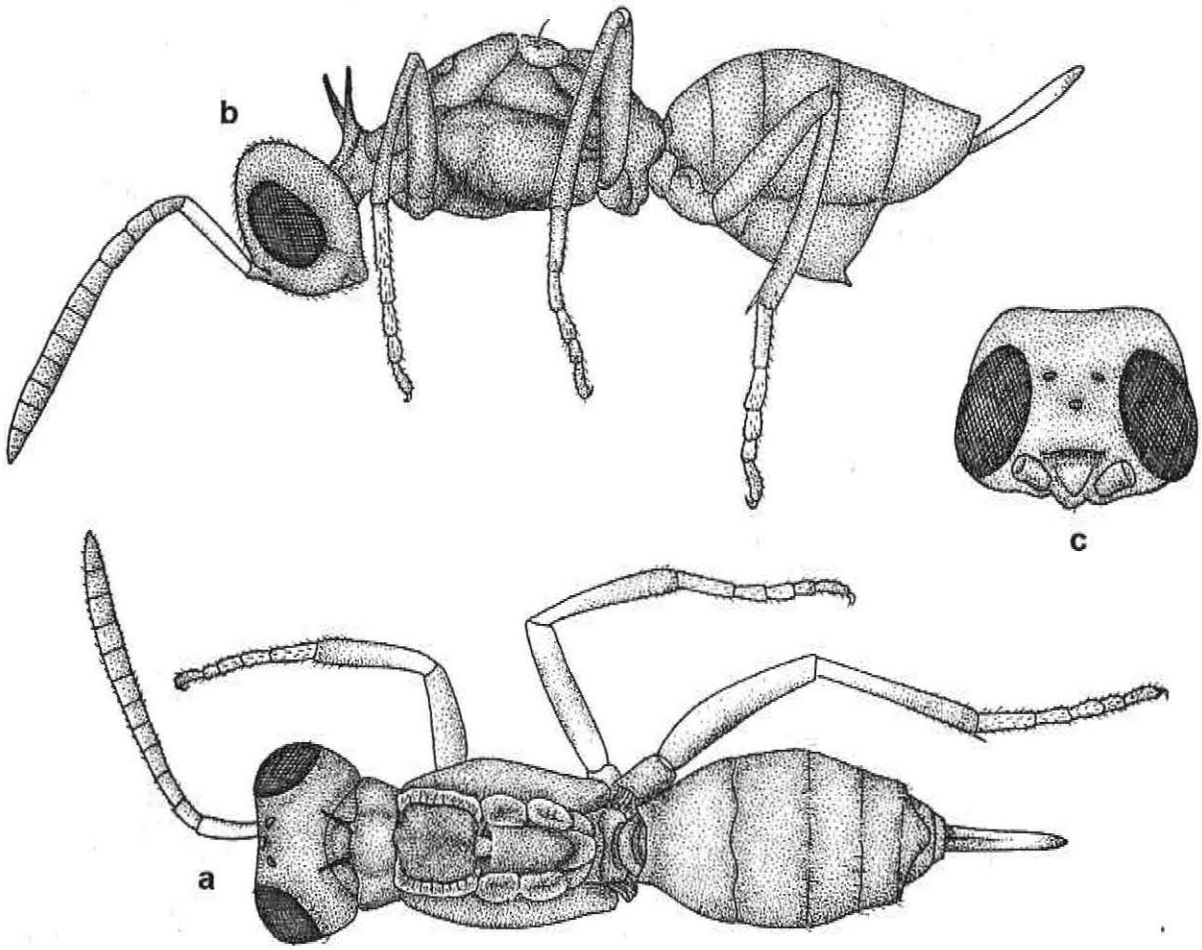

Figure 77 a–c. Dorsal (a) and lateral (b) views and head (c) of *Macroneura* sp.

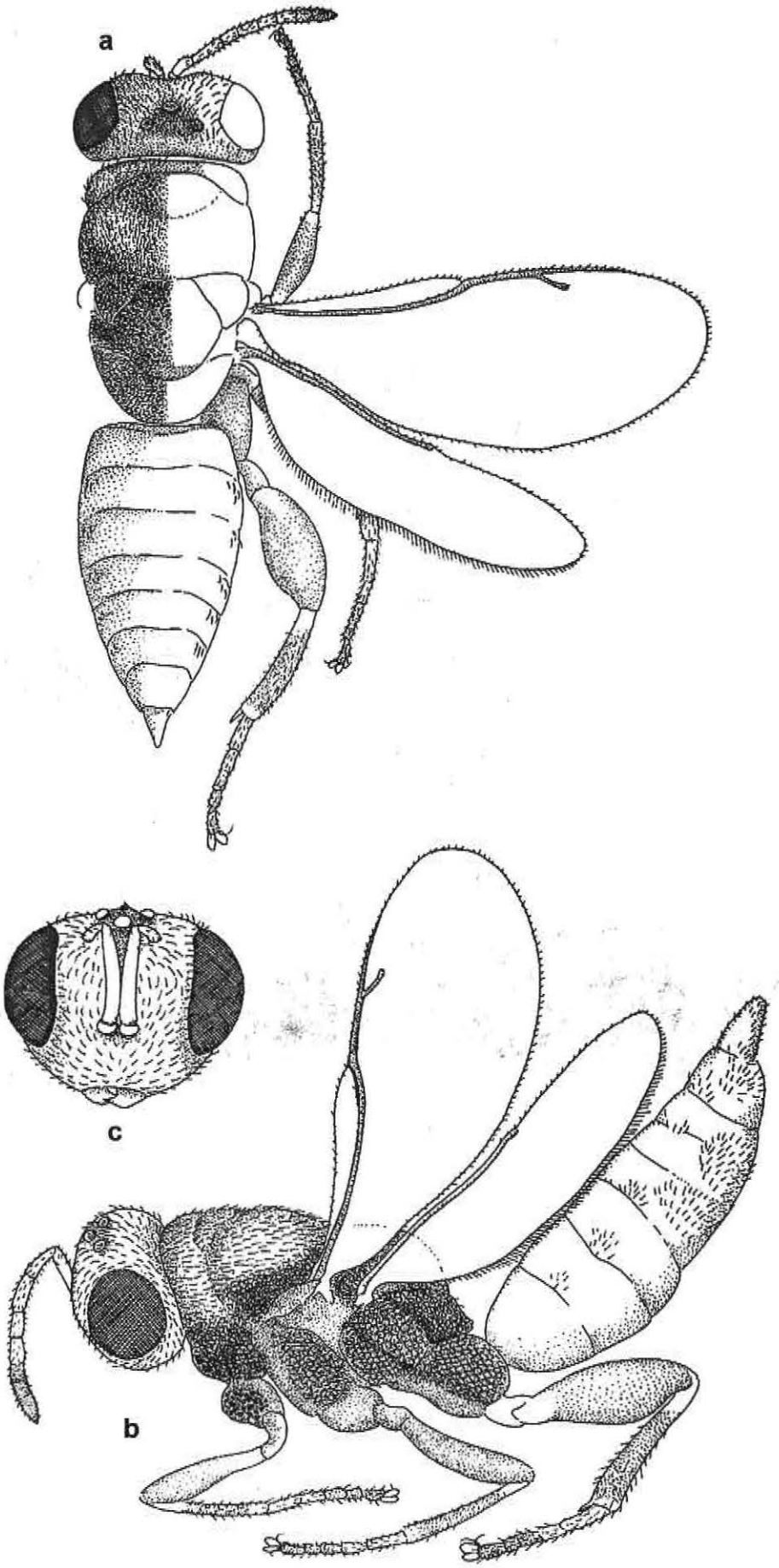

Figure 78 a–c. Dorsal (a) and lateral (b) views and head (c) of *Norbanus* sp.

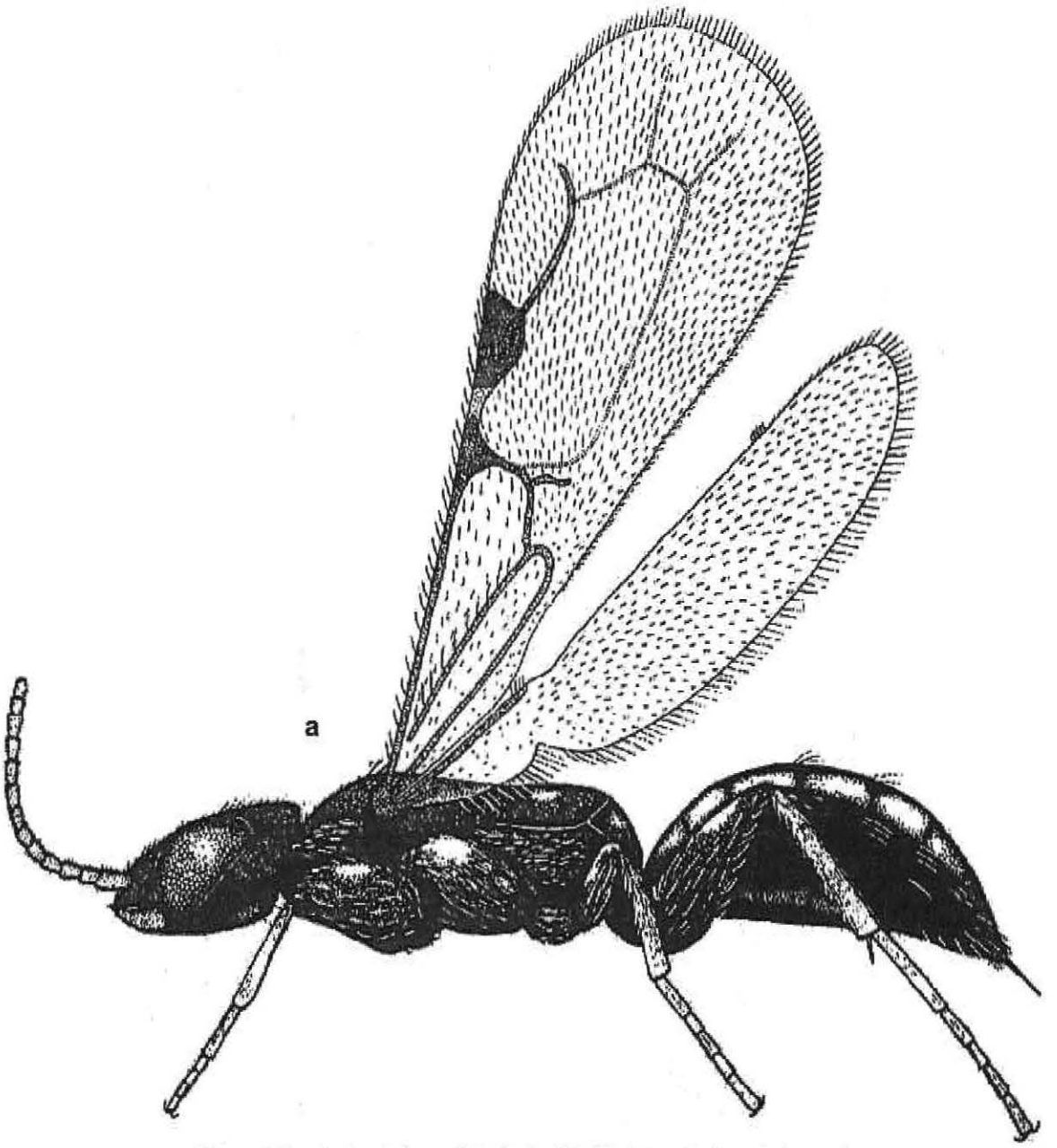

Figure 79 a. Lateral view of the bethylid, *Goniozus indicus* Ashmead

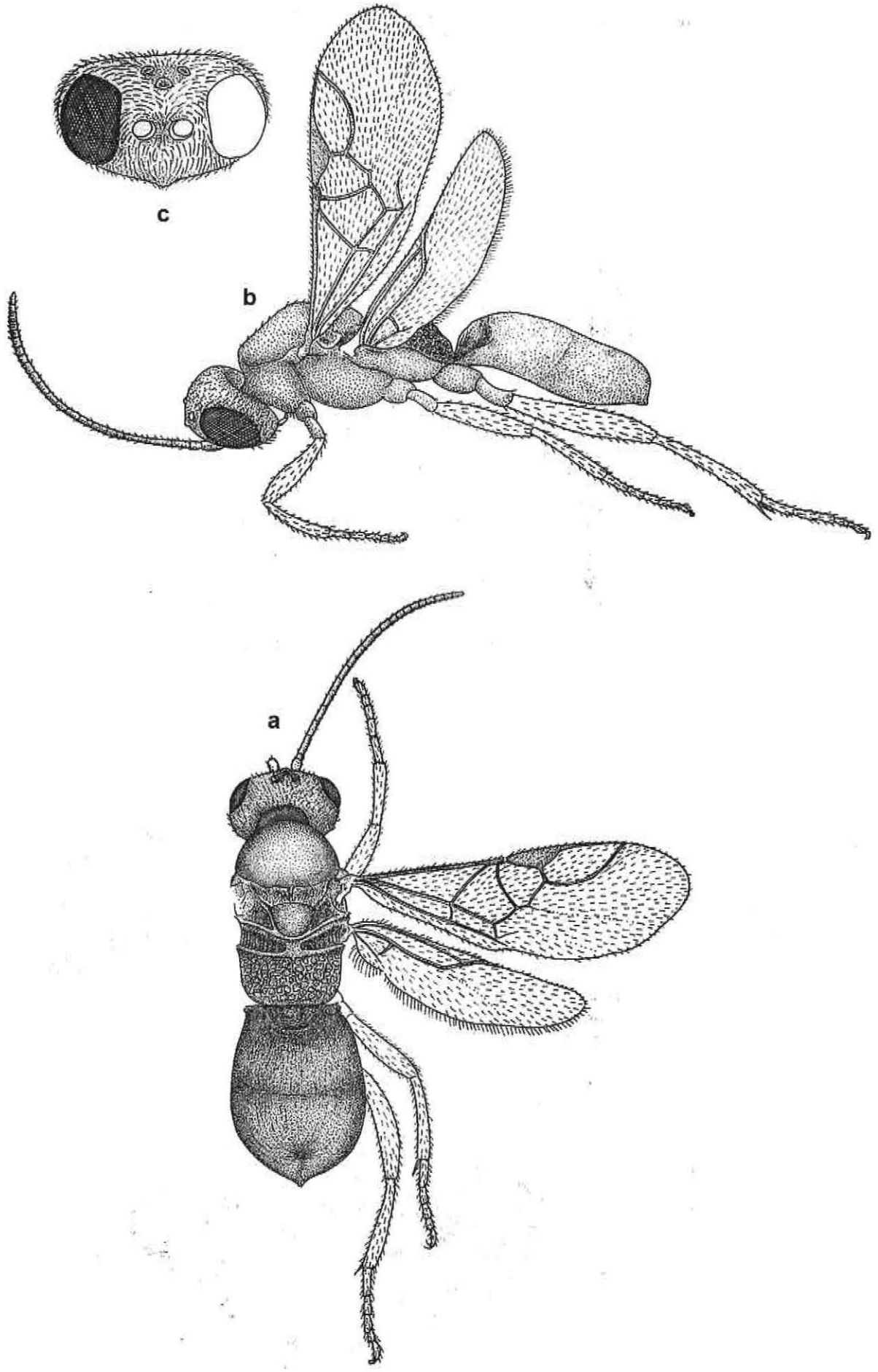

Figure 80 a–c. Dorsal (a) and lateral (b) views and head (c) of *Triaspis* sp.

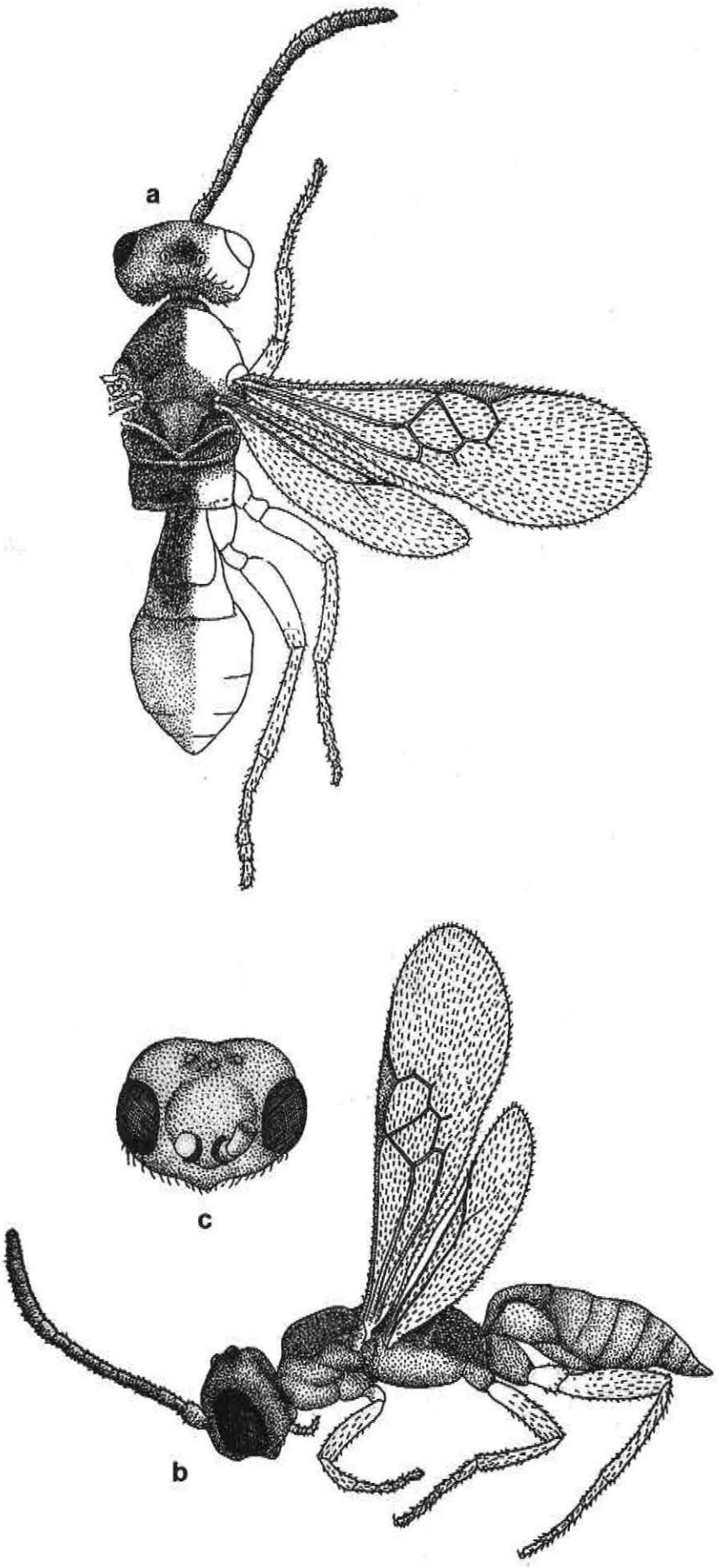

Figure 81 a–c. Dorsal (a) and lateral (b) views and head (c) of *Cotesia flavipes* Cameron

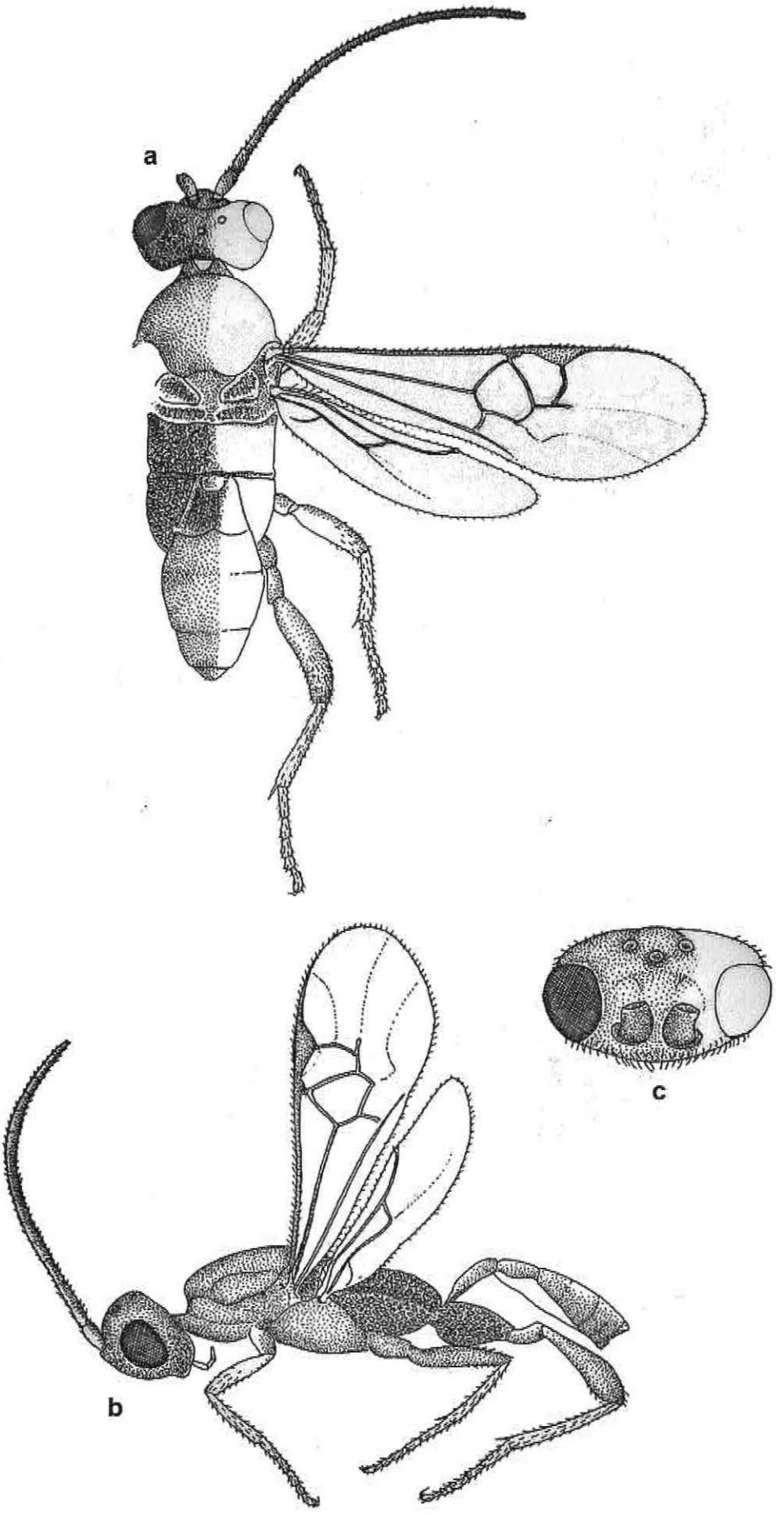

Figure 82 a–c. Dorsal (a) and lateral (b) views and head (c) of *Cotesia sesamiae* Cameron

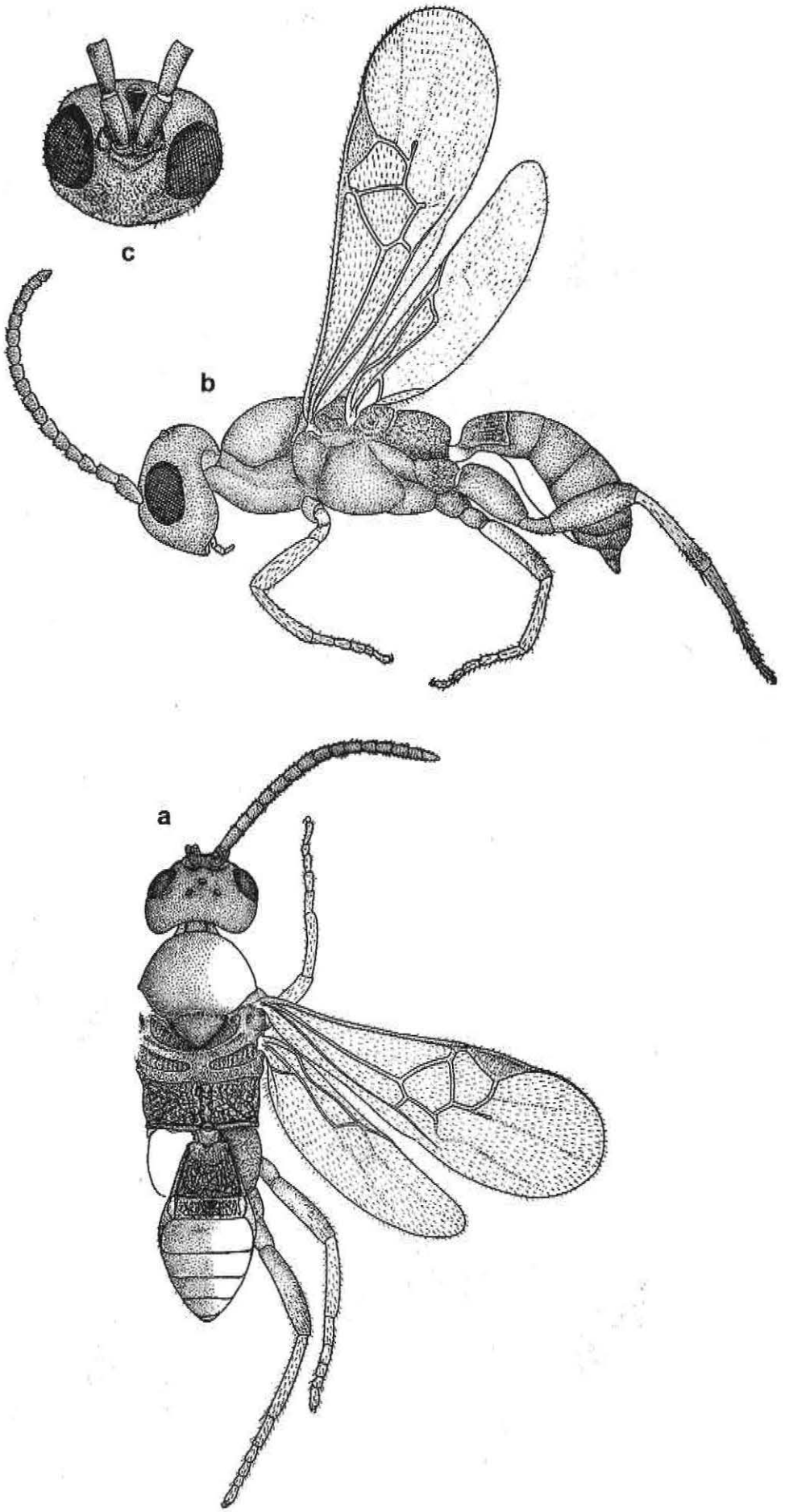

Figure 83 a–c. Dorsal (a) and lateral (b) views and head (c) of *Cotesia* near *sesamiae* Cameron

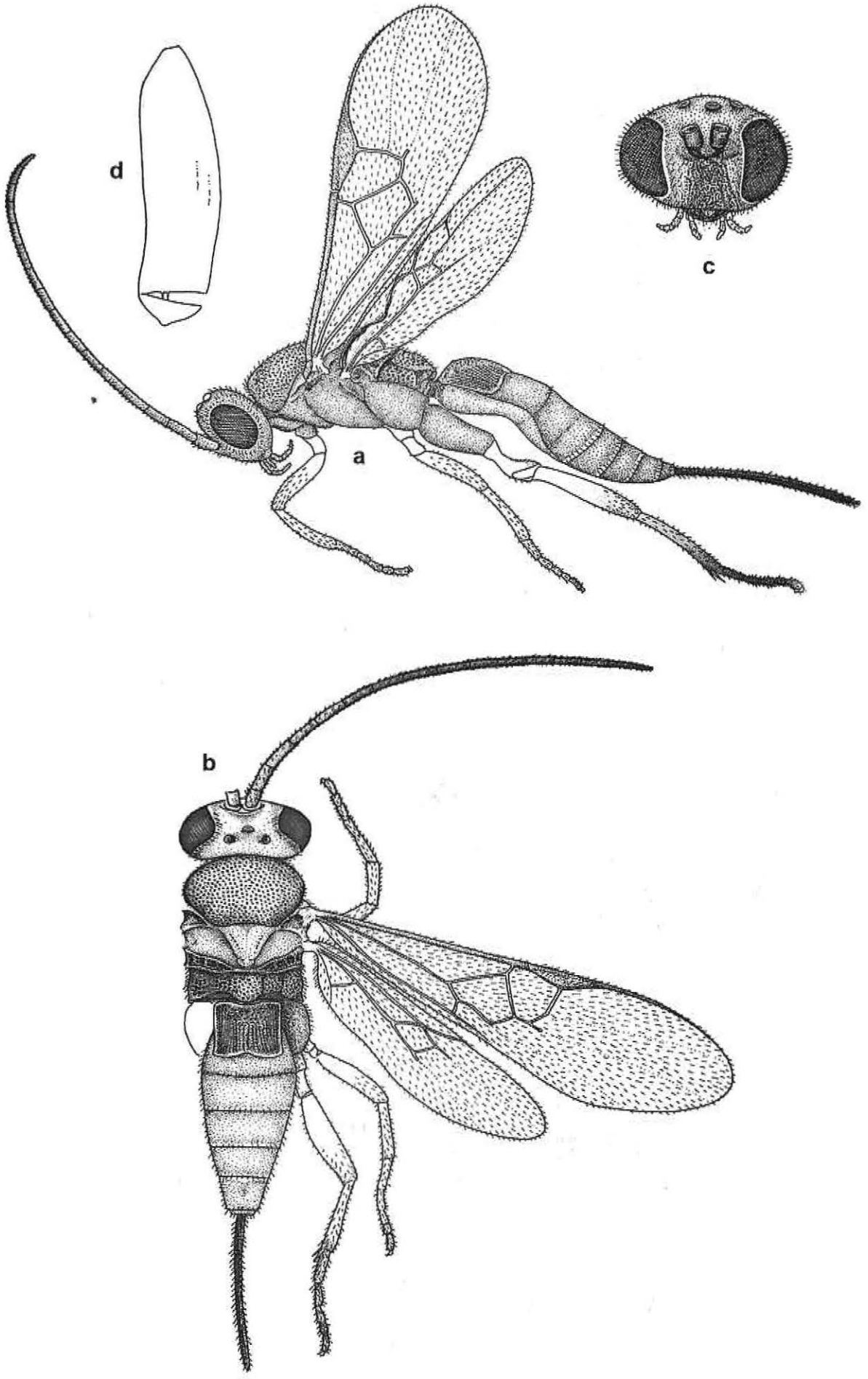

Figure 84 a–d. Lateral (a) and dorsal (b) views, head (c) and pupal cocoon (d) of *Dolichogenidea polaszeki* Walker

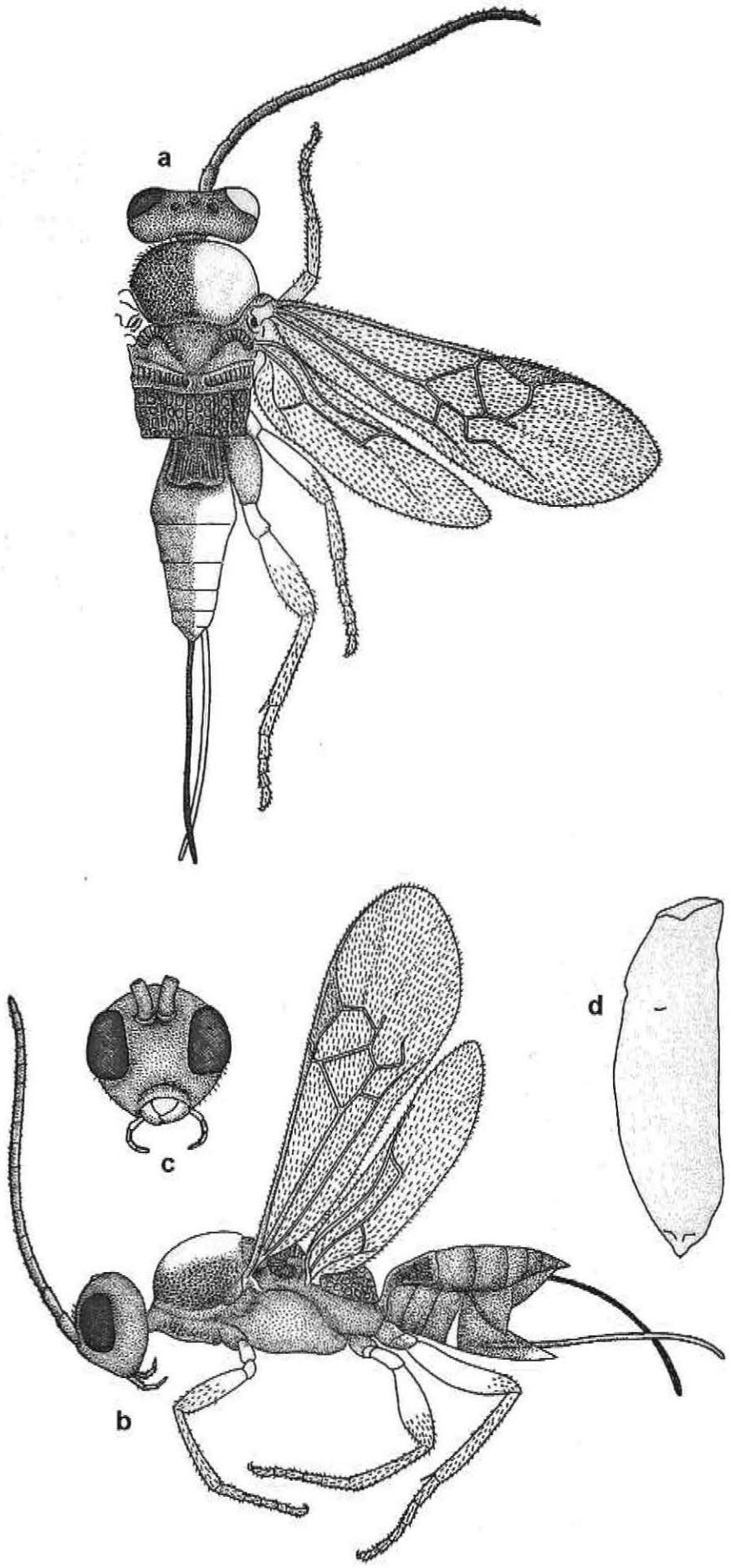

Figure 85 a–d. Dorsal (a) and lateral (b) views, head (c) and pupal cocoon (d) of *Dolichogenidea* sp. C

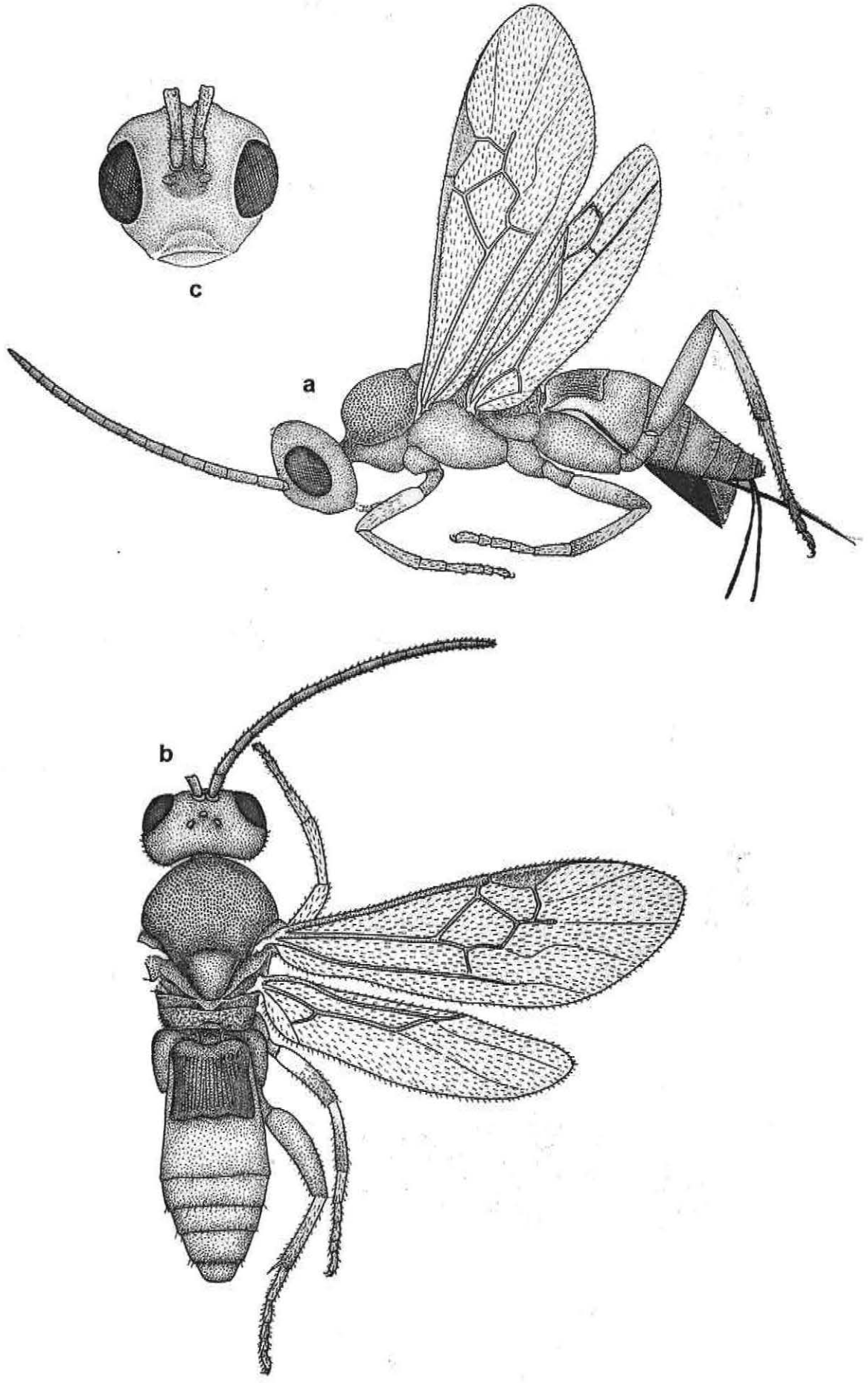

Figure 86 a–c. Lateral (a) and dorsal (b) views with ovipositor hidden underneath and head (c) of *Dolichogenidea* sp. A

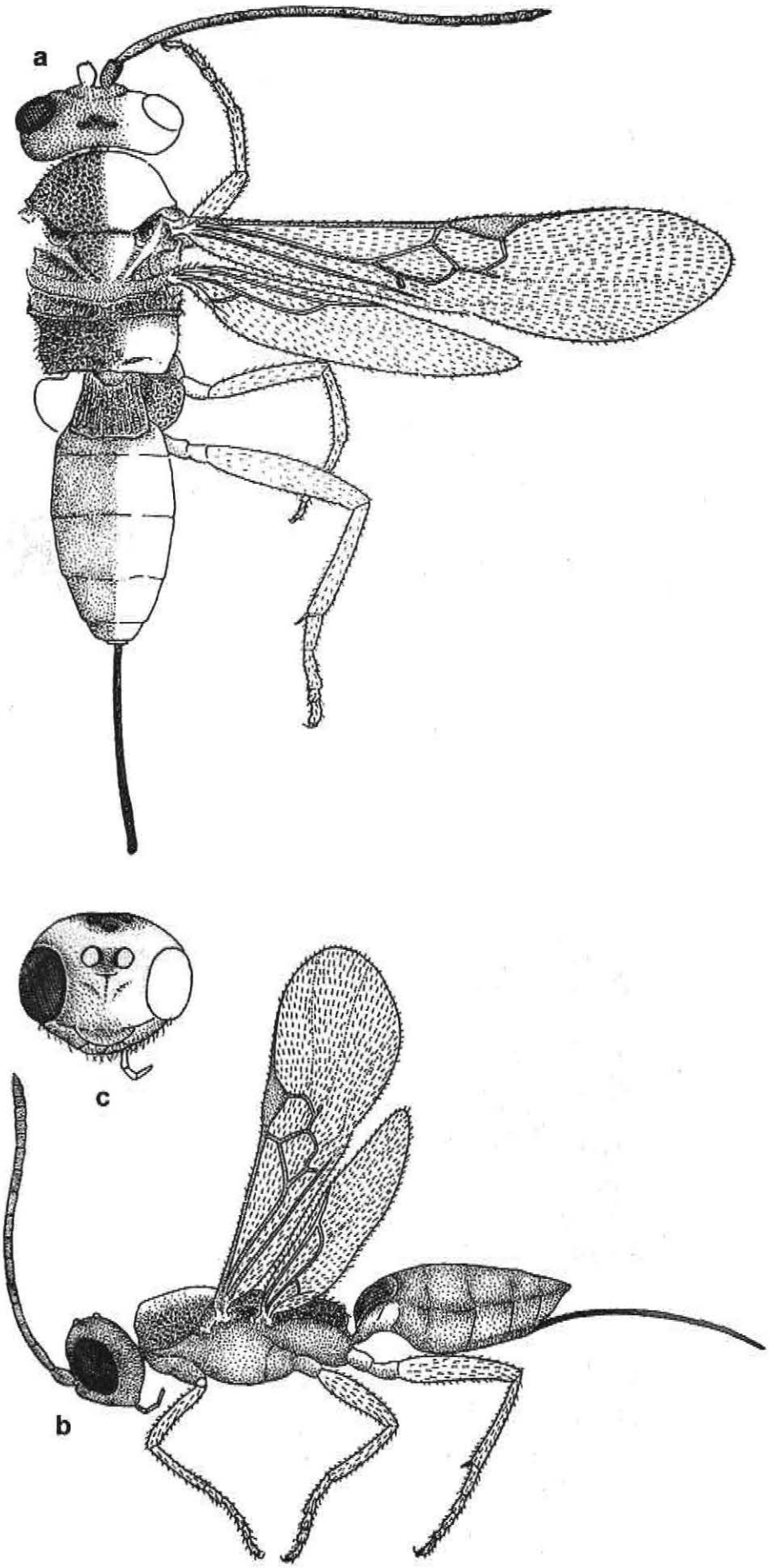

Figure 87 a–c. Dorsal (a) and lateral (b) views and head (c) of *Dolichogenidea* sp. B

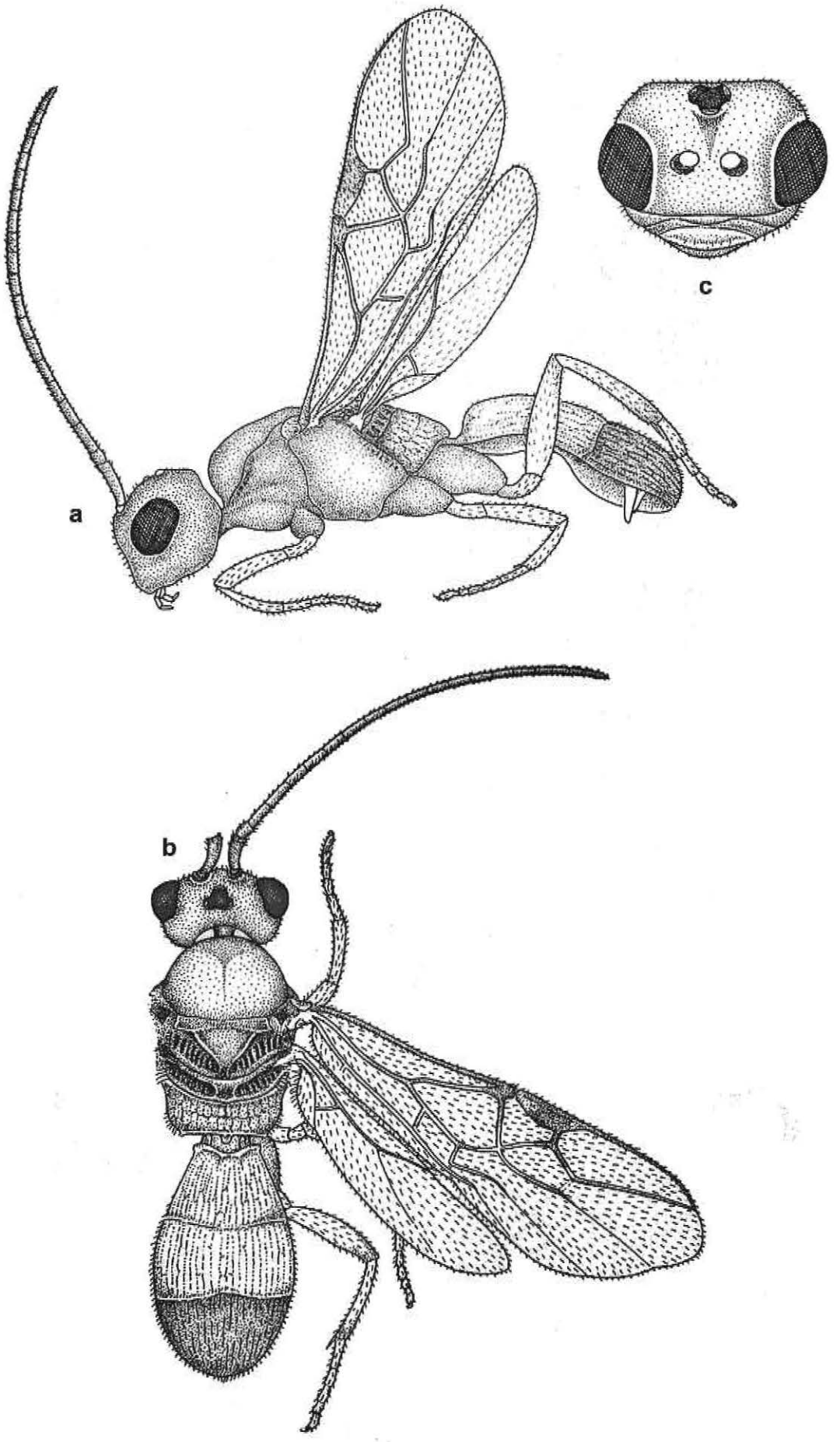

Figure 88 a–c. Lateral (a) and dorsal (b) views and head (c) of *Phanerotoma* sp.

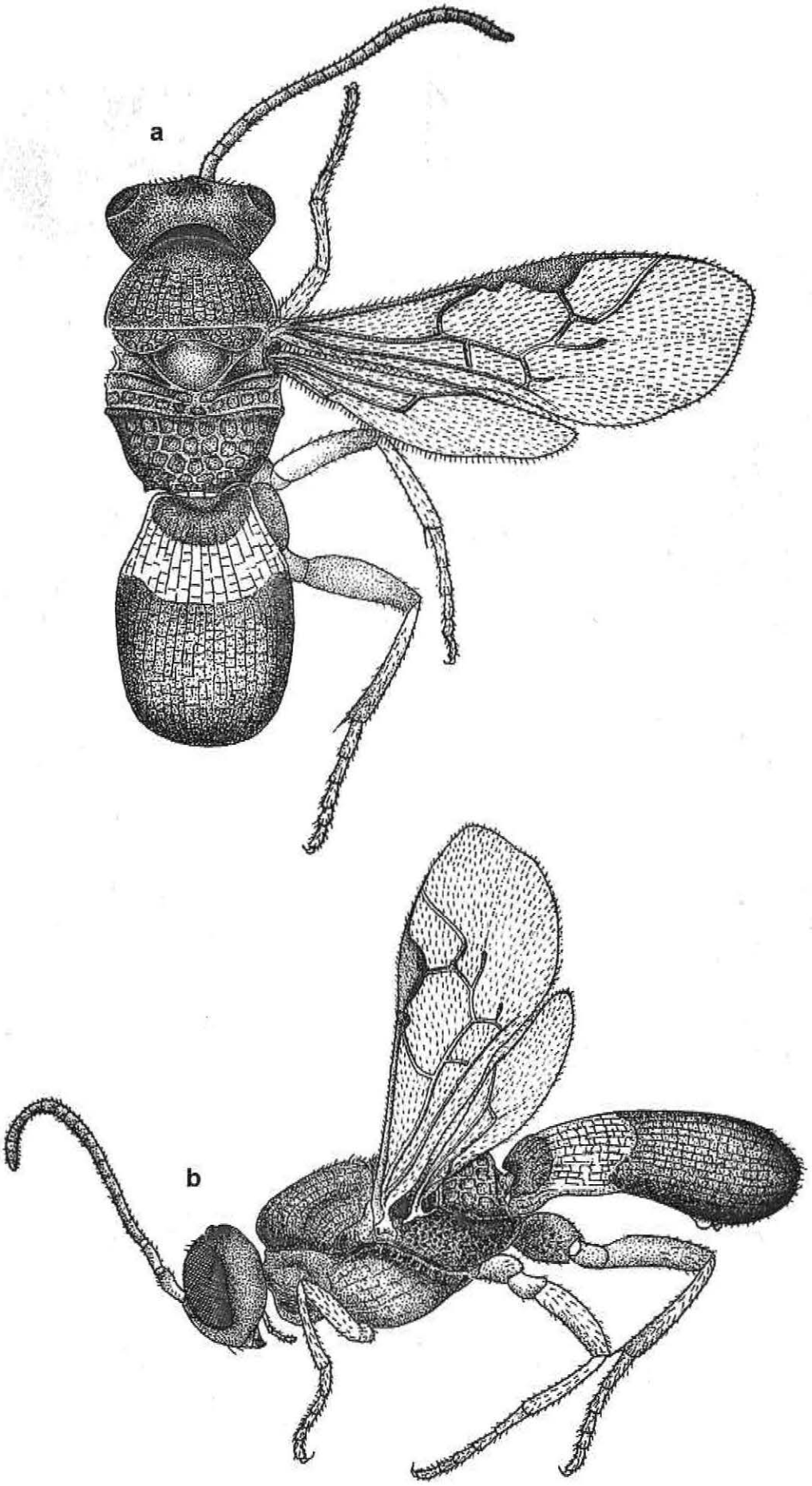

Figure 89 a–b. Dorsal (a) and lateral (b) views of *Chelonus curvimaculatus* Cameron

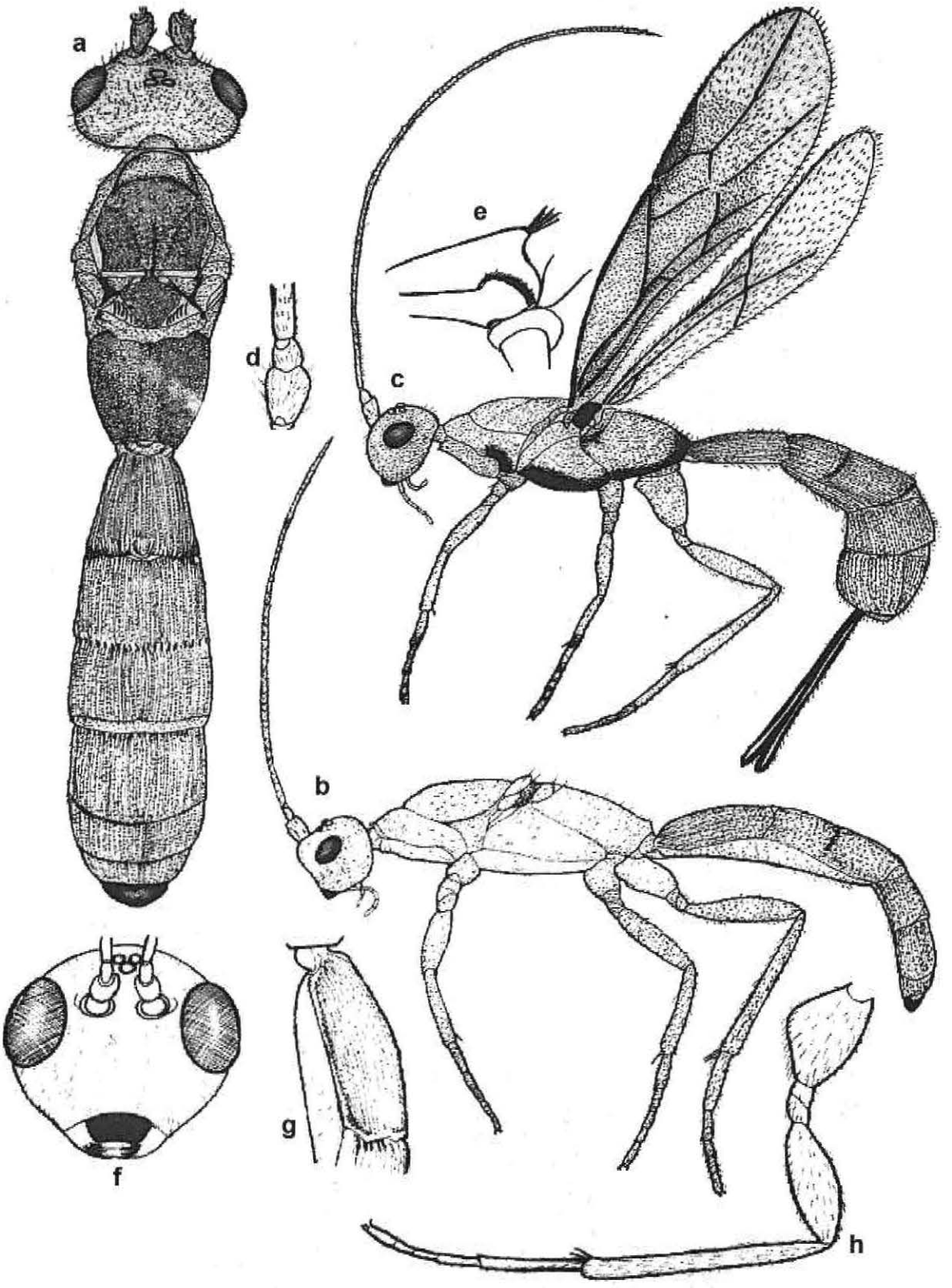

Figure 90 a–h. Dorsal (a) and lateral views of male (b) and female (c), scape and pedicel (d), coxa I and propleuron (e), head (f), side of T1 + 2 (g) and leg III (h) of *Rhaconotus* sp. A

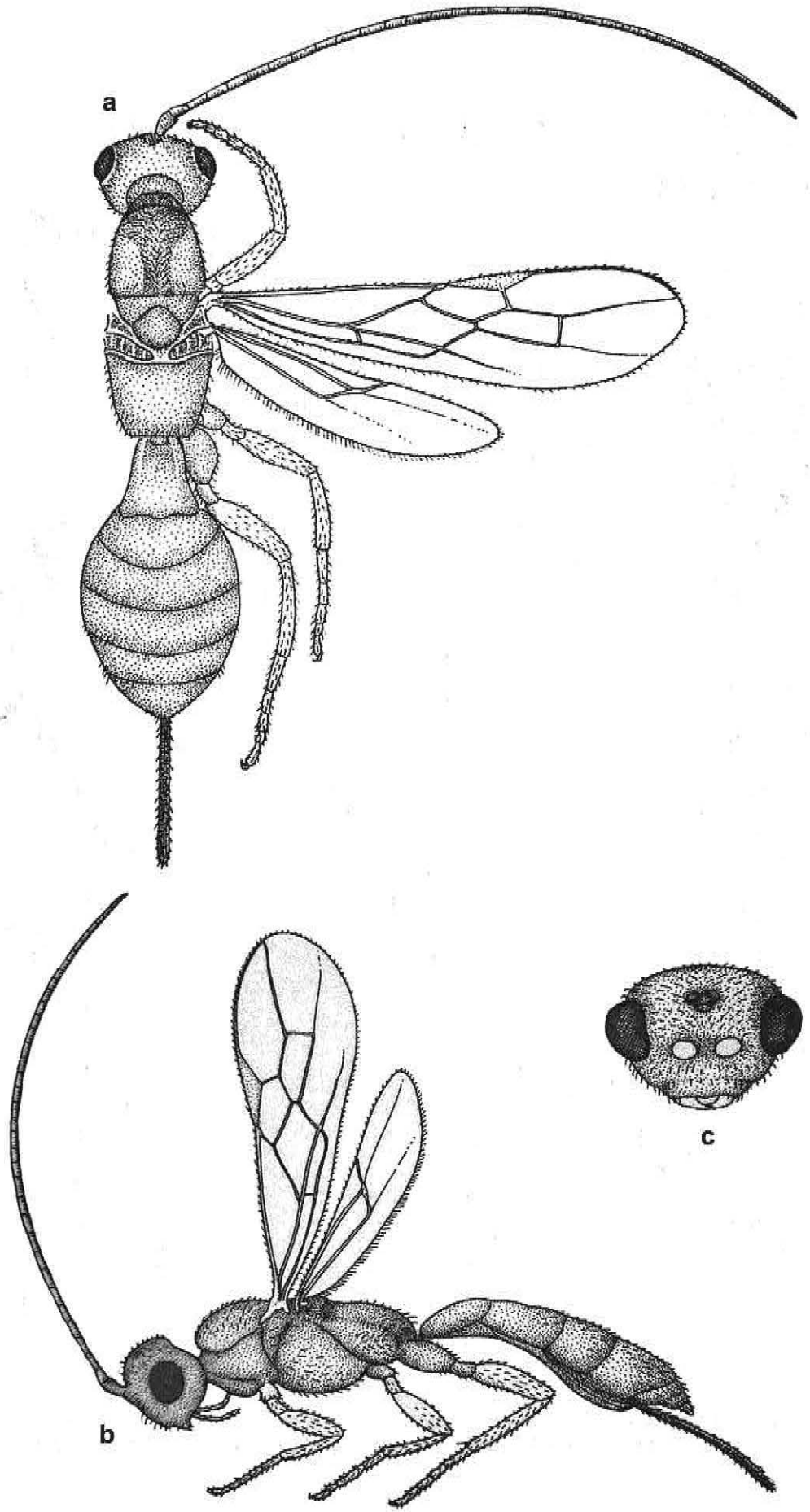

Figure 91 a–c. Dorsal (a) and lateral (b) views and head (c) of *Rhaconotus* sp. B

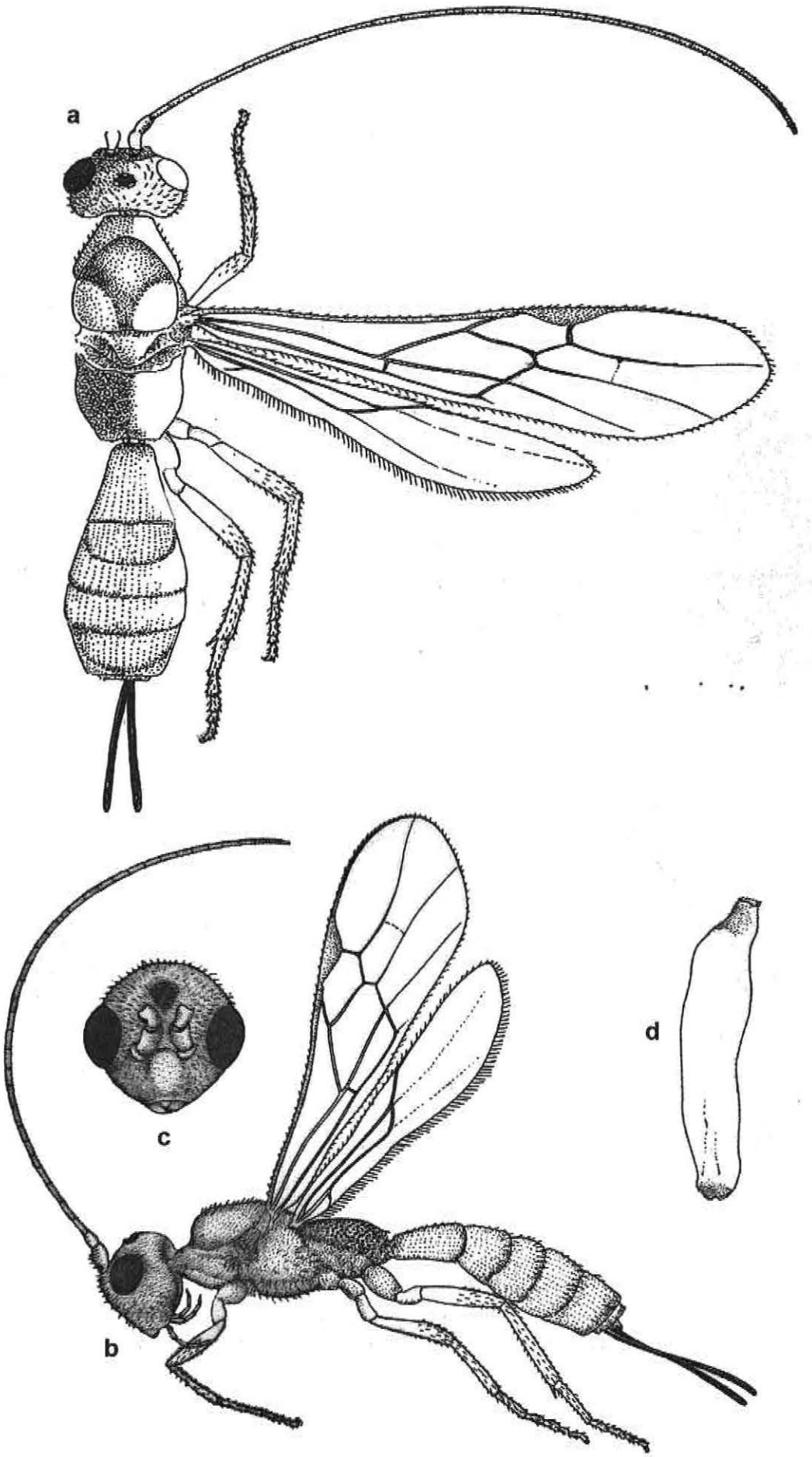

Figure 92 a–d. Dorsal (a) and lateral (b) views, head (c) and pupal cocoon (d) of *Rhaconotus* sp. C

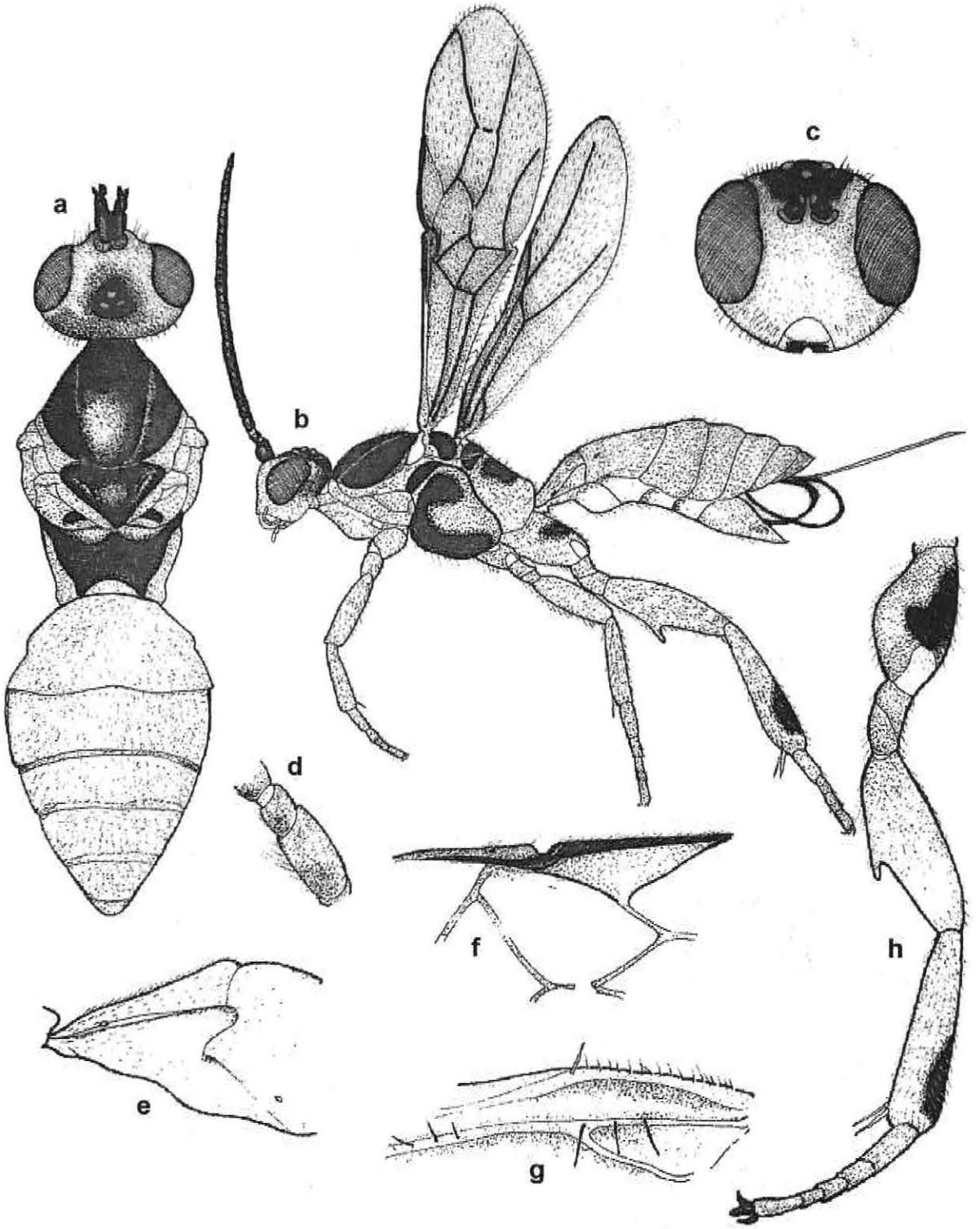

Figure 93 a–h. Dorsal (a) and lateral (b) views, head (c), scape and pedicel (d), side of tergite I (e), stigma and first submarginal cell (f), hindwing venation (g) and leg III (h) of *Habrobracon* sp. A

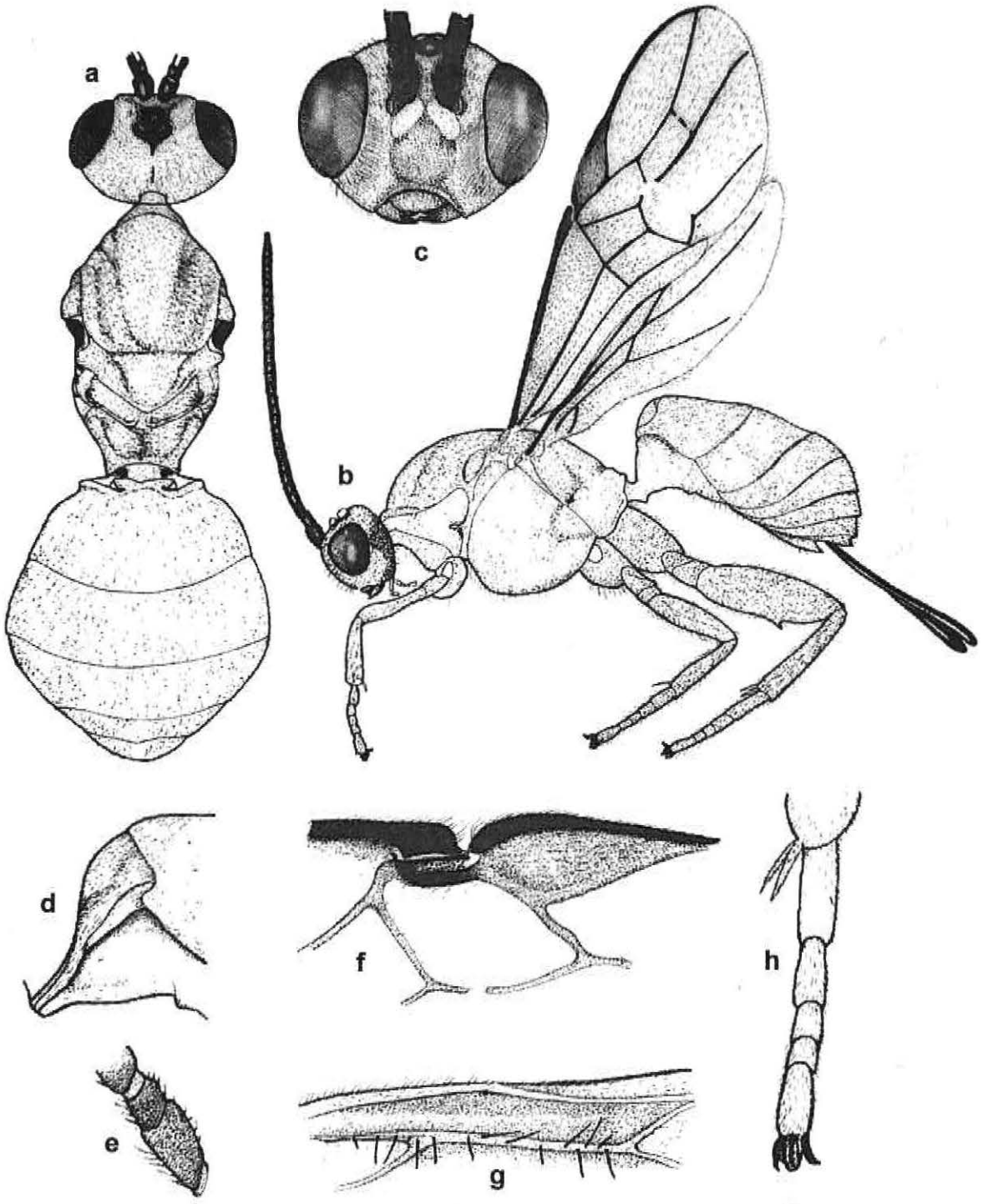

Figure 94 a–h. Dorsal (a) and lateral (b) views, head (c), side of tergite I (d), scape and pedicel (e), stigma and first submarginal cell (f), hindwing venation (g) and tip of tibia and tarsus of leg III (h) of *Habrobracon* sp. B

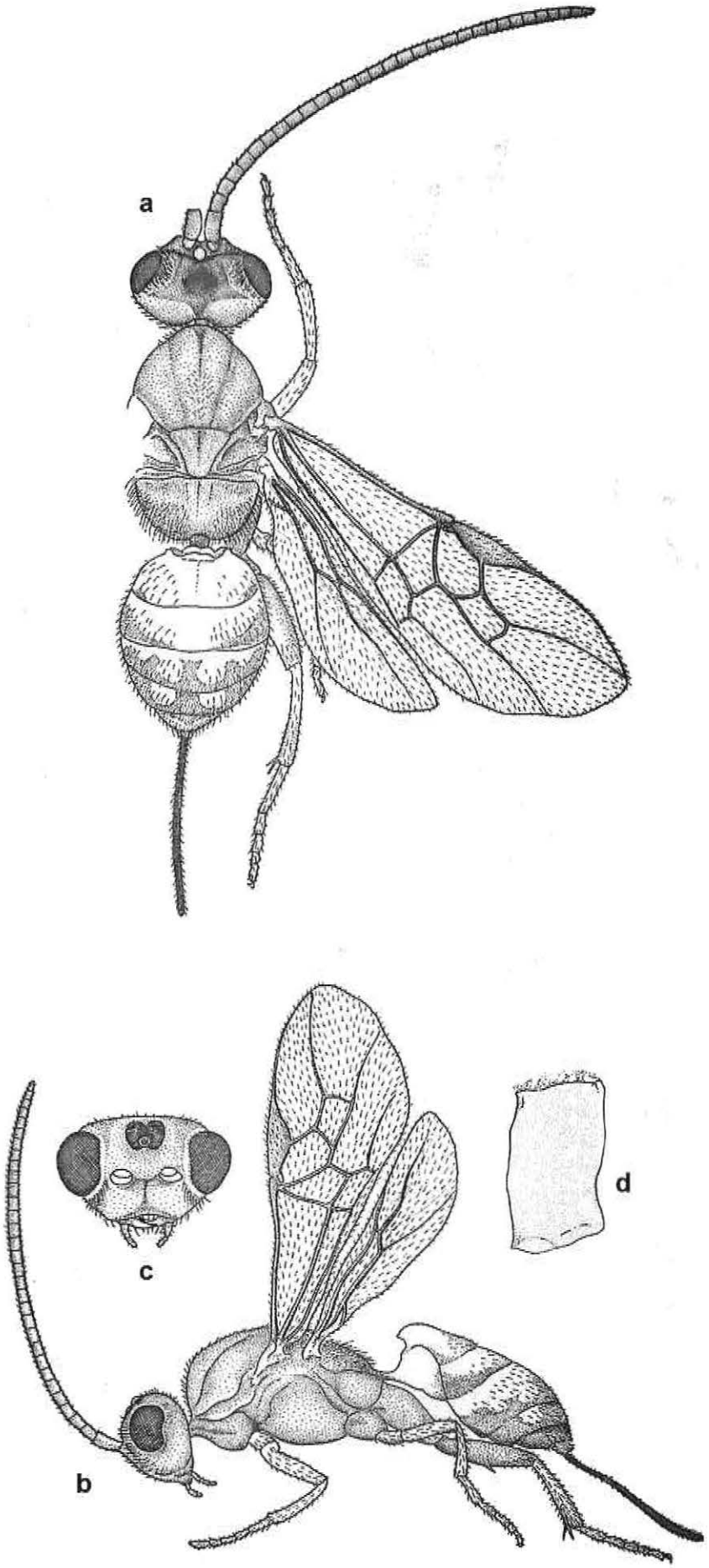

Figure 95 a–d. Dorsal (a) and lateral (b) views, head (c) and pupal cocoon (d) of *Habrobracon* sp. C

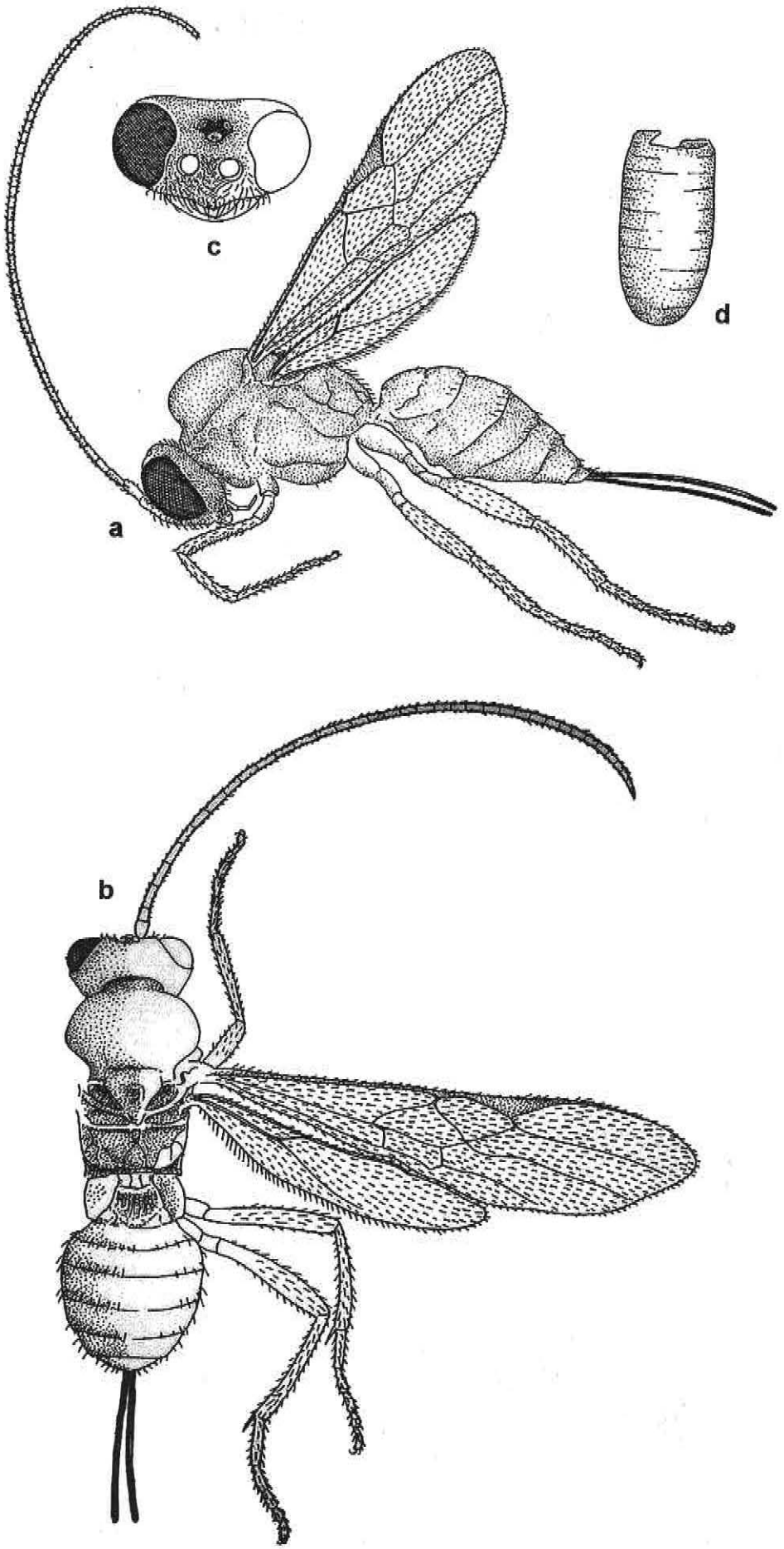

Figure 96 a–d. Lateral (a) and dorsal (b) views, head (c) and pupa (d) of host of *Bracon* sp.

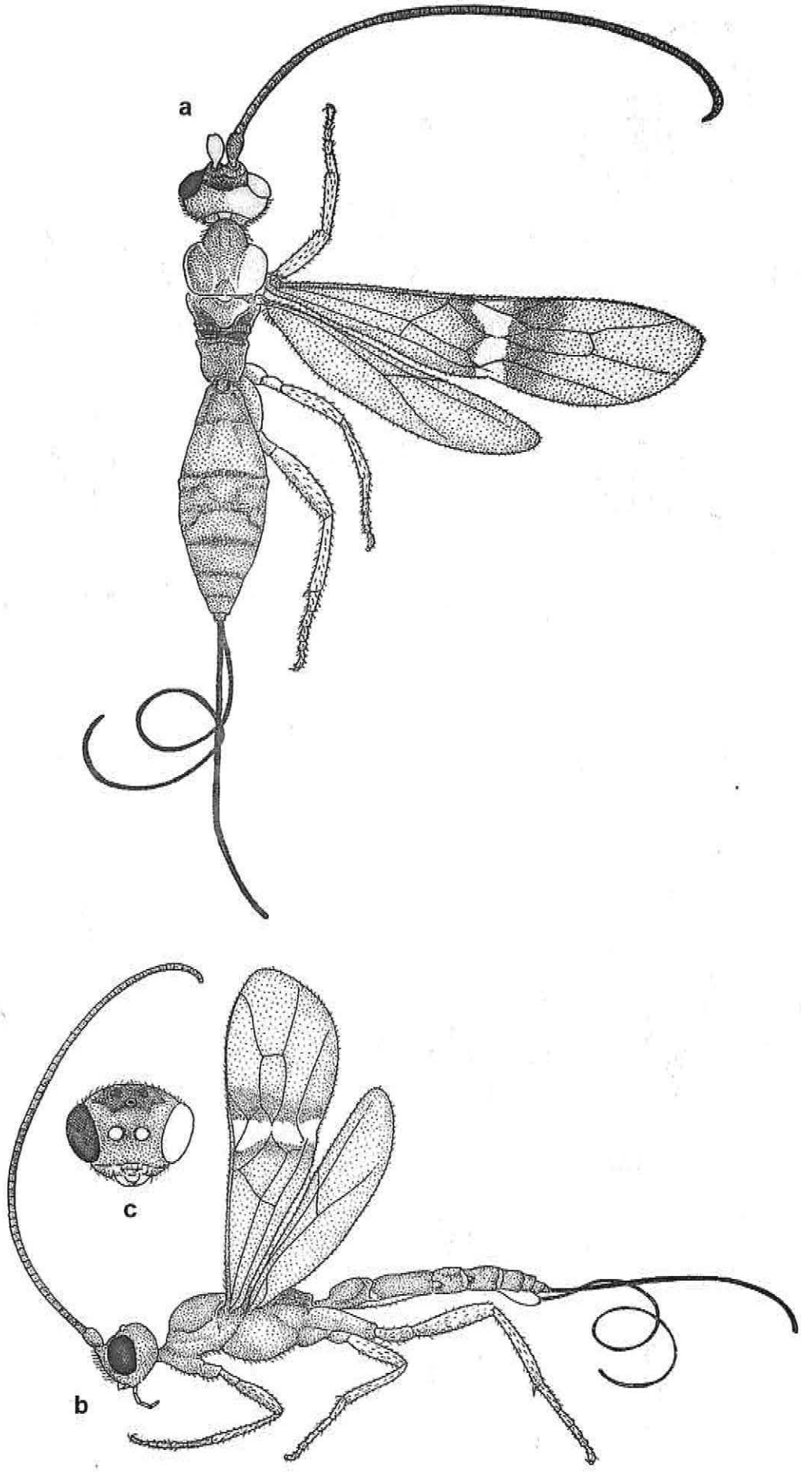

Figure 97 a–c. Dorsal (a) and lateral (b) views and head (c) of *Stenobracon rufus* Szepligèti

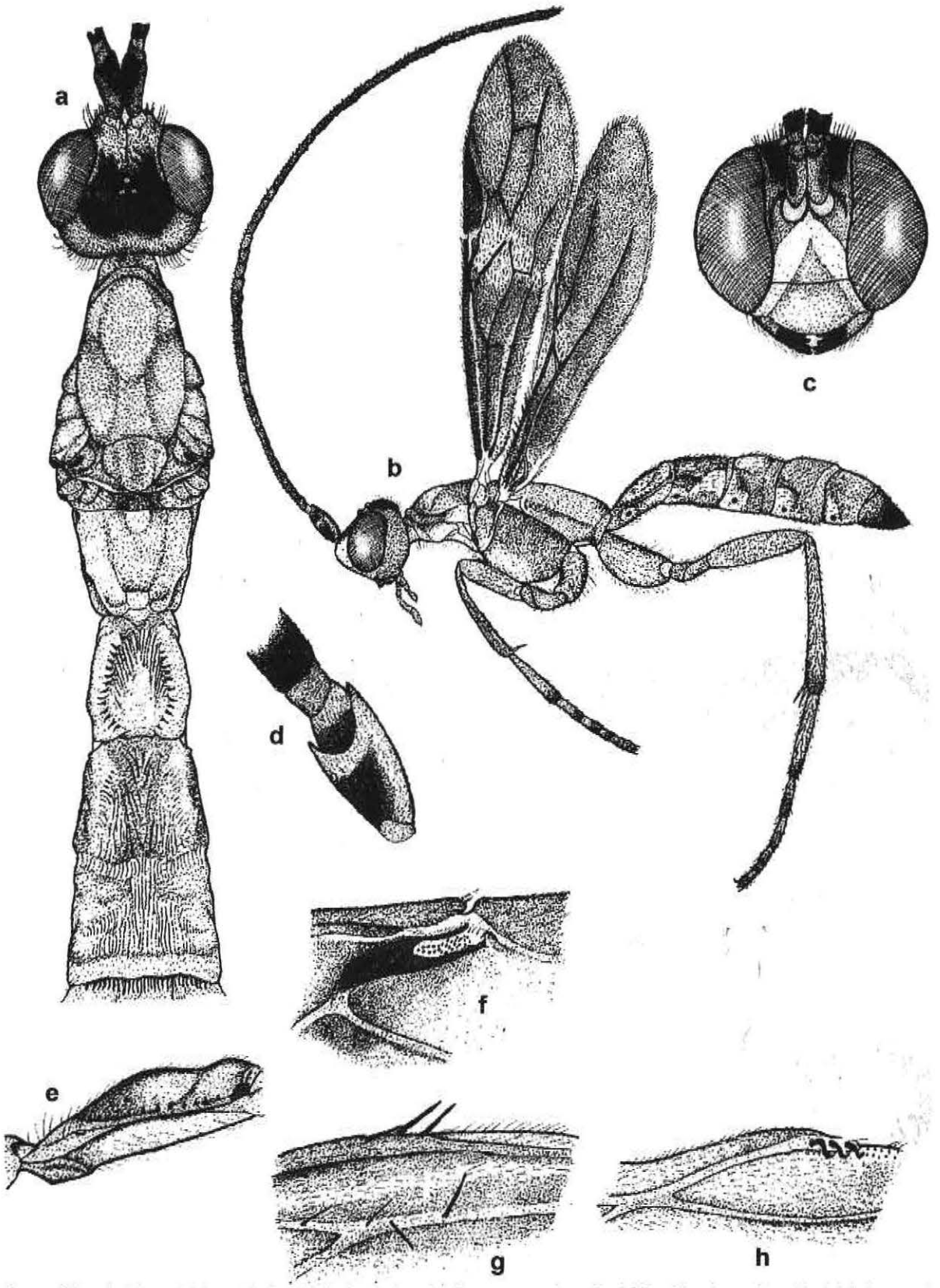

Figure 98 a–h. Dorsal (a) and lateral (b) views, head (c), scape and pedicel (d), side view of tergite I (e), base of stigma and inner part of submarginal cell (f), hairs on hindwing (g) and shape of hamuli (h) of *Stenobracon* sp.

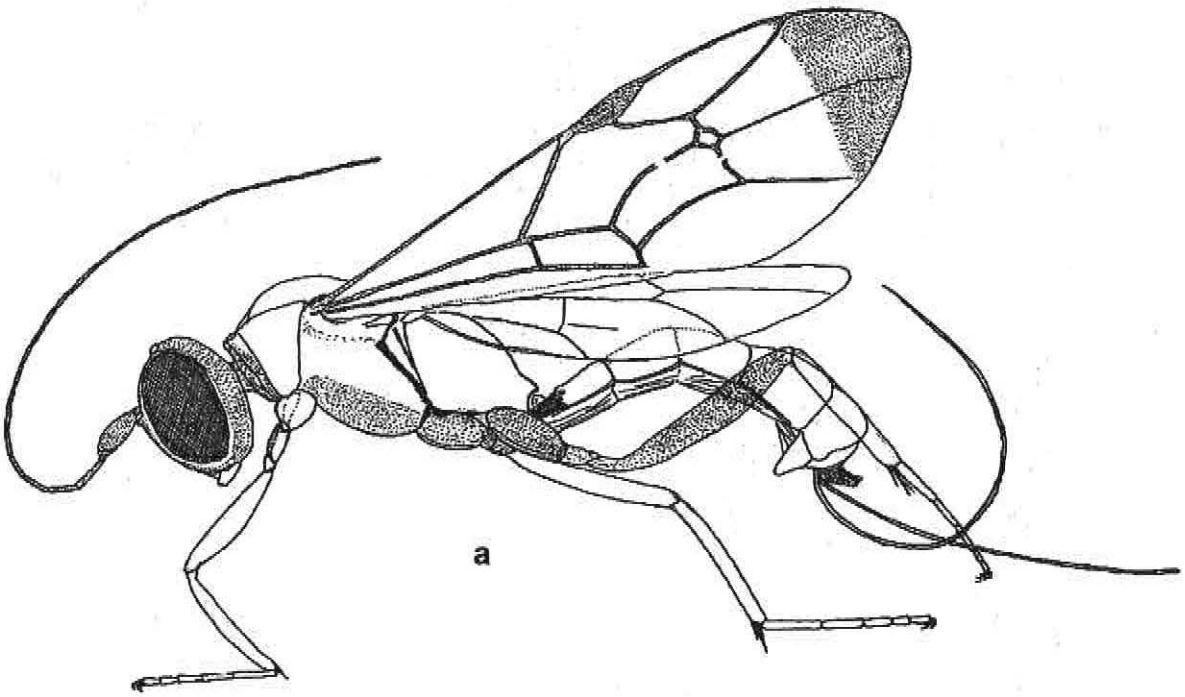

Figure 99 a. Lateral view of *Syzeuctus* sp.

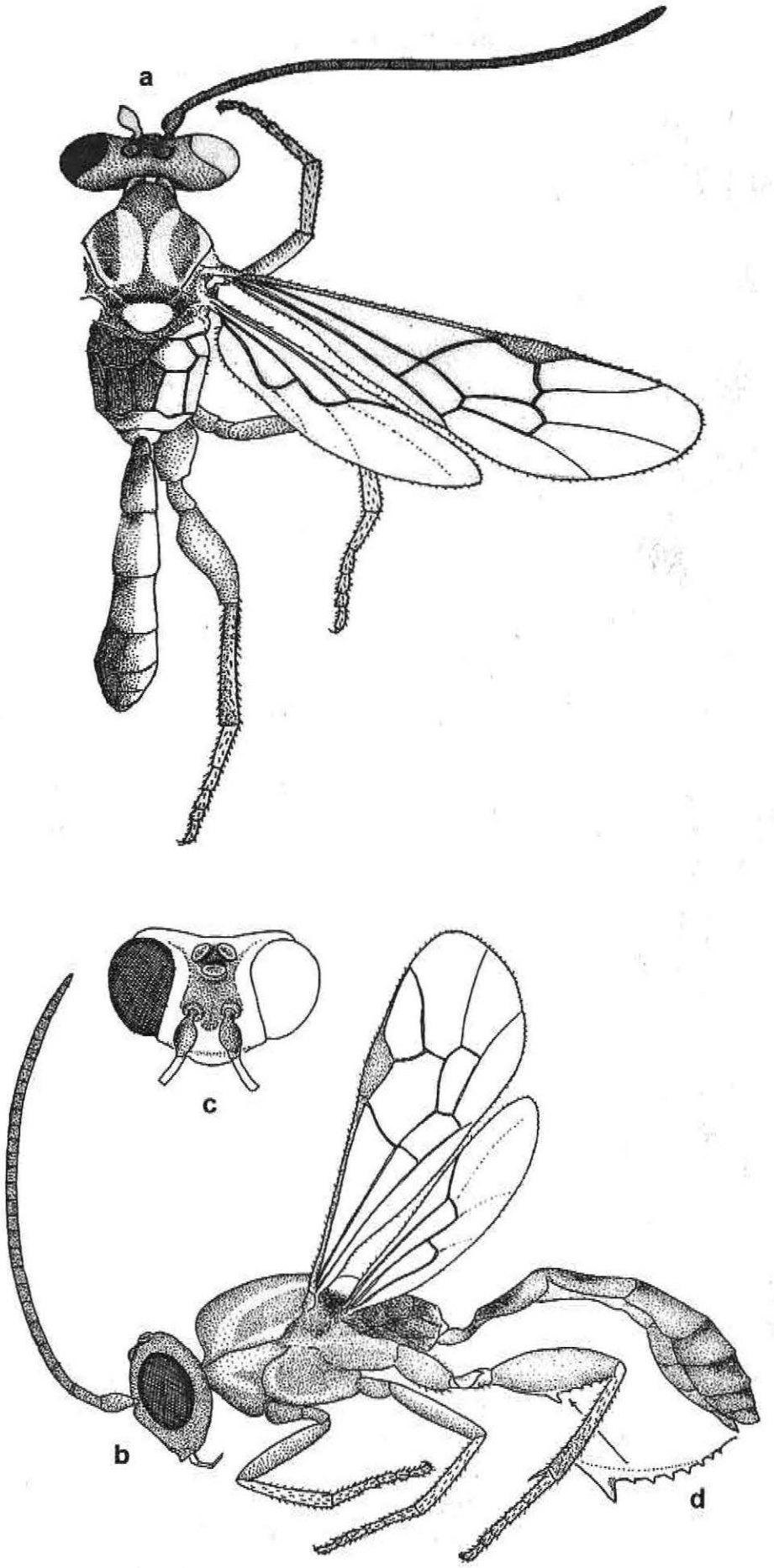

Figure 100 a–d. Dorsal (a) and lateral (b) views, head (c) and spines on femur III (d) of *Pristomerus bullis* Fitton

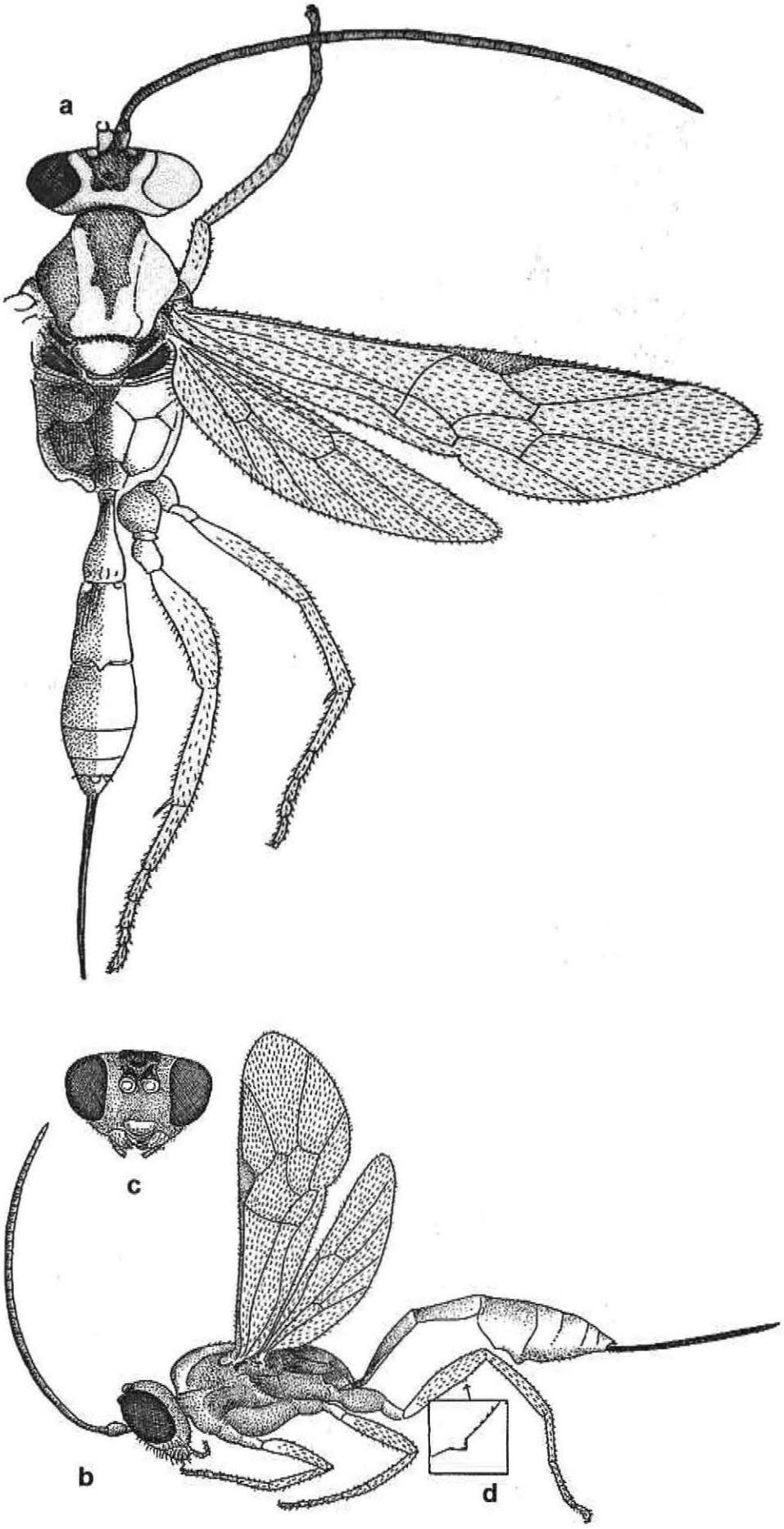

Figure 101 a–d. Dorsal (a) and lateral (b) views, head (c) and spine (d) of femur III of *Pristomerus* sp. A

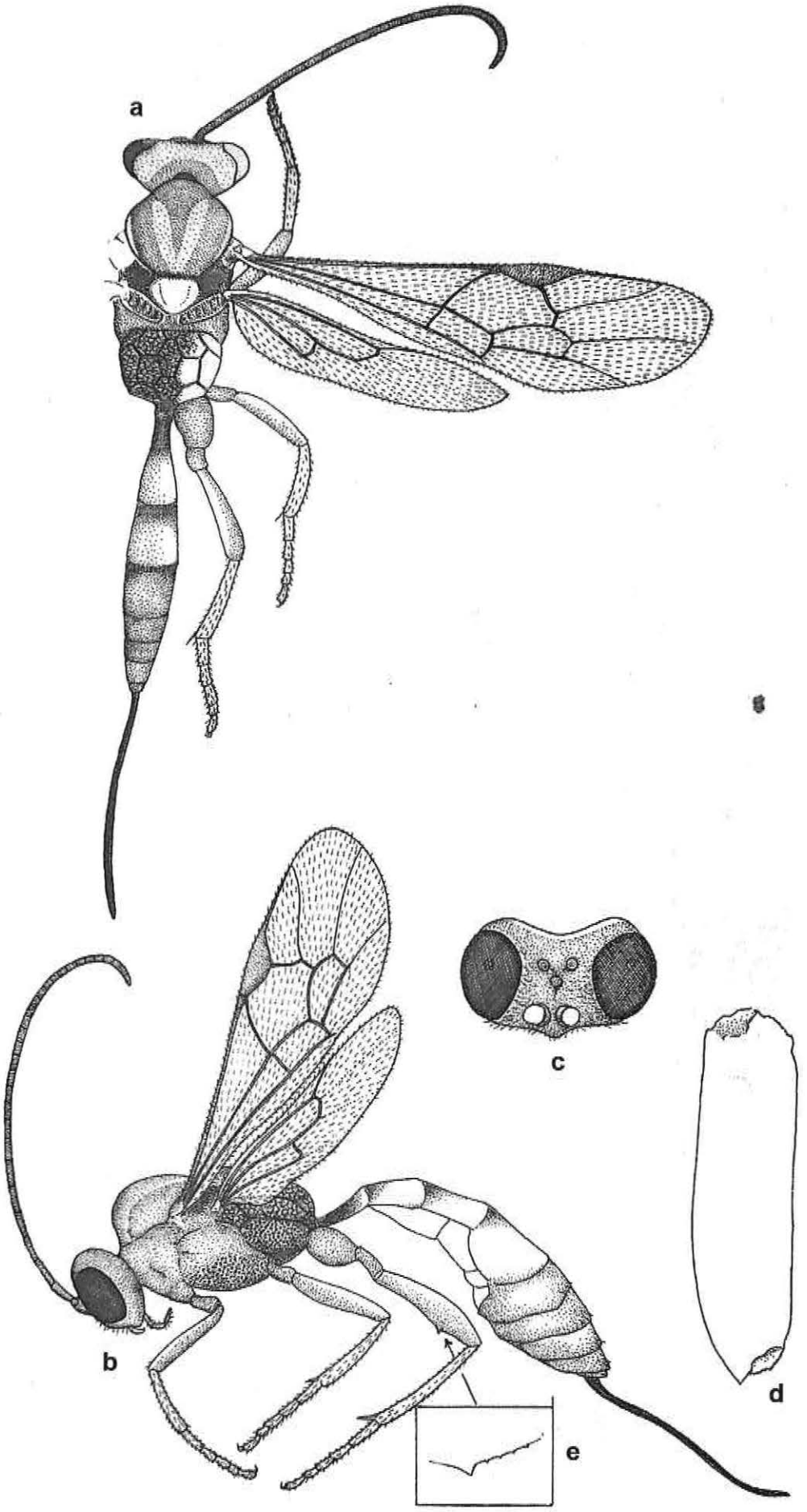

Figure 102 a–e. Dorsal (a) and lateral (b) views, head (c), pupal cocoon (d) and ventral spines on femur III (e) of *Pristomerus* sp. B

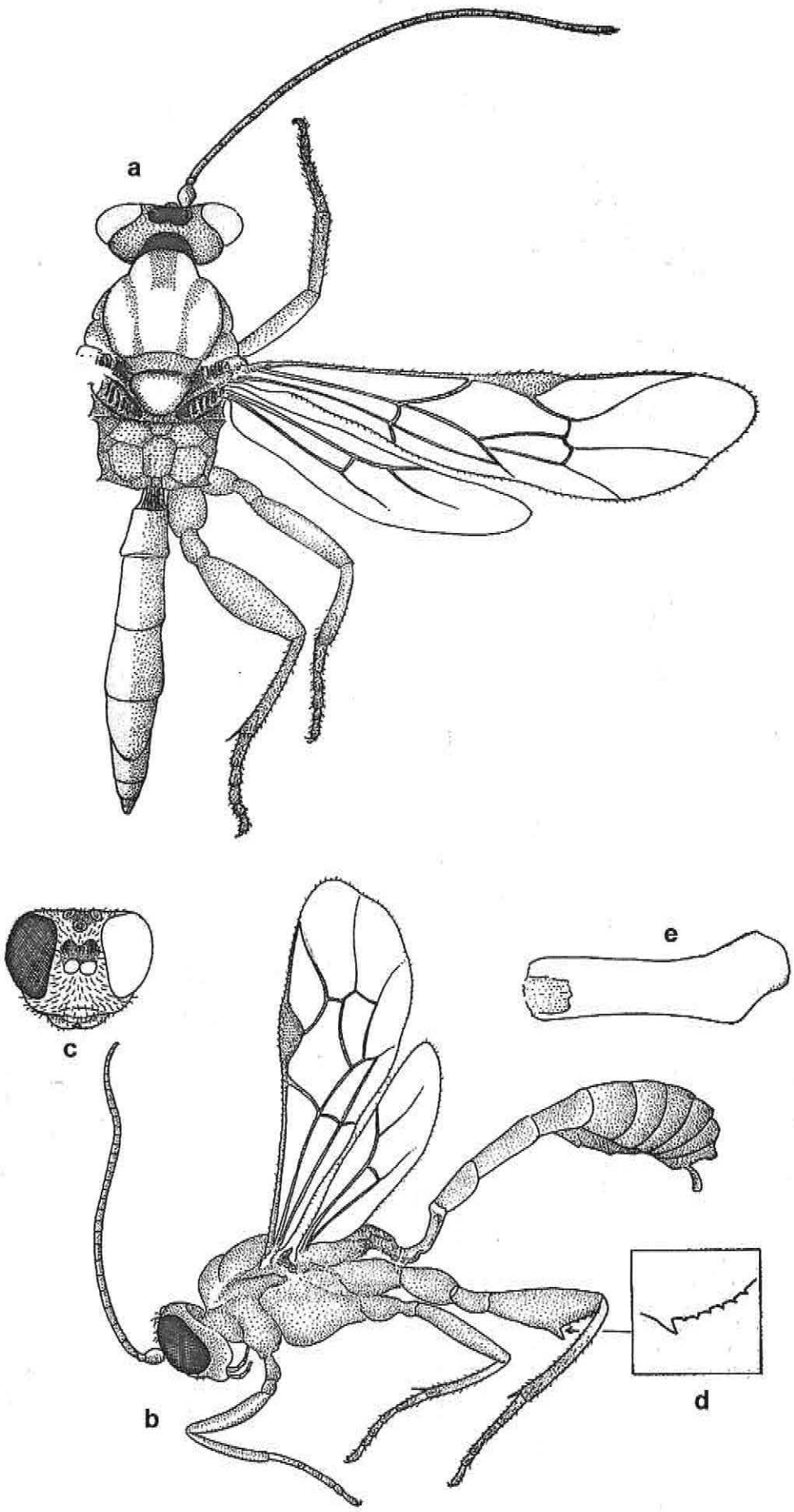

Figure 103 a–e. Dorsal (a) and lateral (b) views, head (c), ventral spines in femur III (d) and pupal cocoon (e) of *Pristomerus* sp. C

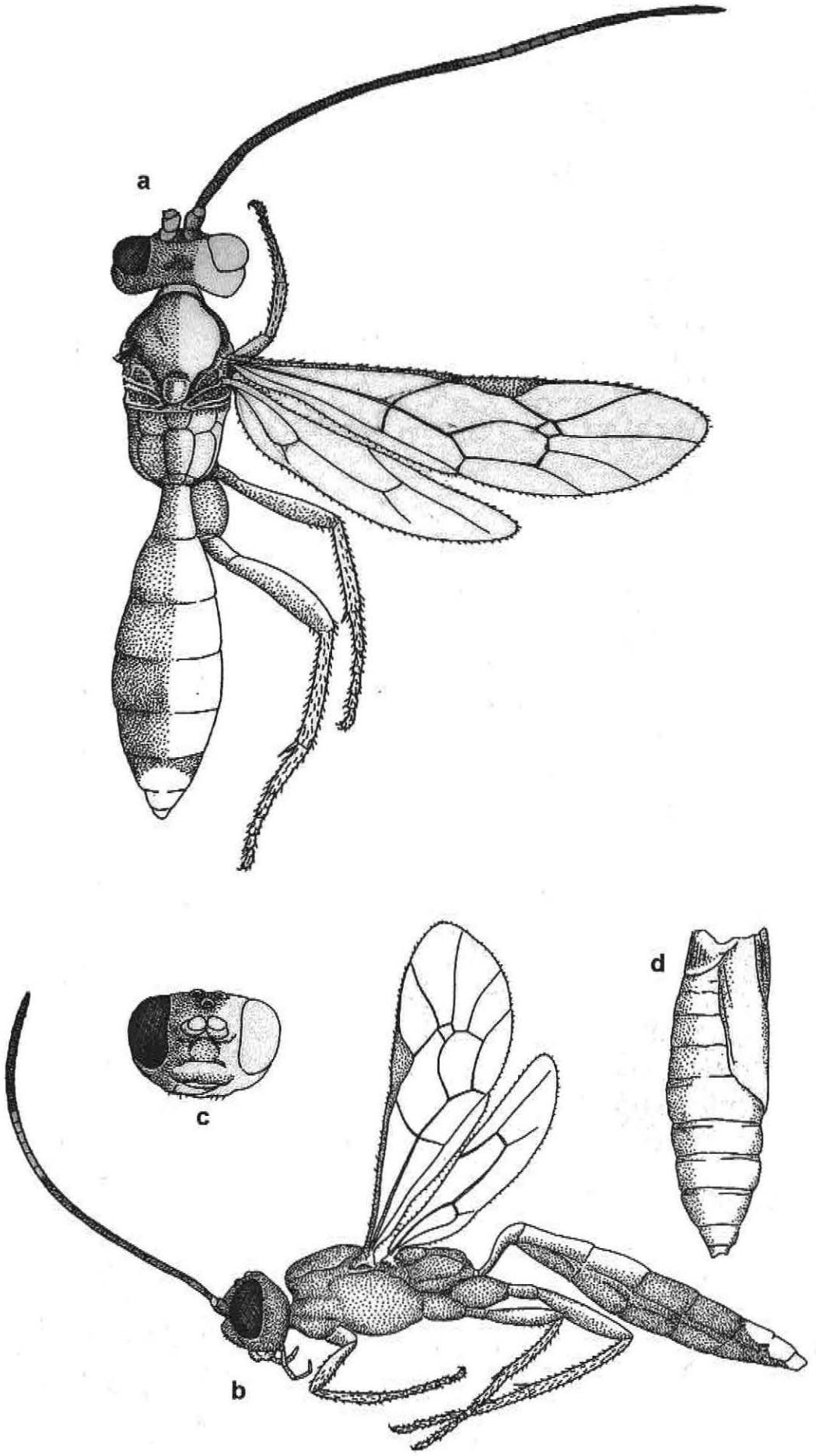

Figure 104 a–d. Dorsal (a) and lateral (b) views and head (c) of *Dentichasmias busseolae* Heinrich, and pupa (d) of its host

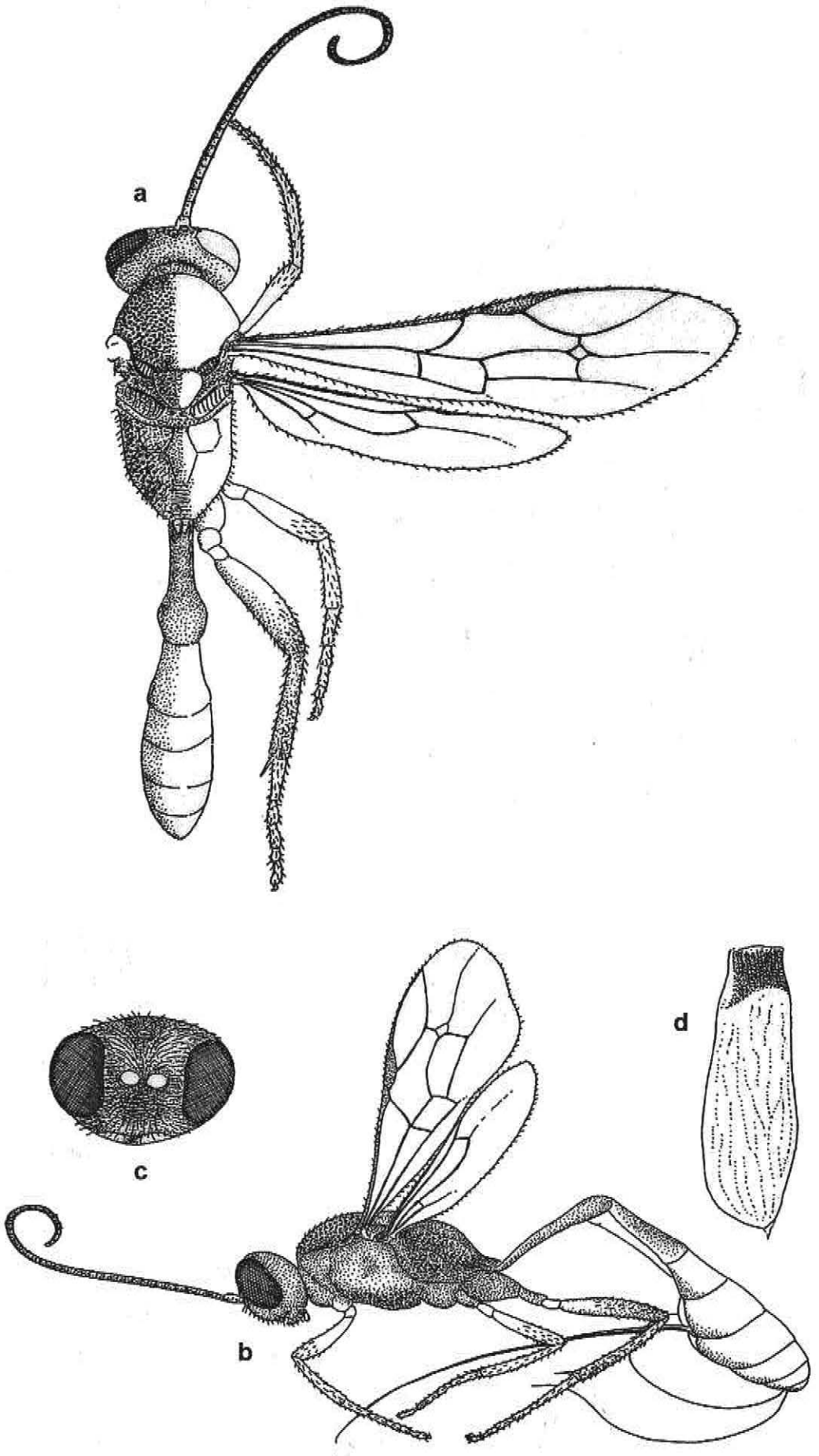

Figure 105 a–d. Dorsal (a) and lateral (b) views, head (c) and pupal cocoon (d) of *Venturia* sp. A

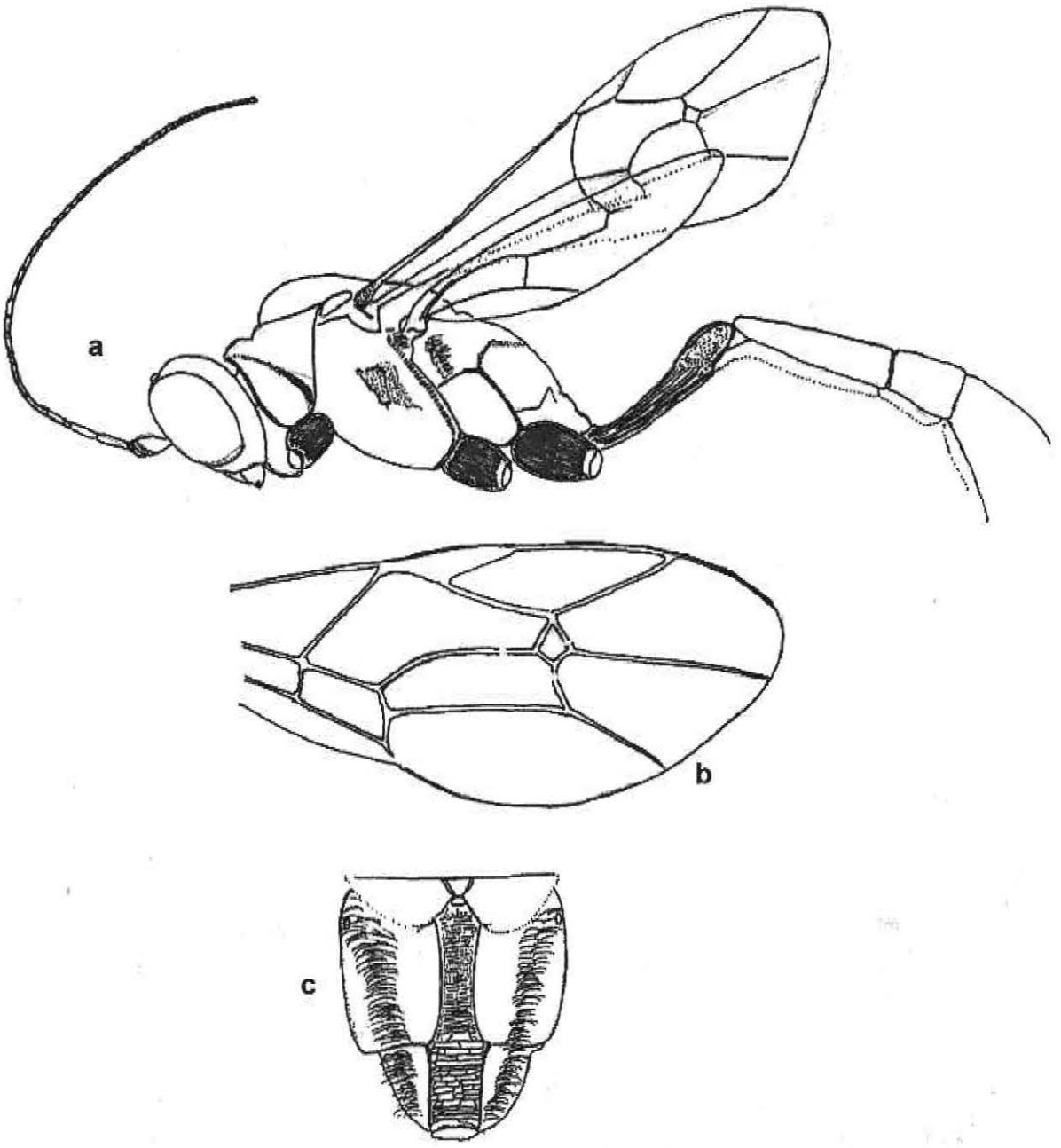

Figure 106 a–c. Lateral view of *Venturia* near *jordanae* Fitton (a), areole in forewing (b) and propodeum (c)

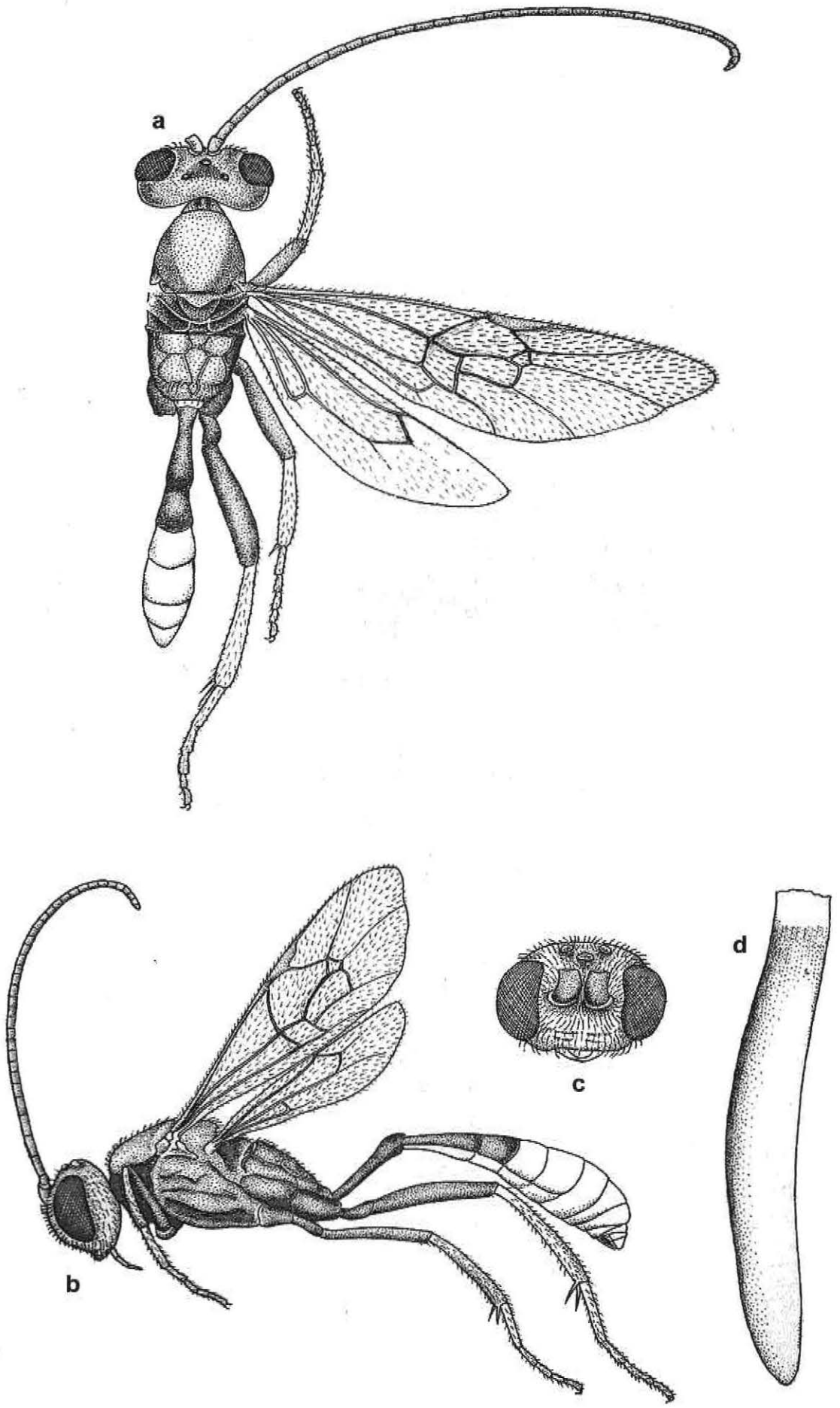

Figure 107 a–d. Dorsal (a) and lateral (b) views, head (c) and pupal cocoon (d) of *Venturia* sp. B

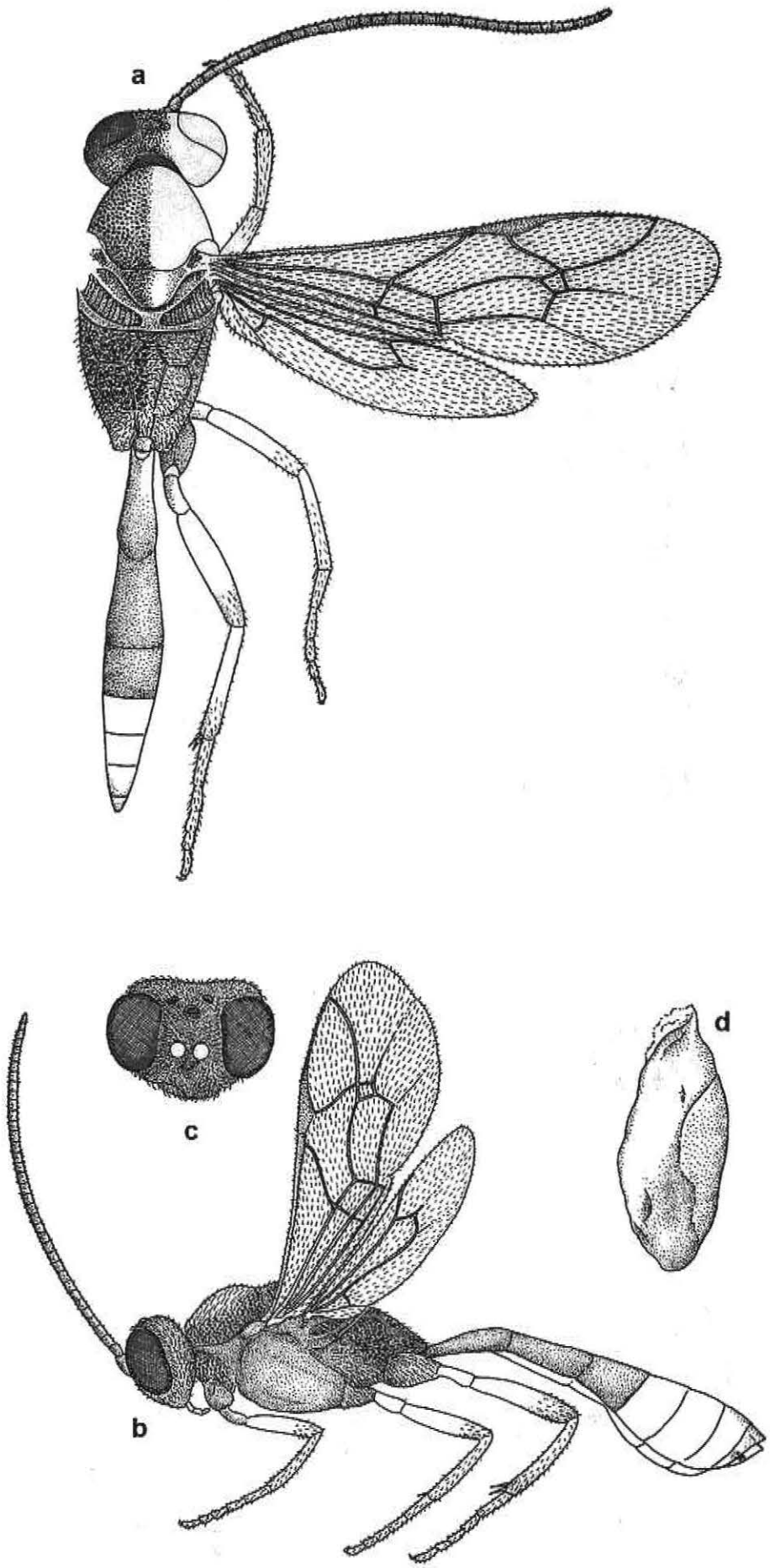

Figure 108 a–d. Dorsal (a) and lateral (b) views, head (c) and pupal cocoon (d) of *Venturia* sp. C

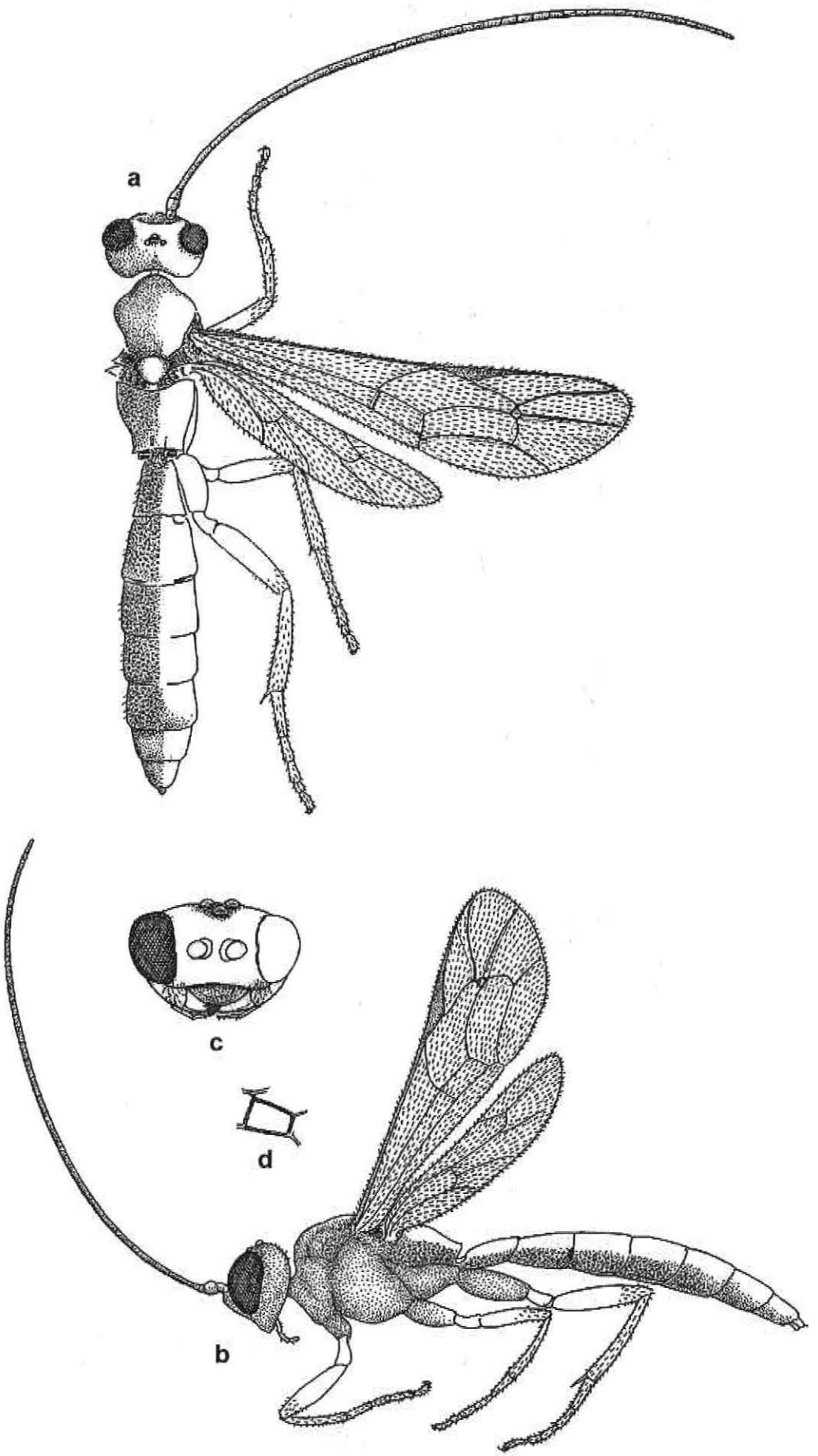

Figure 109 a–d. Dorsal (a) and lateral (b) views, head (c) and areole (d) of *Holcopimpla* sp. A

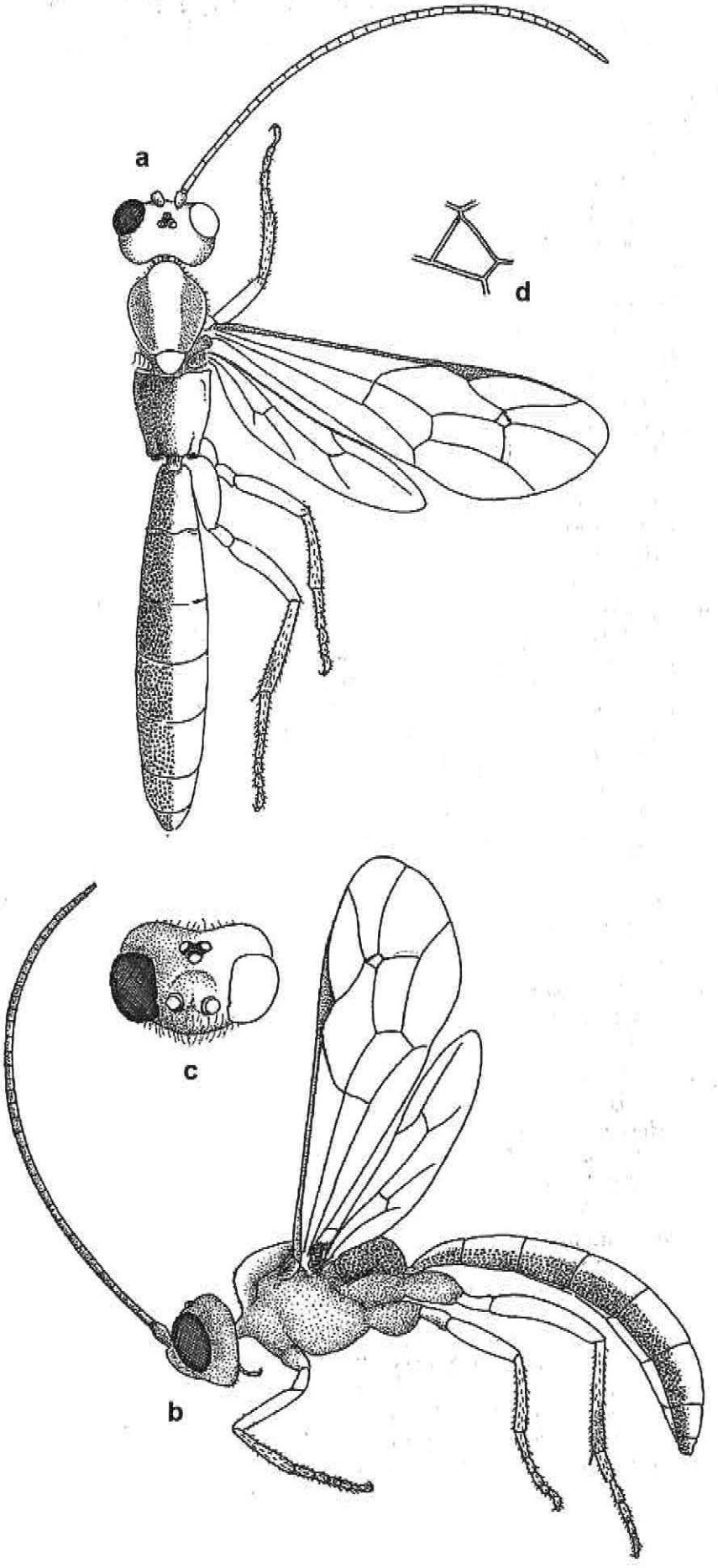

Figure 110 a–d. Dorsal (a) and lateral (b) views, head (c) and areole (d) of *Holcopimpla concolor* (Brullé)

APPENDIX—LIST OF STEMBORERS AND PARASITOIDS REARED FROM GRASSES

STEMBORERS

Order: Lepidoptera

Family: Cossidae

Phragmataecia boisduvalii (Figure 14 a–l)

Family: Gelechiidae

Stegasta sp. (Figure 4 a–l)

Family: Noctuidae

Busseola fusca (Plates 19, 20, 28, 29; Figure 13 a–m)
Busseola obliquifascia (Plates 19, 20, 28)
Busseola phaia (Plates 19, 20, 28)
Manga nubifera (Plates 21, 22, 27; Figure 12 a–i)
Sciomesa piscator (Plates 10, 27)
Sciomesa cf. sp. nov. (Plate 18)
Sesamia calamistis (Plates 11, 13, 14, 26, 29; Figure 11 a–q)
Sesamia nonagrioides botanephaga (Plates 11, 15, 26; Figure 10 a–f)
Sesamia penniseti (Plates 11, 16, 26)
Sesamia poephaga (Plates 11, 14, 17, 26)
Sesamia sp. nov. (Plates 11, 12, 26)

Family: Pyralidae

Chilo incertus (Plate 2)
Chilo orichalcociliellus (Figure 7a–g)
Chilo partellus (Plates 1, 3, 23, 29; Figure 6 a–u)
Chilo thyrsis (Plates 1, 3, 23; Figure 8 a–o)
Eldana saccharina (Plates 1, 2, 23; Figure 5 a–r)
Ematheudes sp. nov. (Plates 7, 8, 25)
Ematheudes straminella (Plates 7, 8, 25)
Maliarpha concinnella (Plates 6, 24)
Peoriinae taxon A (Plates 4, 5, 24)
Peoriinae taxon B (Plates 9, 24)
Saluria lentistrigella (Plates 10, 25)

Family: Tortricidae

Thaumatotibia leucotreta (Figure 9 a–f)

Order: Coleoptera

Family: Anthribidae

Phloebius sp. A (Figure 16 a–c)
Phloebius sp. B (Figure 17 a–c)

Family: Cerambycidae

Hyllisia near *vittata* (Figure 34 a–d)
Hypamazso pauli (Figures 29 a–w, 30 a–i)
Hypamazso sp. B (Figure 31 a–o)
Hypamazso sp. C (Figure 32 a–k)
Obeneopsis sp. (Figure 33 a–y)

Family: Curculionidae

?*Tanymecus* sp. (Figure 23 a–i)
?*Odoiporus* sp. (Figure 18 a–g)
Lixus near *germaini* (Figure 20 a–l)
Lixus sp. A (Figure 19 a–i)
Tanymecus near *dilaticollis* (Figure 21 a–c)
Tanymecus sp. A (Figure 22 a–o)
Unknown genus sp. A (Figure 24 a–z4)
Unknown genus sp. B (Figure 25 a–p)
Unknown genus sp. C (Figure 26 a–i)

Unknown genus sp. D (Figure 27 a–e)
Unknown genus sp. E (Figure 28 a–j)

Family: Languriidae
Barbaropus near *olseni* (Figure 44 a–m)
Barbaropus sp. B (Figure 46 a–h)
Barbaropus sp. C (Figure 45 a–h)
Barbaropus sp. D (Figure 47 a–c)
Barbaropus sp. E (Figure 48 a–h)
Promecolanguria rufocephala (Figure 49 a–i)
Stenolanguria caudata (Figure 42 a–n)
Stenolanguria sp. (Figure 43 a–l)

Family: Mordellidae
Stenalia near *occidentalis* (Figure 35 a–q)
Stenalia sp. B (Figure 36 a–f)
Stenalia sp. C (Figure 37 a–g)
Stenalia sp. D (Figure 38 a–e)
Stenalia sp. E (Figure 39 a–e)

Family: Tenebrionidae
Paramarygmus sp. (Figure 40 a–i)
Zophodes sp. (Figure 41 a–g)

Order: Diptera (Figure 50 a–d)

Family: Chloropidae
Elachiptereicus abessynicus (Figure 54 a–d)
Mepachymerus sp. (Figure 53 a–d)
Pachylophus sp. (Figure 55 a–d)

Family: Diopsidae
Diopsina sp. (Figure 51 a–d)
Diopsis near *lindneri* (Figure 52 a–c)
Diopsis sp. B (Figure 52 d)

Family: Muscidae
Atherigona soccata (Figure 57 a–h)

Family: Tephritidae
Bistrispinaria fortis (Figure 56 a–b)
Bistrispinaria magniceps
Bistrispinaria woodi

PARASITOIDS

Order: Diptera

Family: Tachinidae
Descampsina sesamiae (Figure 62 a–e)
Leskia sp. (Figure 63 a–g)
Lydella nr *sesamiae* (Figure 61 a–g)
Siphona sp. A (Figure 59 a–e)
Siphona sp. B (Figure 60 a–f)

Order: Hymenoptera (Figure 58 a–f)

Family: Bethylidae
Goniozus indicus (Figure 79 a)

Family: Braconidae
Bracon sp. (Figure 96 a–d)
Chelonus curvimaculatus (Figure 89 a–b)
Cotesia flavipes (Figure 81 a–c)
Cotesia nr *sesamiae* (Figure 83 a–c)
Cotesia sesamiae (Figure 82 a–c)
Dolichogenidea polaszeki (Figure 84 a–d)

Dolichogenidea sp. A (Figure 86 a–c)
Dolichogenidea sp. B (Figure 87 a–c)
Dolichogenidea sp. C (Figure 85 a–d)
Habrobracon sp. A (Figure 93 a–h)
Habrobracon sp. B (Figure 94 a–h)
Habrobracon sp. C (Figure 95 a–d)
Phanerotoma sp. (Figure 88 a–c)
Rhaconotus sp. A (Figure 90 a–h)
Rhaconotus sp. B (Figure 91 a–c)
Rhaconotus sp. C (Figure 92 a–d)
Stenobracon rufus (Figure 97 a–c)
Stenobracon sp. (Figure 98 a–h)
Triaspis sp. (Figure 80 a–c)

Family: Chalcididae
Brachymeria kassalensis (Figure 66 a–c)
Hockeria sp. (Figure 67 a–d)

Family: Eulophidae
Pediobius furvus (Figure 71 a–c)
Pediobius homoeus (Figure 70 a–c)
Tetrastichus sp. (Figure 69 a–c)

Family Eupelmidae
Macroneura sp. (Figure 77 a–c)

Family: Eurytomidae
Eurytoma oryzivora (Figure 73 a–c)
Eurytoma sp. A (Figure 74 a–c)
Eurytoma sp. B
? *Eurytoma* sp. C (Figure 75 a–c)
Eurytoma sp. D (Figure 76 a–d)
Sycophila sp. (Figure 72 a–c)

Family: Ichneumonidae
Dentichasmias busseolae (Figure 104 a–d)
Holcopimpla concolor (Figure 110 a–d)
Holcopimpla sp. A (Figure 109 a–d)
Pristomerus bullis (Figure 100 a–d)
Pristomerus sp. A (Figure 101 a–d)
Pristomerus sp. B (Figure 102 a–e)
Pristomerus sp. C (Figure 103 a–e)
Syzeuctus sp. (Figure 99 a)
Venturia near *jordanae* (Figure 106 a–c)
Venturia sp. A (Figure 105 a–d)
Venturia sp. B (Figure 107 a–d)
Venturia sp. C (Figure 108 a–d)

Family: Mymaridae
Gonatocerus sp. (Figure 68 a–j)

Family: Platygasteridae
Inostemma sp. (Figure 65 a–c)

Family: Pteromalidae
Norbanus sp. (Figure 78 a–c)

Family: Scelionidae
Scelio sp. (Figure 64 a–c)

GLOSSARY

Aedeagus: The male copulatory organ.

Ampulla: Of the male genitalia of some moths, a process, arising from the inner face of the valve; of coleopteran larvae, vesicular balloon or blister-like processes on the body surface.

Annellus(i): Of moths; short, ring-like antennal segment between the pedicel and the funicle.

Annular: Ring-shaped.

Anterior: Front of the body or body part (opposite of posterior).

Apical: Toward the end (apex) of a structure (opposite of basal).

Apophysis(es): Of the genitalia of female moths; rod-like support structures.

Area superomedia: Of Ichneumonidae; one of the areolae (spaces) on the propodeum; these spaces defined by bordering carinae. According to Heinrich, for ichneumonine ichneumonids, the area superomedia is the large median areola, set off by a transverse carina dorsally from the area basalis and from another transverse carina ventrally from the area posteromedia.

Areola: A space defined by bordering carinae (see **area superomedia**).

Areole: Of moths; the extra wing cell distal to discal cell.

Areolet: Of Ichneumonidae (Hymenoptera); the small cell in the middle of the wing.

Arista: Bristle-like structure originating on the antennal flagellum of some flies.

Basal: Toward the origin (base) of a structure (opposite of apical).

Bifid: Forked or cleft into two parts.

Biordinal: Of crochets, arranged in two ranks.

Bipectinate: With feather-like setae on both sides of the antenna.

Bulla(e): Sac-like evagination(s).

Bursa copulatrix: Of female moths, the anterior-most part of the genitalia; a sack-like structure into which sperm packet (spermatophore) is deposited.

Carina: A ridge.

Chaetosema(ta): Of moths, raised cuticular area(s) on the head associated with sensory hairs or setae, found near the compound eyes.

Chorda: Of the moth wing; the stem of veins R_{4+5}.

Ciliate: With small hairs.

Clasper: Of male moths, the valve or a specialised grasping structure on the inner surface of the valve.

Clavate: Club-shaped.

Clypeus: The part of the insect head just above the mouthparts.

Coarctate: Of a pupa, where the developing adult is hidden inside the 'case' formed from the last larval skin (e.g. in the higher Diptera).

Coremata: Of male moths; secondary structures typically involved in the dissemination of pheromone; can be as simple as dense patches of specialised scales or setae to complicated eversible balloon-like organs.

Corneous: Horn-like.

Cornutus(i): Sclerotised projection(s) on the vesica of the aedeagus of some moths.

Coronal suture: Longitudinal suture along midline of the head, from the epicranial notch to the apex of the clypeus.

Costa: (a) The vein, when present, along the edge of the wing, usually complete along the anterior margin; along the rest of the wing its presence and strength highly variable among different insect groups;
(b) Of male moths, the dorsal part of the valve (= harpe).

Coxa: The most basal of the five leg segments of insects.

Cremaster: An attachment organ at the posterior of a moth pupa, comprising a group of small hooked sclerites.

Crochets: Small, hook-like sclerotisations on the caterpillar (larva) prolegs.

Cubitus: The 5th longitudinal vein of the wing.

Cucullus: The distal portion of the male valva or clasper.

Denticle(s): Small tooth-like process(es).

Digitate: Finger-like.

Distal: Far away from (opposite of proximal).

Dorsal: The upper surface (opposite of ventral).

Ductus bursae: The duct in female moths connecting the ostium to the bursa copulatrix.

Eclosion: Emergence of the adult from the pupa.

Elytron(a): The sclerotised forewings of Coleoptera (beetles).
Epicranial stem: (= Coronal suture) longitudinal suture on the midline of the head, reaching from the epicranial notch to the apex of the clypeus.
Epicranial suture: A U-, V-, or Y-shaped suture on the dorsal part of the head.
Epiphysis: Lobe-like process on the fore tibia of some moths.
Exarate: Of a pupa, where the appendages of the developing adult are free to move (e.g. in Coleoptera and Hymenoptera).
Face: That part of the insect head between the clypeus and the antennal insertions.
Femur: The third leg segment, usually the most robust.
Filiform: Thin, like a wire.
Flagellomeres: Segments of the flagellum of an antenna.
Flagellum: The part of the antenna distal to the pedicel.
Frenulum: One or more spines on the forward edge of the hindwing of a moth that engage the forewing, synchronising wing action during flight.
Frons: That part of the insect head between the face and the vertex (top).
Funicle: The group of antennal segments between the annellus (see above) and the club.
Funicular: Pertaining to the funicle.
Gaster: Of Hymenoptera; the portion of the abdomen behind the petiole.
Gena: The side of the head below and continuing behind the eyes.
Geniculate: Bent like an elbow.
Gula: Sclerite forming the central part of the ventral (under) side of the head.
Gular: Pertaining to the gula.
Gnathos: Paired sclerotised processes of the vinculum.
Harpe: See **valve.**
Hyaline: Translucent.
Hypognathous: Head oriented more or less vertically, mouthparts pointing down.
Infuscate: Dark, smoky brown.
Juxta: Plate-like structure on which the aedeagal manica rests.
Longitudinal: Running lengthwise along the body or structure.
Medial: Towards or near the middle of a structure.
Notauli: Of Hymenoptera; a more or less straight depression or furrow on the mesoscutum, sometimes complete, often punctuate, usually arranged obliquely.
Obtect: Of a pupa, where the appendages adhere to the body (e.g. in moths)
Occiput: Posterior-most part of the head, behind and below the vertex.
Ocellar triangle: More or less defined area of frons on which ocelli are found.
Ocellus(i): Simple eye; single facet, light sensitive structure on the head.
Ostium: Of Lepidoptera, the external opening of the female genitalia.
Ostium bursae: Of the female genitalia of moths, the opening connecting the bursa copulatrix to the ductus bursae.
Ovipositor: Egg-laying organ.
Patagium: Pad-like structure with hairs or scales located on the thorax of moths.
Pecten: In some moths, elongate scales on ventral surface of the scape.
Pectinate: Comb-like.
Pedicel: The 2nd antennal segment.
Penellipse: An incomplete circle or ellipse.
Penultimate: Next to last.
Petiole: In wasps, the more or less constricted portion of the abdomen that connects it to the propodeum (see below), the apparent last segment of the thorax.
Pinaculum(a): Usually small, variable raised processes on the integument of the larva that bear the primary seta(e).
Plica(e): Ridge(s).
Porrect: Palps projected forward.
Posterior: End of the body or body part (opposite of anterior).
Prolegs: Fleshy leg-like protuberances on the caterpillar abdomen.
Prognathous: Head oriented more or less horizontally, mouthparts pointing forward.
Propodeum: In Hymenoptera, the apparent part of the thorax just above insertion of the abdomen; in reality, the first abdominal segment.
Prothoracic shield: The variably sclerotised dorsum of the prothorax of the larva.
Proximal: Close to (opposite of distal).
Punctate: Having more or less tiny depressions or holes.
Punctation: The pattern of the tiny depressions or holes.

Reclinate: Directed backwards.
Retinaculum: Of Lepidoptera, hook(s) or specialised scales on the posterior, ventral area of forewing which engage the frenulum.
Rostrum: Of some beetles, the produced, snout-like part of the head.
Rugose: Wrinkled, rough.
Sacculus: Of male genitalia, the ventral part of the valve.
Saccus: Anteriorly projecting process from the vinculum or 9th abdominal segment.
Scape: The 1st antennal segment.
Sclerite: A discrete section of hardened exoskeleton.
Sclerotised: Hardened.
Scobinate: Corrugated, wavy.
Scrobe: In weevils, the groove at the side of the rostrum into which the antennae fit.
Scutellum: The sclerotised dorsal surface immediately posterior to the thorax.
Scutum: The dorsal surface of the mesothorax.
Serrate: Saw-like, with teeth.
Seta(e): Bristle(s).
Signum(a): Sclerotised structure(s) on the wall of the corpus bursae of some female moths.
Sinuate: Long and wavy.
Spermatheca(e): In the female, a receptacle for storing sperm, usually sclerotised.
Spiracle: Opening in the insect cuticle through which gases diffuse.
Spur: Sword-like structure on the adult leg, usually at the tip of a segment.
Sternite: The ventral sclerite of a body segment (e.g. an abdominal sternite).
Stigma: Of the wing; a spot-like, usually darkened area on the anterior costal margin.
Stria(e): Fine, longitudinal line(s) or minute ridge(s).
Strigula(e): Fine, short transverse mark or line.
Suture: The fixed seam between two sclerites.
Tarsal formula: The number of segments (tarsomeres) each of the three tarsi is divided into, starting from front to back (i.e. fore, mid and hind tarsus). For example, a tarsal formula of 5-5-4 indicates that the fore and mid tarsi each comprise five segments, while the hind tarsus has only four segments.
Tarsomere: One of the segments making up the tarsus.
Tarsus: The most apical leg segment (usually subdivided into 3–5 parts).
Tegula: A small thoracic sclerite that covers the base of the wing.
Tegumen: Part of the male genitalia of moths; the roughly triangular sclerite derived from the ninth tergite; dorsal to, and articulating with, the vinculum.
Tergite: A dorsal sclerite of a body segment (e.g. an abdominal tergite).
Termen: The outer margin of the wing, between the apex and the posterior angle.
Tibia: The penultimate leg segment.
Torulus(i): At the base of the antenna, the socket joint allowing it to move.
Transverse: Running across the body or structure from side to side.
Triordinal: Of crochets, arranged in three ranks.
Trochanter: The second, usually small, leg segment, basal to the femur.
Tubercle: A small rounded projecting part of the insect cuticle.
Tympanum: The auditory organ of Lepidoptera, more or less round.
Tympanal organ: Membranous surface structures on the abdomen or thorax.
Uncus: Of the male genitalia of moths, the dorsal posterior projection from the tegumen (vinculum).
Valve: Paired structures of the male genitalia, used to clasp the female during mating.
Ventral: The lower surface (opposite of dorsal).
Vermiform: Thin and wormlike.
Verrucae: Wart-like projections.
Vesica: Membrane surrounding the aedeagus of male moths.
Vinculum: Of moths, the sclerotised ring of the male genitalia formed of the combined 9th and 10th fused tergites and sternites; sometimes referring to the usually U- or V-shaped latero-ventral portion.

Some definitions from: http://www.ndsu.edu/ndsu/ndmoths/glossary_h.htm.
Published by the Department of Entomology, North Dakota State University, and some adapted from Gordh and Headrick (2001).

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About this book

Stemborers of cereal crops (such as maize, sorghum and millet) are responsible for serious losses in food production among smallholder farms in Africa. Accurate identification of insect pests of cereal crops is essential for describing the scope and importance of regional and local infestations. The most important of these pests, the moths, are also the most difficult to identify. Adults are relatively fragile, exhibit considerable variation in scale pattern, and the scales are easily rubbed off. Identification is often impossible without pristine specimens. For this reason, examination of the highly conserved characters of moth genitalia is accepted as the 'gold standard' for accurate identification of pests and their close relatives.

This manual provides high magnification photographic images of male and female genitalia of moth stemborers reared from cereal and wild grasses in Kenya. Line drawings are also provided for the moths, and for other stem-boring insects (Coleoptera, Diptera) that were reared from grasses, as well as for their parasitoids. Used together with the accompanying keys, we hope this book fills a gap by providing comprehensive tools for the identification of the insect borers of grasses and the parasitoids associated with them.

All photographic plates by R. S. Copeland except the following by Ms Karie Darrow:

Plate 1: Top to bottom, male genitalia of *Chilo partellus*, *C. thyrsis* and *Eldana saccharina*

Plate 2: Far right, female genitalia of *E. saccharina*

Plate 3: Far right, female genitalia of *C. thyrsis*

Plate 13: Top, male genitalia and aedeagus of *Sesamia calamistis*

Plate 14: Left, female genitalia of *S. calamistis*

Plate 19: Top and middle, male genitalia and aedeagus of *Busseola fusca* and *B. phaia*

Plate 20: Far left and second from left, female genitalia of *B. fusca* and *B. phaia*

Plate 23: Top to bottom, adults of *E. saccharina*, *C. partellus* and *C. thyrsis*

Plate 28: Top, adult *B. fusca*.

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