

## Description of the Female Genitalia of *Hipparchia fagi* Scopoli, *Hipparchia semele* Linnaeus (Satyridae) and their Related Taxa

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**Abstract.** The female genitalia of *Hipparchia fagi* Scopoli, *Hipparchia semele* Linnaeus and most of their related taxa are described and figured and certain aspects of their anatomy are discussed and compared. The male genitalia of these butterflies are also figured for reference purposes. Two locality maps of examined specimens are included.

### Introduction

Little information was available about the female genitalia of *H. fagi*, *H. semele* and their superficially similar related taxa (referred to here as the *fagi*- and *semele*-groups), until the publication of Kudrna's Revision of the Genus *Hipparchia* (Kudrna, 1977).

In this revision are figured and described the female genitalia of almost all the taxa belonging to the genus *Hipparchia*, but, despite the thoroughness of this endeavour, some of the figured genitalia are somewhat distorted, due to pressure from mounting them onto slides and some of the descriptions have missed certain aspects that may prove to be of taxonomic importance.

The purpose of the present paper is to try and rectify this situation in respect of the *fagi*- and *semele*-groups and to provide some supplementary information regarding the structure of the female genitalia of butterflies belonging to these two groups.

### Methods and Materials

The genitalia which are figured here were prepared by the usual method of overnight maceration in a 10% KOH solution, washing in water and dehydration in successive solutions of 20%, 40%, 70% and 80% ethyl alcohol. The appendages were subsequently studied and drawn while immersed in a solution of 80% ethyl alcohol, free from pressure and free to be moved about at will. Whenever necessary they were stabilized by being propped against glass slides. By the use of this

method, distortion due to pressure from mounting was eliminated and a better understanding of the three dimensional structure of the appendages was achieved.

All drawings, with the exception of the explanatory diagrams, were made with the aid of a drawing tube attached to a WILD M5 stereomicroscope and were executed directly in ink, without the use of an intermediate pencil tracing. Some of these drawings are finished in detail and are often shaded, while others are mere contour studies. This discrepancy arises from the fact that often not enough time was available for their completion.

### The female genitalia (Fig. 1)

In the *Ditrysia*, which include the *Rhopalocera*, the female genitalia may be divided into two entities: a) the **Primary Genitalia**, for egg production, fertilization and laying and b) the **Bursa Copulatrix**, for sperm reception and temporary storage. The present paper deals only with the second entity.

Wherever possible, names applied to the various basic parts of the female genitalia are those in current use (Tuxen, 1970; Verity, 1953). Names for structures, or parts of structures, previously unnamed have been coined to facilitate reference to the drawings. The new names are **Post-ostial Funnel, Ventral Lamella, Dorsal Lamella, Mid-dorsal Process, Dorso-lateral Lobe, Ventral Keel, Web, Upper Flange, Lower Flange, Lateral Arm, of Sterigma; Bend of Ductus Bursae; Longitudinal Fold of Corpus Bursae**. These are given in English, or in anglicized Latin, and are descriptive and informal. It is felt that the creation of new formal names would have been meaningless, considering the poor state of our knowledge of homologies in the female genitalia.

The **Bursa Copulatrix** in the *fagi*- and *semele*-groups (Fig. 2) consists of the following parts:

1. The **Corpus Bursae**, which is a membranous, expansible sac, that receives and temporarily stores the male sperm, which, in turn, arrives enclosed in the gelatinous **Spermatophore**. The **Corpus Bursae** carries ventrally two rows of inward projecting, highly sclerotized teeth, the **Signa**, whose function, as it is generally understood, is to rupture the **Spermatophore**, thus releasing the sperm. Its outer surface bears a large number of **Longitudinal Folds**, which probably relate to its ability to expand and contract. The **Distal End of Corpus Bursae** is usually moderately sclerotized, while in some cases it may be highly sclerotized and cup-shaped. It is from this area that arises the **Ductus Seminalis**, through which sperm is transferred to the **Primary Genitalia**.

2. The **Ductus Bursae**, which is a tube, of varying degree of sclerotization, that connects the **Corpus Bursae** to the **Sterigma** and through which sperm enters the **Corpus Bursae**. It terminates distally in the **Ostium Bursae**, which is the genital opening that serves for insemination. The **Ductus Bursae** basally is angled sharply and forms the **Bend of Ductus Bursae**. In the *fagi*- and *semele*-groups it is difficult to decide

whether or not the **Ductus Bursae**, in the strict sense of the word, really exists at all; perhaps what we have here instead is what is usually referred to as an **Atrium**, which is a rather sclerotized tubular section immediately distad of the **Ductus Seminalis** and basad of the **Sterigma**, the **Ductus Bursae** being membranous and placed immediately basad of the **Ductus Seminalis** and distad of the **Corpus Bursae**.

3. The **Sterigma** (Figs. 3 & 4), which consists of heavily sclerotized and highly modified elements, presumably derived from the 8th sternite. One of its functions may be to anchor down the **Bursa Copulatrix** to the outer abdominal wall. the **Sterigma** may be broken down into three basic units: the **Distal**, **Median** and **Proximal Unit**. The **Distal Unit** consists of a **Mid-dorsal Process**, two **Dorsal Lamellae**, a **Ventral Lamella** and a median section, the **Postostial Funnel**, which is directly connected basally to the **Ductus Bursae**. The **Median Unit** is composed of two **Dorso-lateral Lobes** and a mid-ventral carinate structure of I-section, the **Ventral Keel**, consisting of an **Upper** and **Lower Flange**, as well as of a perpendicular **Web**. The **Proximal Unit** consists of two **Lateral Arms** and a mid-ventral plate, the **Ventral Tray**. These three units are intricately interconnected, often by membranous tissue and form a compact and quite rigid whole.

### **Description of the female genitalia**

All female genitalia figured here are accompanied by illustrations of associated male appendages. This has been done in order to show correlations between the genitalia of the two sexes.

The geographic samples and total number of specimens available for study were limited, and several recognized taxa of both groups have been omitted. Thus the present study can only be considered to be a preliminary account.

The taxonomic status assigned to the various taxa of the *fagi*- and *semele*-groups is based primarily on morphological characters of the genitalia, both male and female. In the case of superficially similar, allopatric taxa it becomes anybody's guess to decide which degree of morphological differentiation in the genitalia is sufficient enough to suggest separation at species level. It thus becomes evident that the taxonomic arrangement used here is subjective and tentative.

#### **A. fagi-group.**

1. *Hipparchia fagi* Scopoli 1763 (Figs. 5, 11 & 17).

**Corpus Bursae** flask-shaped. Length of **Signa** as a rule slightly over 3 mm. **Distal End** of **Corpus Bursae** lightly sclerotized. **Ductus Bursae** moderately sclerotized, its length being slightly over  $\frac{1}{3}$  that of **Corpus Bursae**; **Bend** of **Ductus Bursae** prominent and well detached from **Distal End** of **Corpus Bursae**. **Mid-dorsal Process** of **Sterigma** in dorsal view

deeply concave along its longitudinal axis; distal end of this process as a rule rounded, but often with pointed tip; sides parallel to each other. Post-ostial Funnel in dorsal view with inflated sides. Dorsal Lamellae in dorsal view roughly oval, their width being about  $\frac{1}{3}$  that of Post-ostial Funnel. Area of distal half of Dorso-lateral Lobes in dorsal view at least 5 times as large as that of Dorsal Lamellae.

Material examined consists of 6 females from Greece, Macedonia, Mt. Olimbos; 5 females from Greece, Macedonia, Mt. Pangeon; 3 females from Greece, Macedonia, Mt. Falakron; 1 female from Greece, Sterea Ellas, Mt. Tymphristos; 1 female from Greece, Peloponnissos, Zachlorou; 2 females from Greece, Peloponnissos, Mt. Chelmos; 4 females from Greece, Peloponnissos, Mt. Erymanthos; 3 females from Greece, Peloponnissos, Mt. Taiyetos. No individual variation of any importance was observed.

Male genitalia: (Fig. 23)

2. *Hipparchia alcyone* Denis & Schiffermueller 1775 (Figs. 6, 12 & 18).

Corpus Bursae as in *fagi*, but smaller. Length of Signa a little under 2.5 mm. Distal End of Corpus Bursae lightly sclerotized, as in *fagi*. Ductus Bursae as in *fagi*, but half as long. Sterigma smaller than in *fagi*; Mid-dorsal Process in dorsal view as in *fagi*, but, perhaps, slightly longer. Post-ostial Funnel in dorsal view very much as in *fagi*, but somewhat smaller. Dorsal Lamellae slightly smaller than in *fagi* and rounder. Dorso-lateral Lobes smaller than in *fagi* and not as wide distally in dorsal view.

Material examined consists of 3 females from France, Vernet-les-Bains; 1 female from Czechoslovakia, Lany, Praha; 3 females from Spain, Albacete, Sierra de Alcaraz; 1 female from Spain, near Albarracin.

Male genitalia: (Fig. 24)

*H. alcyone* is separated at species level from *fagi* because of morphological differences in the male and female genitalia and because of sympatry and synchronism.

Kudrna in his revision of *Hipparchia* (Kudrna, 1977), employed the name *hermione* Linnaeus 1764, for *alcyone*, the Rock Grayling (Higgins & Riley, 1980). Higgins & Riley in a subsequent critical article on Kudrna's action (Higgins & Riley, 1978), reestablished *alcyone* Denis & Schiffermueller 1775, as the correct name for this taxon.

3. *Hipparchia syriaca syriaca* Staudinger 1871 (Figs. 7, 13 & 19).

Corpus Bursae as in *fagi*, but slightly larger. Length of Signa as a rule slightly over 3.5 mm. Distal End of Corpus Bursae and Ductus Bursae as in *fagi*, the latter being about twice as long as that of *alcyone*. Sterigma smaller than that of *alcyone*; Mid-dorsal Process in dorsal view wider at base than that of *fagi*, stubby, triangular, with pointed distal end and without the deep concavity present in *fagi* and *alcyone*. Post-ostial Funnel in dorsal view about half the size of that of *fagi*; sides not inflated. Dorsal

Lamellae about equal in size to those of *alcyone* and rather rounded in dorsal view. Dorso-lateral Lobes of about the same size as in *alcyone*, but distally not as wide in dorsal view.

Material examined consists of 10 females from Greece, Attiki, Ekali; 4 females from Greece, Attiki, Mt. Parnis; 2 females from Greece, Peloponnissos, Mt. Erymanthos; 1 female from Greece, Peloponnissos, Korfos; 1 female from Greece, Kithira island; 3 females from Greece, Samothraki island, Mt. Fengari; 1 female from Greece, Thassos island, Potamia.

Male genitalia: (Fig. 25)

*H. syriaca* has often been regarded as a subspecies of *alcyone*, by virtue of the fact that they both possess fairly similar Jullien's Organs and that they replace each other geographically (Higgins, 1975). A comparison, however, between the female genitalia of *fagi*, *alcyone* and *syriaca* suggests a closer affinity in some respects between the first two than between *alcyone* and *syriaca*. In view of this and the fact that *fagi* and *alcyone* are proven separate species, it would seem rather logical to have reservations about considering *syriaca* as being a subspecies of *alcyone*. Therefore, it is perhaps better regarded as a distinct species.

4. *Hipparchia syriaca ghigi* Turati 1929 (Figs. 8, 14 & 20).

The female genitalia of *ghigi* are identical with those of the nominate subspecies. This taxon is separable from the nominate subspecies on superficial grounds only (Turati, 1929).

7 females examined, all from Greece, island of Rhodes, Mt. Ataviros.

Male genitalia: (Fig. 26)

5. *Hipparchia caroli* Rothschild 1933 (Figs. 9, 15 & 21).

Corpus Bursae, Signa and Distal End of Corpus Bursae as in *fagi*. Ductus Bursae as in *alcyone*, being about half the length of that of *fagi* and *syriaca*. Sterigma about equal in size to that of *syriaca*. Mid-dorsal Process as in *syriaca*, but longer. Post-ostial Funnel in dorsal view very much as in *syriaca*, but sides somewhat more expanded. Dorsal Lamellae in dorsal view about equal in size to those of *syriaca*, but distally rather pointed. Dorso-lateral Lobes as in *syriaca*.

2 females examined, both from Morocco, Middle Atlas, Ifrane.

Male genitalia: (Fig. 27)

In some respects the female genitalia of *caroli* bear a closer resemblance to those of *syriaca* than to those of *alcyone* (Mid-dorsal Process, Post-ostial Funnel), while in others quite the opposite holds true (Ductus Bursae). Often regarded as a subspecies of the allopatric *alcyone* because of superficial similarities, as well as affinities in their respective Jullien's Organs (Higgins, 1975; Higgins & Riley, 1980). This decision is not devoid of doubt, as the female genitalia alone suggest also a close relationship to *syriaca*. At present, perhaps best regarded as a distinct

species, on the basis of genitalic characters, both male and female.

6. *Hipparchia ellena* Oberthuer 1894 (Figs. 10, 16 & 22).

Corpus Bursae, Signa, Distal End of Corpus Bursae and Ductus Bursae as in *alcyone*. Sterigma of about same size as that of *syriaca* and *caroli*. Mid-dorsal Process as in *caroli*, being more pronounced than in *syriaca*. Post-ostial Funnel in dorsal view very close to that of *caroli*, but sides perhaps not quite as expanded and overall size smaller. Dorsal Lamellae in dorsal view as in *caroli*. Dorso-lateral Lobes as in *syriaca*, but perhaps somewhat wider in dorsal view.

2 females examined, both from Algeria, Batna.

Male genitalia: (Fig. 28)

The female genitalia of *ellena* on the whole seem to bear a closer affinity to those of *caroli* than to those of *alcyone*, despite the fact that superficially *caroli* is closer to *alcyone* than to *ellena*.

At present, perhaps best regarded as a separate species, on the basis of superficial, as well as genitalic characters both male and female.

## B. semele-group

1. *Hipparchia semele* Linnaeus 1758 (Figs. 29, 30, 31, 47 & 54).

Corpus Bursae about same size as that of *alcyone*, Signa slightly under 2.5 mm in length. Distal End of Corpus Bursae lightly sclerotized. Ductus Bursae moderately sclerotized; Bend of Ductus Bursae prominent and well detached from Distal End of Ductus Bursae. Sterigma smaller than in any member of the *fagi*-group; Mid-dorsal Process in dorsal view about 1½ times as long as in *fagi*, pointed and of variable width. Post-ostial Funnel shallower than in *fagi*, its width in dorsal view being about ½ that of *fagi*. Dorsal Lamellae about 2½ times as large as those of *fagi*, with rounded basal edge and straight distal edge. Dorso-lateral Lobes smaller than in any member of the *fagi*-group, their distal end in dorsal view being much narrower than in *fagi*.

Material examined consists of 1 female from England, Surrey, Woking; 1 female from Scotland, Stinchcombe, Glasgow; 1 female from Scotland, Troon; 1 female from W. Scotland; 2 females from France, Fontainebleau; 1 female from France, Brittany; 1 female from Denmark, Ryjlland; 3 females from Czechoslovakia, Moravia, Mohelno; 1 female from Czechoslovakia, Cermakovice; 1 female from U.S.S.R., Ukraine, Kaniev, Kiev; 2 females from Italy, Malchina, Monfalcone; 4 females from Spain, Aranjuez; 1 female from Spain, Valencia; 1 female from Yugoslavia, Croatia; 1 female from Albania, Jablanica.

Some individual variation present in the length and width of the Mid-dorsal Process of the Sterigma.

Male genitalia: (Figs. 70, 71 & 72)

The male genitalia of *semele* show a variation in size (the larger ones

belonging to southern populations; while the smaller ones to northern populations), but they tend to show stability in their proportions. An exception to this rule are those belonging to Scottish specimens, which quite often have disproportionately short Brachia.

2. *Hipparchia cretica* Rebel 1916 (Figs. 32, 48 & 55).

Corpus Bursae as in *semele*, Signa about 2 mm in length, being somewhat shorter than in *semele*. Distal End of Corpus Bursae more heavily sclerotized and wider than in *semele*. Ductus Bursae at times slightly longer than in *semele* and Bend of Ductus Bursae more compressed against Distal End of Corpus Bursae. Sterigma slightly larger than in *semele*; Mid-dorsal Process and Post-ostial Funnel as in *semele*. Dorsal Lamellae and Dorso-lateral Lobes as in *semele*, but somewhat larger.

Material examined consists of 8 females from Greece, island of Crete, near Zenia; 3 females from Greece, island of Crete, Gonia.

Male genitalia: (Fig. 73)

The female genitalia of *cretica* differ only slightly from those of *semele*, quite in contrast with their respective male appendages, which exhibit between them a much greater degree of differentiation.

The pronounced disparity in size between the male genitalia of *cretica* and *semele* would tempt one to believe that, in the event of sympatry, it would be mechanically incompatible for these two taxa to copulate. The affinities between their respective female genitalia, however, tend to disprove this hypothesis.

At present, perhaps best regarded as a distinct species, primarily on the basis of characters in the male genitalia.

3. *Hipparchia mersina* Staudinger 1871 (Figs. 33, 49 & 56).

Corpus Bursae smaller than in *semele*. Signa about 1.5 mm in length, being shorter than in *semele* and *cretica*. Distal End of Corpus Bursae more heavily sclerotized than in *semele*, being as in *cretica*, but narrower than that of the latter. Ductus Bursae of about same length as that of *semele*, but Bend of Ductus Bursae rather compressed against Distal End of Corpus Bursae, as in *cretica*. Sterigma very much as in *semele*; Mid-dorsal Process, Post-ostial Funnel, Dorsal Lamellae and Dorso-lateral Lobes as in *semele*.

2 specimens examined from Turkey, Asia Minor.

Male genitalia: (Fig. 74)

The characteristic feature of the female genitalia of *mersina* is the relatively small size of the Corpus Bursae and of the Signa. Generally considered a distinct species because of minor superficial and moderate genitalic differences, as well as because of the different size and shape of the androconia (Kudrna, 1977).

4. *Hipparchia volgensis volgensis* Mazochin-Porshnjakov 1952 (Figs. 34 & 57).

Corpus Bursae and Signa as in *semele*. Distal End of Corpus Bursae unique, being highly sclerotized, wider than in all above described taxa and often cup-shaped. Bend of Ductus Bursae imperceptible, highly compressed against Distal End of Corpus Bursae and not apparent in side view. Size and shape of Sterigma as in *semele*; Mid-dorsal Process, Post-ostial Funnel, Dorsal Lamellae and Dorso-lateral Lobes as in *semele*.

Material examined consists of 1 female from U.S.S.R., near Volgograd; 2 females from U.S.S.R., Lower Volga, Krasnoarmeysk.

Male genitalia: (Fig. 75)

The characteristic features of the female genitalia of *volgensis* are the shape, high sclerotization and great width of the Distal End of Corpus Bursae, as well as the compression of the Bend of Ductus Bursae against the Distal End of Corpus Bursae. At present, perhaps best regarded as a distinct species, on account of genitalic differences, both male and female.

5. *Hipparchia volgensis delattini* Kudrna 1975 (Figs. 35, 50 & 58).

The female genitalia of *delattini* are identical with those of nominate *volgensis*. Distal End of Corpus Bursae most often cup-shaped.

Material examined consists of 3 females from Greece, Macedonia, Mt. Vermion; 7 females from Greece, Macedonia, Mt. Kaimaktsalan; 3 females from Greece, Macedonia, between Edessa and Florina; 2 females from Greece, Ipiros, Mt. Tzoumerka; 2 females from Greece, Ipiros, Mt. Siniatsiko; 3 females from Greece, Sterea Ellas, N.W. of Amphilochia; 3 females from Yugoslavia, Macedonia, Stepanci, Babuna Planina.

Male genitalia: (Fig. 76)

The similarities between *delattini* and the nominate subspecies in the female genitalia show the very close affinity between these two taxa. Separated from the nominate subspecies on the basis of minor superficial characters and small differences in the male genitalia (Kudrna, 1975; Kudrna, 1977).

The exact relationship between *delattini* and *semele* is, at present, a matter of personal conjecture, but recent evidence suggests that the two might be sympatric (thus supporting separation at species level), as their respective known distribution areas in the Balkans come very close to each other. (Southern Yugoslavia for the former and southeastern Albania for the latter).

6. *Hipparchia volgensis muelleri* Kudrna 1975 (Figs. 36, 51 & 59).

The female genitalia of *muelleri* are identical with those of *volgensis* and *delattini*, suggesting that these three taxa are very closely related to each other in this respect. The male genitalia of *muelleri*, however, appear to have features common to both *semele* on the one hand and to *volgensis* and *delattini* on the other. I have found the male genitalia of *muelleri* from the Chelmos, Peloponnissos, consistently different from those of *delattini* from northern Greece, despite individual variation in both and I do not



agree with the view that the two are inseparable (Kudrna, 1977). Furthermore, all males from the Chelmos appear to have a darker upperside than does *delattini* and *volgensis*. Past evidence suggested that *muelleri* was a geographic isolate, inhabiting exclusively certain restricted areas in the Peloponnissos, Greece, but recent finds (Holloway, pers. comm.) show that possibly it also inhabits northwestern Greece, thus overlapping with *delattini*. It is my opinion that the possible record of *semele* from northwest Greece (Holloway, 1979), quite probably refers to *muelleri*. All this shows that more information is required from the Balkan area in order to form a better opinion on the distribution patterns of and the interrelationship between *muelleri* and *delattini*.

7 females and 8 males examined, all from Greece, Peloponnissos, Mt. Chelmos. Length of Mid-dorsal Process of Sterigma variable.

Male genitalia: (Fig. 77)

At present, perhaps best regarded as a subspecies of *volgensis* on the basis of minor superficial differences in the male and minor structural differences in the male genitalia.

7. *Hipparchia turcmenica* Heydemann 1942 (Figs. 37 & 60).

The female genitalia of *turcmenica* are close to those of *volgensis* and differ from them only by the narrower Distal End of Corpus Bursae and narrower Ductus Bursae.

1 female examined from U.S.S.R., Kazakhstan.

Male genitalia: not available.

At present, perhaps best regarded as a distinct species on the basis of structural characters in the genitalia, both male and female.

8. *Hipparchia pellucida pellucida* Stauder 1923 (Figs. 38 & 61).

The female genitalia of this taxon are very close to those of *volgensis*, but differ from them by the shorter and wider Ductus Bursae and the somewhat shorter Signa, being just under 2 mm in length.

Material examined consists of 3 females from Kurdistan, Sersang; 1 female from Turkey, east Anatolia, Buglan-Gecidi.

Male genitalia: not available.

The characters of the female genitalia of *pellucida* suggest a close affinity towards *volgensis* and, to a lesser extent, towards *turcmenica*.

At present, perhaps best regarded as a distinct species, on the basis of structural characters primarily in the male genitalia.

9. *Hipparchia pellucida cypriensis* Holik 1949 (Figs. 39, 52 & 62).

The female genitalia of *cypriensis* are identical with those of the nominate subspecies, thus showing, together with the characters of the male genitalia, the very close relationship between the two.

4 specimens examined from Cyprus, Mt. Kornos, near Larnaka Lapithou.

Male genitalia: (Figs. 78 & 79)

Separable from the nominate subspecies on the basis of superficial characters present both in the male and the female (Kudrna, 1977).

10. *Hipparchia aristaeus aristaeus* Bonelli 1826 (Figs. 40, 41, 63 & 64).

Corpus Bursae larger than in all above mentioned *semele*-group taxa. Signa slightly under 3 mm in length, being longer than in all above mentioned *semele*-group taxa. Overall size of Sterigma smaller than in *semele*; Dorsal Lamellae considerably smaller than in *semele*, having about  $\frac{1}{2}$  the area of those of *semele*; Mid-dorsal Process in dorsal view about  $\frac{1}{2}$  as long as in *semele*, as a rule wider at base than in *semele* and more or less triangular in shape. Post-ostial Funnel deeper than in *semele*. Ductus Bursae somewhat more heavily sclerotized than in *semele*. Distal End of Corpus Bursae as in *semele*, but slightly more heavily sclerotized. Bend of Ductus Bursae prominent and well detached from Distal End of Corpus Bursae, much as in *semele*.

Material examined consists of 2 females from Sardinia, Bolotana; 1 female from Sardinia, Carbonia; 2 females from Corsica, Lano; 1 female from Corsica, La Joce.

Male genitalia: (Figs. 80 & 81)

The female genitalia of *aristaeus* are characterized by the relative size of the Dorsal Lamellae, being smaller than in all above mentioned *semele*-group taxa and by the relative length and width of the Mid-dorsal Process of the Sterigma, being both shorter and wider at base than in all above mentioned *semele*-group taxa. In at least two respects, namely the Bend of Ductus Bursae and the Distal End of Corpus Bursae, *aristaeus* seems to be more closely allied to *semele* than are either *volgensis*, *pellucida*, or *turcmenica*. On the other hand the Sterigma of all these taxa is much closer to that of *semele* than is the Sterigma of *aristaeus*.

Regarded as a distinct species on the basis of pronounced morphological differences both in the male and female genitalia.

Kudrna in his revision of *Hipparchia* (Kudrna, 1977) used the name *algorica* Oberthuer 1876 for *aristaeus*. Tremewan in a book review of Kudrna (Tremewan, 1978) criticizes Kudrna's action and explains the reasons for retaining *aristaeus* as the proper name for this taxon.

11. *Hipparchia aristaeus algerica* Oberthuer 1876 (Figs. 42 & 65).

The female genitalia are identical with those of the nominate subspecies.

3 females examined, all from Morocco, Middle Atlas, Ifrane; 1 female from Algeria, Sebdou.

Male genitalia: (Fig. 82)

Separable from the nominate subspecies on the basis of superficial characters, both male and female (Higgins & Riley, 1980; Kudrna, 1977).

12. *Hipparchia aristaeus maderensis* Bethune-Baker 1891 (Figs. 43 & 66).

The female genitalia are identical with those of the nominate subspecies and those of *algorica*.

12 females examined, all from Madeira, Monte.

Male genitalia: (Fig. 83)

Separable from the nominate subspecies and from subspecies *algorica*, on the basis of superficial characters, both male and female (Higgins & Riley, 1980; Kudrna, 1977), as well as on the basis of slight morphological characters in the male genitalia (Kudrna, 1977).

13. *Hipparchia aristaeus blachieri* Fruhstorfer 1908 (Figs. 44 & 67).

Corpus Bursae larger than that of nominate subspecies. Signa just over 3 mm in length, being somewhat longer than in nominate subspecies. Overall size of Sterigma intermediate between that of *semele* and of the nominate subspecies. In all other characters identical with nominate subspecies; Dorsal Lamellae perhaps, at times, slightly larger than in nominate subspecies, but smaller than in *semele*.

Material examined consists of 2 females from Sicily, Ficuzza; 1 female from Sicily, Cefalu.

Male genitalia: (Fig. 84)

The genitalia of *blachieri*, both male and female, though bearing close affinities to those of the nominate subspecies, do, however, exhibit a certain degree of differentiation from them. This taxon is sympatric and synchronic with *semele* and, therefore, positively separated from it at the species level. Also separable from the nominate subspecies and from subspecies *algorica* and *maderensis* on the basis of superficial characters, both male and female (Higgins & Riley, 1980; Kudrna, 1977).

14. *Hipparchia aristaeus senthes* Fruhstorfer 1908 (Figs. 45, 53 & 68).

The female genitalia of *senthes* are very close to those of *blachieri*, but differ from them by the rather shorter Signa, being slightly over 2.5 mm in length, and by the somewhat shallower Post-ostial Funnel.

Material examined consists of 1 female from Greece, Sterea Ellas, near Arahova; 2 females from Greece, Sterea Ellas, Mt. Parnassos; 2 females from Greece, Attiki, Mt. Parnis; 1 female from Greece, Attiki, Ekali; 1 female from Greece, Attiki, Sounion; 1 female from Greece, Attiki, near Athens; 3 females from Greece, Hydra island; 1 female from Greece, Spetses island; 2 females from Greece, Aegina island; 3 females from Greece, Paros island; 1 female from Turkey, Anatolia, near Ankara. Some minor individual variation observed in the size and shape of the Mid-dorsal Process of the Sterigma. In Greece sympatric and synchronic with *delattini*; in Asia Minor and its Greek offshore islands, sympatric and synchronic with *mersina*, and, therefore, positively separated from both at

species level.

Male genitalia: (Fig. 85)

This subspecies of *aristaeus* seems to be even more differentiated from the nominate subspecies than is *blachieri*. Separable from all above mentioned subspecies of *aristaeus* on the basis of superficial characters, both male and female (Higgins & Riley, 1980; Kudrna, 1977), as well as on the basis of minor morphological characters both in the male and female genitalia.

15. *Hipparchia azorina* Strecker 1899 (Figs. 46 & 69).

Overall size of Sterigma smaller than in *aristaeus*. Dorsal Lamellae about half as large as in *aristaeus*, or less. Mid-dorsal Process of Sterigma and Post-ostial Funnel very much as in *aristaeus*. Corpus Bursae about half the size of that of *aristaeus*. Signa shorter than in all above mentioned *semele*-group taxa, being slightly over 1 mm in length. Distal End of Corpus Bursae very lightly sclerotized. Ductus Bursae shorter than in all other *semele*-group taxa; Bend of Ductus Bursae well defined and clearly detached from Distal End of Corpus Bursae.

2 females examined from the Azores, Fayal; 1 female from the Azores, San Jorge.

Male genitalia: (Fig. 86)

The genitalia of *azorina*, both male and female, bear closer affinities to those of *aristaeus* and its subspecies than they do to those of the other taxa of the *semele*-group, thus suggesting its closer relationship to the *aristaeus* complex. Although *azorina* is sometimes regarded as a subspecies of *aristaeus* (Higgins, 1975), it is best regarded as a distinct species both on the basis of pronounced superficial differences in both male and female and because of morphological characters present in the male and female genitalia. See Oehmig (1983) for further discussion.

### The female abdominal Sphragis

The existence of a Sphragis on the abdominal tip of female *H. cretica* was first observed and figured by Higgins (1973). The present author found the Sphragis present only in individuals that also had a Spermatophore inside the Corpus Bursae, suggesting that it is associated with copulation, much as in the genus *Parnassius*. The Sphragis occurs in *semele*, *volgensis*, *delattini* and *muelleri* as a barely visible appendage, while in *pellucida*, *cypriensis* and *cretica*, as a prominent carinate structure. None whatsoever was found to exist in any of the subspecies of *aristaeus* and in *azorina*, while in the case of *mersina* and *turcmenica* the available females turned out to be virgins, thus precluding judgment as to the existence or not of such an appendage. It is interesting to note that affinities based on the female genitalia do not always seem to agree with those based on the Sphragis.

Two maps showing distribution of the *H. semele* and *H. fagi* taxa are given as Figures 87 and 88.

*Acknowledgments.* In conclusion I would like to extend my thanks to R. F. Bretherton, John Brown, Sir John Dacie and L. G. Higgins for their invaluable help in providing a good many of the specimens used for the present paper. I am also very grateful to R. I. Vane-Wright for his kindness to read through this paper in its original form, suggesting many corrections and improvements. I would also like to extend my thanks to J. D. Holloway, who had the kindness to show me his slides of the male genitalia of *semele*-group specimens recorded by himself during a collecting expedition in northwest Greece. Comments of an anonymous reviewer are also acknowledged.

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### Diagrammatic drawing of:

- Fig. 1.** Generalized genitalia of a female butterfly.  
**Fig. 2.** **Bursa Copulatrix** of a *fagi*-, or *semele*-group female butterfly.  
**Fig. 3.** Exploded view of the **Sterigma** of a *fagi*-, or *semele*-group female butterfly.  
**Fig. 4.** Dorsal view of the **Sterigma** of a *fagi*-, or *semele*-group female butterfly.  
 Side view of **Bursa Copulatrix (Sterigma removed)** of:  
**Fig. 5.** *Hipparchia fagi* Scopoli. Greece, Macedonia, Mt. Olimbos, 600-800 m, 23 July.  
**Fig. 6.** *Hipparchia alcyone* Denis & Schiffermueller. Czechoslovakia, Lany, Praha.  
**Fig. 7.** *Hipparchia syriaca syriaca* Staudinger. Greece, Attiki, Ekali, 25 August.

**Fig. 8.** *Hipparchia syriaca ghigii* Turati. Greece, island of Rhodes, Mt. Ataviros, 450 m, 4 June.

**Fig. 9.** *Hipparchia caroli* Rothschild. Morocco, Middle Atlas, Ifrane, 3400 ft., 12 June.

**Fig. 10.** *Hipparchia ellena* Oberthuer. Algeria, Batna, August.

Side view of **Ductus Bursae** of:

**Fig. 11.** *Hipparchia fagi* Scopoli. Greece, Macedonia, Mt. Olimbos, 600-800 m, 23 July.

**Fig. 12.** *Hipparchia alcyone* Denis & Schiffermueller. France, Vernet-les-Bains, August.

**Fig. 13.** *Hipparchia syriaca syriaca* Staudinger. Greece, Attiki, Ekali, 25 August.

**Fig. 14.** *Hipparchia syriaca ghigii* Turati. Greece, island of Rhodes, Mt. Ataviros, 450 m, 4 June.

**Fig. 15.** *Hipparchia caroli* Rothschild. Morocco, Middle Atlas, Ifrane, 3400 ft., 12 June.

**Fig. 16.** *Hipparchia ellena* Oberthuer. Algeria, Batna, August.

Dorsal view of **Sterigma** of:

**Fig. 17.** *Hipparchia fagi* Scopoli. Greece, Macedonia, Mt. Pangeon, 1600 m, 26 July.

**Fig. 18.** *Hipparchia alcyone* Denis & Schiffermueller. France, Vernet-les-Bains, 19 August.

**Fig. 19.** *Hipparchia syriaca syriaca* Staudinger. Greece, Attiki, Ekali, 27 July.

**Fig. 20.** *Hipparchia syriaca ghigii* Turati. Greece, island of Rhodes, Mt. Ataviros, 450 m, 4 June.

**Fig. 21.** *Hipparchia caroli* Rothschild. Morocco, Middle Atlas, Ifrane, 3400 ft., 12 June.

**Fig. 22.** *Hipparchia ellena* Oberthuer. Algeria, Batna, August.

Side view of male genitalia (right **Valva** removed) of:

**Fig. 23.** *Hipparchia fagi* Scopoli. Greece, Peloponnissos, Mt. Taiyetos, 800-1000 m, 23 July.

**Fig. 24.** *Hipparchia alcyone* Denis & Schiffermueller. Austria, Steinfeld, 10 July.

**Fig. 25.** *Hipparchia syriaca syriaca* Staudinger. Greece, Attiki, Ekali, 12 July (**Penis** detached).

**Fig. 26.** *Hipparchia syriaca ghigii* Turati. Greece, island of Rhodes, Mt. Ataviros, 450 m, 2 June.

**Fig. 27.** *Hipparchia caroli* Rothschild. Morocco, Middle Atlas, 6500 ft., September (**Penis** detached).

**Fig. 28.** *Hipparchia ellena* Oberthuer. Algeria, Lambese, June (**Penis** detached).

Side view of **Bursa Copulatrix** (**Sterigma** removed) of:

**Fig. 29.** *Hipparchia semele* Linnaeus. Denmark, Ryjlland, 7 August.

**Fig. 30.** *Hipparchia semele* Linnaeus. W. Scotland, July.

**Fig. 31.** *Hipparchia semele* Linnaeus. Albania, Jablanica, June.

**Fig. 32.** *Hipparchia cretica* Rebel. Greece, island of Crete, near Zenia, 800 m, 14 June. (Seemingly excessive length of **Ductus Bursae** due to fact that part of **Post-ostial Funnel** of **Sterigma** accidentally left attached to it.)

- Fig. 33.** *Hipparchia mersina* Staudinger. Turkey, Asia Minor.  
**Fig. 34.** *Hipparchia volgensis volgensis* Mazochin-Porshnjakov. U.S.S.R., Krasnoarmeysk, Lower Volga.  
**Fig. 35.** *Hipparchia volgensis delattini* Kudrna. Yugoslavia, Macedonia, Stepanci, Babuna, July.  
**Fig. 36.** *Hipparchia volgensis muelleri* Kudrna. Greece, Peloponnissos, Mt. Chelmos, 1300 m, 24 July.  
**Fig. 37.** *Hipparchia turcmenica* Heydemann. U.S.S.R., Kazakhstan, Zaysan, upper Irtysh.  
**Fig. 38.** *Hipparchia pellucida pellucida* Stauder. Iraq, Kurdistan, Sersang, 3500 ft., 27 May.  
**Fig. 39.** *Hipparchia pellucida cypriensis* Holik. Cyprus, Mt. Kornos, near Larnaka Lapithou, 310 m, 28 April.  
**Fig. 40.** *Hipparchia aristaeus aristaeus* Bonelli. Corsica, La Joce, 6 August.  
**Fig. 41.** *Hipparchia aristaeus aristaeus* Bonelli. Sardinia, Carbonia, 20 July.  
**Fig. 42.** *Hipparchia aristaeus algerica* Oberthuer. Algeria, Sebdu.  
**Fig. 43.** *Hipparchia aristaeus maderensis* Baker. Madeira, Monte.  
**Fig. 44.** *Hipparchia aristaeus blachieri* Fruhstorfer. Italy, Sicily, Ficuzza, 2300 ft., 29 June.  
**Fig. 45.** *Hipparchia aristaeus senthes* Fruhstorfer. Greece, Attiki, near Athens.  
**Fig. 46.** *Hipparchia azorina* Strecker. Azores, San Jorge, 8 September.

Side view of **Ductus Bursae** of:

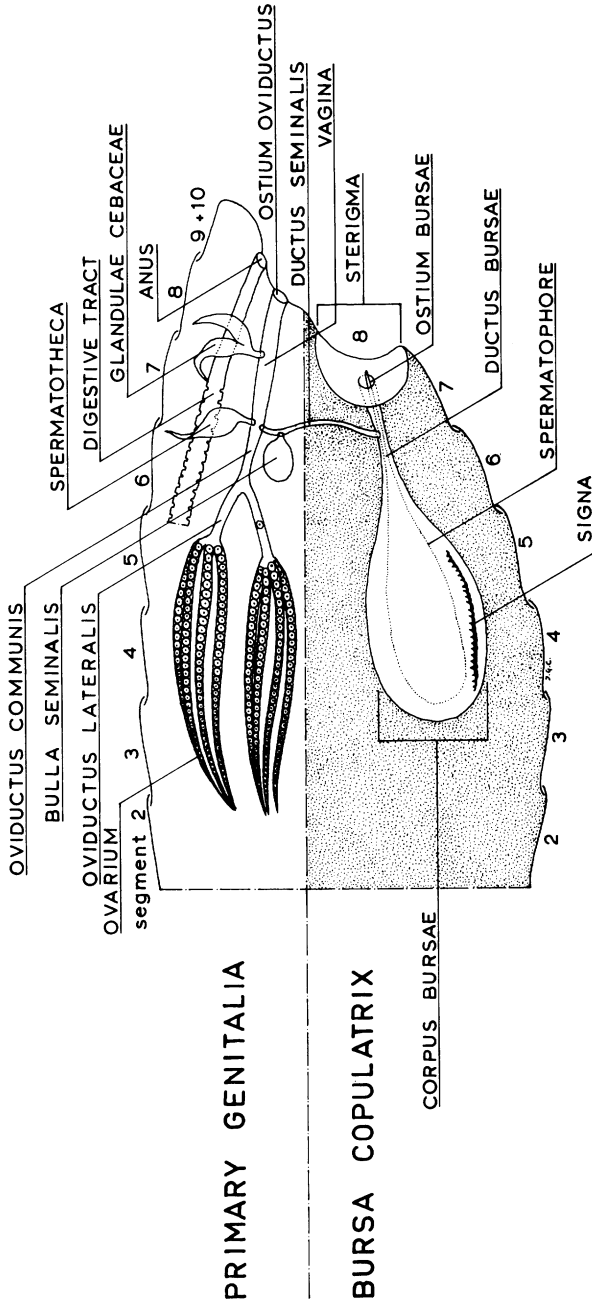
- Fig. 47.** *Hipparchia semele* Linnaeus. Albania, Jablanica, June.  
**Fig. 48.** *Hipparchia cretica* Rebel. Greece, island of Crete, near Zenia, 800 m, 14 June.  
**Fig. 49.** *Hipparchia mersina* Staudinger. Turkey, Asia Minor.  
**Fig. 50.** *Hipparchia volgensis delattini* Kudrna. Greece, Macedonia, Mt. Vermion, 1000 m, 24 July.  
**Fig. 51.** *Hipparchia volgensis muelleri* Kudrna. Greece, Peloponnissos, Mt. Chelmos, 1300 m, 24 July.  
**Fig. 52.** *Hipparchia pellucida cypriensis* Holik. Cyprus, Mt. Kornos, near Larnaka Lapithou, 310 m, 28 April.  
**Fig. 53.** *Hipparchia aristaeus senthes* Fruhstorfer. Greece, Attiki, Mt. Parnis, 6 June.

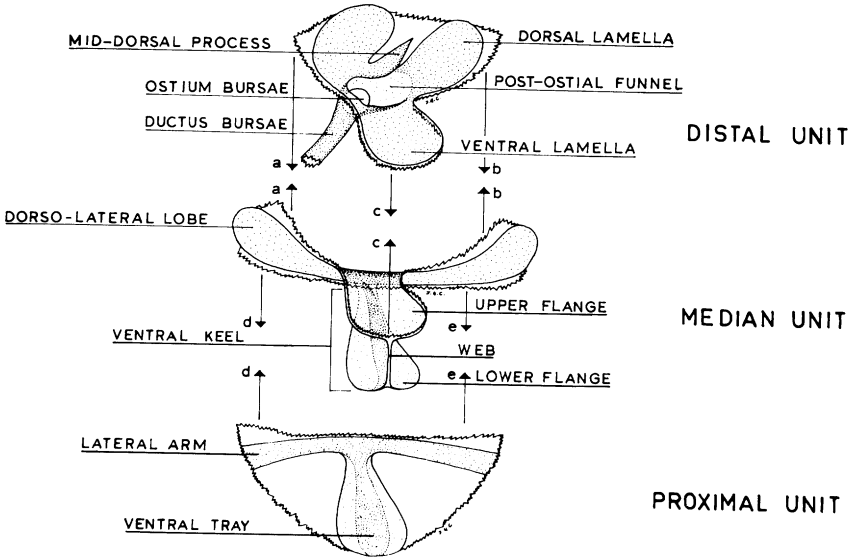
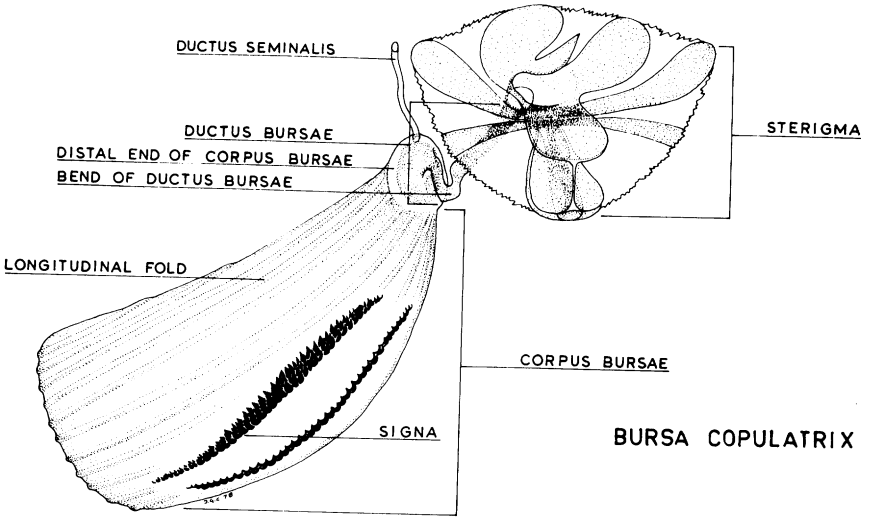
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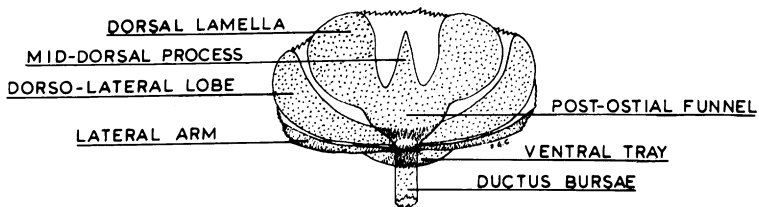
- Fig. 54.** *Hipparchia semele* Linnaeus. Spain, Aranjuez, 1500 ft., 29 April.  
**Fig. 55.** *Hipparchia cretica* Rebel. Greece, island of Crete, near Zenia, 800 m, 14 June.  
**Fig. 56.** *Hipparchia mersina* Staudinger. Turkey, Asia Minor.  
**Fig. 57.** *Hipparchia volgensis volgensis* Mazochin-Porshnjakov. U.S.S.R., Krasnoarmeysk, Lower Volga.  
**Fig. 58.** *Hipparchia volgensis delattini* Kudrna. Greece, Macedonia, Mt. Vermion, 1000 m, 24 July.  
**Fig. 59.** *Hipparchia volgensis muelleri* Kudrna. Greece, Peloponnissos, Mt. Chelmos, 1300 m, 24 July.  
**Fig. 60.** *Hipparchia turcmenica* Heydemann. U.S.S.R., Kazakhstan, Zaysan, upper Irtysh.

- Fig. 61.** *Hipparchia pellucida pellucida* Staudinger. Iraq, Kurdistan, Sersang, 3500 ft., 27 May.
- Fig. 62.** *Hipparchia pellucida cypriensis* Holik. Cyprus, Mt. Kornos, near Larnaka Lapithou, 310 m, 28 April.
- Fig. 63.** *Hipparchia aristaeus aristaeus* Bonelli. Corsica, La Joce, 6 August.
- Fig. 64.** *Hipparchia aristaeus aristaeus* Bonelli. Sardinia, Carbonia, 20 July.
- Fig. 65.** *Hipparchia aristaeus algerica* Oberthuer. Algeria, Sebdu.
- Fig. 66.** *Hipparchia aristaeus maderensis* Baker. Madeira, Monte.
- Fig. 67.** *Hipparchia aristaeus blachieri* Fruhstorfer. Italy, Sicily, Cefalu, 2500 ft., 13 July.
- Fig. 68.** *Hipparchia aristaeus senthes* Fruhstorfer. Greece, Attiki, near Athens.
- Fig. 69.** *Hipparchia azorina* Strecker. Azores, San Jorge, 8 September.
- Side view of male genitalia (unless otherwise stated, right **Valva** removed) of:
- Fig. 70.** *Hipparchia semele* Linnaeus. Spain, Albarracin, July (**Setae** not shown).
- Fig. 71.** *Hipparchia semele* Linnaeus. Albania, Jablanica, June (**Setae** not shown, left **Valva** removed, **Penis** detached).
- Fig. 72.** *Hipparchia semele* Linnaeus. Scotland, July (**Setae** not shown).
- Fig. 73.** *Hipparchia cretica* Rebel. Greece, island of Crete, Aghios Nikolaos, sea level, October.
- Fig. 74.** *Hipparchia mersina* Staudinger. Turkey, Antalya, 4000 ft., 16 June.
- Fig. 75.** *Hipparchia volgensis volgensis* Mazochin-Porshnjakov. U.S.S.R., Krasnoarmeysk, Lower Volga (**Penis** detached).
- Fig. 76.** *Hipparchia volgensis delattini* Kudrna. Greece, Macedonia, between Edessa and Florina, 4 July (**Setae** not shown).
- Fig. 77.** *Hipparchia volgensis muelleri* Kudrna. Greece, Peloponnissos, Mt. Chelmos, 1400 m, 15 July. (**Setae** not shown, **Penis** detached; this individual has a **Valva** that is close to that of *semele* and is rather exceptional; usually the **Valva** is intermediate between that of *semele* and nominate *volgensis*).
- Fig. 78.** *Hipparchia pellucida cypriensis* Holik. Cyprus, Mt. Pentadaktylos, April. (**Penis** detached, left **Valva** tilted outward and, therefore, presenting distorted view.)
- Fig. 79.** *Hipparchia pellucida cypriensis* Holik. Cyprus, Mt. Pentadactylos, near Halevga, 450 m, 29 April (side view of left **Valva**; **Setae** not shown).
- Fig. 80.** *Hipparchia aristaeus aristaeus* Bonelli. Corsica Lano, 1000 m, 13 July (left **Valva** removed, **Penis** detached).
- Fig. 81.** *Hipparchia aristaeus aristaeus* Bonelli. Sardinia (**Setae** not shown).
- Fig. 82.** *Hipparchia aristaeus algerica* Oberthuer. Algeria, Anosseur, Middle Atlas, 14 May.
- Fig. 83.** *Hipparchia aristaeus maderensis* Baker. Madeira (**Penis** detached).
- Fig. 84.** *Hipparchia aristaeus blachieri* Fruhstorfer. Italy, Sicily, Cefalu, 2500 ft., 13 July (**Penis** detached).
- Fig. 85.** *Hipparchia aristaeus senthes* Fruhstorfer. Greece, Macedonia, near Kentrikon, 26 June (**Setae** not shown).
- Fig. 86.** *Hipparchia azorina* Strecker. Azores, Fayal, Crater lip, 1 August (**Penis** detached).
- Fig. 87.** Locality map of examined *fagi*-group taxa.
- Fig. 88.** Locality map of examined *semele*-group taxa.

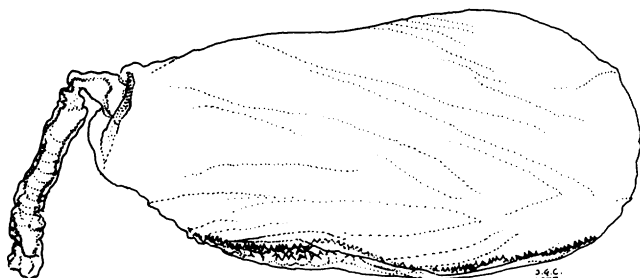






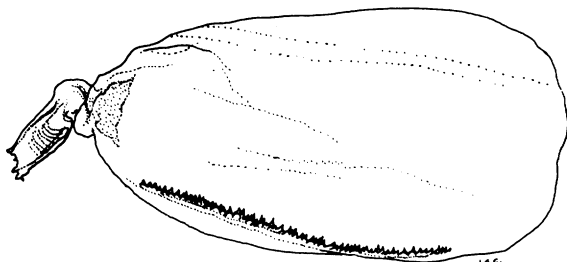


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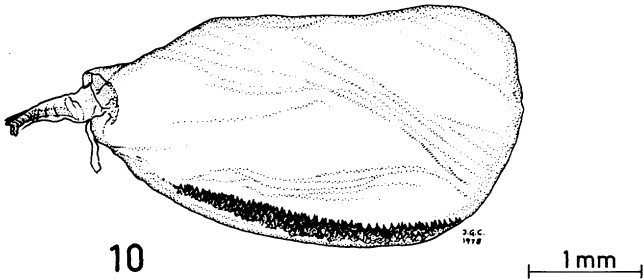
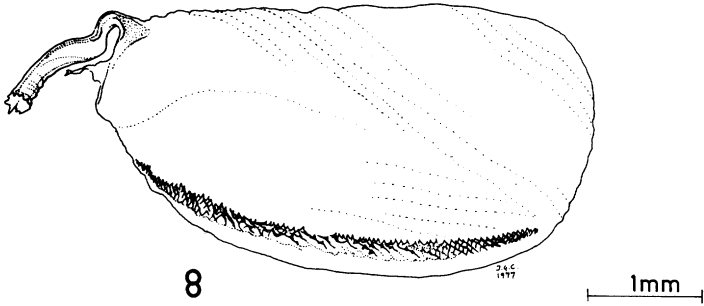
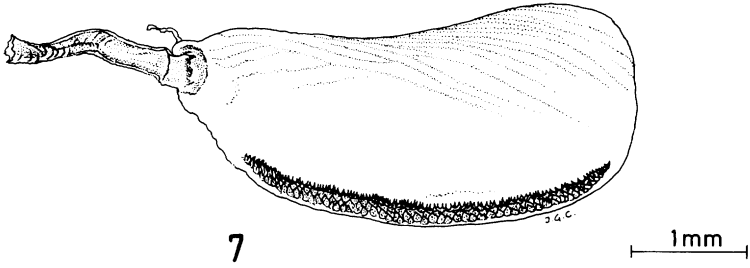
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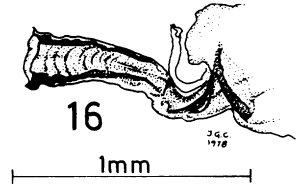
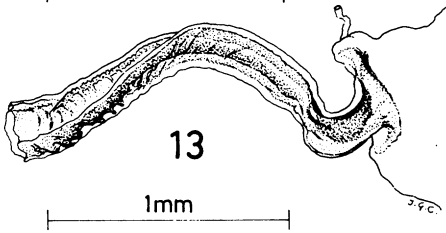
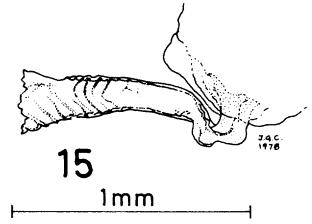
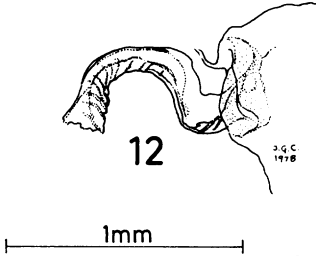
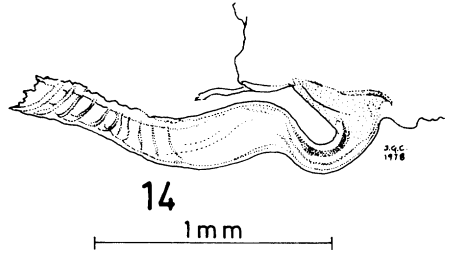
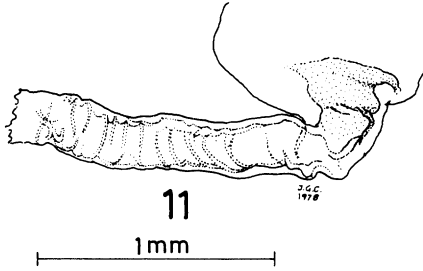
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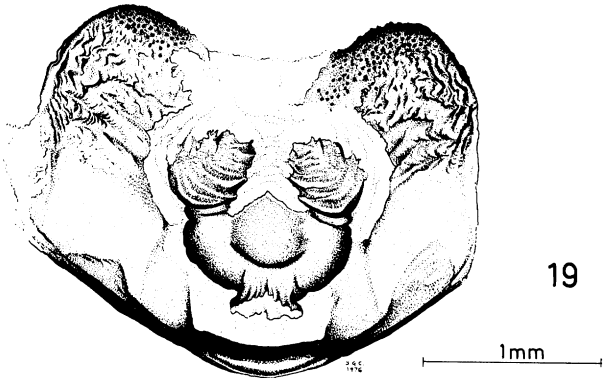
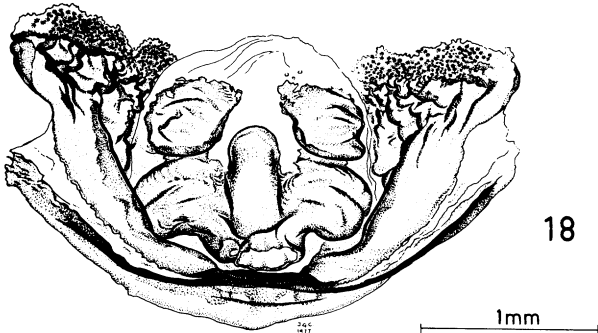
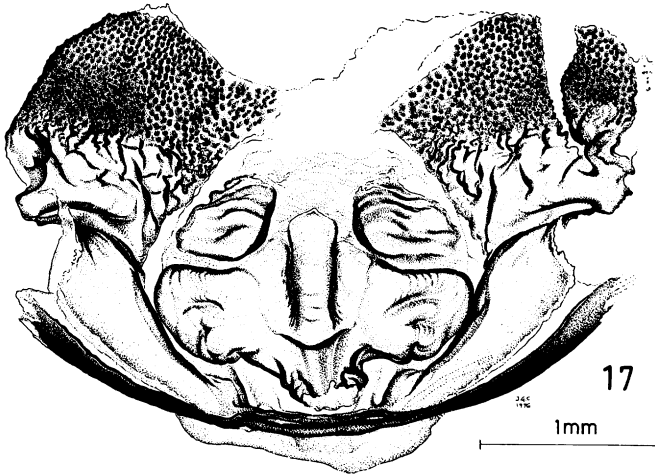


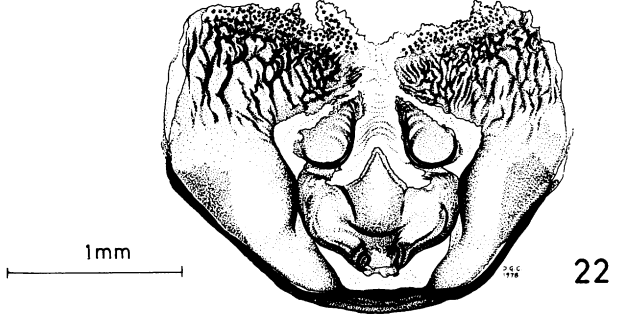
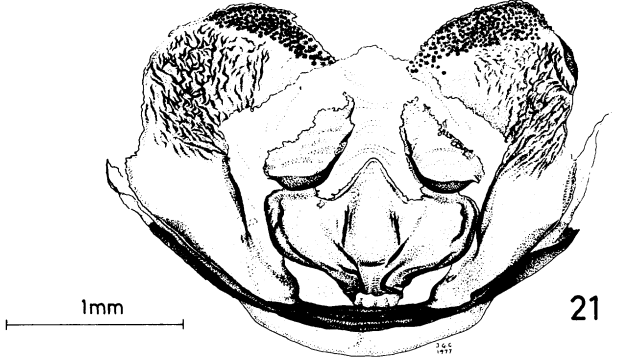
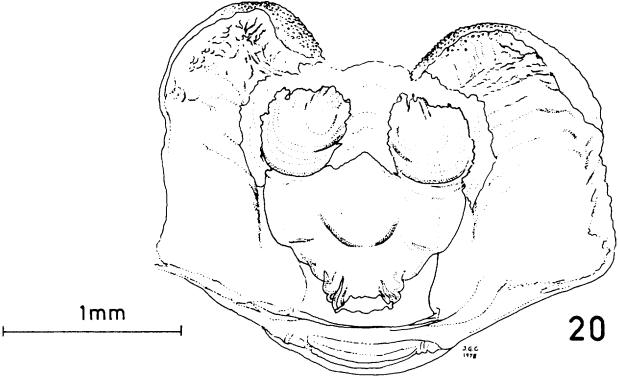
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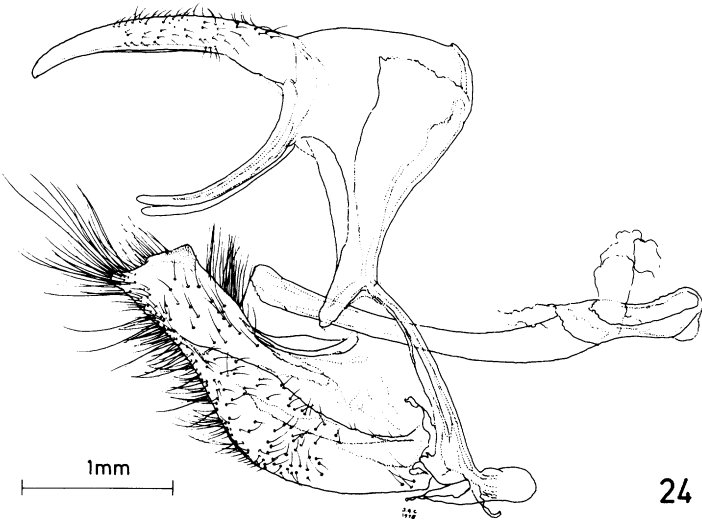
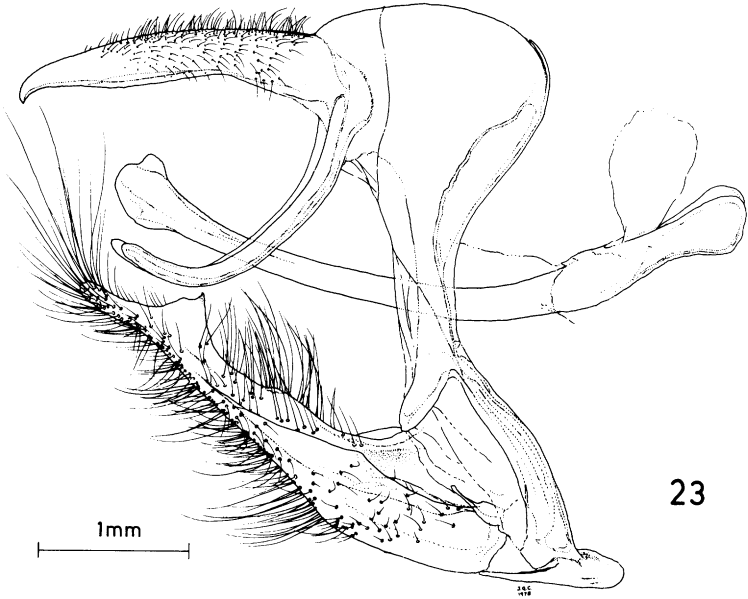
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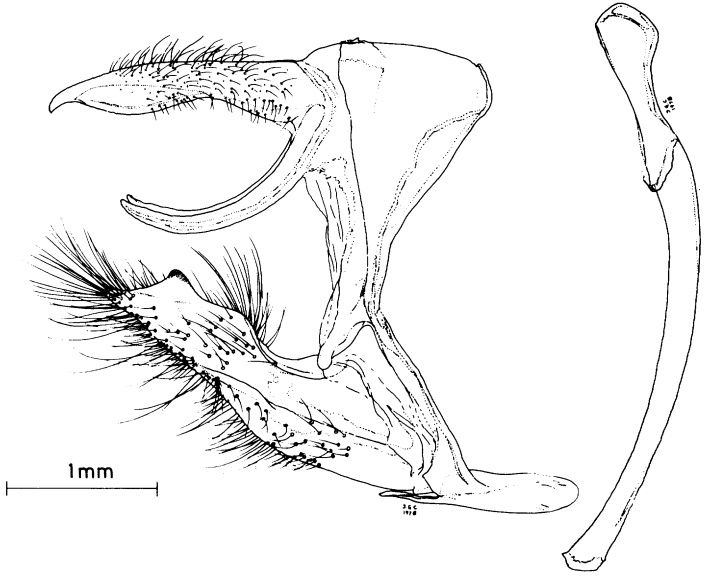




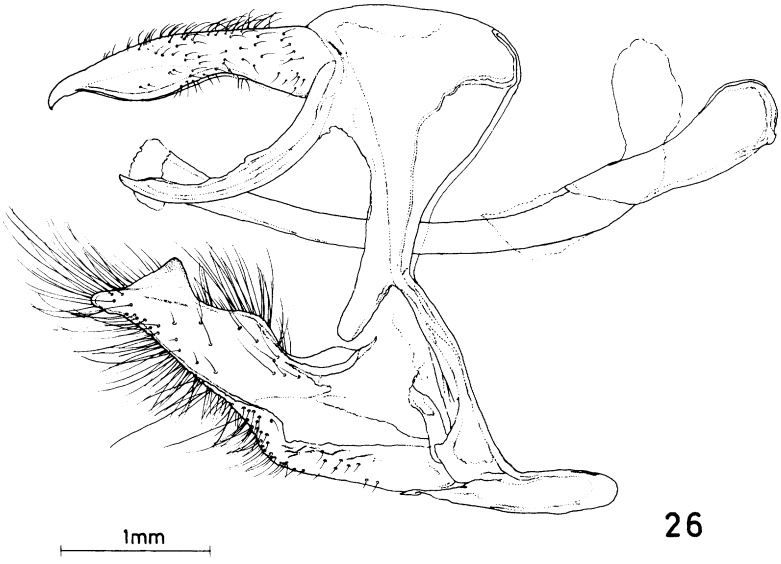




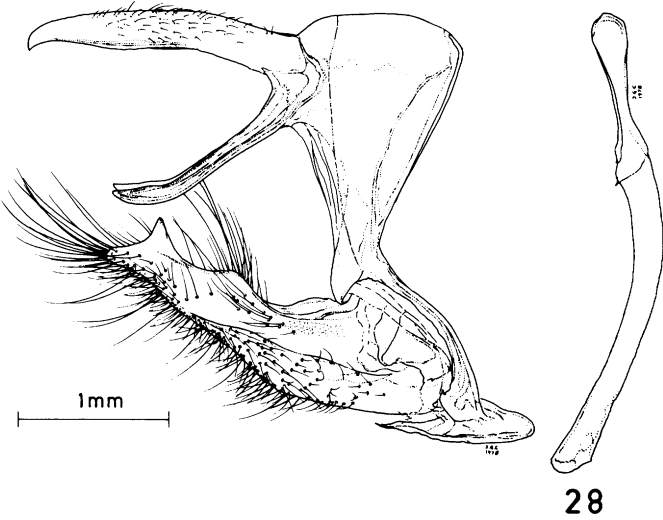
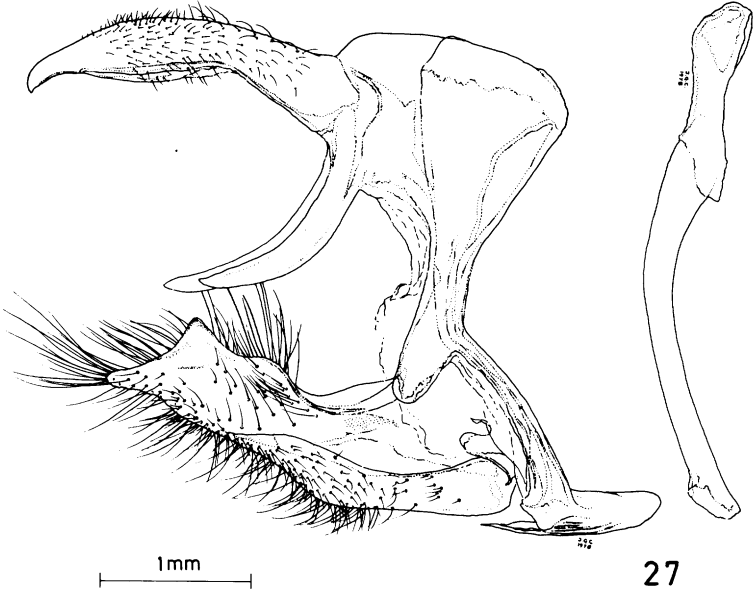


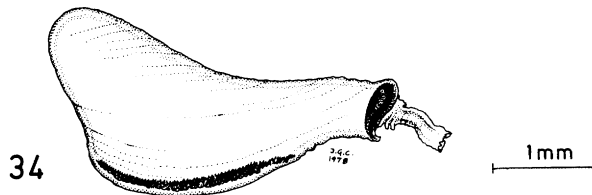
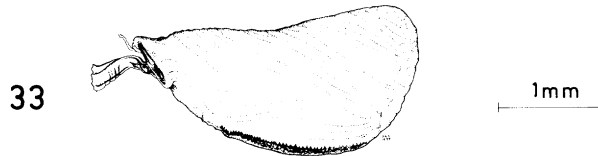
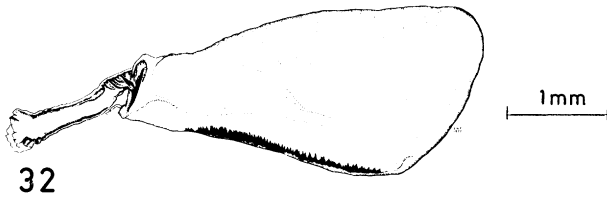
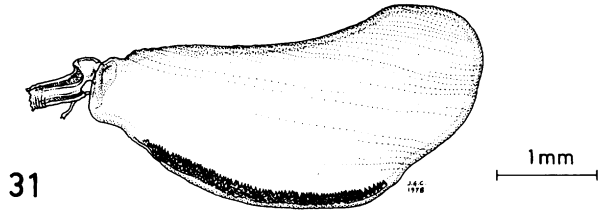
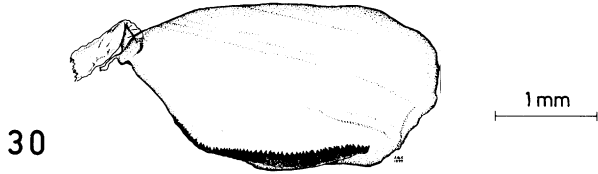
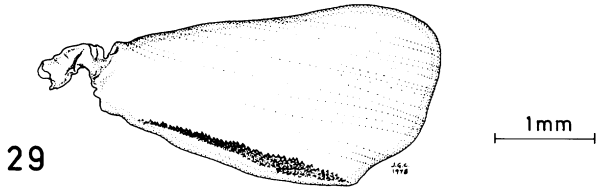


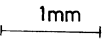
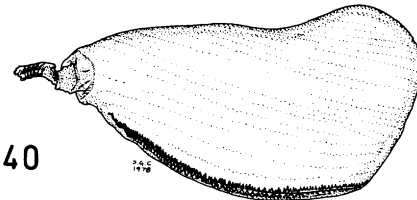
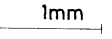
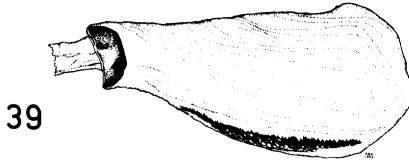
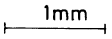
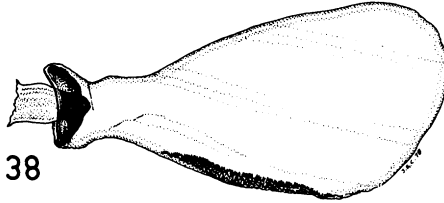
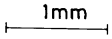
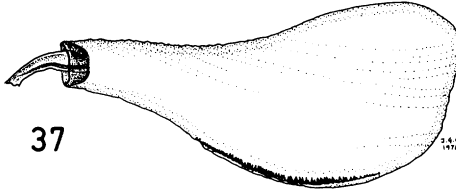
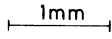
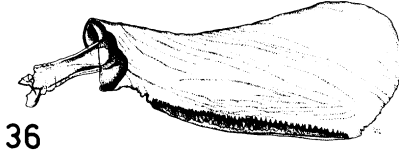
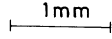
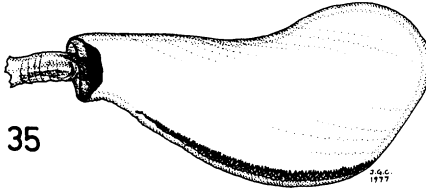
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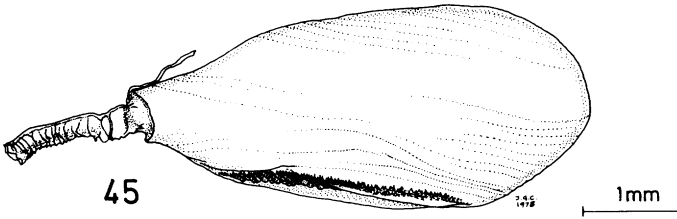
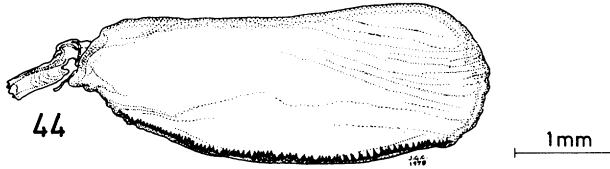
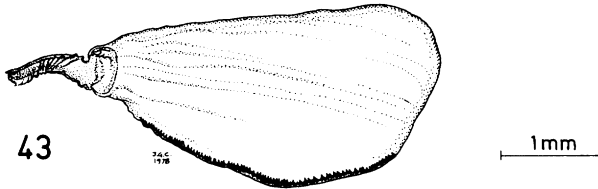
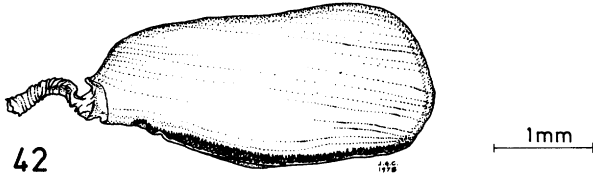
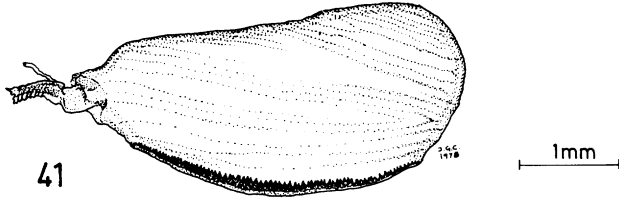


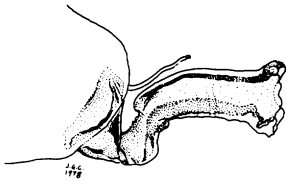
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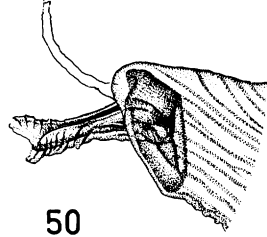
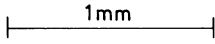




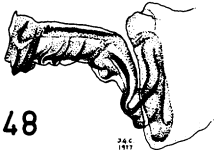
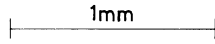




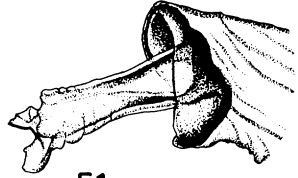
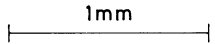
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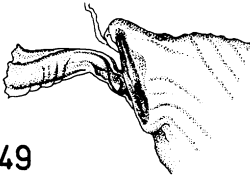
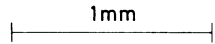
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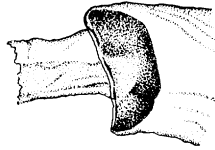
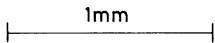
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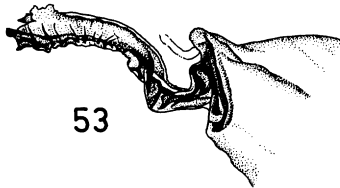
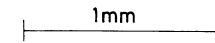
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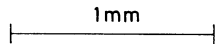
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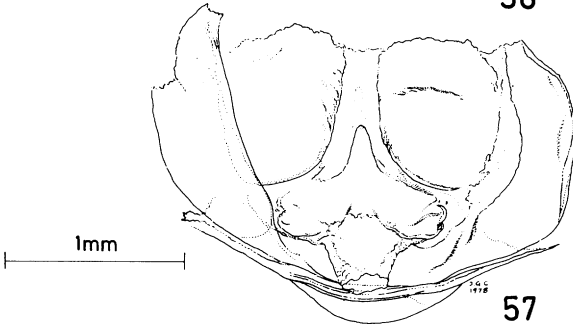
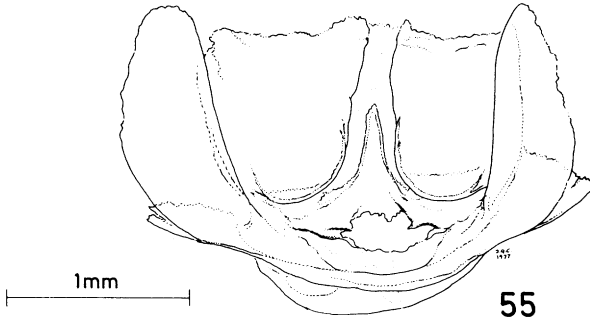
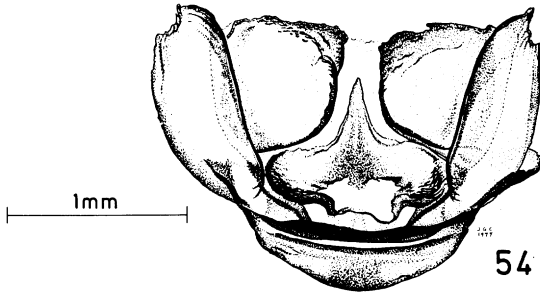


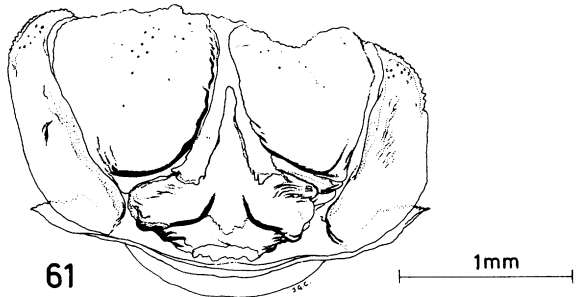
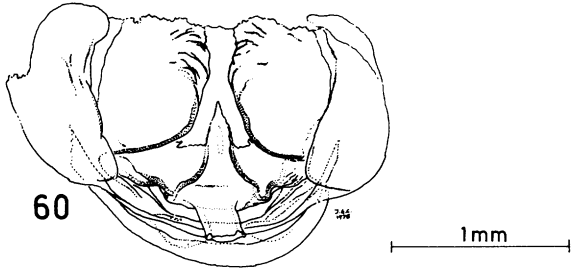
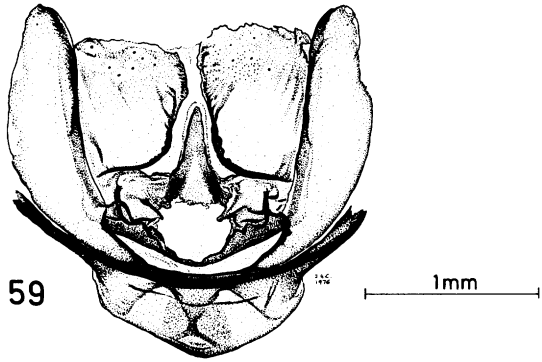
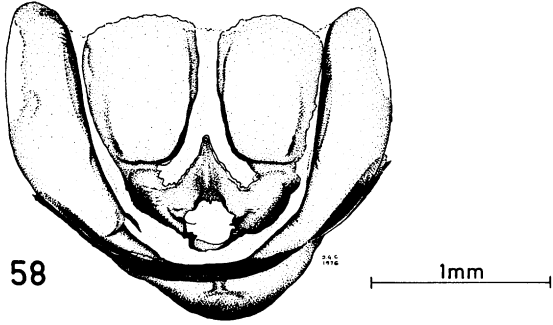
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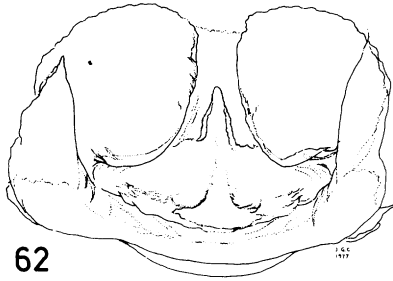
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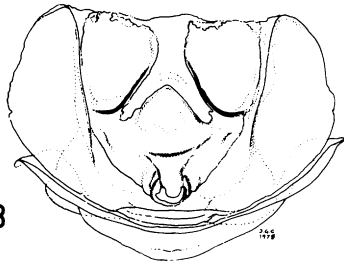






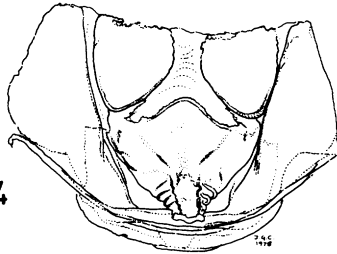
1mm

63



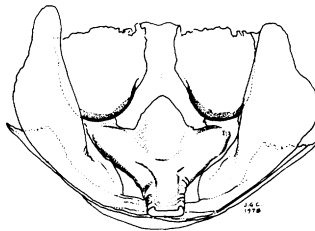
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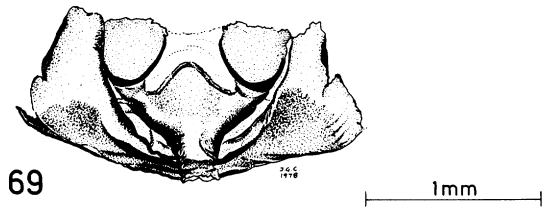
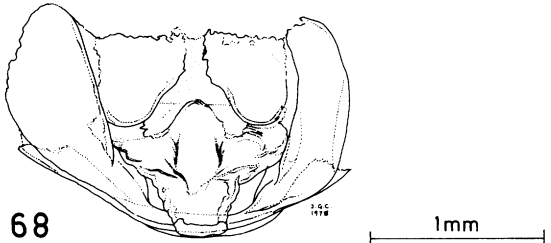
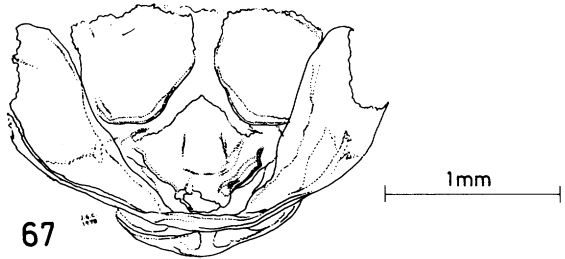
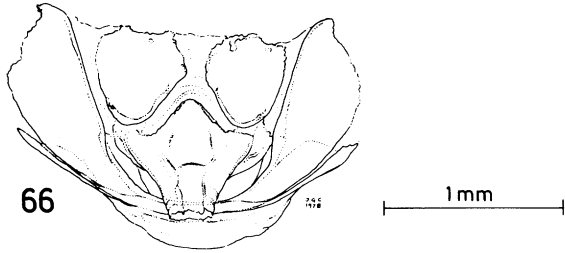


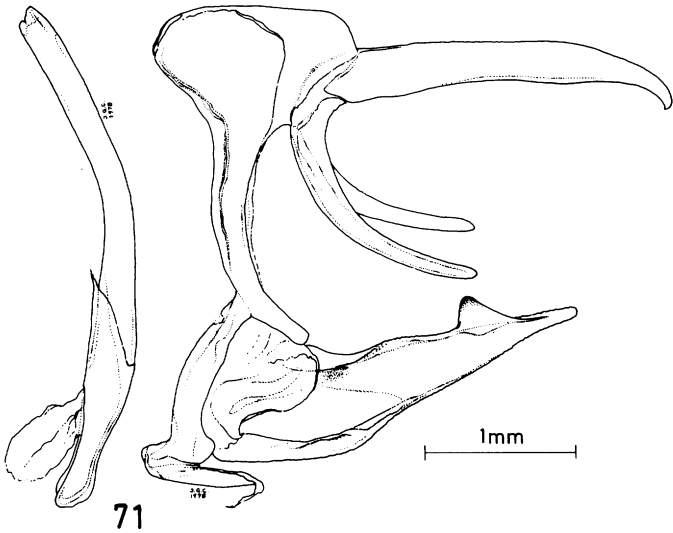
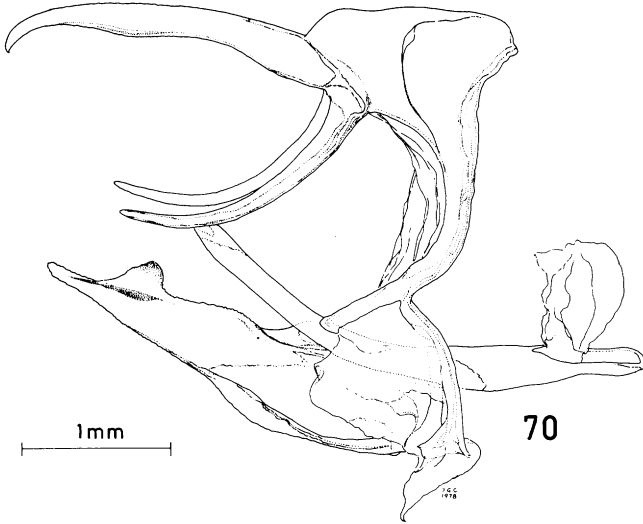
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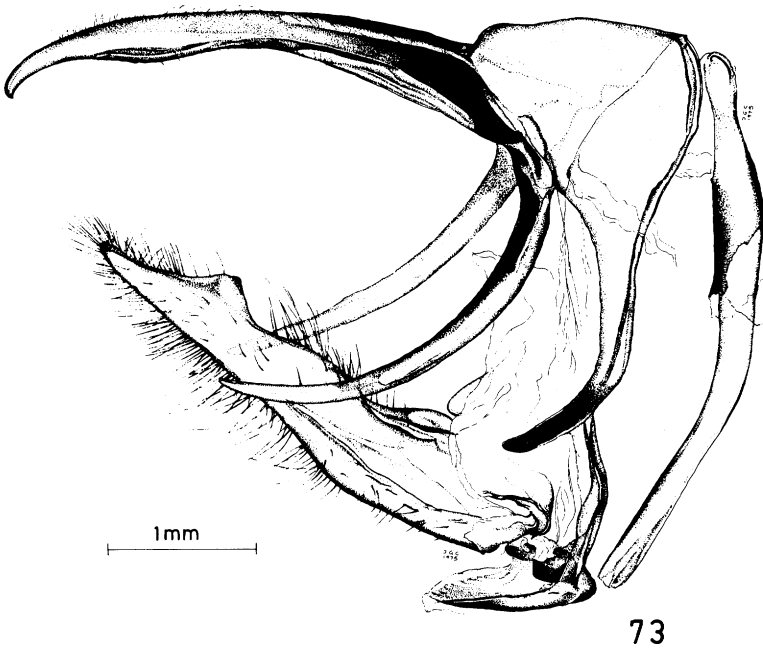
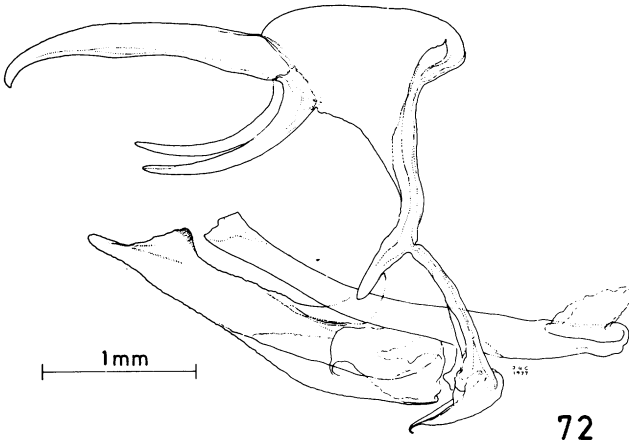
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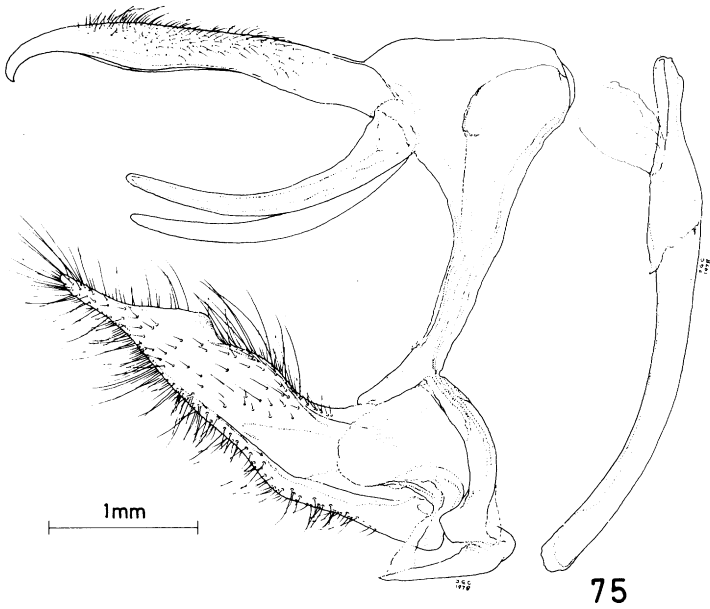
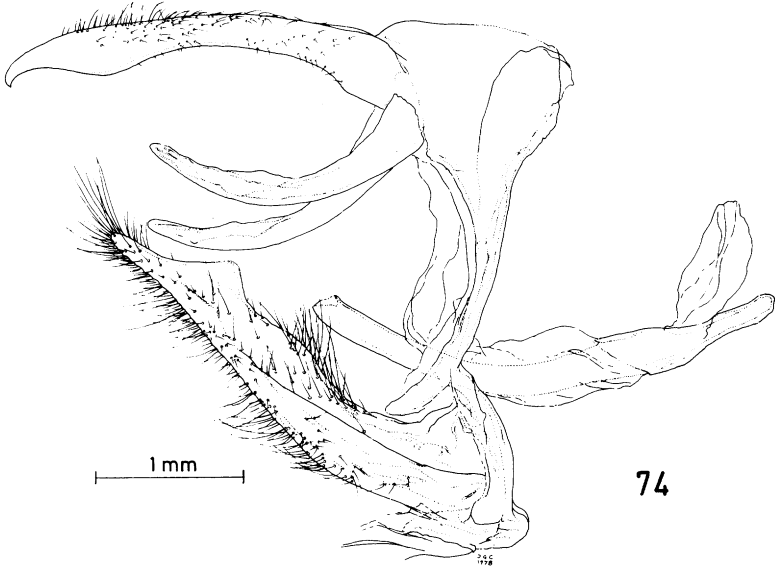


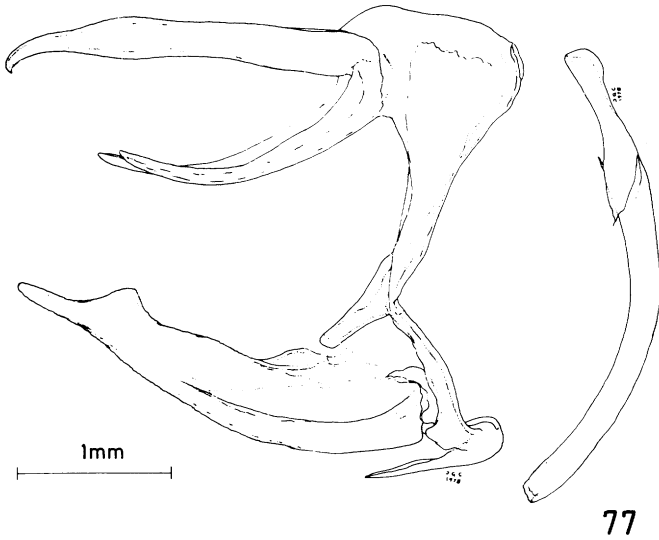
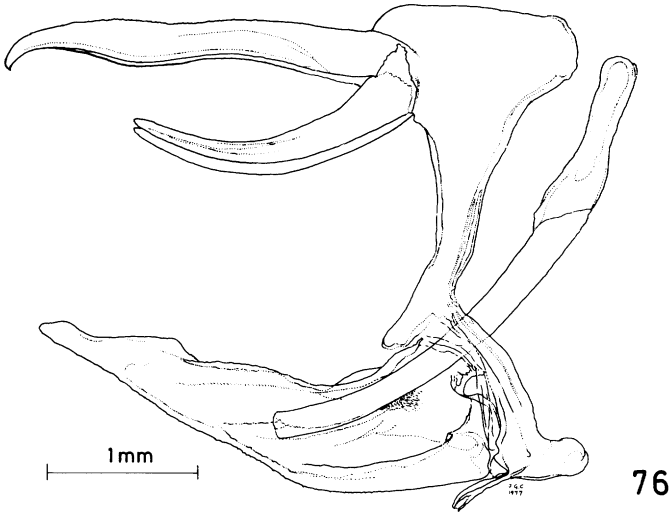
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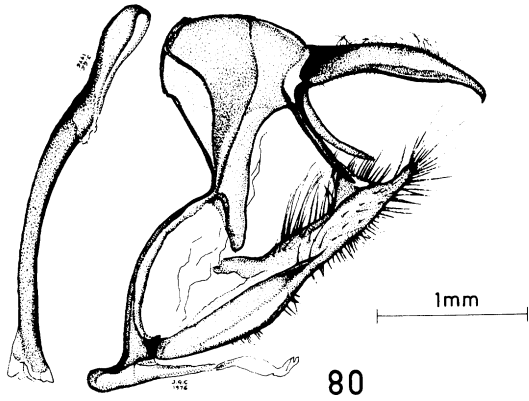
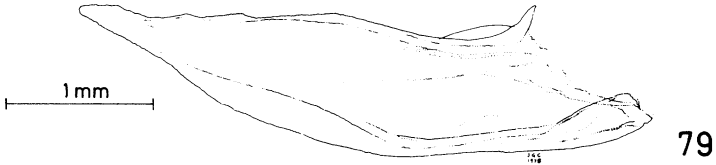
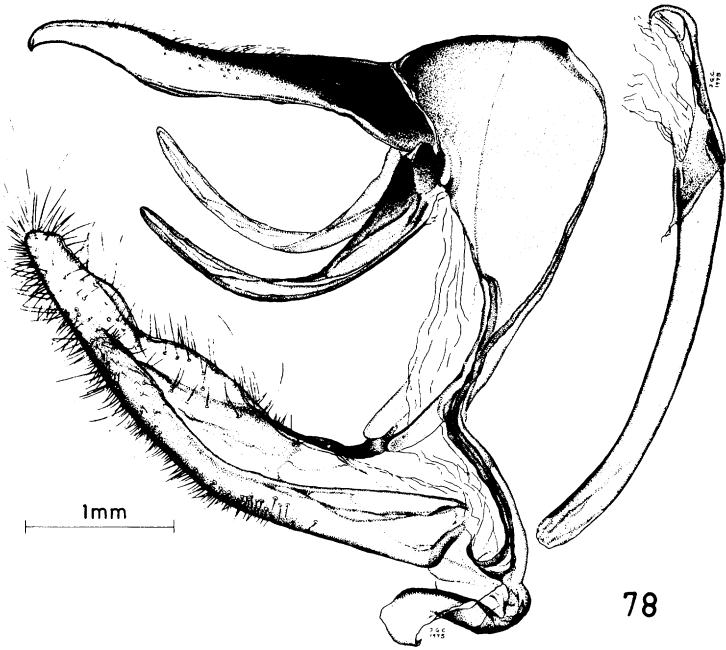


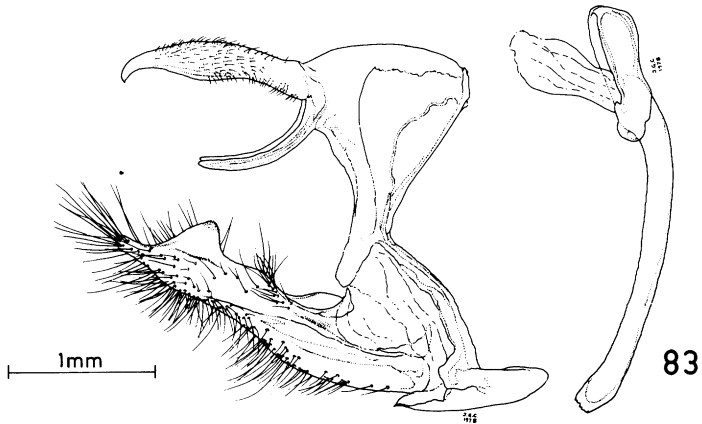
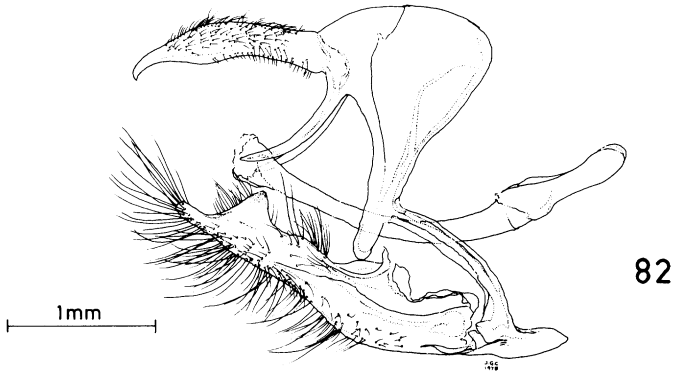
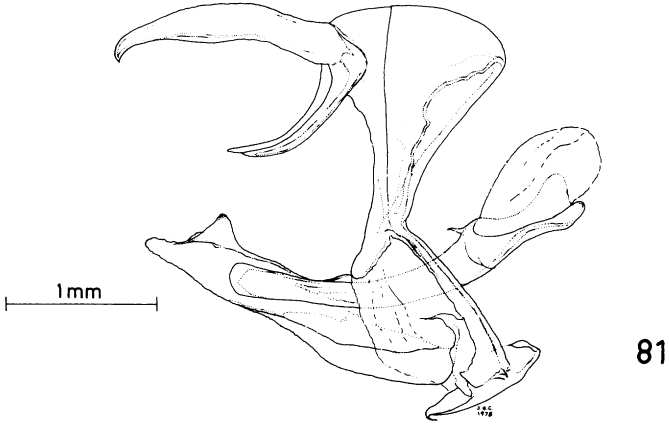




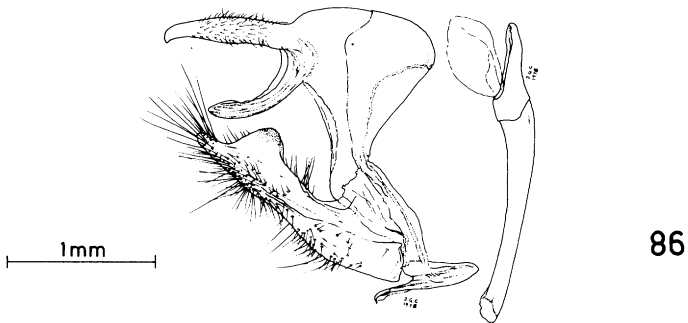
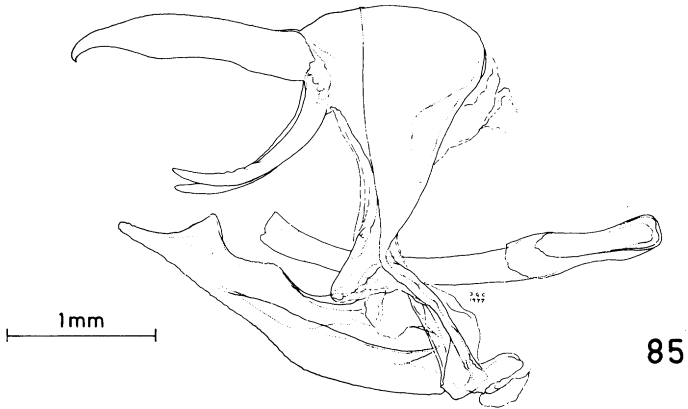
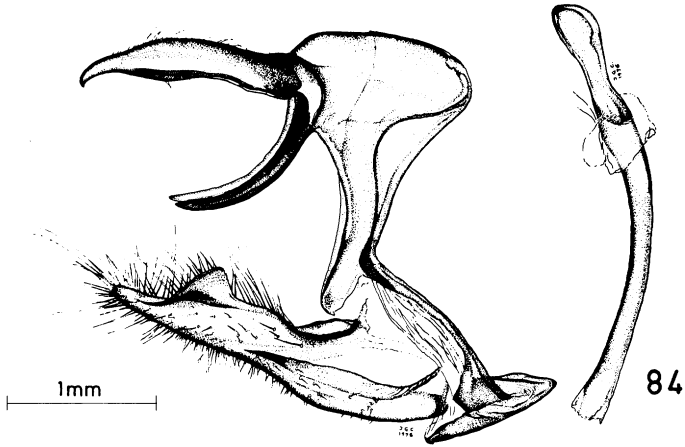


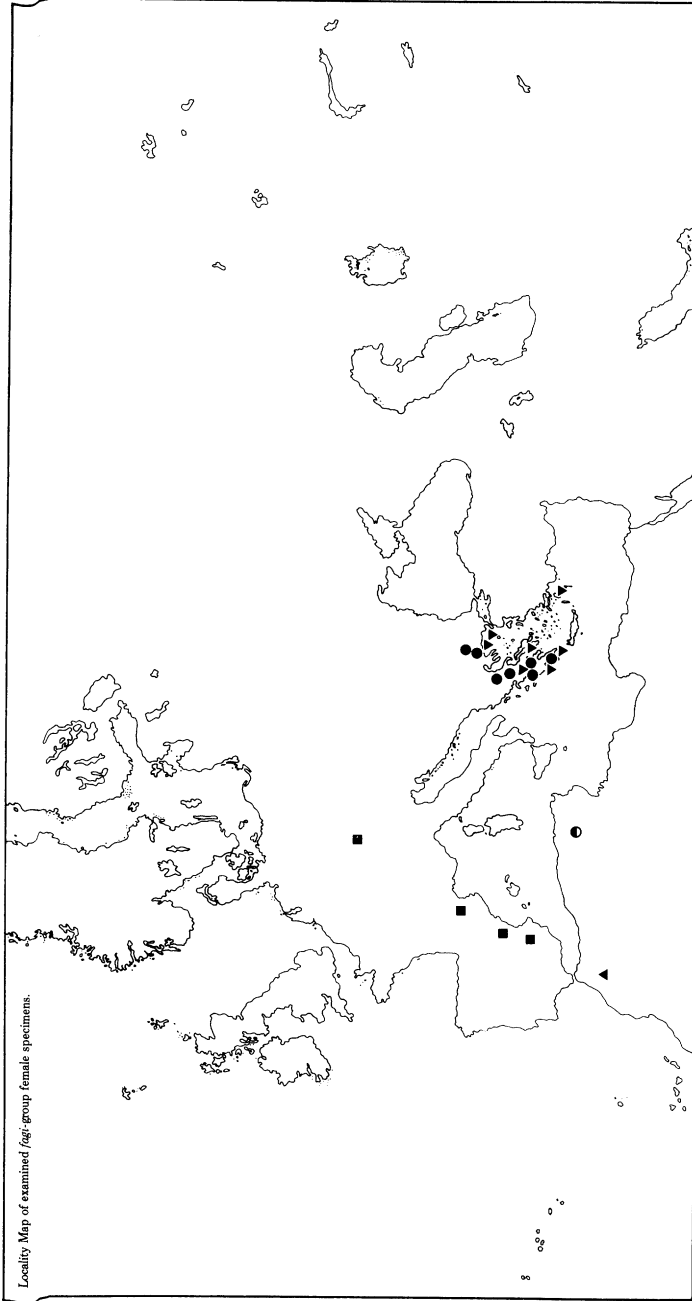


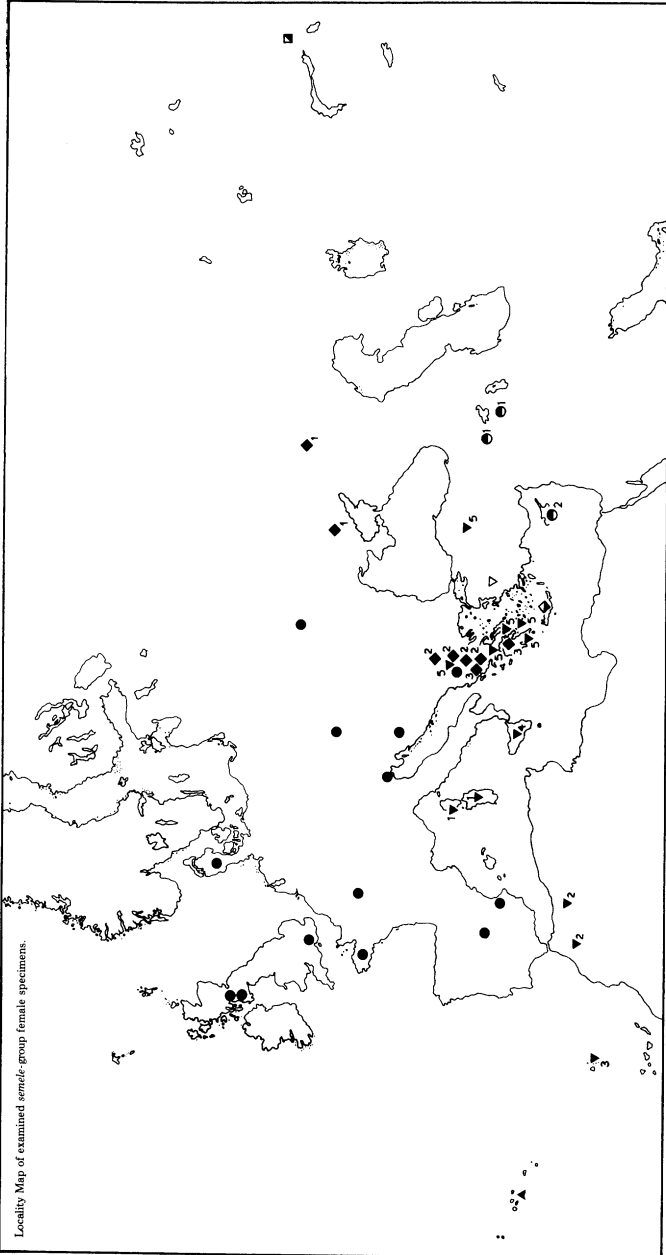












Locality Map of examined *semele*-group female specimens.

- *Hipparchia semele* Linnaeus
- ◆ *Hipparchia eretica* Rebel
- ▽ *Hipparchia morina* Staudinger
- ◆ *Hipparchia volgensis volgensis* Mazonchi-Porshnjakov
- ◆ *Hipparchia volgensis delatini* Kudrna
- ◆ *Hipparchia volgensis muelleri* Kudrna
- ◆ *Hipparchia tarimensis* Heydemann
- *Hipparchia pellucida pellucida* Stauder
- ⊙ *Hipparchia pellucida cyprensis* Holik
- ▽1 *Hipparchia aristaeus aristaeus* Bonelli
- ▽2 *Hipparchia aristaeus algerica* Oberthuer
- ▽3 *Hipparchia aristaeus madrensis* Bethune-Baker
- ▽4 *Hipparchia aristaeus blancheri* Fruhstorfer
- ▽5 *Hipparchia aristaeus senilis* Fruhstorfer
- ▲ *Hipparchia asarina* Strecker