THE GENUS ATRACTOMORPHA SAUSSURE,1862, WITH SPECIAL REFERENCES TO THE PHALLIC STRUCTURES. (ORTHOPTERA:ACRIDIOIDEA:PYRGOMORPHIDAE)

by

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A THESIS

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I INTRODUCTION

Atractomorpha Saussure,1862, is the type genus of the tribe Atractomorphini (Orthoptera; Acridoidea; Pyrgomorphidae), the modern concept of which is indicated by Kevan and Akbar (1964). Various species of this genus are wide-spread throughout the Old World tropics and subtropics, occurring from West Africa to the Indo-Malayan and Papuan regions, and as far east as the Solomon Islands. One species has also become established in the Hawaiian chain. In temperate regions, they are found in the east as far north as Hokkaido, Japan, Korea and northern China, and as far south as Victoria, Australia. In the west, however, although they reach almost to the Cape, they do not occur in Africa north of the Sahara; in western Asia the genus is found only as far north as Afghanistan and Kashmir.

The description of Truxalis crenulata from south India, by Fabricius (1793), constituted that of the first species referable to Atractomorpha. Truxalis scaber of Thunberg (1815) and Truxalis crenatus of Thunberg (1827) are early synonyms. The second valid species was Acridium (Truxalis) psittacinum of Haan (1842) from Indonesia; the third was Truxalis (Pyrgomorpha) acutipennis of Guérin-Méneville (1844) from Madagascar; and the fourth was Pyrgomorpha crenaticeps of Blanchard (1853) from New Guinea, Truxalis oceanicus Montrouzier (1855) being an early synonym. Species of Atractomorpha in earlier days were, in fact, described under Truxalis or Pyrgomorpha, which

continued to be used for a considerable length of time by various authors. Saussure (1862), when he erected the genus Atractomorpha, included Fabricius' crenulata and a species, A.consobrina. The latter is now known to be a synonym of A.crenulata, which subsequently was designated as the type species of the genus by Kirby (1910). Saussure (l.c.) also pointed out that Truxalis psittacina Haan was close to A.consobrina.

Bolívar (1884) was the first to revise the genus Atractomorpha in his "Monografía de los Pyrgomórfinos", and, since then, numerous species have been added to the list, many of them uncritically described as new species, particularly by Bolívar (1905). The true situation thus became greatly obscured, no less than forty species, the majority of them invalid, having been described or subsequently placed in the genus. A revision of Atractomorpha had long been deemed necessary (Willemse,1930; Uvarov,1937; Kevan,1957), by the time that the first modern (preliminary) revision was published by Banerjee and Kevan (1960). These last authors recognized only nine species and five subspecies.

The genitalia of insects in general have long been used by taxonomists in classification, but it was Chopard (1920) who first initiated the serious study of phallic structures of Acridoidea (amongst other Orthoptera) from a taxonomic point of view. Znoiko (1928), Tarbinskiĭ (1931), Hubbell (1932; 1960), Hebard (1936), Gurney (1940), Salfi (1941), Uvarov (1943), Grasse and Hollande (1946) and several later authors,

all used the form of the phallic structures mainly for specific discrimination within certain of the Acridoidea.

The first major advance in the application of the study of phallic structures to the problems of phylogeny and taxonomic relationships of higher categories of Acridoidea was made by Roberts (1941), who demonstrated two well defined groups: the Chasmossacci (having an open ejaculatory sac), and the Cryptossacci (with a closed ejaculatory sac), depending upon the presence or absence of a ventral phallotreme cleft. Dirsh (1956) then made further use of the phallic complex of the Acridoidea and brought about radical changes in the taxonomy of the group. Akbar (1963) adapted and standardized the terminology used by several previous authors, and has slightly modified it in order to make it appropriate to the Pyrgomorphidae. His work has not yet been published, although a number of publications notably that of Kevan and Akbar (1964) have used and illustrated his terminology.

The present revision of Atractomorpha, based almost entirely upon the form of the male phallic structures, now shows that there are fourteen species in the genus, two of which are new (viz., A.orientalis,* sp.n., and A.occidentalis,* sp.n.). Two other species considered to be synonyms by Banerjee and Kevan (1960) are apparently valid species (viz., A.rufopunctata Bolívar,1894, and A.himalayica Bolívar,1905).

*These new names are used in this thesis for the sake of convenience only. At the time of writing they do not have any nomenclatorial status.

One other species regarded by Banerjee and Kevan (l.c.) as a subspecies (viz., A.crenaticeps australiana Bolívar,1905) also seems to merit species rank. True subspecies cannot be distinguished by the structures of the male phallic complex, except probably in the case of A.psittacina, so that no attempt is made to assess their status, with this one exception.

This study was carried out under the guidance of Professor D.K.McE.Kevan. I express my deep gratitude to him for his keen interest in this study, and the privilege of unrestricted access to his personal collections and library. Thanks are also due to different museums and other institutions, all of whom most willingly lent the material which forms the basis of this work. In the course of writing this thesis, much valuable information has been taken from Banerjee's (1959) thesis and from Banerjee and Kevan (1960). Financial support was received from the National Research Council of Canada.

II MATERIAL AND METHODS

More than 650 male specimens of Atractomorpha were dissected and examined. The material used in the course of the study was mainly from the personal collection of Dr.D.K.McE. Kevan, currently in the Lyman Entomological Museum, Macdonald College of McGill University. Most of the remainder was borrowed from the following institutions: the British Museum (Natural History), London; the Academy of Natural Sciences of Philadelphia; the California Academy of Sciences, San Francisco; the U.S.National Museum, Washington; the B.P.Bishop Museum, Honolulu; le Museum National d'Histoire Naturelle, Paris; l'Institute Royal des Sciences Naturelles de Belgique, Brussels; le Musee Royal de l'Afrique Centrale, Tervuren, Belgium; Naturhistoriska Riksmuseet, Stockholm; das Zoologisches Museum der Humboldt Universitat, Berlin; das Naturhistorsches Museum, Vienna; and l'Institute Francaise d'Afrique Noire, Dakar. Some West African material was also kindly supplied by Dr.N.D.Jago, now of University College, Dar-es-Salaam.

The phallic structures were extracted from dry-pinned specimens, using the following techniques:

The data for each specimen were recorded exactly as given on the accompanying labels, and each specimen was given an identification number.

For relaxing the insects, small desiccators containing water in their lower parts were used. A wire gause rested over the inner rim of each desiccator, and was covered by a layer

of filter-paper moistened with water. The specimens were placed in the desiccators by pinning them into the layer of filter-paper over the water, until they had become sufficiently relaxed. It was found to be more advantageous to use warm rather than cold water for the following reasons: (1), if cold water is used, some phenol crystals are necessary in the water of the desiccator, in order to avoid fungus growth, but unfortunately these are undesirable as they cause the specimens to become discoloured (from green, in the great majority of specimens, to yellowish brown); and (2), the use of warm water for relaxing specimens decreases the time required to as little as 10-12 hours, instead of at least 24 hours when cold water is used, and the avaiable period for fungal growth is then reduced, even if the temperature increase might be expected to encourage this.

Once a specimen was fully relaxed, the epiproct was raised and the subgenital plate lowered, the palium was then slit and the phallic complex extracted by means of a fine needle. After the extraction, the epiproct and the subgenital plate were pushed back to their normal positions, so that little sign of the operation remained.

The removed phallus was then immersed in a warm 10 per cent. potassium hydroxide solution for about five minutes, after which it was washed with cold water, and placed in a drop of glycerol in a microvial which was then pinned through its cork to the specimen from which it came. The phallic complex was examined on a cavity slide in glycerol under a stereoscopic

binocular microscope. The epiphallus, ectophallus and endophallus were carefully dissected apart, and drawn and measured with the aid of a microprojector. The epiphallus was drawn from the dorsal aspect only, the ectophallus from dorsal and ventral views, and the endophallus from dorsal, ventral and lateral aspects. All drawings of the phallic structures were made to the same scale by means of a microprojector, which was also used for obtain measurments of the various parts.

Variation in the form of the phallic structures, together with geographical distribution were considered along with certain other features in reaching taxonomic conclusions. Females (including preparations of their genital apparatus made by miss Yu-Chen Chang) have also been examined for comparsion, but do not form part of this study.

No direct examination of types were made (except in the case of the two new species), but photographs of all existing type specimens are available in Banerjee (1959), in various publications (particularly in Kevan,1953), or in the personal collection of Professor D.K.McE.Kevan.

III TERMINOLOGY

The morphological studies by Walker (1922) on the phallic complex of Dissosteira carolina, and further elaborations by Snodgrass (1935b; 1937), Roberts (1941) and Dirsh (1956), have helped much to formulate a generalized terminology of the Acridoid phallus. This has been reviewed by Akbar (1963), after whom almost all of the terms used in the present work have been adopted. Only one new term, the membranous area of the bridge of the epiphallus (MA), peculiar to Atractomorpha, has been introduced here. Although Akbar's terminology has not been published in full (a paper is in preparation), it has already been used and illustrated fairly extensively in a number of publications by Drs. Akbar and/or Kevan, notably by Kevan and Akbar (1964).

The following is a list of those terms used in this thesis, with the definitions (occasionally slightly modified) as given by Akbar (1963):

A, Appendices of epiphallus - A pair of club-shaped sclerites with basal stalks and distal lobes, articulating marginally with the lateral plates and the anterior projections of the epiphallus.

AC, Apodemal plates of cingulum - A pair of lobe-like structures forming the proximal parts (dorsal and ventral) of the cingulum.

(Apodemes of cingulum of Akbar (1963), but modified to the present term by Kevan and Akbar (1964) .

AE, Aedeagus - The distal parts of the endophallus which act as the chief intromittant organ.

AP, Anterior projections of epiphallus - Projections of the lateral plates of epiphallus, situated antero-laterally.

AS, Aedeagal sclerites - A pair of long, narrow, plate-like sclerites extending from the endophallic apodemes and forming part of the distal region of the phallus.

AV, Aedeagal valves - The distal projecting lobes of the aedeagus into which the aedeagal sclerites extend.

B, Bridge of the epiphallus - The medium sclerites by which the epiphallus connecting the lateral plates.

BC, Basal thickening of cingulum - A strongly sclerotized thickening running marginally along the proximal parts (dorsal and ventral) of the apodemal plates of the cingulum; forming a fairly wide, plate-like structure extending towards the middle of the suprazygomal plate (SZ).

BE, Basal emargination - A fairly conspicuous emargination of the proximal part of the cingulum.

C, Cingulum - A capsule-like sclerite covering the endophallus on all sides, forming the main part of the ectophallus. It includes apodemal plates, zygoma, suprazygomal plate, and rami.

CM, Central membrane - A membranous dorsal area of the cingulum, enclosed by the zygoma and suprarami.

Cv, Valves of cingulum - A pair of valves, arising directly from the cingulum, located at the distal part of suprarami.

E, Epiphallus - A strongly sclerotized plate-like structure

covering the dorsal surface of the ectophallus.

EA, Endophallic apodemes - The proximal expanded parts of the endophallic sclerites.

EDP, Endophallus - The internal parts of the phallic complex including the endophallic sclerites, spermatophore sac, and parts of the aedeagal valves.

EP, Ectophallus - The external parts of the phallic complex except the epiphallus and endophallus.

ES, Endophallic sclerites - The sclerotized parts of the endophallus, consisting of basal endophallic apodemes and distal aedeagal sclerites.

G, Gonopore - A short passage which communicates ventrally between the ejaculatory sac and the spermatophore sac.

L, Lophi - A pair of strongly sclerotized, usually hook-like processes arising from the posterior terminal parts of the lateral plates of the epiphallus. (In Atractomorpha these are outwardly directed and connected by the distal part of the very wide bridge to give an anchor-like appearance to the epiphallus).

LP, Lateral plates of the epiphallus - A pair elongate plates lying on either side of the epiphallus, and connected with each other by the bridge.

MA, Membranous area of the bridge - A more weakly sclerotized area at the proximal part of the bridge of the epiphallus. (More or less peculiar to Atractomorpha).

PC, Phallic complex - The epiphallus and ectophallus, endophallus together.

PEA, Processes of endophallic apodemes - A pair of plate-like processes formed by the ventral walls of the endophallic apodemes.

PZ, Pseudoarch - A small sclerite lying posterior to the central membrane of the cingulum between the suprarami, and connecting the bases of the valves of the cingulum; it also connected the aedeagal valves with the cingulum.

RC, Rami of cingulum - A pair sclerotized plate forming the latero-ventral walls of the cingulum, and elongated so as to participate in the formation of the ventral cleft.

SR, Suprarami - A pair of small processes extending dorsally from the rami of the cingulum.

SS, Spermatophore sac - A (usually) large endophallic sac situated dorsal to the aedeagal sclerites and communicating ventrally with the ejaculatory sac through the gonopore.

SZ, Suprazygomal plate - A sclerotized, usually horse-shoe-shaped, dorsal structure lying in the proximal part of the cingulum.

VC, Ventral cleft - The ventral longitudinal opening of the phallotreme and ejaculatory sac, on the distal part of the cingulum.

VLC, Ventral longitudinal thickenings - A pair of thickenings of the cingulum formed by the posterior extensions of the ventral parts of the basal thickenings of the cingulum.

VP, Ventral process - A triangular or subtriangular process, extending anteriorlly to a varying extent from the mid-

ventral part of the cingulum.

Z, Zygoma - A broad plate-like structure forming the dorsal part of the cingulum, firmly fused antero-laterally with the apodemal plates of the cingulum.

VI THE GENUS ATRACTOMORPHA SAUSSURE,1862

A. Synonyms

The genus Atractomorpha, the name of which means fusiform, was erected by Saussure (1862). Before, and even after the publication of Saussure's description, however, certain species now referable to Atractomorpha, were described by several authors under the following different generic names:

Truxalis Fabricius, 1793:26 (partim);
Palisot de Beauvois, 1806:16 (partim);
Thunberg, 1815:263 (partim); 1827:76 (partim);
Burmeister, 1838:606 (partim);
Acridium (Truxalis); Haan, 1842:138 (partim);
Truxalis (Pyrgomorpha); Guérin-Méneville, 1844:340 (partim);
Pyrgomorpha; Blanchard, 1853:567 (partim);
Atractomorpha Saussure, 1862:474.
Truxalis; Walker, 1870:474 (partim);
Pyrgomorpha; Walker, 1870:497 (partim);
Perena Walker, 1870:506.
Minorissa; Thomas, 1874:63-71. [nec Walker] (cf. Kevan,1960).

Type species by subsequently designation (Kirby, 1910:331): Truxalis crenulatus Fabricius,1793 = Atractomorpha crenulata (Fabricius).

B. Redescription of the external features

Body fusiform, certain species comparatively stout, others quite slender, the majority of species typically of intermediate form. Head subconical, frontal profile strongly oblique; fastigium of vertex always long, but variable; postocular row of tubercles usually prominent and discrete. Antennae subtriquetrous at base and subcylindrical apically. Eyes elongate-ovate or oblong in shape, the size and width of the interocular space variable. Pronotum dorsally tricarinate with anterior margin subemarginate to truncate, and posterior margin angular or convex, lateral lobes in several species with a membranous area toward the posterior margin, inferior margin rather straight, often with a submarginal row of small tubercles. Tegmina fully developed extending beyond the apex of the abdomen, acute at their apices. Hind wing often much shorter than tegmina, usually rosy or red at base, in certain species yellowish or hyaline. Cerci short and conical in both sex, shorter in the female.

Species of Atractomorpha exhibit a definite colour polymorphism as noted by Rehn (1953) who refers to the dichromatism of the Australian species of the genus. Certain species occur in both green and yellow or brown colour forms, while others possess individuals that are tinged with purple hues. In general, however, the coloration is rather uniform bright green; some species possess small, dark spots on pronotum and tegmina.

C. Description of phallic complex

The male phallic structures in Atractomorpha vary to some extent within species as well as between species, but the genus does not exhibit a wide range of morphological variation when compared with such pyrgomorphid genera as Orthacris (Singh and Kevan,1965). There are a number of instances where it is difficult to separate species on the basis of the morphology of the male phallic structures, but several species may very readily be distinguished by this means, particularly if the aedeagal valves are examined. This was not indicated by Banerjee (1959), or by Banerjee and Kevan (1960), who confined their attention to the epiphallus, where reliable diagnostic differences between species are few.

The following is a description of the phallic structures as applied to the genus as a whole:

Epiphallus anchor-shaped and strongly sclerotized. Bridge very wide and expanded at the distal part, its proximal part being weakly sclerotized, forming a membranous area, very characteristic of the genus. Lateral plates posteriorly directed, with expanded distal ends. Lophi arising directly from the ends of the lateral plates, with blade-like apices, somewhat upcurved and directed antero-laterally, connected by the distal part of the bridge. Appendices club-shaped, attached marginally to the posterior parts of the lateral plates, and directed postero-laterally, with expanded distal parts.

Ectophallus capsule-like, connected to the epiphallus

by a membrane and with a basal fold covering the aedeagus. Basal emargination of cingulum relatively wide and deep. Basal thickening strongly sclerotized, expanded and plate-like posterior. Apodemal plates of cingulum broad. Zygoma projecting posteriorly beyond the central membrane. Suprazygomal plate horse-shoe-shaped, surrounding the basal thickening latero-posteriorly. Central membrane comparatively wide, confined to the postero-dorsal parts of the cingulum. Rami comparatively large, and very variable among species, situated ventrally and forming an outer rim dorsally. Valves of cingulum deep or shallow, nipple-like, directed posteriorly. Ventral process triangular or subtriangular, not extending as far as the base of the cingulum, rarely beyond.

Endophallus strongly sclerotized. Endophallic apodemes dorso-ventrally flattened, usually extending above the spermatophore sac, rarely covering part of it. Aedeagal sclerites undivided, relatively long, with the middle part thickened and the distal part comparatively short or long, acute or subacute, upwardly directed. Aedeagal valves short or comparatively long, with acute, subacute or even rather blunt apices. Spermatophore sac spherical to longitudinally ovoid, gonopore usually at the central part of the spermatophore sac, rarely near the anterior end.

V SPECIES NOW RECOGNIZED

As previously indicated, only nine species and five subspecies of Atractomorpha are recognized by Banerjee and Kevan (1960), but the present work shows that there are fourteen species in the genus. Subspecies are not considered here. The following is a list, in chronological order of their original description, of the species now recognized:

Atractomorpha crenulata (Fabricius,1793)

Atractomorpha psittacina (Haan,1842)

Atractomorpha acutipennis (Guérin-Méneville,1844)

Atractomorpha crenaticeps (Blanchard,1853)

Atractomorpha lata (Motschoulsky,1866)

Atractomorpha aberrans Karsch,1888

Atractomorpha rufopunctata Bolívar,1894

Atractomorpha burri Bolívar,1905

Atractomorpha australiana Bolívar,1905

Atractomorpha himalayica Bolívar,1905

Atractomorpha sinensis Bolívar,1905

Atractomorpha australis Rehn,1907

Atractomorpha orientalis, sp.n.

Atractomorpha occidentalis, sp.n.

According to the characteristics of the male phallic structures, the different species of Atractomorpha are provisionally divided here into several groups, partly for the sake of convenience, but also in an attempt to indicate their possible phylogenetic relationships. This grouping is indicated

in the following keys to the species:

Key to Species-Groups

1, Body form robust, strongly fusiform; lateral pronotal lobe very broad, without a membranous area on the posterior margin; tegmen broad and short. Epiphallus apically more or less broadly truncated; ectophallus large and broad, zygoma never projecting into the central membrane; aedeagal valves of endophallus rather large, blunt or cap-like..... ..... A.aberrans-group. (figs. 11-14)

Body form moderately robust to slender and elongate; lateral pronotal lobe moderately broad to rather narrow, with or without a membranous area on the posterior margin; tegmen usually rather narrow, sometimes fairly broad but rather long. Epiphallus apically rounded or narrowly truncated; ectophallus small, or of medium size and somewhat elongate, zygoma always projecting into the central membrane; aedeagal valves of endophallus short, acute, or elongate and slender. ..... 2.

2, Eyes smaller, roundish; lateral pronotal lobe usually narrow, with a distinct (even if small) membranous area on the posterior part. Aedeagal valves of endophallus short and only slightly curved..... A.crenulata-group. (figs. 1-4)

Eyes larger, oval-elongate; lateral pronotal lobe varying from fairly broad to narrow-elongate, with or without a membranous area on the posterior part. Aedeagal valves of endophallus long and rather strongly curved..... 3.

3, Body form variable, sometimes very elongate; antennae as long as head and pronotum together; lateral pronotal lobe with or without a membranous area. Epiphallus with bridge very narrow in the distal part; ectophallus fairly broad; aedeagal valves of endophallus long and strongly curved. ..... A.psittacina-group. (figs. 5-7)

Body form variable, but not very elongate; antennae shorter than head and pronotum together; lateral pronotal lobe without a membranous area in majority of forms. Epiphallus with bridge wider in the distal part; ectophallus slender; aedeagal valves of endophallus somewhat shorter and less strongly curved..... A.crenaticeps-group. (figs. 8-10)

The following keys to the species are mainly based upon the forms of the aedeagal valves of the endophallus, as species of Atractomorpha are very variable both in external and internal morphology. In order to diagnose species, it is more satisfactory to deal with each species-group separately than to follow straight through with a single key to all species together.

Key to Species of the aberrans-Group

1, Pronotum and tegmina in female with distinct, scattered, dark spots. Aedeagal valves of the endophallus very broad. ..... 2. (fig.12, 13).

Pronotum and tegmina in female without dark spots. Aedeagal valves of the endophallus not very broad..... ..... 3. (fig.11, 14).

2, Body form stouter and shorter; head and pronotum comparatively stout, the surface in female with distinct scattered reddish-brown spots; tehmen in female provided with dark reddish spots on its surface; hind femur with distinct reddish spots; hind wing vermillion-coloured. Epiphallus rather broad, very strongly sclerotized, distal parts of appendices considerably expanded; central membrane of ectophallus broad, transverse, somewhat rectangular; endophallus with apodemes of aedeagal sclerites very large, their distal ends extending over the gonopore, central parts of valves of aedeagus expanded laterally in dorsal view. (S.W.Nigeria; Togo; Ghana; Ivory Coast; N.E.Liberia; Sierra Leone)..... ..... A.rufopunctata Bolívar (fig.12).

Body form usually less stout and longer; head and pronotum usually rather more elongate, the surface in female with or without scattered dark spots; tegmen in female usually without dark spots; hind femur without reddish spots; hind wing red. Epiphallus more elongate, not so strongly sclerotized, distal parts of appendices not very expanded; central membrane of ectophallus not very broad, somewhat triangular;

endophallus with apodemes of aedeagal sclerites smaller, their distal ends not overlapping the spermatophore sac (or doing so for only a very short distance), central parts of valves of aedeagus not expanded laterally in dorsal view. (N.W.Kenya; W.Uganda; N.E.Rep.Congo).....
..... A.orientalis, sp.n. (fig.13). (pls. ~~pl.~~ 3-4)

3, Eyes rather prominent, oval-elongate; tubercles of postocular area and on pronotal lobe very distinct, regularly arranged along the inferior margin of the latter; pronotum and tegmen in female distinct, scattered, dark brown spots; apex of tegmen often light pink; hind wing light to bright red. Bridge of epiphallus fairly long; ectophallus strongly contracted in the distal part, suprarami not prominent, central membrane limited at the distal part; aedeagal valves of endophallus strongly curved, broad at base, bluntly pointed apically in lateral view, the inferior margin very convex, more or less forming a right angle. (S.W.Ghana; Ivory Coast; S.E. Guinea; Liberia; E.Sierra Leone).....
..... A.occidentalis, sp.n. (fig.14). (pls. ~~pl.~~ 1-2)

Eyes less prominent, oval; tubercles of postocular area and on pronotal lobe not distinct, irregularly arranged along the inferior margin of the latter; pronotum and tegmen in female without distinct dark brown spots; apex of tegmen light green; hind wing nearly vermillion-coloured. Bridge of epiphallus shorter; ectophallus with the distal aprt broader, suprarami very broad and strongly sclerotized, central membrane not limited at the distal part; aedeagal valves of endophallus

cap-like, and denticulate at the distal part. (N.W.Zambia; N.Angola; Rep.Congo (except N.E.); Central African Rep; Congo; Gabon; Cameroons; S.E.Nigeria)..... ..... A.aberrans Karsch (fig.11).

Key to Species of the crenulata-Group

1, Membranous area of lateral pronotal lobe poorly developed or entirely absent. Phallic structures usually larger... ..... 2. (fig. 2,3)

Membranous area of lateral pronotal lobe strongly developed, even if small. Phallic structures comparatively smaller... ..... 3. (fig. 1,4)

2, Body form usually elongate; fastigium of vertex longer; eyes oval-elongate; lateral pronotal lobe slightly concave in the middle, membranous area present posteriorlly (at least in female) but weakly developed; hind femur rather short; hind wing rosy at base. Phallic complex smaller; ventral process of ectophallus short and obtuse apically; aedeagal sclerites of endophallus slightly contracted in the middle. (Afghanistan to Yemen; Madagascar; Comoro Islands; tropical and southern Africa)..... ..... A.acutipennis (Guérin-Méneville) (fig. 2)

Body form fairly stout; fastigium of vertex shorter; eyes roundish; lateral pronotal lobe not concave in the middle, without a membranous area on the posterior part; hind femur comparatively longer; hind wing yellowish, faintly pinkish at base or hyaline. Phallic complex rather larger; ventral

process of ectophallus not obtuse apically; aedeagal sclerites of endophallus not contracted in the middle. (Butan; Nepal; Sikkim; N.India)..... ..... A.himalayica Bolívar (fig. 3).

3, Body form generally rather shorter; fastigium of vertex shorte and slender; eyes roundish; interocular space slightly convex; hind wing smaller and purplish-pink at base. Appendices of epiphallus longer reach to the lophi; ventral process of ectophallus slightly contracted in the middle; aedeagal valves of endophallus shorter. (S.Iran; Nepal; India; E. Pakistan; Ceylon; Viet Nam; Cambodia; Thailand; Malaya; Sumatra; Java)..... ..... A.crenulata (Fabricius) (fig. 1).

Body form generally more longer; fastigum of vertex longer and broader; eyes oval-elongate; interocular space flatter; hind wing larger and rosy at base. Appendices of epiphallus shorter not surpassing the lophi; ventral process of ectophallus not contracted in the middle; aedeagal valves of endophallus longer. (India; China (including Tawan); Hong-Kong; Ryu-Kyu Islands; introduced into Hawaiian Islands).. ..... A.sinensis Bolívar (fig. 4).

Key to Species of the psittacina-Group

1, Body form very slender; fastigium of vertex very elongate; pronotal lobe long and slender, with or without a small membranous area on the posterior margin; tegmen with very acuminate apex; hind wing light rosy at base. Central

membrane of ectophallus very expanded laterally at base; valves of aedeagus somewhat variable in length, but usually rather broader. (S.China; Indo-China; Burma; Assam; E.Pakistan; Ceylon; Thailand; Malaya; Borneo; Sumatra; Java; Philippine Islands).....
..... A.psittacina (Haan) (fig. 5).
Body form not so slender; fastigium of vertex comparatively shorter and broader; pronotal lobe rather broad, without a membranous area on the posterior margin; tegmen with less acuminate apex; hind wing hyaline or pinkish. Central membrane of ectophallus not expanded at the base; valves of aedeagus slender elongate ..... 2.

2, Body form rather elongate; head and pronotum rather long; interocular space wider and convex; hind wing fairly short and narrow, virtually colourless; base of hind femur not strongly convex. Basal emargination of ectophallus rather narrow and shallow; aedeagal sclerites of endophallus slightly contracted in the middle, valves of aedeagal shorter and broader. (N.& C. China; Korea; Ryu-Kyu Islands; Japan)...
..... A.lata (Motschoulsky) (fig. 7).
Body form shorter and stouter; head and pronotum shorter and rather stouter; interocular space narrower and flatter; hind wing fairly long and broad, pinkish; base of hind femur strongly convex. Basal emargination of ectophallus generally wider and deeper; aedeagal sclerites of endophallus not contracted in the middle, valves of aedeagus longer and rather slender. (E.Pakistan; N.E.India; Nepal; S.China; Viet

Nam; Burma; Thailand; Malaya).....
..... A.burri Bolívar (fig. 6).

Key to Species of the crenaticeps-Group

1, Body form usually broader and shorter; fastigium of vertex shorter and broader; lateral pronotal lobe without a membranous area, tubercles of inferior margin distinct; hind wing very small. Phallic structures larger and broader; valves of aedeagus shorter and broader. (E.& S.E Australia).
..... A.australis Rehn (fig. 10).
Body form generally slender and rather elongate; fastigium of vertex longer and rather slender; lateral pronotal lobe with or without a membranous area, tubercles of inferior margin not distinct; hind wing comparatively rather large. Phallic structures usually smaller and more elongate; valves of aedeagus longer and more slender.....
..... 2

2, Body form usually rather small; lateral pronotal lobe generally short and shallow, in female usually (male occsionally) with a membranous area near the posterior margin. Phallic complex comparatively smaller and less elongate; gonopore of endophallus near the center of spermatophore sac; valves of aedeagus shorter and more slender. (S.& E. Papua (New Guinea); Islands of Torres Strait; N.& E.Australia).....
..... A.australiana Bolívar (fig.9).
Body form comparatively larger; lateral pronotal lobe longer and deeper, without a membranous area on the posterior margin.

Phallic complex larger and more elongate; gonopore of endophallus near the apical part of spermatophore sac; valves of aedeagus longer and broader. (New Guinea (except S.&.E. Papua); Bismarck Archipelago; Solomon Islands)..... ..... A.crenaticeps (Blanchard) (fig.8).

VI SYNONYMIES AND DIAGNOSES OF SPECIES

A. The A.crenulata-group

1. Atractomorpha crenulata (Fabricius,1793)

Synonymy:

(a), Atractomorpha crenulata crenulata (Fabricius,1793)

Truxalis crenulatus Fabricius, 1793:28

Truxalis scaber Thunberg, 1815:266

Truxalis crenatus Thunberg, 1827:86

Truxalis porrecta Walker, 1859:222

Atractomorpha consobrina Saussure, 1862:475

Atractomorpha gerstaeckeri Bolívar, 1884:64,66 (partim);

Atractomorpha similis Bolívar, 1884, Ibid:64,66 (partim);

Atractomorpha angusta Karsch, 1888:333

Atractomorpha infumata Bolívar, 1898:86

Atractomorpha crenulata var. prasina Bolívar, 1905:197,201

Atractomorpha obscura Bolívar, 1916:392

Atractomorpha crenulata crenulata; Banerjee and Kevan, 1960:184,185 - [illegible].

(b), Atractomorpha crenulata rhodoptera Karsch, 1888

Atractomorpha rhodoptera Karsch, 1888:332

Atractomorpha crenulata var. fumosa Bolívar, 1905:197,201

Atractomorpha sinuata Bolívar, 1905:197,201

Atractomorpha lanceolata Bolívar, 1905:197,202

Atractomorpha crenulata rhodoptera; Banerjee and Kevan, 1960:185,186 - [illegible].

Type localities: T.crenulata; Tranquebar, South India.

T.scaber; (type without any data label).

T.porrecta; Ceylon.

A.consobrina; Peredeniya, Ceylon.

A.gerstaeckeri; Calcutta, India.

A.similis; Andaman Islands.

A.angusta; Bintang, Rotger, Java.

A.infumata; Si-Rambe, Sumatra.

A.crenulata var. prasina; Trichinopoly, S.India.

A.obscura; Godavari Distr. South India.

A.rhodoptera; Java.

A.crenulata var. fumosa; Tjibodar, Java.

A.sinuata; Java.

A.lanceolata; Padang, Java.

Types: T.crenulatus; ♀ (lectotype), Copenhagen.

T.scaber; ♀ (holotype), Uppsala.

T.porrecta; type specimen is missing.

A.consobrina; ♂ (lectotype), Geneva.

A.gerstaeckeri; ♀ (lectotype), Cambridge Museum (Harvard University).

A.similis; ♀ (holotype), Madrid.

A.angusta; ♂ (lectotype), Berlin.

A.infumata; ♀ (lectotype), Genoa.

A.crenulata var. prasina; ♂ (lectotype), Madrid.

A.obscura; ♀ (lectotype), ♂ (lectotype), Madrid.

A.rhodoptera; ♀ (holotype), Berlin.

A.crenulata var. fumosa; ♀ (holotype), Madrid.

A.sinuata; ♀ (lectotype), Madrid.

A.lanceolata; ♂ (holotype), Madrid.

The original description of Truxalis crenulatus given by Fabricius (1793) is mainly concerned with the general coloration of the body; the few other characters given have little taxonomic value. Saussure (1862) was the first to recognize that Fabricius' T.crenulatus was a species of his own genus Atractomorpha.

The single female holotype of Thunberg's (1815) Truxalis scaber is without any data on the type specimen. His original description is also very brief: he states that the hind wings are hyaline. Stål (1873) synonymized T.scaber with A.crenulata and indicated it to be a variety of the latter (see Kevan,1963).

The description of Truxalis crenatus by Thunberg (1827) is also so brief as to be valueless. Stål (1873) correctly considered the species to be a variety of A.crenulata Fabricius.

The original description of Truxalis porrecta by Walker (1859) gives no distinctive characters by which the species may be identified, although he mentions some features that are commonly found in A.crenulata and other species (e.g. the body with various blackish marks; antennae hardly longer than the head). What is more important, however, is that he records the species from Ceylon, which is within the distributional range for A.crenulata, but only dubiously for any other species (A.psittacina ?).

Saussure's (1862) Atractomorpha consobrina is said by its

author to be very similar to A.crenulata, but is alleged to differ from the latter in the antennae being more slender, the body form slightly narrower, the tegmina slightly less wide, the head more horizontal with a slightly elongate fastigium verticis, and prosternal lamina subemarginate and subdentate, All these characters are insufficient to separate the species from A.crenulata. Saussure also mentions that A.consobrina perfectly resembles A.crenulata in the form of the body, but later says that the form is slightly narrower. At the end of his description, he mentions that his species and A.crenulata are also related to A.psittacina (Haan), but he presumably implied little more than all belong to Atractomorpha, Kevan (1963) has discussed the types of A.consobrina.

In the original description of Atractomorpha angusta, Karsch (1888) remarks that this species is similar to A.crenulata in having the ocellus placed close to the base of the antennae, but differs in the slender body form, and in the more arcuate margin of the lateral lobe of the pronotum. None of these features has any diagnotic value.

Bolívar (1898), in his original description of Atractomorpha infumata, does not indicate any character by which the species can be separated from others. Most of the characters mentioned are either individual variations, or may be found in most species of Atractomorpha. The hind wings are said to be strongly infumate, but infumate hind wings are also found in most brown specimens of A.crenulata. Because the degree of infumation is so variable, it cannot considered to be a specific

character. Later, Bolívar (1905) again mentions the infumate wing colour and says that the lateral lobes of pronotum are less broad and more elongate, that the tegmina are long, and that the fastigium of the vertex is somewhat longer in profile. All these variable characters are useless for the identification of the species.

Atractomorpha crenulata var. prasina is said by Bolívar (1905) to differ from typical A.crenulata in having the dorsal carinae of the pronotum somewhat indistinct and the caudal margin rather obtuse. In general, however, Atractomorpha species vary in the degree of development of the carinae and in the exact shape of the caudal margin of the pronotum.

Atractomorpha obscura is said by Bolívar (1916) to be similar in form and size to A.crenulata, but to differ from the latter in the more elongate head, the slightly longer fastigium as compared with the eyes, and in the entirely infumate hind wings. These differences, however, have no taxonomic significance.

Karsch's (1888) description of Atractomorpha rhodoptera is as follows: the antennae separated from the ocellus by a space equal to the breadth of the antenna, the fastigium of vertex almost double the length of the eye and having a narrow anterior margin and subacute apex, the anterior pronotal margin truncate and somewhat emarginate in the middle, the lateral pronotal lobe posteriorly rounded, the prosternal tubercles broad and with a rounded apex, the hind wings shorter than the tegmina by one-third of their length and with the inner part

rosy in colour, etc. None of these characters is very helpful for identification. Karsch (op. cit.) mentions that his species closely approaches to A.similis Bolívar, but differs from the latter by the very short hind wings (which are, in fact, usually short).

Atractomorpha crenulata var. fumosa is said by Bolívar (1905) to differ from typical A.crenulata in the following features: the dark testaceous colour of the body; the form and colour of the tegmen, which has a very acute apex and a gradually arcuate anterior margin and which is posteriorly narrow and reddish in colour; the hind wing being scarcely shorter than tegmen, rosy at the base and with its external margin slightly infumate. None of these characters is of taxonomic importance.

Bolívar's (1905) Atractomorpha sinuata was described very ambiguously and he did not indicate whether the types possess a membranous area on the lateral pronotal lobe. The types have been examined by Banerjee and Kevan (1960); they show all the characteristics of A.cr.rhodoptera.

In the original description of Atractomorpha lanceolata, Bolívar (1905) mentions some characters, e.g. body form large and broad, the absence of the distinct membranous area on the pronotal lobe, etc. The most important feature of his species, as considered by Bolívar, is the prosternum, of which the anterior margin has a broad tubercles in the middle, emarginate apically. This character, however, has no diagnostic value.

Diagnosis of the species:

Body form small and slender (a little shorter in subspecies

rhodoptera), polymorphic in coloration. Head short, fairly broad at base; fastigium of vertex rather short and narrow; eyes not prominent and roundish; oblique rows of postocular tubercles fairly distinctly raised and regularly arranged. Pronotum comparatively deep, broad at base; its surface rather granular; lateral lobe in both sexes always with a membranous area near the posterior margin, typically very distinct, but less so in subspecies rhodoptera; the tubercles along the lower margin prominent or not, caudal margin fairly strongly arcuate. Hind wings usually comparatively large (sometimes rather small in subspecies rhodoptera), rosy at base, except in certain brown specimens when they may be infumated.

Phallic structures (fig. 1) very samll. Epiphallus with its apical margin rounded and the distal margin semicirclarly excised; bridge comparatively long and the distal part not very wide; membranous area fairly large; lateral plates slender; appendices extremely wide at distal ends. Ectophallus slender; basal thickening strongly sclerotized; central membrane relatively wide; suprarami very distinct; ventral process short and slender, not extending beyond the apodemal plates of the cigulum, and slightly contracted in the middle; ventral cleft rather shallow. Endophallus slender; valves of aedeagus very short, fairly broad at base.

Male specimens examined:

Iran:

2, Gew, Baluchistan. iv-1951

Nepal:

2, 3 mil. NE.Palung, 1840 mil. 22-xi-1961

1, nr.Tarebhir, 4-500 ft. 26-x-1960

1, W.Bengal, 5 mil. S.Rongpo 375 mil. 27-x-1961

1, E.Reg. Arun Val.

India:

1, S.Reg. Dohnavur, Tinnevelly Distr. 3-x-1938

1, S.Reg. Madras, Anamalai Hills, 4-5000 ft. 24-vi-1946

2, S.Reg. Madara, Karikal Terr. Kurum Dagaram. 26-iv-1946

2, S.Reg. Madras, Tanjore Distr. Nedungadu. 20-v-1938

5, S.Reg. Madras, Anamalai Hills, Cinchoua, 3500 ft. v-1962

1, S.Reg. Pondicheray Sta. Karial. I-1962

3, S.Reg. Madras, Coimbatore, 1400 ft. x-1961

2, Mysore, 10 mil. N.Belur, 1025 mil. 20-xi-1962

1, S.Reg. Kerala, S.Malahar, Walayar. 28-viii-1938

1, S.Reg. Kallar, 1500 ft. 18-v-1928

1, Bihar, 5 mil. SE.Netarhat 1000 mil. 11-xi-1961

1, M.P.Pharasgaon 550 mil. 11-I-1962

1, Trichinopoly Pres Madras. 1920

1, Okhla. 22-vi-1958

1, Madhupur, Bihar Sta. 20-xii-1953

1, Chotanagpur, Manoharpur, Singhhnum Distr. 26-II-1954

1, Orissa, 3 mil. SE.Pottangi, 3345 ft. 3-II-1962

1, N.Agpur. 8-III-1945

Pakistan:

1, E.Reg. Chittagong, 2 mil. 10-ix-1961

Ceylon:

1, Kandy. 12-1907

Viet Nam:

1, Dailung, N.Nha Trang. 30-xi-1960

1, Ninh Hoa, N.Nha Trang. 28-xi-1960

2, M'Drak.

Cambodia:

1, Bdeng Po. 26-I-1960

Thailand:

1, Bongkok. 26-v-1926

1, Yan Hee Dam, 250 mil. 13-vii-1962

1, Klong Rang Sit. 26-v-1926

Malaya:

1, 2 mil. E.Gofeng, 100 mil. 21-vi-1962

1, Kedah, P. K. 3300-3978 ft. 28-vi-1962

1, Stapak, Kuala Lumpur. vii-1921

Sumatra:

L, W.Reg. P.Tello. 11-1924

2, Medan. 16-xi-1919

1, Verlaten Eiland, Krakatau.

1, Lang Eiland, Krakatau.

Java:

4, Buitenzorg (= Bogor).

1, Soerabaja.

2, E.Indies, Sabang, Wai Island.

1, Middle Java, Krang-Nongk.

1, Bandoeng.

1, Batoeriti, 3500 ft. vi-1939

1, Belang. vii-1937

2, Atractomorpha acutipennis (Guérin-Méneville,1844)

Synonymy:

(a), Atractomorpha acutipennis acutipennis (Guérin-Méneville,1844)

Truxalis (Pyrgomorpha) acutipennis Guérin-Méneville,1844:340

Atractomorpha hova Saussure, 1899:640

Atractomorpha madacassis Bruner, 1910:628 (referred to typical subspecies by Kevan (1962)

Atractomorpha acutipennis acutipennis; Banerjee and Kevan, 1960:182

(b), Atractomorpha acutipennis gerstaeckeri Bolívar,1884

Truxalis crenulata; Burmeister, 1838:609 (nec Fabricius,1793

Atractomorpha gersraeckeri Bolívar, 1884:64,66,495 (partim);

Atractomorpha aurivillii Bolívar, 1884:64,67,495, pls. fig. 8 (partim);

Atractomorpha congenesis Saussure, 1893:581 - nomen nudum (cf. Kevan,1960)

Atractomorpha aurivilliusi; Yakobson, 1902:198,289 (partim);

Atractomorpha acutipennis gerstaeckeri; Banerjee and Kevan, 1960:183

(c), Atractomorpha acutipennis brevis Uvarov,1938*

Atractomorpha blanchardi Bolívar, 1905:198,206

*It may be that the name of this subspecies should be A.a.blanchardi, but as the type of A.blanchardi is lost, no change is propared for the present.

Atractomorpha blanchardi Kirby, 1914:181,184
(Error for A.blanchardi Bolívar)
Atractomorpha brevis Uvarov, 1938:274,280, fig. 3, a,b,
Atractomorpha externa Bei-Bienko, 1949:173,174, fig. 1-2.
Atractomorpha acutipennis brevis; Banerjee and Kevan,
1960:184

Type localities: T.acutipennis; Nossi Bé Island, Madagascar.
A.hova; Nossi Bé, Madagascar.
A.madacassis; Madagascar.
A.gerstaeckeri; Victoria, "Gabon"/ (actually Camroons).
A.aurivillii; Cape, South Africa.
A.blanchardi; Karachi, W.Pakistan.
A.brevis; Wadi Sharis, Yemen.
A.externa; Nemlia, Afganistan.

Types: T.acutipennis; ♀ (neotype), Geneva.
A.hova; ♀ (lectotype), geneva.
A.madacassis; ♀ (lectotype), Berlin.
A.gerstaeckeri; ♀ (lectotype), Madrid.
A.aurivillii; ♀ (lectotype), Stockholm.
A.blanchardi; type material is lost.
A.brevis; ♀ (holotype), Cairo.
A.externa; ♀ (holotype), Leningrad.

In the original description of Truxalis (Pyrgomorpha) acutipennis, Guérin-Méneville (1844) mentions the postocular

row of tubercles, the narrow, elongate body form and the slender and long tegmina. These features are important in indicating that the species belongs to Atractomorpha, but the rest of the characters described by him are of little significance.

Saussure's (1899) description of Atractomorpha hova contains nothing worthy of note. He mentions that the head in the female is a little shorter than the pronotum, and that of the male is about the same length. He also mentions that the tegmina greatly surpass the abdomen. At the end of his description, Saussure states that the species stands close to A.aurivillii Bolivar, but differs in possessing a more elongate hind end to the pronotum.

In his original description of Atractomorpha madacassis, Bruner (1910) mentions very briefly that this species is smaller in size than A.hova Saussure. He also describes the general body colour of the type specimens, but this and other characters emphasized by him have no taxonomic value. The female lectotype of A.madacassis has been examined by Banerjee and Kevan (1960), and was considered to be an example of A.a.gerstaeckeri, but later, Kevan (1962) referred it to typical A.a.acutipennis.

In the description of Atractomorpha gerstaeckeri, Bolívar (1884) considers that the following features are diagnostic to his species; the triangular fastigium with its apex gradually narrowed and sinuated on both sides, the pronotum anteriorly excised, and the apex of the tegmen acuminate and short. The above do not indicate any good specific characters, since in

all species of Atractomorpha the fastigium is somewhat triangular.

According to Bolívar (1884), Atractomorpha aurivillii is distinguished by having the posterior portion of the dorsum of the pronotum gradually enlarged, with the carinae almost inconspicuous, the posterior lobe provided with granules, and the transverse sulcus somewhat indistinct. Bolívar separated his A.aurivillii from A.gerstaeckeri by its longer tegmina, which exceed the hind femora by one-third of its length, by the hind femur being granulated, and by the tibia being somewhat shorter than the head and pronotum together. Because of great individual variation, all these differences, however, are of no practical significance.

Bolívar's (1905) Atractomorpha blanchardi was described from Karachi, but the type is lost (see Kevan,1963). Bolívar gives no character of practical significance in his original description, the most important feature considered by him is that the antennae are rather long, with the segments distinctly elongate. But the length of antennae, as well as that of their segments, varies considerably in most species of Atractomorpha. Banerjee and Kevan (1960), and Kevan (1963) list A.blanchardi as synonym of A.crenulata, because the type locality was believed to be within the distributional range of the latter, but the only known material from the appropriate parts of Pakistan seems to belong to the present species. The identity of this form is still in doubt.

Uvarov (1938) says that his new species Atractomorpha

brevis differs from A.gerstaeckeri Bolívar by its shorter fastigium of vertex and shorter tegmen. He has also indicates that the species may be a subspecies of A.gerstaeckeri.

The original description of Atractomorpha externa by Bei-Bienko (1949) does not mention any distinctive characters by which his species could be separated from other species. However, such characters as occiput 1-2 times longer than its width near the base, and pronotum with indistinct lateral carinae, etc. are given. The original figure of A.externa shows distinctly the less convex eye, which is characteristic of A.acutipennis. Bei-Bienko (l.c.) also remarks that his A.externa superficially resembles A.crenulata, which indeed it does.

Diagnosis of the species:

Body form slender. Head rather broad at base; fastigium of vertex fairly long and wide; coronal suture very distinct; oblique rows of postocular tubercles prominent and regularly arranged; eyes distinctly elongate-oval. Pronotum moderately broad at base, its surface with evenly scattered granules; lateral lobe fairly concave and with a fairly distinct membranous area posteriorly (at least in the female); tubercles on the lower margin prominent or not. Tegmina comparatively long and broad, with acute apices. Hind wings fairly large, rosy at the base.

Phallic structures of moderate size (fig. 2). Epiphallus with a fairly narrow bridge, its apex rounded and the basal margin semicircularly excised; lateral plates of cingulum

strongly sclerotized and very sinuous at their bases; anterior projections extending laterally. Ectophallus with a fairly broad cingulum; basal emargination comparatively narrow and deep; suprazygomal plate broad; zygoma projecting into central membrane, and with an acute apex; ventral process short and obtuse apically. Spermatophore sac of endophallus very large; aedeagal sclerites slightly contracted in the middle; valves of aedaegus very short, their apices not acute.

Male specimens examined:

Madagascar:

2, Maraoncetra.

1, Ambanja. 30-x-1952

2, Tananarive.

Comoro Islands:

1, Ampefy Prov. Itasy.

2, Grande. 5-ix-1911

Senegal:

3, Ziguinchor. 3-ix-1962

S.Africa:

2, 10 mil. NE.Haenertsburg. 20-iv-1961

Rep.Congo:

1, Kalulu. 6-v-1939

Middle Congo:

3, Nola Sanga R. Elev.1300 ft. 30-x-1934

Cameroons:

4, Bota. 7-x-1961

2, Bitji, Ja River.

2, S.Reg. 6 mil. E.Kumba. 26-xii-1960

Sudan:

1, Nimule, S.Border. 6-xi-1948

Uganda:

1, Attak. 24-xi-1931

1, Kilembe, 4500 ft. 1935

Ghana:

3, W.Reg. 7 mil. N.Cape Coast Brimsu. 17-x-1959

2, W.Reg. Dadiseso, Dadieso-Enchi Rd. 27-ix-1962

1, Ashanti, nr. Na Aume. 14-viii-1959

1, Ashanti, nr. Kubease 22 mil. Kumasi-Accua Rd. 27-v-1957

1, W.Reg. 5 mil. W.Tano R. Ferry. 12-vii-1962

3, Weija, E.Reg. 24-x-1958

Saudi Arabia:

1, Asir, Wadi Jowra, 1000-2000 ft. 25-xii-1947

1, Asir, Jaheri. 29-xi-1947

Iran:

1, Persian Baluchistan, Seimacha, Sarhaz. 17-II-1901

1, Pischin. v-1949

1, Umgeb v.Kabul, 1740 mil. 19-ix-1952

Kashmir:

1, NW.Reg. Hunza-Nagan, Chalt 1880 mil. 15-vii-1959

3. Atractomorpha sinensis Bolívar,1905

Synonymy:

Perena concolor Walker, 1870:506 (partim);

Atractomorpha aurivillii Bolívar, 1884:64,67,495 (partim);

Atractomorpha aurivillius; Yakobson, 1902:198,289 (partim);

Atractomorpha sinensis Bolívar, 1905:198,205

Atractomorpha angusta Bolívar, 1905:198,207 (nec Karsch,1888)

Atractomorpha ambigua Bolívar, 1905:198,209 (cf. Banerjee and Kevan,1960)

Pyrgomorpha indica Blanchard (partim) - museum name.

Type localities: A.sinensis; China.
A.angusta; Mou-Pin, China.
A.ambigua; Shanghai, China.

Types: A.sinensis; ♀ (holotype), Paris.
A.angusta; ♀ (lectotype), Paris.
A.ambigua; ♀ (holotype), Paris.

One of the syntypes of Perena concolor of Walker (1870) belongs to this species; no locality is given on its data label. The lectotype, however, is referable to A.lata. The fact that the hind wings are colourless, may be due, in this case, to preservation in alcohol. The lectotype of A.aurivillii is synonymous with A.acutipennis (subspecies gerstaeckeri) - see Banerjee and Kevan,1960 - but one of Bolívar's (1884) syntypes belongs to the present species, and is from Taiwan, and not conspecific with the South African syntype which has generally

been accepted as forming the basis of A.aurivillii (see Kevan, 1960).

In his description of Atractomorpha sinensis, Bolívar (1905) mentions the pronotal membrane and also comments that the hind wings are a little shorter than the tegmina, rosy at base. These features are characteristic of the species, but other characters described by him are individual variations and have no practical significance.

Atractomorpha angusta (nec Karsch) is described as a new species by Bolivar (1905), the original specimens (a male and a female) are in the Paris Museum. Kevan (1963) has discussed this problem thoroughly, and also has designated the female as lectotype.

According to Bolívar (1905) the most distinct characters of Atractomorpha ambigua, are that the mesosternal interspace is not transverse and that the fastigium of vertex is rather wide, little longer than broad, but these characters are merely individual variations. He also indicates certain characteristics of A.sinensis in the description, e.g. the pronotal membrnae and the colour of the hind wings.

Diagnosis of the species:

Body form fairly slender. Head rather broad at base; fastigium of vertex comparatively long and broad; postocular tubercles distinct and regularly arranged; eyes elongate-oval, their interspace fairly wide. Pronotum not very deep, but broad at base; lateral lobe without prominent tubercles but with a distinct membranous area at the posterior margin, the caudal

margin fairly strongly arcuate. Tegmina fairly long and broad, with acute apices. Hind wings relatively large, reddish at base.

Phallic complex fairly small (fig. 4). Epiphallus slender; bridge comparatively long with a fairly large membranous area in the basal part, basal margin somewhat excised, apical margin rounded; appendices usually short with strongly expanded apices. Ectophallus with a fairly broad cingulum; zygoma projecting posteriorly with the distal margin slightly concave; central membrane wider than its length; suprarami very distinct; ventral process subtriangular, not extending beyond the apodemal plates of cingulum; ventral cleft fairly deep. Endophallus slender; gonopore at centre of the spermatophore sac; valves of aedeagus short, broad at base.

Male specimens examined:

Taiwan:

60, Taichung and Hwa-Lien. vii-1964

Mainland China:

1, Fukien Prov. Yen Ping. ix-1920

1, Foochow. 1936-37

1, Yunnan Fou, San Nen Kai.

1, Nanking. 14-ix-1923

1, Canton. 30-xi-1932

1, Shanghai. 28-ix-1919

1, Shanghai. 19-x-1954

4, Shantung, Tsinan. 17-x-1929

1, Manchuria, Djalantun. 25-v-1939

Hong-Kong:

1, New terr. Yuan Chau (on coast east of Kowloon). vii-1957

Ryu Kyu Islands:

1, Hirara, Mijako. 23-x-1952

Hawaiian Islands:

1, Midway Island. 10-xi-1959

4. Atractomorpha himalayica Bolívar,1905

Synonymy:

Atractomorpha aurivillii Navas, 1904:133 (nec Bolivar)

Atractomorpha himalayica Bolívar, 1905:198,204

Atractomorpha hymalaica Salfi, 1934:9, fig. 5 a-c

Atractomorpha burri; Banerjee and Kevan, 1960:177 (partim);

Type locality: Kurseong, Himalaya.

Type: ♀ (holotype), Madrid.

In the original description of Atractomorpha himalayica, Bolívar (1905) gives the following among the characters: posterior margin of lateral lobes of pronotum obtusely angulate, their posterior angles not produced backwards; fastigium cephalad of the eye subelongate; body form large. Other features described by him, are more or less applicable the similar species, A.burri.

Navas (1904) identified material from Kurseong as Atractomorpha aurivillii, but after the publication of Bolivar's

description of A.himalayica, he corrected the error.

Salfi (1934) was a little doubtful about the identification of his material, however, his figure shows no membrane on the lateral pronotal lobe, its absence being a characteristic feature of the present species as comparad with A.crenulata which might occur in same general area, so that Salfi's material is probably A.himalayica.

Atractomorpha himalayica is regarded by Banerjee and Kevan (1960) as a synonym of A.burri, although they suggested it might merit subspecies status. The phallic structures, and particularly the aedeagal valves are quite different in the two forms.

Diagnosis of the species:

Body form rather robust. Head short, very broad at base; eyes roundish, fairly prominent, interocular space wide, and slightly concave; fastigium of vertex short, rather broad; oblique rows of postocular tubercles distinct. Pronotum stout, rather deep; posterior margin of pronotal lobe without a membranous area, its lower margin without tubercles, caudal margin rather arcuate. Tegmina without dark spots, fairly short, apices not very acute. Hind wings rather large, variable in coloration (yellowish, very faintly rosy or hyaline).

The phallic complex is the largest in the group (fig. 3). Epiphallus rather large, bridge wide; lateral plates not very broad, strongly sinuous at the base. Ectophallus broad; basal emargination wide and deep; basal thickening strongly sclerotized and rather small; projection of zygoma not acute; central

membrane narrow; suprarami strongly sclerotized and broad; ventral process triangular, extending to the ends of the apodemal plates of the cingulum; ventral cleft fairly deep. Endophallus slender, rather elongate; spermatophore sac comparatively small; valves of aedeagus very short, their upper margins rather arcuate.

Male specimens examined:

Butan:

3, anglais. 1900

Sikkim:

1, Singhik, 4000 ft. 23-iv-1924

Nepal:

1, N.Reg. Arun Val. 7000 ft. 15-vi-1954

1, Pokhara.

N.India:

1, Himalaya: Umgebung v. Darjiling.

B. The A.psittacina-group

1. Atractomorpha psittacina (Haan,1842)

Synonymy:

Acridium (Truxalis) psittacinum Haan, 1842:142 (as A.(Truxalis) psittacinum), 1844:146, pl. 23, fig. 2 (as Acridium psittacinum).

Pyrgomorpha parabolica Walker, 1870:498

Pyrgomorpha contracta Walker, 1870:499

Atractomorpha philippina Bolívar, 1905:199,212

Atractomorpha dohrni Bolívar, 1905:199,212

Type localities: A.(T) psittacinum; Java.
P.parabolica; Borneo.
P.contracta; Philippine Islands.
A.philippina; Dolores, Philippines.
A.dohrni; N.Borneo.

Types: A.psittacinum; ♂ (lectotype), Leiden.
P.parabolica; ♀ (holotype), London.
P.contracta; ♂ (holotype), London.
A.philippina; ♂ (holotype), Madrid.
A.dohrni; ♀ (lectotype), Madrid.

In his description of Acridium psittacinum, Haan (1842) gives no character of importance other than the elongate head. He did not mention the very slender body form of the species, although this is clearly illustrated in his figure (Haan,1844).

Walker's (1870) description of Pyrgomorpha parabolica

indicates certain characteristic features of A.psittacina, as "the head a little longer than pronotum; eyes not prominent; fore wings narrow, very acute; legs slender". Kirby (1910), who had access to the type, correctly considered the two species to be synonymous.

In Walker's (1870) description of Pyrgomorpha contracta, that species is said to be different from P.parabolica in the "longer fore part of the head". Other characteristics mentioned are similar to those of A.psittacina. Kirby (1910) also rightly considered P.contracta and A.psittacina to be identical.

In his description of Atractomorpha philippina, Bolivar (1905) says that it differs from A.psittacina in the following characters: head strongly granular and carinate above; antennae shorter and somewhat broader; pronotal lobes deflexed with posterior angle not produced backwards; hind wing with its anterior margin at the end marked with black, elongate and subnebulous. All these differences are rather generalized, merely individual variations, since, in the Philippines no other species of Atractomorpha than A.psittacina occurs.

Bolívar's (1905) description of Atractomorpha dohrni is very brief; the species is said to differ from A.psittacina by the shorter fastigium and by mesosternal interspace being less narrow posteriorlly. These characters are purely individual variations.

Diagnosis of the species:

Body form very slender and elongate. Head rather narrow and very elongate; fastigium of vertex long and slender; eyes

small, oval, not prominent; interocular space fairly narrow; oblique rows of postocular tubercles distinct; antennae comparatively short. Pronotum slender, not very deep; lower margin of lateral lobe provided with large, regularly arranged tubercles; the caudal margin without or with only a very small membranous area. Tegmina very long and narrow, with very acute apices. Hind wings rather large, rosy at the base.

Phallic complex variable, usually of modertae size (fig.5), but in some populations particularly from upper Burma and Assam, they are rather larger. Epiphallus broad; lateral plates narrower at distal sinuous part; membranous area of bridge comparatively large, and bridge wide in the group. Ectophallus variable, fairly broad or slender elongate; central membrane with the anterior parts very expansive laterally; ventral cleft not deep. Endophallus generally stout; spermatophore sac rather broad; valves of aedeagus elongate and broad, their length much more variable than in other species.

Male specimens examined:

N.India:

1, Assam, Ledo Rd. 3.5 mil. from Ledo.

4, Assam, Chabua. vii-1943

1, Assam, Rupsi. 6-xi-1943

1, Assam, Kohara, Kaziranga, 110 mil. 7-x-1961

E.Pakistan:

1, Chittagong. 10-ix-1961

Ceylon:

2, Ceylon. 1889 (? incorrectly labelled).

N.E.Burma:

1, "Yunnan" (sic). Nam ti. 1908

Thailand:

1, Bangkok, 3 mil. 24-vii-1962

1, Khao-Yai Nat. Pk. 750 mil. 26-vii-1962

1, Bangkok. 25-xii-1939

1, Chieng Mai. 17-III-1926

1, Depok. 8-viii-1920

Laos:

1, Mong Hsing.

Viet Nam:

1, Kouy-Tcheou, Reg. Pin Fa. 1910

2, Tonkin, Reg. Hoa Bing. 1908

Philippine Islands:

1, Negros or. 1 Km. N.Dumaguete. 5-I-1961

2, Los Banod, Elev.30 mil. 26-vi-1962

1, Mt.Makiling Elev.200 mil. 8-vii-1962

1, Polillo.

1, San Jose, Mindoro. x-1945

2, Negros I. Cauayang, Masaling. 2-III-1962

2, Mindanao, Agusan, Leo Arcos. 19-II-1959

1, Negros or. Dumaguete City. 5-I-1961

1, Batangas. 8-viii-1943

1, Palo Leyte. 9-vi-1957

1, Palawan, Brookes Point, Uring Uring. 14-viii-1961

Borneo:

1, NW.Reg. Kuching. 30-ix-1900

4, Sarawak, Kampong Pueh, Lundu Distr. 12-vi-1958

2, W.Coast Residency, Ranau, 500 mil. 28-vi-1958

1, Sarawak Kuching, Santubong, 797-1500 mil. 30-vi-1958

1, Sarawak, Shelford.

Sumatra:

1, W.Sumatra.

1, Sungei Penok, Korinchi Val. 2600 ft. 3-1914

Malaya:

1, E.Gopend 2 mil. 21-vi-1962

3, Penang. viii-1889

2. Atractomorpha lata (Motschoulsky,1866)

Synonymy:

Truxalis brevicornis; Thunberg, 1815:264 (nec Truxalis brevicornis; Fabricius,1775 = Gryllus brevicornis Linnaeus,1764

Truxalis lata Motschousky, 1866:181

Perena concolor Walker, 1870:506 (partim);

Truxalis diminuta Walker, 1871:50

Minorissa alata Thomas, 1874:63 (cf. Kevan,1960)

Atractomorpha bedeli Bolívar, 1884:63,69

Acrida lata * Yakobson, 1902:214

Atractomorpha heteroptera Bei-Bienko, 1951:274,276

*It should be noted that Acrida lata of Various other authors refers to Acrida cinerea (Thunberg,1815) (Acrididae) and not to the present species (see Kevan,1963).

Atractomorpha lata Bei-Bienko, 1951:277

Atractomorpha brevicornis brevicornis; Banerjee and Kevan, 1960:185-187

Atractomorpha brevicornis heteroptera; Banerjee and Kevan, 1960:187

Type localities: T. lata; Japan.
P.concolor; Korea.
T.diminuta; China.
M.alata; "S.America ?" (cf. Kevan,1960)
A.bedeli; Yokohama, Japan.
A.heteroptera; Mukden, China.

Types: T.lata; ♀ (neotype = lectotype of A.bedeli), Madrid. (holotype, Moscow, destroyed, see Kevan,1963)
P.concolor; ♀ (lectotype), London.
T.diminuta; ♂ (holotype), London.
M.alata; ♀ (holotype), Washington.
A.bedeli; ♀ (lectotype), Madrid. (not in Paris, see Kevan,1963)
A.heteroptera; ♀ (lectotype), Leningrad.

In his reference to Truxalis brevicornis, Thunberg (1815) states: "hemelytra sesqui longiora, alis hyalinis", a distinctive characteristic of this species. The other characters given by him have no significance for identification. Since Thunberg's use of the name Truxalis brevicornis was based on a misidentification and did not involve the description of a

new species, brevicornis of Thunberg cannot be regarded or having any status in nomenclature, contrary to the mistaken interpretation given by Banerjee and Kevan (1960) who used the name for the species (see Kevan,1963).

Motschoulsky's (1866) description of Truxalis lata is very brief; "Statura tr. nasutae sed vrevior et fere duplo latior. Elongata, antice posticepue attenuata, opaca, unicolor viridis; mucrone frontali supra subconvexo, medio impresso; thorace dorso vix carinato, hemielytris carinulatis". In spite of this, and the fact that the type is no longer in existence, it would seem that Bei-Bienko (1951:277) was connect in synonyming the well-known name, Atractomorpha bedeli Bolivar, was correct.

In his original description of Perena concolor, Walker (1870) also made a very brief statement, but he described the hind wings as being pellucid, which is characteristic of A.lata.

In the description of Truxalis diminuta, Walker (1871) also stated that the hind wings were pellucid and also that they were much shorter than the fore wings. The shortness as well as the absence of colour on the hind wings is also very distinctive of A.lata.

Thomas' (1874) description of Minorissa alata gives no distinctive characters by which the species could be identified; e.g., "the wings are fully developed and nearly as long as the elytra; the sides of the pronotum are not tuberculate except the slightly tubercles along the lower margin, and colour uniform pale-green". He also mentions the species corresponds

very closely with Walker's Minorissa pustulata; many other characters described by him are similar to the latter. The species has been fully discussed by Kevan (1960), who was the first to point out that the species is a member of the genus Atractomorpha, and that it is identical with A.lata.

In his description of Atractomorpha bedeli, Bolívar (1884) mentions several characteristic features of the species, e.g., the long fastigium, the pronotum longer than the head, and the conspicuous parallel dorsal carinae. The hind wings, however, are said to be rosy at the base, but Professor Kevan, who examined the type in Madrid (not in Paris, see Kevan,1963), discovered that the hind wings are, in fact, virtually colourless.

The original description of Atractomorpha heteroptera, Bei-Bienko (1951) does not give much information for the identification of the species, except that the hind wings are significantly shorter than the tegmina. A.heteroptera was later reduced to subspecific status (see Banerjee and Kevan, 1960). Kevan (1963), after subsequent examination of all avaiable material, was led to the conclusion that there are no good morphological grounds for regarding A.heteroptera as distinct from typical A.lata.

Diagnosis of the species:

Body form fairly slender and rather elongate. Head comparatively long, not very broad at base; fastigium of vertex rather long and broad; interocular space rather wide; eyes comparatively small, oval in shape; oblique rows of postocular

tubercles not prominent; antennae short in female, rather long in male. Pronotum rather elongate, and fairly deep, dorsal carinae rather strong; lateral lobe always without a membranous area, its lower margin provided with prominent, regularly arranged tubercles, caudal margin fairly arcuate. Tegmina rather elongate and broad, with apex rather acute, the surface without dark spots. Hind wings very variable, but usually rather small; much shorter than tegmina, virtually colourless.

Phallic structures fairly large (fig. 7). Epiphallus with a rather wide bridge, the basal part little expanded; lateral plates fairly broad, very sinuous distally; lophi widely extending laterally; appendices rather elongate. Ectophallus large; basal emargination very narrow and shallow; basal thickening strongly sclerotized and small; apodemal plates of cingulum broad; suprazygomal plate large; zygoma arcuate, projecting posteriorlly; central membrane not very wide, rather deep; rami fairly wide; ventral process subtriangular, nearly reaching to the ends of apodemal plates of cingulum; ventral cleft rather wide. Endophallus rather elongate aedeagal sclerites with middle part arcuate; spermatophore sac rather wide, not very long; valves of aedeagus very long and broad.

Male specimens examined:

Japan:

26, nr. Tokyo, Nishikawagnchi. 14-x-1954

China:

2, Kwong Tung, Maan Chi Shaan. 12-x-1921

1, Gung Chuling, Manchuria. viii-1954

2, Chutse Siang nr. Shanghai. 17-x-1954

3. Atractomorpha burri Bolívar,1905

Atractomorpha burri Bolívar, 1905:197,203

Type locality: India, Assam, Khasia Hills, Cherapungi.
Type: ♀ (lectotype), Madrid.

Bolívar's (1905) description of the species is of no practical value, examples of the characteristics given being: fastigium subtriangulate with an anteriorlly rounded angulate apex, and antennae separated from ocelli by a rather narrower space than the width of the scape, short, slightly depressed at the base, with the third segment not longer than the first. Banerjee (1959) considered that the only important character given was the stout form of the body. All of the other characters are very generalized and fit most species of this genus. Even the rather stout body is by no means diagnostic.

Diagnosis of the species:

Body form rather robust. Head rather broad; oblique rows of postocular tubercles prominent and regularly arranged. Pronotum broad at the base, the lower margin of the lateral lobe with large tubercles, the posterior margin of which is rather strongly arcuate. Tegmina without dark spots. Hind wings well developed and rosy basally, their size very variable.

Phallic complex comparatively large (fig. 6). Epiphallus with strongly sclerotized lateral plates, their proximal parts slightly expanded; bridge fairly narrow. Ectophallus relatively long; central membrane wide; ventral process subtriangular, not extending beyond the apodemal plates of cingulum. Endophallus long and slender; spermatophore sac almost as wide as the aedeagal sclerites; aedeagal sclerites slender; valves of aedeagus long and slender, curved and directed upwards.

Male specimens examined:

Nepal:

1, W.Hitaura.

1, W.Reg. Kalimpong, 1275 mil. 26-x-1961

N.India:

2, Assam, Abhoypur For. Naphuk 360 mil. 12-x-1961

1, Assam, 12 mil. S.Shillong, 1660 mil. 3-x-1961

1, Assam, Shillong, Khasi Hills. 15-xi-1930

3, Tukdah, 12 mil. E.Darjeeling, 5000 ft.

2, Assam, Ledo Rd. 8.5 mil. from Ledo.

1, N.Reg. Pedong. 1938

1, Assam, Vicinity of Ledo. 2-vii-1944

3, N.Reg. Darjeeling.

E.Pakistan:

1, Baraiyadhala, For. Res. 150 ft. 21-ix-1961

Burma:

2, Upper Burma, Mali Hka Val. Kachun Hill. 25-xi-1926

13, Mishmi Hills. 1935

3, N.Burma, Nam Tamai.

Thailand:

1, NW.Chiangmai Prov. Chiangnao, 450 mil. 5-iv-1958

1, Krachong For. nr. Trang 100 mil. 2-vii-1962

Malaya:

1, Selangor, Bukit Kutu, 3500 ft. 17-iv-1926

1, Selangor, Ululangat. III-1950

1, 3 mil. SE.Lpoh, 50 mil. 21-vi-1926

1, Selangor, Penin.

Viet Nam:

1, Tonkin, Hoa Bing. 1928

1, Tonkin, Dong Dang. 1906

1, Dak Song, 76 Km. SW.Nan Me Thout, 870 mil. 19-v-1960

14, Dalat, 6 mil. S. 1400-1500 mil. 9-vi-1961

1, Dilinh (Djiring), 1200 mil. 22-iv-1960

1, Fyan, 1200 mil. 11-vii-1961

Laos:

2, Muong Sing, WN.Luang Prabang 650 mil. 6-vi-1960

China:

1, Canton (? mislabelled or an imported specimen).

Unknown:

2, Maria Basti Island.

C. The A.crenaticeps-group

1. Atractomorpha crenaticeps (Blanchard,1853)

Synonymy:

Pyrgomorpha crenaticeps Blanchard, 1853:568, fig. 5,6, Non 4.

Truxalis oceanicus Montrouzier, 1855:90

Atractomorpha similis Bolívar, 1884:64,68,495 (partim);

Atractomorpha dentifrons Bolívar, 1905:199,210

Atractomorpha crenaticeps crenaticeps; Rehn, 1953:33 (partim);

Atractomorpha crenaticeps crenaticeps; Banerjee and Kevan, 1960:180

Type localities: P.crenaticeps; Triton Bay, New Guinea.
T.oceanicus; Woodlark Island.
A.similis; Moluccas.
A.dentifrons; Ceram, Waroe.

Types: P.crenaticeps; ♀ (lectotype), Paris.
T.oceanicus; type specimen is lost.
A.similis; ♀ (lectotype), Brussels.
A.dentifrons; ♀ (holotype), Paris.

The description of Pyrgomorpha crenaticeps by Blanchard (1853) does not have any value for identification of the species; e.g., the hind wings are merely said to be very much shorter than the tegmina, and the species id mainly distinguished by the crenulation of the head and thorax. The slender antennae and very pointed tegmina mentioned are both characters applicable to almost any species.

Although its type is lost, two reasons were advanced by Banerjee and Kevan (1960) for synonyming Truxalis oceanicus with Atractomorpha crenaticeps. Firstly, the type locality of T.oceanicus is within the geographic distributional range of A.crenaticeps, where no other species of the genus is known; and secondly, in Montrouzier's (1855) original description the oblong eye, characteristic of the species, is mentioned.

Bolívar's (1884) description of Atractomorpha similis, does not touch the important features of the species, but in the key he mentions that the dorsum of the pronotum is rather parallel-sided and that the carinae are evident; he does not mention the elongate-oval eyes or other diagnostic characters. The species, however, has been fully discussed by Kevan (1963); the type specimens show that A.similis ans A.crenaticeps are conspecific.

The original description of Atractomorpha dentifrons given by Bolívar (1905), contains two of the distinguishing characters of A.crenaticeps, viz., the distinctly elongate eyes and the weak lateral pronotal carinae. The distributional range given is within that of A.crenaticeps.

Diagnosis of the species:

Body form rather slender and elongate. Head wide at base; fastigium of vertex fairly narrow and elongate; oblique rows of postocular tubercles regularly arranged, prominent or not; eyes elongate-oval. Pronotum comparatively deep, broad at base, only weakly carinate dorsally and without distinctive tubercles along the lower margin of the lateral lobe; the caudal margin

of which is only weakly arcuate and without any membranous area. Tegmina long with moderately acute apices. Hind wings fairly wide, with rosy bases.

Phallic structures rather elongate and of moderate size (fig. 8). Epiphallus with bridge very expanded at the base; lophi extending very widely laterally; lateral plates broad and thickened. Ectophallus comparatively slender; basal emargination fairly wide and deep; suprazygomal plate quite narrow; zygoma projecting posteriorlly; central membrane wide. Endophallus fairly stout; gonopore near the top of the spermatophore sac; aedeagal sclerites slender; the valves of aedeagus are the longest form in the group; they are not very acute at apex.

Male specimens examined:

New Guinea (W. & N.E.):

1, Moife, 2100 mil. 15 Km. NW.Okapa. 7-x-1959

2, 16 Km. NW.Banz, 1700-2100 mil. 29-II-1963

1, Karimui, 1080 mil. 13-vii-1963

2, Lake Strumki, 2550 mil. 16-vi-1963

1, Wan, Morobe Distr. 1500 mil. 14-vi-1961

3, Huon Pen. Tobozengaren, 1000-1500 mil. 25-iv-1963

2, Dreikikir Sepik Distr. 350 mil. 25-II-1961

1, Wan, Morobe Distr. 1200 mil. 4-x-1961

2, Maprik, 150 mil. 29-xii-1960

1, Karimui, S.Goroka, 1000 mil. 2-vi-1961

1, Swart Val. Karubaka, 1350 mil. 2-xi-1958

1, Adelbert Mts. Wanuma, 800-1000 mil. 26-x-1959

1, Bubia, Markham Val. 50 mil. 19-ix-1955

1, Feramina, 150-120 mil. 6-vi-1959

2. Atractomorpha australiana Bolívar,1905

Synonymy:

Atractomorpha australiana Bolívar, 1905:198,209

Atractomorpha crenaticeps crenaticeps; Rehn, 1953:23 (partim); pl. 1, fig. 1-3; pl. 2, fig. 7; pl. 27, fig. 191-195 (nec Blanchard).

Atractomorpha crenaticeps australiana; Banerjee and Kevan, 1960:179

Type locality: Australia, Queensland, Rockhampton.

Type: ♀ (holotype), Stockholm.

In his description, Bolívar (1905) mentions that Atractomorpha australiana is very similar to A.similis (= A.crenaticeps), but differs in having a smaller body form a less robust hind femur, in the eyes being elongate and in the pronotal lobe having a membranous area. The other characters given by him have little taxonomic significance.

Rehn (1953) regarded A.australiana and A.crenaticeps as being synonyms. An examination of the types (see Banerjee and Kevan,1960) however, has shown that A.crenaticeps and A.similis are synonymous, and that A.australiana is distinct, at least subspecifically from them. The characteristic membranous area, which is absent from the type material of both A.crenaticeps

and A.similis, is present in A.australiana (virtually all females, and in many of the males). Other differences between A.crenaticeps and A.australiana are also given by Banerjee and Kevan (1960), who consider that australiana differ from crenaticeps also in having a less deep pronotum.

The phallic structures of A.australiana are consistently smaller than in A.crenaticeps, and together with the other characteristics, particularly the more slender build and shallow lateral pronotal lobes, indicate that australiana should be reinstated as a full species.

Diagnosis of the species:

Body form slender, rather elongate. Head fairly long and wide at base; fastigium of vertex comparatively elongate; oblique rows of postocular tubercles prominent and regularly arranged. Pronotum rather narrow at base; lateral pronotal lobes distinctly shallower than in A.crenaticeps, the tubercles on the lower margin not very distinct; a small membranous area on the posterior margin in all of the females, and in some of the males. Tegmina fairly long, not very acute at apices. Hind wings wide, rosy at base.

The phallic complex is the smallest in the group, and is narrow in form (fig. 9). Epiphallus with a fairly wide bridge; lophi extending very widely; lateral plates not very broad, very sinuous at the base. Ectophallus rather slender; basal emargination not deep; zygoma projecting into central membrane; suprazygomal plate fairly elongate. Endophallus small; spermatophore sac relatively large; aedeagal sclerites

fairly slender; aedeagal valves shorter than in A.crenaticeps and more slender.

Male specimens examined:

New Guinea (Papua):

2, Cape Rodrey, 10 mil. 2-4-xi-1960

5, Brown River, 5 mil. 23-x-1960

1, Normanby I. Wakaiuna, Sewa Bay. 21-31-II-1956

4, Laloki, nr. Port Moresby. 30-vii-1959

1, Brown River. 22-v-1956

1, betw. Laloki R. and Brown R. 35 mil. 15-III-1956

1, Aroa est. ate W.Redscar Baym 1 mil. 30-ix-1958

1, Port Moresby. 19-v-1956

1, Bisianumu, E.Port Moresby, 500 mil. 23-ix-1955

1, Laloki, Sentral Distr. 24-iv-1959

2, W.Distr. Oriomo Govt. Sta. 28-x-1960

Australia:

1, Queensland, Kuranda. 21-I-1925

1, N.Queensland, Redlynch. 23-ix-1938

1, Murray Island, Torres Straits. 7-viii-1899

3. Atractomorpha australis Rehn,1907

Synonymy:

Atractomorpha australis Rehn, 1907:449, fig.5

Atractomorpha crenaticeps australis; Rehn, 1953:37, pl.1 fig.46, pl.27, fig.196-200

Type locality: Australia, New South Wales.

Type: ♀ (holotype), Philadelphia (Acad.Nat.Sci.Philad.)

In his description, Rehn (1907) claimed that Atractomorpha australis possesses a short head and fastigium, a rounded caudal margin to the pronotum, and short hind wings. However, the "shallowness of the metasternal interspace", and "the cephalic width of the mesosternal interspace slightly greater than the caudal", as mentioned by him, are characters found in all species of Atractomorpha.

A.australis was reduced to a subspecies of A.crenaticeps by Rehn (1953), because of the existence of what he believed to have intermediate forms between what he called A.c.crenaticeps (= A.australiana) and A.c.australis (= A.australis). He also mentioned that although Bolívar's australiana "may not be fully typical of A.c.crenaticeps it would clearly be nearer that form than A.c.australis". Banerjee and Kevan (1960) after further consideration, have now recognized australis as a full species, rather than a subspecies. Apart from its heavier build and shorter wings, A.australis can be distinguished from A.crenaticeps by the eyes being rather broad dorso-ventrally

by the subtruncated or obtusely angulate posterior margin of pronotal disc, by the short hind wings, and from A.australiana Bolívar, by the complete absence of a membranous area on the lateral pronotal lobe. The view that A.australis ans A.australiana belong to different species is also supported by some cytological evidence provided by Professor M.J.D.White (see Banerjee and Kevan,1960), and now by a consideration of the phallic structures.

Diagnosis of the species:

Body form comparatively stout. Head broad; fastigium of vertex of medium length; oblique rows of postocular tubercles strongly raised and regularly arranged. Pronotum wide and broad at base; lateral lobe without a membranous area, its lower margin provided with large, distinct strongly raised tubercles, the caudal margin arcuate. Tegmina fairly long and wide, lacking dark spots on the surface, apices very acute. Hind wings distinctly shorter than tegmina when at rest, rosy at their bases.

The phallic complex is the largest form in the group (fig. 10). Epiphallus well developed; bridge very long and wide, with the membranous area fairly small; lateral plates very widely separated. Ectophallus not much longer than epiphallus; basal emargination very deep; suprazygomal plate rather broad; zygoma expanded posteriorlly; central membrane fairly wide; suprarami prominent and expanded centrally; ventral process subtriangular, not attain to the ends of apodemal plates of cingulum. Endophallus very strongly sclerotized; the middle

part of the aedeagal sclerites slightly contracted and expanded basally; valves of aedeagus fairly long and broad.

Male specimens examined:

Australia:

1, Canberra. II-1936

1, Blundell's Crk. A.C.T. 3-III-1938

2, Sullivan's Crk. A.C.T. 12-I-1938

1, N.S.Wales.

D. The A.aberrans-group

1. Atractomorpha aberrans Karsch,1888

Synonymy:

Truxalis crenulatus; Palisot de Beauvois, 1807:79-80, pl.3
(nec Fabricius)

Atractomorpha aberrans Karsch, 1888:333

Type locality: Angola, San Salvador.

Type: ♀ (holotype), Berlin.

That Truxalis crenulatus of Beauvois was not the same species as Truxalis crenulatus of Fabricius, was first pointed out by Kirby (1910:332). Beauvois' figure is clearly of a member of the aberrans group, and the data given indicate that his material was from the Cameroon or Gabon coast, where A.aberrans, s.str., is the only member of the group to be found.

The characters given in Karsch's (1888) original description of the species are not very helpful for identification, e.g., he mentions that the antennae are slightly depressed and scarcely far away from the ocelli. The only characters in his description which have some value, are the short fastigium and the broad pronotum. At the end of his discussion, Karsch mentions that the black spots on pronotum and tegmina are characteristics of the species.

Diagnosis of the species:

Body form robust. Head fairly broad, the length of vertex very variable, but always comparatively shorter in the genus, postocular tubercles prominent and scattered. Pronotum broad at the base, lateral pronotal lobe strongly arcuate at the posterior margin, with numerous prominent tubercles along the lower margin. Tegmina rather short and broad, usually with a few small scattered black spots in female. Hind wings well developed, bright reddish basally.

Phallic structures fairly large (fig. 11). Epiphallus with very elongate anterior projections; appendices strongly sclerotized; lateral plates relatively broad. Ectophallus comparatively long in dorsal view; suprarami very broad and expanded centrally; central membrane very small; valves of cingulum directed upwards, the distal margin truncated in ventral view. Endophallic apodemes covering a part of the spermatophore sac; valves of aedeagus cap-like, denticulate in the distal part. This last feature is the most characteristic for the species.

Male specimens examined:

Nigeria:

1, E.Prov. Savannah, 20 mil. E.Abakaliki. 23-xii-1960

1, E.Prov. Kom-Mamfe Rd. 2 mil. W.Cros R. 23-xii-1960

Cameroon:

1,N.Kembone.

1, Atok.

1, S. 6 mil. S.Mamfe-Kumba Rd. 6-I-1961

1, Bitye, Ja R. iv-1909

3, Batonni Distr,

2, D'Ja Posten.

Middle Congo:

18, Nola Sanga R. Elev.1300 ft. 2-x-1934

1, Mussana.

1, Brazzaville. xi-1963

Rep.Congo:

2, Kihali-Lturi, Epulu Terr. Wamba. ix-1956

2, Mwenda, Mt.Ruwenzori.

1, Monghwalu (Kilo).

1, S.Albertiville.

1, Irangi, Luhoho R.

2, Wamba.

2, Sibiti. xi-1963

1, Bangui (Oubangui-Chari).

1, 39 Km. S.Walikala, 700 mil. xii-1957

2, Mbila (Mts.Duchaillu). xii-1963

1, Dimonika (Mayumbe). 1-1964

1, "Congo Belge".

1, Ngowa. 1-1-1934

1, Leopoldville. 29-ix-1923

1, Uele-Poko.

1, Kivu, Kavumu Kabunga 82 Km. (Mingazi). 2-111-1954

1, Kivu, Costermansville. 1951

2, Kivu, Kayumu Walikale. 11-1950

1, Stanbyville. T.Bafnasende, Aduhia. 1953

1, Etshushu. x-1912

2, M'Paka, Terr. Libenge. 7-viii-1959

1, Benza-Masola. v-1913

1, Limete (Leopoldville). 1958

Zambia:

1, N.Reg. Mwinilunga. 111-1960

2. Atractomorpha rufopunctata Bolívar,1894

Synonymy:

Atractomorpha rufopunctata Bolívar, 1894:clxi

Atractomorpha rufopunctata var. ashantica Bolívar, 1905:197,200

Atractomorpha aberrans; Banerjee and Kevan, 1960:176,177 (partim)

Type localities: A.rufopunctata; Togo.

A.rufopunctata var. ashantica; Ashanti.

Type: A.rufopunctata; ♀ (lectotype), Madrid.

A.rufopunctata var. ashantica; ♂ (lectotype), Madrid.

Bolívar's (1894) original description of Atractomorpha rufopunctata, is somewhat similar to Karsch's (1888) for A.aberrans, but he mentions a few differences, e.g., the maculation on the prothorax and tegmina; colour of the hind wings, and antennae subcylindrical, etc. Moreover, in his discussion, Bolivar notes that A.rufopunctata differs from A.aberrans in the form of the pronotum, its posterior margin being angular and with a carina, and in the lateral lobe having its external margin straight with the posterior angle acute and directed backward. In a later paper, Bolívar (1905) indicates some other differences, such as the mesosternal interspace being more transverse, subrectangular with the posterior part slightly narrowed, and the inferior margin of the lateral lobe of the pronotum being coarsely granulated.

Atractomorpha rufopunctata var, ashantica was described very briefly by Bolívar (1905). He mentions the small size of the body, and lack of puncturation. In the female syntype, Bolivar indicated that the posterior margin of pronotum is distinctly sinuate on each side, and that the mesosternal interspace is not enlarged anteriorlly, the lobes, subrectangular with their angles slightly rounded. None of these characters is sufficiently important to permit its recognation as a separate entity.

A.rufopunctata was considered to be a synonym of A.aberrans by Banerjee and Kevan (1960) and subsequent authors, but the male phallic structures clearly indicated that it is indeed a good species.

Diagnosis of the species:

Body form rather stout. Head short, very broad at the base; eyes prominent, oval; ocular interspace wide, rather concave; fastigium of vertex very short and broad; oblique rows of postocular tubercles strongly raised, and irregularly arranged; antennae comparatively long. Pronotum very stout and broad at base, provided with large distinctive granules on the surface; lateral lobe without a membranous area at the posterior margin, the lower margin provided with prominent tubercles; the caudal margin less arcuate. Tegmina short, rather broad, apices not very acute, usually with numerous reddish or black spots in the female. Hind wings large, bright red at base.

Phallic structures fairly large (fig. 12). Epiphallus very stout, and strongly sclerotized; bridge rather wide; lateral plates fairly broad, with their proximal parts relatively expanded, the distal parts very sinuous; appendices very elongate, distal parts very wide; lophi very acute. Ectophallus rather wide; basal emargination rather shallow; basal thickening rather elongate; apodemal plates of cingulum rather broad; zygoma with its margin projecting posteriorlly; central membrane large, somewhat rectangular; ventral process subtriangular, extending beyond the apodemal plates of cingulum; rami rather wide; ventral cleft deep. Endophallus strongly contracted in middle; apodemes of aedeagus large, covering a part of the spermatophore sac; aedeagal sclerites very wide at base; valves of aedeagus rather long and broad, capsule-

like, their central parts expanded laterally in dorsal view.

Male specimens examined:

Ghana:

2, Volta Reg. 3 mil. E.Dadieso. 21-xii-1962

2, Volta Reg. 6 mil. S.Nkwanta. 26-xii-1962

1, Vilta Reg. Nkwanta to Chiare 3 mil. W.Chiare. 19-xii-1962

1, T.V.T. EN & Kati Kradei, Kpetchu R. 18-v-1960

1, Nfumada. 17-v-1960

1, Begoro. 20-v-1959

Guinea:

1, Nio, Nimba. vi-1942

1, Yalanzou, Nimba. vi-1942

1, N'Zerekore. 1920

2, Mt.Nimba, NE.500-700 mil. 1946

Liberia:

2, E.Reg. Zouidrou. 1948

Sierra Leone:

1, Dimadugo.

1, Bewana.

3, Atractomorpha orientalis, sp.n.

Pl. 1, - fig. 13.

Synonymy:

Atractomorpha rufopunctata; Rehn, 1914:104 (et auctt.)
(nec Bolívar)

Atractomorpha aberrans; Banerjee and Kevan, 1960:176,177 (partim)
(nec Karsch)

Holotype ♂, Epulu, Congo Belge. 27-xii-1948 (J.D.Bradley). (Lyman Entomological Museum).

Body robust strongly fusiform. Head slightly shorter than pronotum, a little less broad at base than in A.rufopunctata. Antennae a little shorter than head and pronotum together. Eyes oval, less prominent than in A.aberrans. Fastigium of vertex a little less broad than in A.rufopunctata, interocular space fairly wide and flat. Oblique rows of postocular tubercles distinctly raised, regularly arranged. Pronotum rather stout, and rather deep, the caudal margin of the disc rather angular, lateral lobes without a membranous area on the posterior part, the inferior margin provided with only moderately prominent irregularly arranged tubercles, not extending to the posterior angle. Tegmina extending slightly beyond the end of the hind femur, apex rather acute. Hind wings at rest, slightly shorter than tegmen. Epiproct triangular, slightly longer than cerci. Cerci fairly long, and concial.

Phallic structures rather large and broad (fig. 13). Epiphallus more or less rectangular; appendices rod-like, with distal end rather expanded; lateral plates strongly sclerotized, their central parts expanded, lateral margin very concave at base; bridge very wide, its membranous area fairly large, apical margin truncated, triangulate. Ectophallus large and broad, not strongly tapered apically; basal thickening very wide and strongly sclerotized; apodemal plates of cingulum fairly broad; suprazygomal plate rather broad; zygoma not projecting into central membrane; the latter broadly triangular; suprarami broad and distinct; rami broad, narrowed apically; ventral cleft very deep; ventral process slightly shorter than apodemal plates of cingulum, triangular. Endophallus with broad very strongly sclerotized aedeagal sclerites; spermatophore sac wide; aedeagal valves very long and broad, subtruncate apically in lateral view, inferior margin gradually curved.

Coloration: Body colour yellow-green, antennae dark green, distal larts brown; head and pronotum greenishtestaceous; tegmina immaculate; hind wings rosy in basal two-third, hyaline apically.

Measurements: Body length 20.9; antennae 8; fastigium verticis 4; pronotum 5.5; tegmen 20; hind femur 11.5; hind tibia 11 mm.

Allotype ♀ , Sama data as holotype. (Lyman Entomological Museum).

Body form much stouter than in male. Head very short, rather broad at base. Eyes small, oval, weakly prominent.

Fastigium of vertex broad, and slightly concave in basal part, interocular space very wide, two-third as wide as long. Frons smooth, without any tubercles; postocular tubercles in distinct. Pronotum very stout, its surface fairly smooth, tubercles of inferior margin of pronotal lobe even more prominent than in holotype. Tegmina fairly broad, reaching to the middle of the hind tibia, apex not very acute. Hind wings at rest slightly shorter than tegmina. Epiproct much longer than cerci. Cerci short, and conical. Ovipositor valves rather broad, and denticulate on the upper margins, apices directed slightly upward.

Coloration: Body colour yellow-green; pronotum and tegmina with some small scattered dark choealute-brown spots; apical part of tegmen light green; hind wings rosy-red in basal two-thirds, hyaline apically; femora yellowish.

Measurements: Body length 30.4; fastigium verticis 5; pronotum 7; tegmen 20.3; hind femur 16; hind tibia 12 mm.

Other male specimens examined:

Rep.Congo:

13, Monghwalu (Kilo). vii-1939

2, Epulu. 28-x-1946

2, Mwenda, Mt.Ruwenzori, 1455 mil. alt. 10-ix-1948

1, Atso, 72 Km. d'Aru (S.route D'Aru a Aba). 1948

7, Lesse.

18, Beni.

1, Uele, Ogandra. 22-xi-1937

3, Kilo.

4, Wamba. 1936

1, Urw Moera. 1910

4, Reg. Deo Lacs.

1, Buta. 1911

1, Isangi, Reg. Du Lemami.

1, Kibali-Ituri, Kilomines. v-1957

1, Bunia, 4500 ft. 30-viii-1935

1, Van Someren, Bwamba Val. 7-1945

1, Mawambi, Irumu. 1910

Kenya:

1, Lake Rudolf, Mouth of Kahua R. 3-iv-1931

As this thesis does not constitute publication, the above specimens, and other (including females) are not yet listed as paratypes.

4. Atractomorpha occidentalis, sp.n.

Synonymy:

Atractomorpha aberrans; Banerjee and Kevan, 1960:176,177 (partim)

Holotype ♂ , Rep.Liberia, N.of Monrovia, Bomi Hills, 5 mil. N.E.of Mines, Forest Res. Rest House. 23-vii-1963. (N.D.Jago). (Lyman Entomological Museum).

Body rather strongly fusiform, less stout. Head slightly shorter than pronotum, rather broad at base, similar to

A.aberrans. Antennae long, nearly as long as head and pronotum together. Eyes elongate-oval, prominent. Fastigium of vertex fairly broad, similar to A.aberrans; interocular space wide and flat. Oblique rows of postocular tubercles prominently raised and irregularly arranged. Pronotum stout and not very deep, the caudal margin of the disc rather wide and angular, lateral lobe without a membranous area on the posterior part, the inferior margin provided with very distinct irregularly arranged tubercles, extending to the inferior and posterior angle. Tegmina extending slightly beyond the distal end of hind femur, apex not very acute. Hind wing at rest slightly shorter than tegmina. Epiproct triangular, distinctly longer than cerci. Cerci short, conical.

Phallic structures of moderate size, rather elongate (fig. 14). Epiphallus somewhat rectangular; appendices rather broad; lateral plates fairly broad; bridge rather narrow, its basal part wider than its length, membranous area extensive; apical margin more or less truncated. Ectophallus with broad cingulum, strongly contracted apically; basal thickening fairly large; apodemal plates og cingulum comparatively narrow; supra-zygomal plate narrow; zygoma extending very posteriorlly; central membrane limited to the distal part of the cingulum, not so wide as in other related species; suprarami not prominent; rami narrow, expanded apically; ventral cleft rather shallow; ventral process long, extending beyond to the apodemal plates of cingulum. Endophallus with rather broad aedeagal sclerites; spermatophore sac rather elongate; aedeagal valves long, broad

at base, subacute in lateral view, the inferior margin very convex, more or less forming a right angle.

Coloration: Body colour green; tubercles yellowish; head and pronotum dark green; antennae brown; apex of tegmen tinged pink, base with some short dark striae; hind wings bright red, except for greenish-hyaline apex.

Measurements: Body length 20.8; fastigium verticis 4; pronotum 5; tegmen 19; hind femur 12; hind tibia 11 mm.

Allotype ♀ , Ghana, W.Reg. Dadieso, Dadieso-Enchi Rd. 27-ix-1962. (N.D.Jago). (Lyman Entomological Museum).

Body form much stouter than in male. Head short, very broad at base. Fastigium of vertex broad, interocular space wide, and slightly convex, frons provided with some raised tubercles; postocular tubercles distinct. Pronotum rather broad, with distinct scatter granules; inferior pronotal tubercles prominent. Tegmina fairly broad, extending slightly beyond the apical end of hind femur, apex not very acute. Hind wing at rest slightly shorter than tegmina. Ovipositor valves fairly long, and denticulate on the upper margins, apical end directed upward.

Coloration: Body colour green; head and pronotum light brownish green; tubercles yellowish; pronotum and tegmina with some small, dark brown spots; apices of tegmina pinkish; hind wings light red, except for greenish-hyaline apex.

Measurements: Body length 30.5; fastigium verticis 5;

pronotum 7.8; tegmen 24; hind femur 16; hind tibia 14 mm.

Other male specimens examined:

Liberia:

1, N.Monrovia, Bomi Hills. 23-vii-1963

4, E.Reg. Hslasct. 1948

1, Genoke. 1948

1, Dioleba. 1948

1, Asidjan, Bingerville. 12-xii-1958

1, Tonkoui, C.I. 900-1200 mil. 30-ix-1946

Guinea:

1, Seredou, W.Irie. 16-vii-1963

1, Himba. vi-1942

Ivory Coast:

1, Forest of Sango.

1, Konibly. 1938

As this thesis does not constitute publication, the above specimens, and other (including females) are not yet listed as paratypes.

VII VARIATION OF PHALLIC STRUCTURES WITHIN SPECIES

In the course of this work, the morphological variation of the phallic structures was studied. For each species twenty specimens were taken by random sampling, and then each part of the phallic complex was measured by means of a microprojector.

The following lists of figures give only the mean ($\bar{x}$), standard deviation ($S\bar{x}$) and ranges for the different species. Statistical analysis, such as the "t" test or "F" test to differentiate between species did not prove useful with the measurements available, because the chief characteristic feature of each species is the shape of the aedeagal valves of the endophallus, which always form a curve, or are strongly angulate, so that it is very difficult to measure exactly. For example; the length of aedeagal valves in A.orientalis (fig. 13) ($\bar{x}$ = 0.58 mm.) is shorter than that in A.aberrans (fig. 11) ($\bar{x}$ = 0.59 mm.), but from the illustrations the aedeagal valves of orientalis appear much longer than those of the latter species. Similarly, A.psittacina (fig. 5) and A.australis (fig. 10) have the same mean length of aedeagal valves ($\bar{x}$ = 0.37 mm.), but they clearly differ from each other.

The figures for each species are listed separatly as follows;

1. Atractomorpha crenulata (Fabricius,1793)

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.08	0.001	1.08 ± 0.001
Width	0.89	0.0009	0.89 ± 0.0009
Length of bridge	0.93	0.001	0.93 ± 0.001
Width of bridge	0.13	0.001	0.13 ± 0.001
Ectophallus:			
Length	1.14	0.0009	1.14 ± 0.0009
Width	0.87	0.0002	0.87 ± 0.0002
Length of BE	0.23	0.001	0.23 ± 0.001
Width of BE	0.19	0.0009	0.19 ± 0.0009
Length of CM	0.25	0.0009	0.25 ± 0.0009
Width of CM	0.54	0.01	0.54 ± 0.01
Endophallus:			
Length (lateral)	1.03	0.0009	1.03 ± 0.0009
Width (dorsal)	0.42	0.0002	0.42 ± 0.0002
Length of SS	0.55	0.0009	0.55 ± 0.0009
Width of SS	0.36	0.001	0.36 ± 0.001
Length of AV	0.24	0.002	0.24 ± 0.002

2. Atractomorpha acutipennis (Guérin-Méneville,1844)

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.19	0.016	1.19 ± 0.016
Width	1.01	0.01	1.01 ± 0.01
Length of bridge	1.03	0.017	1.03 ± 0.017
Width of bridge	0.18	0.012	0.18 ± 0.012
Ectophallus:			
Length	1.24	0.001	1.24 ± 0.001
Width	1.02	0.009	1.02 ± 0.009
Length of BE	0.26	0.01	0.26 ± 0.01
Width of BE	0.19	0.009	0.19 ± 0.009
Length of CM	0.21	0.001	0.21 ± 0.001
Width of CM	0.57	0.01	0.57 ± 0.01
Endophallus:			
Length (lateral)	1.14	0.01	1.14 ± 0.01
Width (dorsal)	0.50	0.001	0.50 ± 0.001
Length of SS	0.58	0.012	0.58 ± 0.012
Width of SS	0.40	0.002	0.40 ± 0.002
Length of AV	0.25	0.00005	0.25 ± 0.00005

3. Atractomorpha himalayica Bolívar,1905

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.41	0.001	1.41 ± 0.001
Width	1.16	0.0001	1.16 ± 0.0001
Length of bridge	1.21	0.0001	1.21 ± 0.0001
Width of bridge	0.22	0.0001	0.22 ± 0.0001
Ectophallus:			
Length	1.46	0.0001	1.46 ± 0.0001
Width	1.17	0.0001	1.17 ± 0.0001
Length of BE	0.34	0.0001	0.34 ± 0.0001
Width of BE	0.37	0.0001	0.37 ± 0.0001
Length of Cm	0.30	0.0001	0.30 ± 0.0001
Width of CM	0.65	0.0001	0.65 ± 0.0001
Endophallus:			
Length (lateral)	1.28	0.0001	1.28 ± 0.0001
Width (dorsal)	0.62	0.0001	0.63 ± 0.0001
Length of SS	0.65	0.0001	0.65 ± 0.0001
Width of SS	0.41	0.0001	0.41 ± 0.0001
Length of AV	0.28	0.0001	0.28 ± 0.0001

4. Atractomorpha sinensis Bolívar,1905

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.13	0.005	1.13 ± 0.005
Width	0.89	0.006	0.89 ± 0.006
Length of bridge	0.93	0.002	0.93 ± 0.002
Width of bridge	0.16	0.002	0.16 ± 0.002
Ectophallus:			
Length	1.17	0.006	1.17 ± 0.006
Width	0.93	0.002	0.93 ± 0.002
Length of BE	0.24	0.002	0.24 ± 0.002
Width of BE	0.21	0.006	0.21 ± 0.006
Length of CM	0.13	0.005	0.13 ± 0.005
Width of CM	0.46	0.009	0.46 ± 0.009
Endophallus:			
Length (lateral)	1.09	0.002	1.09 ± 0.002
Width (dorsal)	0.40	0.001	0.40 ± 0.001
Length Of SS	0.55	0.0005	0.55 ± 0.0005
Width of SS	0.35	0.004	0.35 ± 0.004
Length of AV	0.28	0.007	0.28 ± 0.007

5. Atractomorpha psittacina (Haan,1842)

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.07	0.016	1.07 ± 0.016
Wide	0.92	0.001	0.92 ± 0.001
Length of bridge	0.88	0.015	0.88 ± 0.015
Width of bridge	0.15	0.01	0.15 ± 0.01
Ectophallus:			
Length	1.18	0.011	1.18 ± 0.011
Width	0.96	0.01	0.96 ± 0.01
Length of BE	0.25	0.001	0.25 ± 0.001
Width of BE	0.19	0.016	0.19 ± 0.016
Length of CM	0.25	0.018	0.25 ± 0.018
Width of CM	0.55	0.013	0.55 ± 0.013
Endophallus:			
Length (lateral)	1.10	0.015	1.10 ± 0.015
Width (dorsal)	0.48	0.0002	0.48 ± 0.0002
Length of SS	0.46	0.008	0.46 ± 0.008
Width of SS	0.39	0.01	0.39 ± 0.01
Length of AV	0.37	0.01	0.37 ± 0.01

6. Atractomorpha burri Bolívar,1905

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.22	0.013	1.22 ± 0.013
Width	0.96	0.015	0.96 ± 0.015
Length of bridge	1.01	0.016	1.01 ± 0.016
Width of bridge	0.14	0.014	0.14 ± 0.014
Ectophallus:			
Length	1.35	0.002	1.35 ± 0.002
Width	1.08	0.02	1.08 ± 0.02
Length of BE	0.31	0.016	0.31 ± 0.016
Width of BE	0.23	0.009	0.23 ± 0.009
Length of CM	0.33	0.016	0.33 ± 0.016
Width of CM	0.63	0.0007	0.63 ± 0.0007
Endophallus:			
Length (lateral)	1.30	0.024	1.30 ± 0.024
Width (dorsal)	0.44	0.009	0.44 ± 0.009
Length of SS	0.57	0.001	0.57 ± 0.001
Width of SS	0.43	0.004	0.43 ± 0.004
Length of AV	0.46	0.001	0.46 ± 0.001

7. Atractomorpha lata (Motschoulsky,1866)

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.24	0.01	1.24 ± 0.01
Width	1.04	0.001	1.04 ± 0.001
Length of bridge	1.03	0.004	1.03 ± 0.004
Width of bridge	0.13	0.008	0.13 ± 0.008
Ectophallus:			
Length	1.42	0.012	1.42 ± 0.012
Width	1.10	0.016	1.10 ± 0.016
Length of BE	0.32	0.004	0.32 ± 0.004
Width of BE	0.21	0.012	0.21 ± 0.012
Length of CM	0.23	0.002	0.23 ± 0.002
Width of CM	0.58	0.005	0.58 ± 0.005
Endophallus:			
Length (lateral)	1.34	0.002	1.34 ± 0.002
Width (dorsal)	0.56	0.0008	0.56 ± 0.0008
Length of SS	0.49	0.0006	0.49 ± 0.0006
Width of SS	0.49	0.0004	0.49 ± 0.0004
Length of AV	0.48	0.01	0.48 ± 0.01

8. Atractomorpha crenaticeps (Blanchard,1853)

	$\bar{x}$ (mm)	$S_{\bar{x}}$ (mm)	Range (mm)
Epiphallus:			
Length	1.22	0.015	1.22 ± 0.015
Width	1.11	0.003	1.11 ± 0.003
Length of bridge	1.01	0.016	1.01 ± 0.016
Width of bridge	0.16	0.017	0.16 ± 0.017
Ectophallus:			
Length	1.29	0.014	1.29 ± 0.014
Width	0.93	0.011	0.93 ± 0.011
Length of BE	0.39	0.095	0.39 ± 0.095
Width of BE	0.20	0.013	0.20 ± 0.013
Length of CM	0.20	0.011	0.20 ± 0.011
Width of CM	0.56	0.016	0.56 ± 0.016
Endophallus:			
Length (lateral)	1.19	0.013	1.19 ± 0.013
Width (dorsal)	0.51	0.013	0.51 ± 0.013
Length of SS	0.47	0.009	0.47 ± 0.009
Width of SS	0.34	0.007	0.34 ± 0.007
Length of AV	0.38	0.004	0.38 ± 0.004

9. Atractomorpha australiana Bolívar,1905

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.17	0.011	1.17 ± 0.011
Width	1.05	0.011	1.05 ± 0.011
Length of bridge	0.95	0.004	0.95 ± 0.004
Width of bridge	0.16	0.006	0.16 ± 0.006
Ectophallus:			
Length	1.19	0.0002	1.19 ± 0.0002
Width	0.87	0.008	0.87 ± 0.008
Length of BE	0.33	0.013	0.33 ± 0.013
Width of BE	0.16	0.07	0.16 ± 0.07
Length of CM	0.19	0.003	0.19 ± 0.003
Width of CM	0.54	0.014	0.54 ± 0.014
Endophallus:			
Length (lateral)	1.07	0.001	1.07 ± 0.001
Width (dorsal)	0.45	0.008	0.45 ± 0.008
Length of SS	0.46	0.0004	0.46 ± 0.0004
Width of SS	0.34	0.002	0.34 ± 0.002
Length of AV	0.34	0.0004	0.34 ± 0.0004

10. Atractomorpha australis Rehn,1907

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.32	0.06	1.32 ± 0.06
Width	1.15	0.004	1.15 ± 0.004
Length of bridge	1.05	0.03	1.05 ± 0.03
Width of bridge	0.25	0.05	0.25 ± 0.05
Ectophallus:			
Length	1.37	0.08	1.37 ± 0.08
Width	1.11	0.05	1.11 ± 0.05
Length of BE	0.32	0.01	0.32 ± 0.01
Width of BE	0.27	0.05	0.27 ± 0.05
Length of CM	0.27	0.003	0.27 ± 0.003
Width of CM	0.70	0.006	0.70 ± 0.006
Endophallus:			
Length (lateral)	1.24	0.004	1.24 ± 0.004
Width (dorsal)	0.56	0.005	0.56 ± 0.005
Length of SS	0.55	0.003	0.55 ± 0.003
Width of SS	0.45	0.004	0.45 ± 0.004
Length of Av	0.37	0.004	0.37 ± 0.004

11. *Atractomorpha aberrans* Karsch,1888

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.16	0.0003	1.16 ± 0.0003
Width	0.92	0.0003	0.92 ± 0.0003
Length of bridge	0.89	0.0003	0.89 ± 0.0003
Width of bridge	0.20	0.0007	0.20 ± 0.0007
Ectophallus:			
Length	1.76	0.0007	1.76 ± 0.0007
Width	1.26	0.0007	1.26 ± 0.0007
Length of BE	0.29	0.0003	0.29 ± 0.0003
Width of BE	0.37	0.0003	0.37 ± 0.0003
Length of CM	0.27	0.0003	0.27 ± 0.0003
Width of CM	0.38	0.0001	0.38 ± 0.0001
Endophallus:			
Length (lateral)	1.27	0.0003	1.27 ± 0.0003
Width (dorsal)	0.70	0.0003	0.70 ± 0.0003
Length of SS	0.55	0.0003	0.55 ± 0.0003
Width of SS	0.47	0.0003	0.47 ± 0.0003
Length of AV	0.59	0.0003	0.59 ± 0.0003

12. Atractomorpha rufopunctata Bolívar,1894

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.34	0.001	1.34 ± 0.001
Width	1.22	0.0005	1.22 ± 0.0005
Length of bridge	0.93	0.0005	0.93 ± 0.0005
Width of bridge	0.27	0.0005	0.27 ± 0.0005
Ectophallus:			
Length	1.84	0.0005	1.84 ± 0.0005
Width	1.48	0.0005	1.48 ± 0.0005
Length of BE	0.30	0.0005	0.30 ± 0.0005
Width of BE	0.28	0.0005	0.28 ± 0.0005
Length of CM	0.40	0.0005	0.40 ± 0.0005
Width of CM	0.89	0.0005	0.89 ± 0.0005
Endophallus:			
Length (lateral)	1.55	0.005	1.55 ± 0.005
Width (dorsal)	0.96	0.0005	0.96 ± 0.0005
length of SS	0.60	0.0005	0.60 ± 0.0005
Width of SS	0.52	0.001	0.52 ± 0.001
Length of AV	0.90	0.0005	0.90 ± 0.0005

13. Atractomorpha orientalis, sp.n

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.15	0.012	1.15 ± 0.012
Width	0.95	0.007	0.95 ± 0.007
Length of bridge	0.91	0.014	0.91 ± 0.014
Width of bridge	0.18	0.001	0.18 ± 0.001
Ectophallus:			
Length	1.77	0.001	1.77 ± 0.001
Width	1.29	0.016	1.29 ± 0.016
Length of BE	0.30	0.001	0.30 ± 0.001
Width of BE	0.38	0.001	0.38 ± 0.001
Length of CM	0.29	0.012	0.29 ± 0.012
Width of CM	0.39	0.002	0.39 ± 0.002
Endophallus:			
Length (lateral)	1.28	0.001	1.28 ± 0.001
Width (dorsal)	0.72	0.012	0.72 ± 0.012
Length of SS	0.52	0.003	0.52 ± 0.003
Width of SS	0.47	0.001	0.47 ± 0.001
Length of AV	0.58	0.008	0.58 ± 0.008

14. Atractomorpha occidentalis, sp.n.

	$\bar{x}$ (mm)	$S\bar{x}$ (mm)	Range (mm)
Epiphallus:			
Length	1.33	0.001	1.33 ± 0.001
Width	1.07	0.001	1.07 ± 0.001
Length of bridge	1.14	0.001	1.14 ± 0.001
Width of bridge	0.16	0.001	0.16 ± 0.001
Ectophallus:			
Length	1.65	0.001	1.65 ± 0.001
Width	1.26	0.001	1.26 ± 0.001
Length of BE	0.35	0.001	0.35 ± 0.001
Width of BE	0.43	0.001	0.43 ± 0.001
Length of CM	0.40	0.001	0.40 ± 0.001
Width of CM	0.30	0.001	0.30 ± 0.001
Endophallus:			
Length (lateral)	1.50	0.001	1.50 ± 0.001
Width (dorsal)	0.70	0.001	0.70 ± 0.001
Length of SS	0.65	0.001	0.65 ± 0.001
Width of SS	0.52	0.001	0.52 ± 0.001
Length of AV	0.60	0.001	0.60 ± 0.001

VIII DISCUSSION AND CONCLUSION

The appearance of Atractomorpha is so characteristic, that it can be recognized very easily. On the other hand, the genus is widely distributed throughout the Old World tropics and subtropics, and individual species are very variable in morphology and coloration. Certain features, such as the length of fastigium verticis, the width of interocular space, the presence or absence of a membranous area on the posterior margin of the pronotal lobe, the degree of sinuation of its caudal margin and the tubercles, granules and pigmental spots on its surface, the length of tegmen, the size of hind wings and their coloration, the width/length ratio of the femur, etc., all vary considerably within as well as between species. All these characters have been emphasized by previous authors in describing species, but many of them are valueless for diagnostic purpose, as they exhibit great plasticity which has led to remarkable dissimilarities occurring among different populations of same species. It is no wonder that no less than forty species (see Banerjee and Kevan,1960) have been described or subsequently placed in the genus by previous authors. Banerjee and Kevan (l.c.) have correctly commented that the recognition of most of these nominal species have been due to (1), individual variations within species and (2), the insufficient material avaliable to earlier authors which have led to a mutiplicity of invalid species being erected.

The phallic structures of insects provide, in many groups, very reliable characters for classification. Most previous authors have used the morphology of genitalia in the Orthoptera for discrimination of higher categories, although specific differences have also been recognized by several workers. The present study is a attempt to use the male phallic structures at the specific level, although Banerjee (1959) and Banerjee and Kevan (1960) did not find them useful in Atractomorpha - mainly because they examined only the epiphallus, which does not provide many useful diagnostic characters. In Atractomorpha, the morphological characters of the concealed reproductive organs are usually less variable than those of the external features. The phallic complex of a species tend to be very uniform in structure, and the standard deviations of their measurements are also smaller than those for other structures. If the species concept is correct, smallness of the differences in phallic structures of species, particularly in the morphology of the aedeagal valves of the endophallus, provide the best comment on the concept that species are groups of populations that actually or potentially interbreed with each other, and not with member of other species. Radical differences in the morphology of aedeagal valves, for example, would provide natural mechanical barriers by which species may remain reproductively isolated. Such differences exist between certain species of Atractomorpha, but not between others. Subspecies theoretically have similar phallic structures to those of other subspecies of the same species, and this has been compared in

the course of this study, where no subspecies could be recognized on phallic morphology (except probably for the Assam and N. Borneo populations of A.psittacina).

Measurements of the parts of the phallic structures are in general, not suitable for statistical analysis in Atractomorpha, because the most important ones, the aedeagal valves of endophallus, are always curved or angulate, so that it is very difficult to measure them exactly. In any case, other distinct differences, such as shape, are sometimes quite obvious at a first glance, but statistically nonsignificant, treated merely from the point of view of single measurements. For example, the aedeagal valves of the endophallus of A.orientalis and A.aberrans differ markedly in form, but not in length.

The fourteen species recognized in this thesis, are separated into several species-groups, based mainly upon the length and form of the aedeagal valves. In the A.crenulata-group, the various species are very widely distributed from China through India, Pakistan, Iran and parts of Arabia to Africa and Madagascar. One species has even been introduced into the Hawaii Islands, including the Midway Island group. The phallic structures of all species are similar to each other, except that those of A.himalayica are rather larger. The aedeagal valves are all very short, indicating close phylogenetic relationship of the form species. A.sinensis is eastern (mainly China), A.crenulata is south-central (India and Indo-Malayan) and A.acutipennis is western (S.W.Asiatic,

African and Malagasy) in distribution. A.himalayica appears to be a specialized form restricted to the S.E.Himalaya region.

The A.psittacina-group is distributed from Japan, Korea and China to N.India, W.Pakistan and to Viet Nam, Thailand, Burma, Malaya, Sumatra, Borneo and the Philippine Islands. It may also occur in Ceylon. The phallic structures are of moderate size and the aedeagal valves slender, elongate and strongly curved. Populations of A.psittacina are variable in size of phallic complex, and in the length of the aedeagal valves. It may indicate that this species is still in the course of speciation, particularly as the material from Assam and N.Burma to be consistently seems different (longer and larger aedeagal valves) although overlapping in character with more southerly material. The three species of this group differ considerably in appearance. A.lata has the most common form for the genus being moderately slender. It is confined to N.and C.China, Korea and Japan. A.psittacina, by contrast is very slender and does not occur in the same areas as the last, barely reaching S.China, but it is found throughout the rest of the distributional area of the group. The last member is A.burri, which is small and short and which is not very similar in external morphology, is found only in continental S.E.Asia although its ranges from Assam to Malaya and Indo-China.

Members of the A.crenaticeps-group, are limited to N.& E. Australia, New Guinea, the Bismarck Archipelago, the Solomon Islands and some associated islands further west. The phallic structures are variable, those of A.australis (confined to

S.E.Australia) being distinct from those of the other two species. The phallic structures of A.australiana (from E, N.E. and N.Australia, and S.E.New Guinea) and A.crenaticeps (from the other parts of New Guinea and the other islands) are extremely similar, except in size showing that they have recently developed from the same phylogenetic line.

The A.aberrans-group is the most distinctive and the various species have the most specialized aedeagal valves, externally all four species are very similar in form, but phallic structures are very different. They may be regarded as sibiling species as they are sometimes impossible to distinguish by their external differences. This group is limited to W. & C.Africa. A.aberrans is found from Zambia through N.Angola and most of the Congo as far northern as E.Nigeria. A.rufopunctata is found from W.Nigeria to Sierra Leone, but overlaps with a new species, A.occidentalis in W.Ghana, S. Guinea, N.Ivory Coast, Liberia and Sierra Leone. A.orientalis, the second new species is restricted to the N.E.Congo and east to Uganda and N.W.Kenya.

The present study is an attempt to discriminate specifically between the species, using the male phallic structures, and this has been to be possible. The concealed genitalia in many species are more distinctive than the characters previously used by museum taxonomists, who have mainly based their diagnoses on external characters, Banerjee and Kevan (1960), however, used the epiphallus as a taxonomic character, although not very widely or successfully.

IX SUMMARY

1, Atractomorpha is very widely distributed throughout the Old World tropics and subtropics. With its characteristic body forms, the genus is easily recognized.

2, Members of species are variable in general form, and in the details of their external characters, but the male phallic structures are fairly distinctive in most species, particularly in the form of the aedeagal valves of the endophallus.

3, Classification based upon statistical analysis of measurements of the male phallic complex has not proved satisfactory, because some of the most important distinguishing characters are not readily measurable.

4, Fourteen species are recognized and separated into four species-groups, according to their phallic characters, these clearly indicate their phylogenetic relationships.

5, Two new species were discovered among the African material studied, and another two species previously considered to be synonyms have been found to be good species.

6, Subspecies theoretically having the same form of phallic structures throughout a species, are not considered in the course of this study, except for populations of A.psittacina from Assam and N.Burma.

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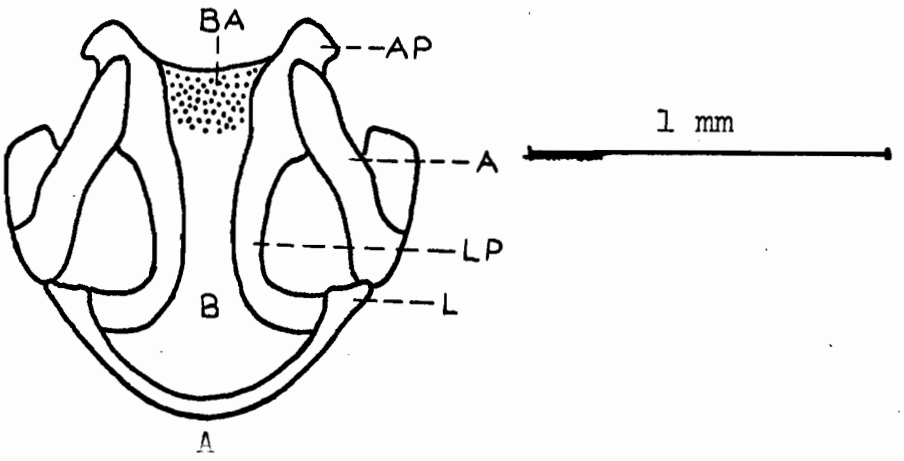
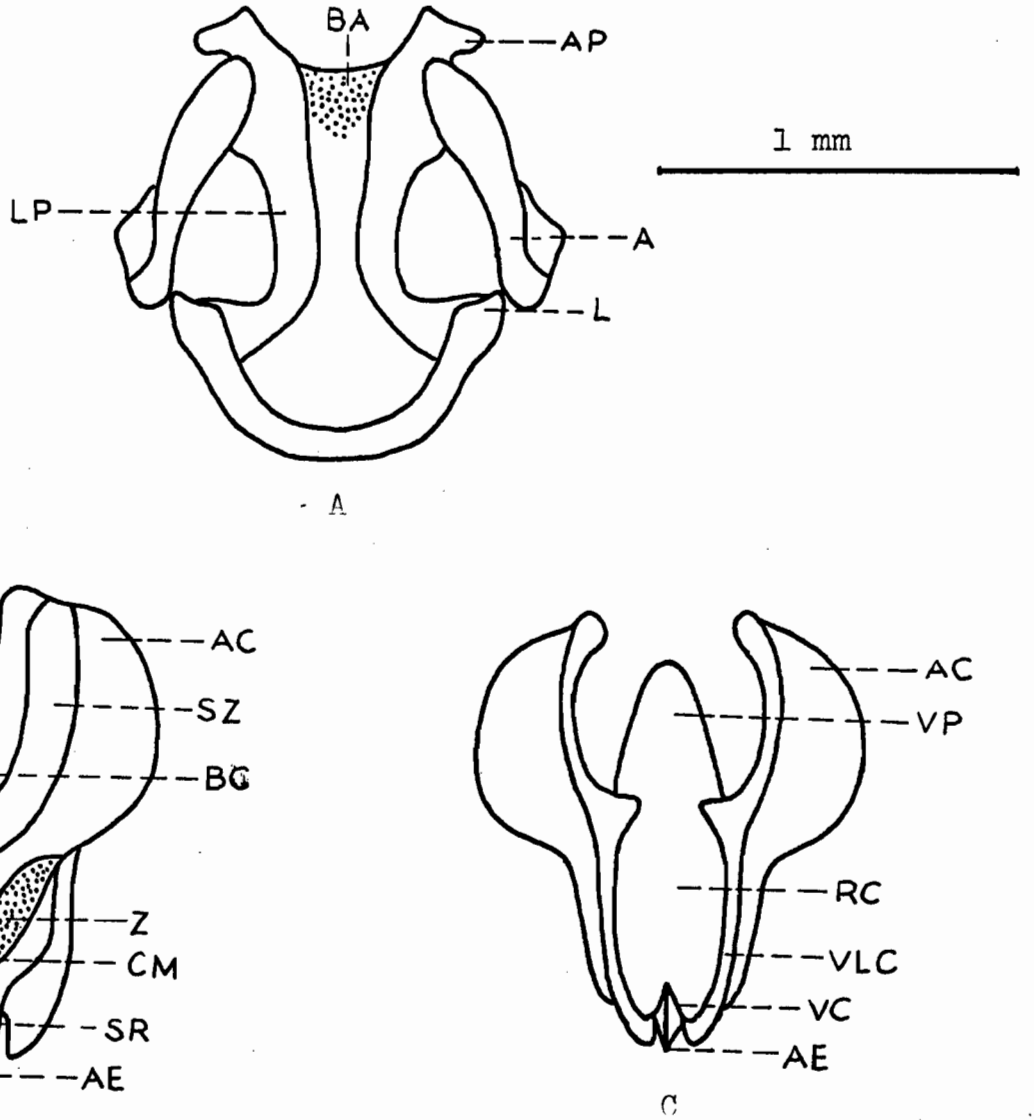
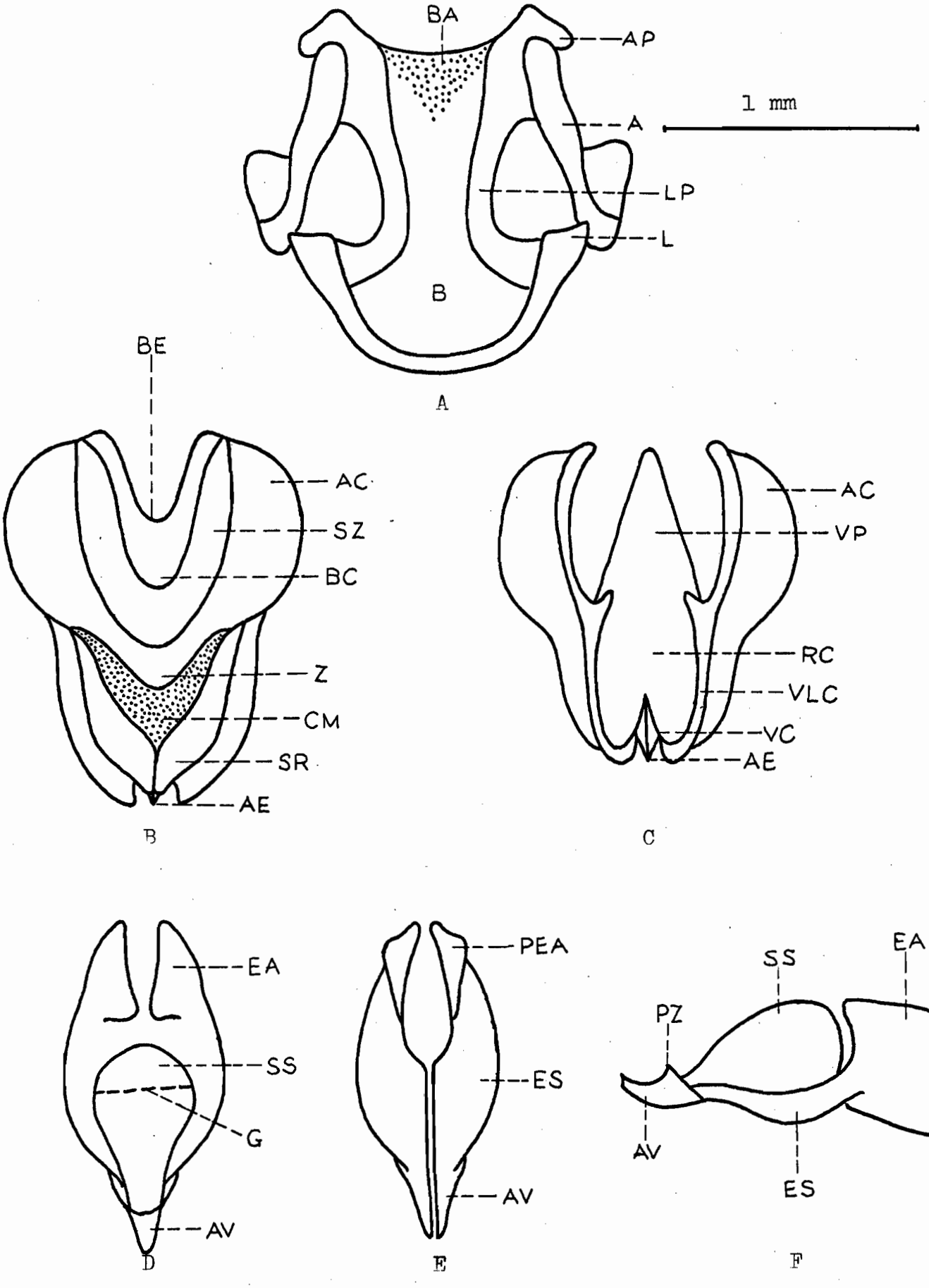
A.crenulata(Fabricius). fig. 1.



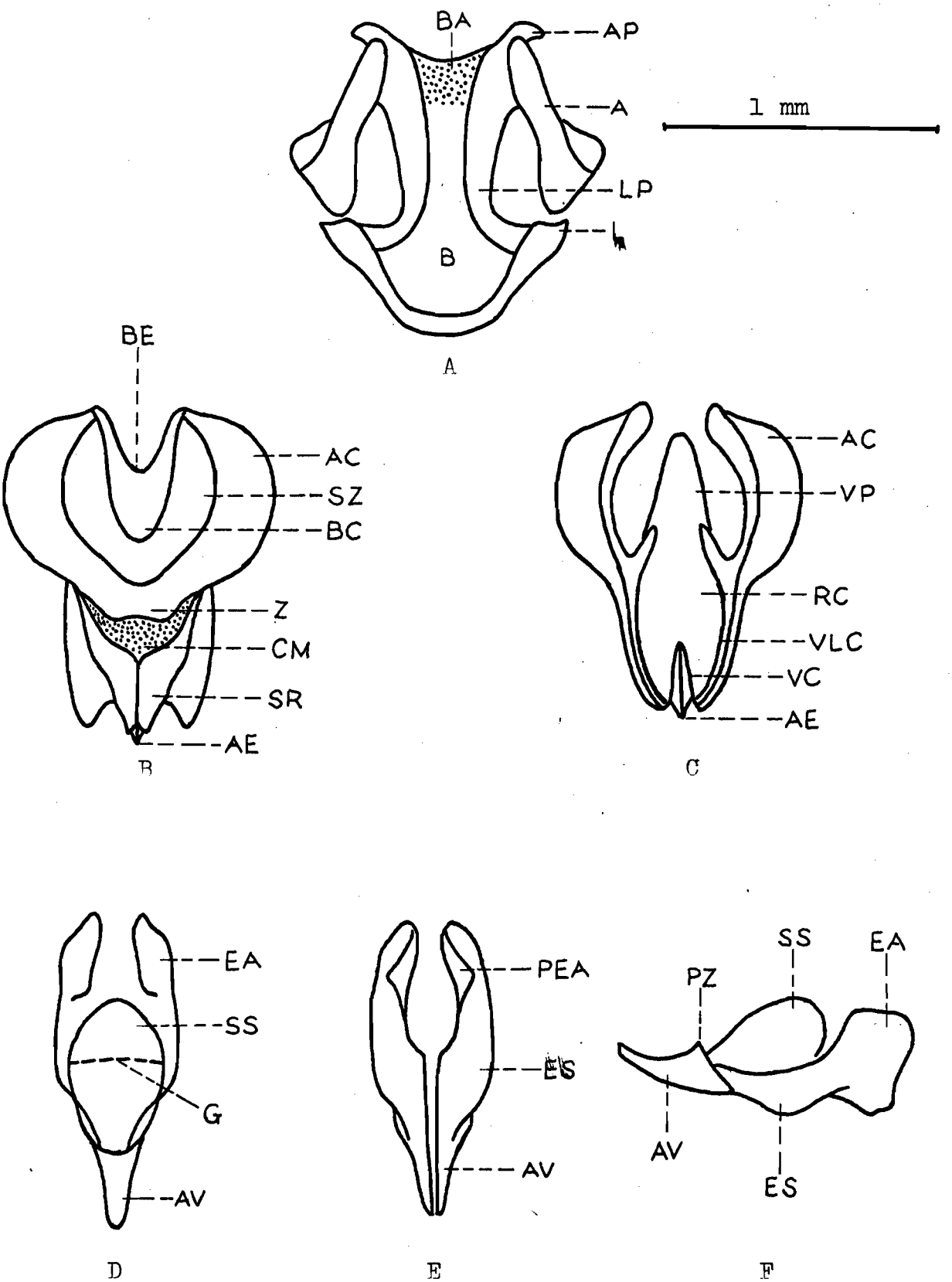
A.acutipennis (Guérin-Méneville). fig. 2.



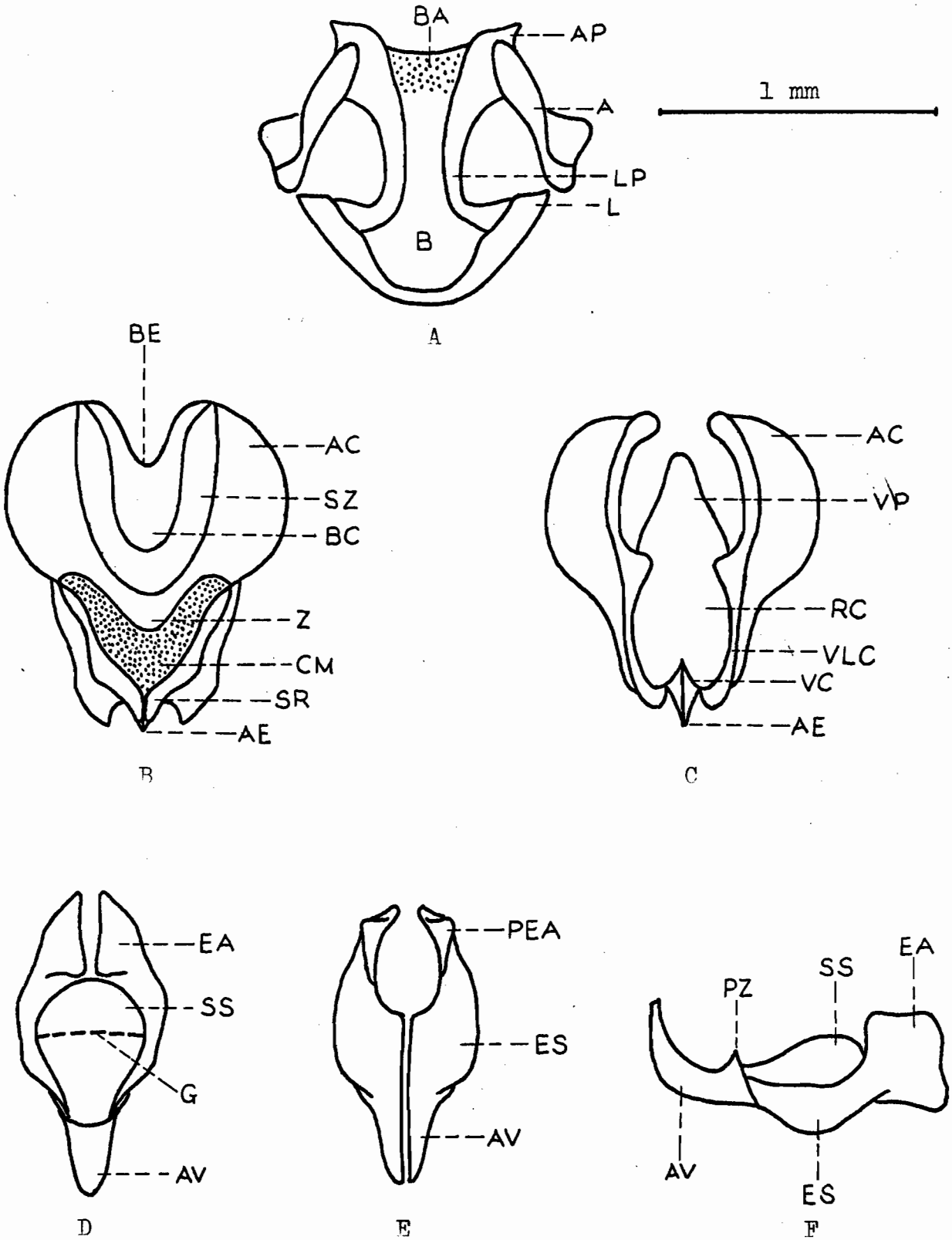
A.himalavica Bolívar. fig. 3.



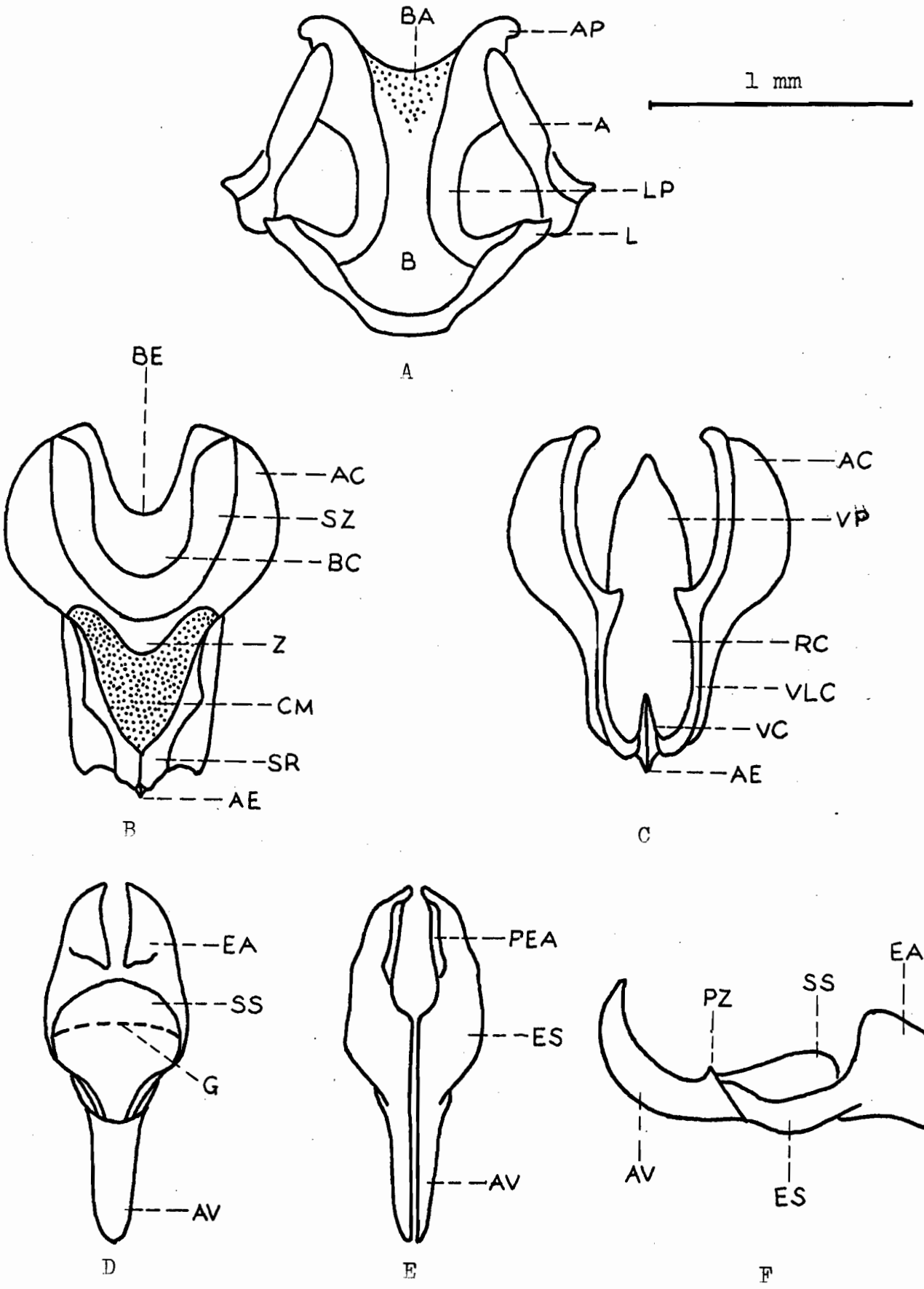
<u>A.sinensis</u> Bolívar. fig. 4.



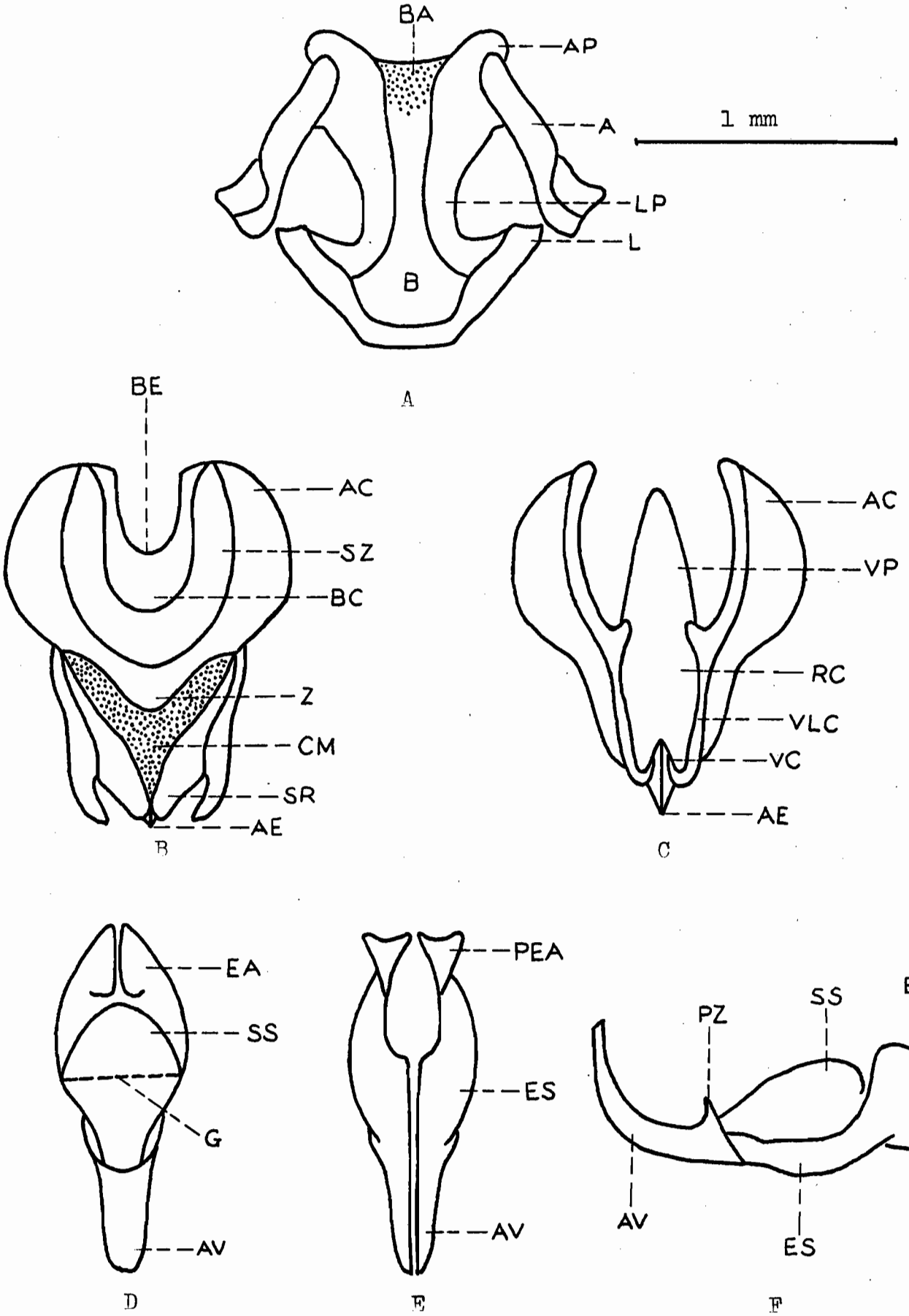
A.psittacina(Haan). fig. 5.



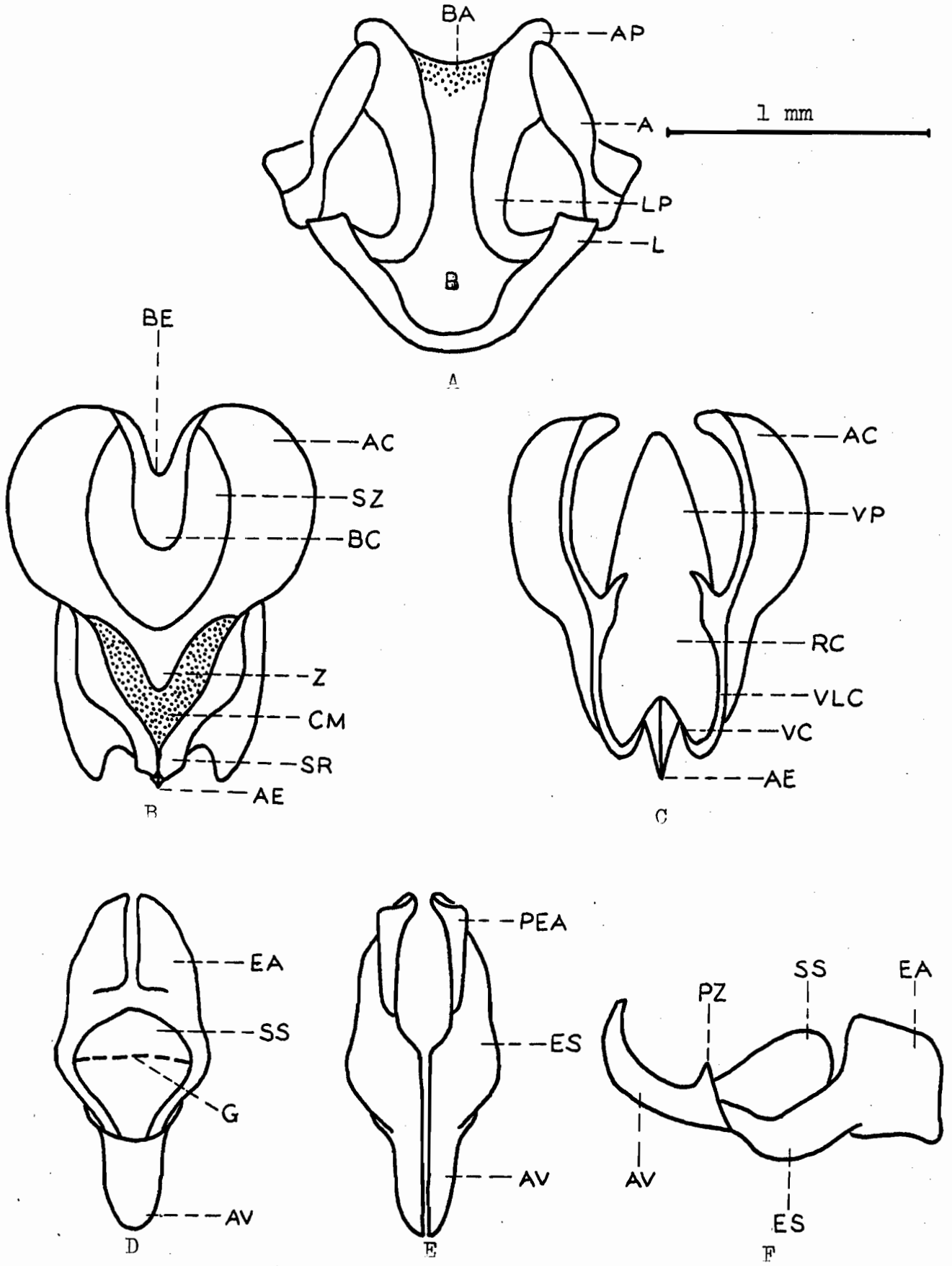
A. psittacina (Haan) fig. 5.



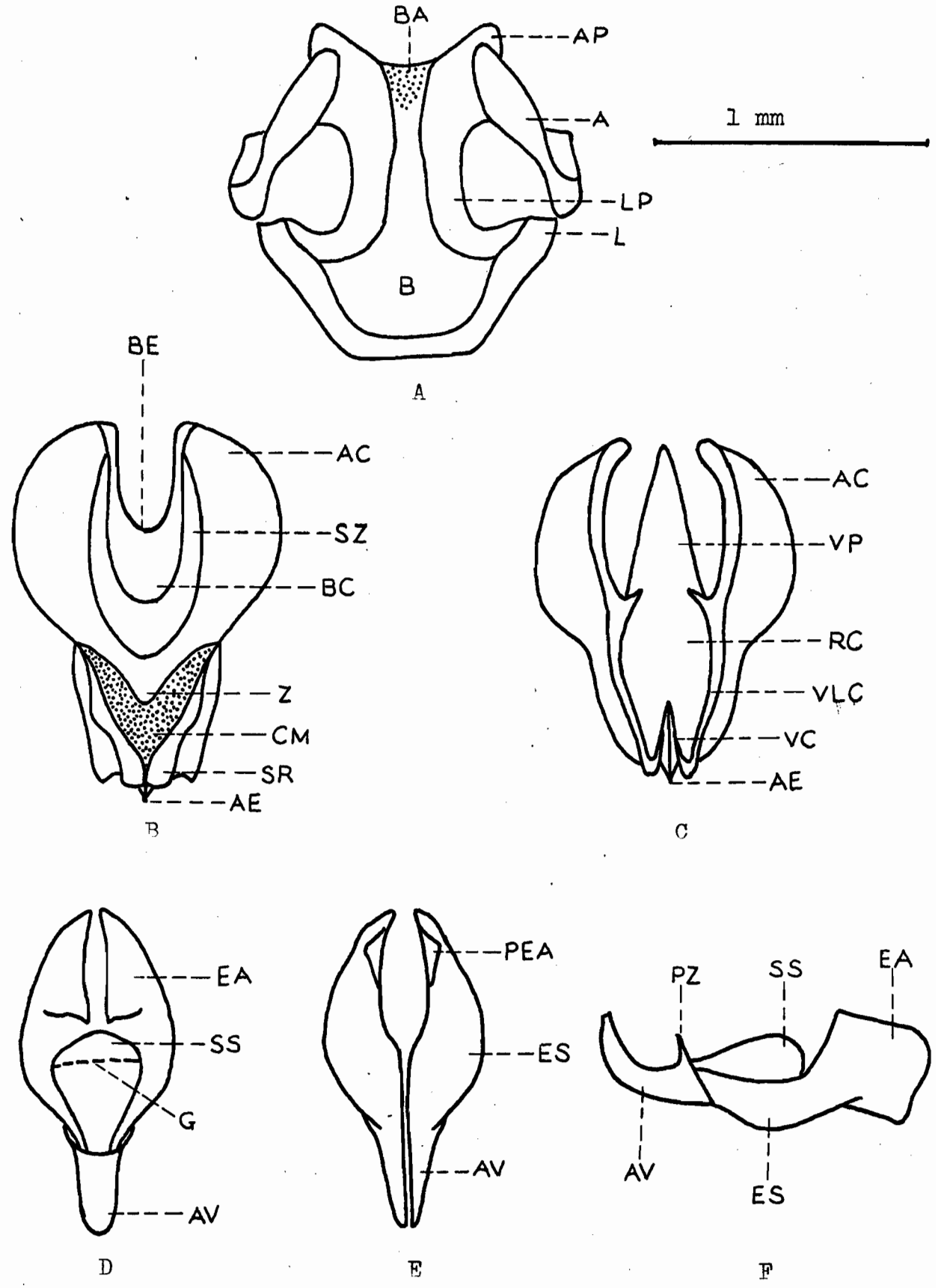
A.burri Bolívar fig. 6.



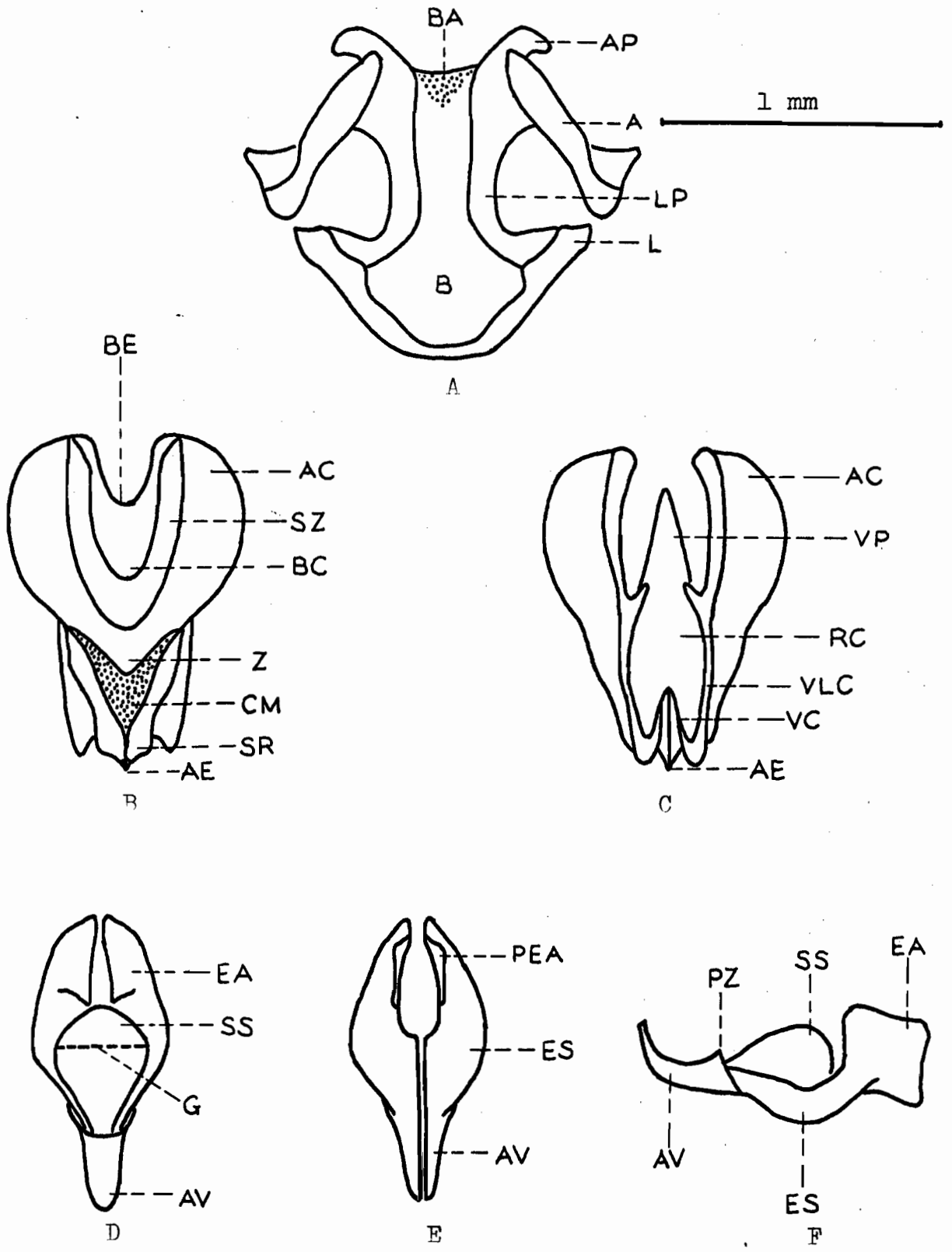
A.lata (Motschoulsky) fig. 7.



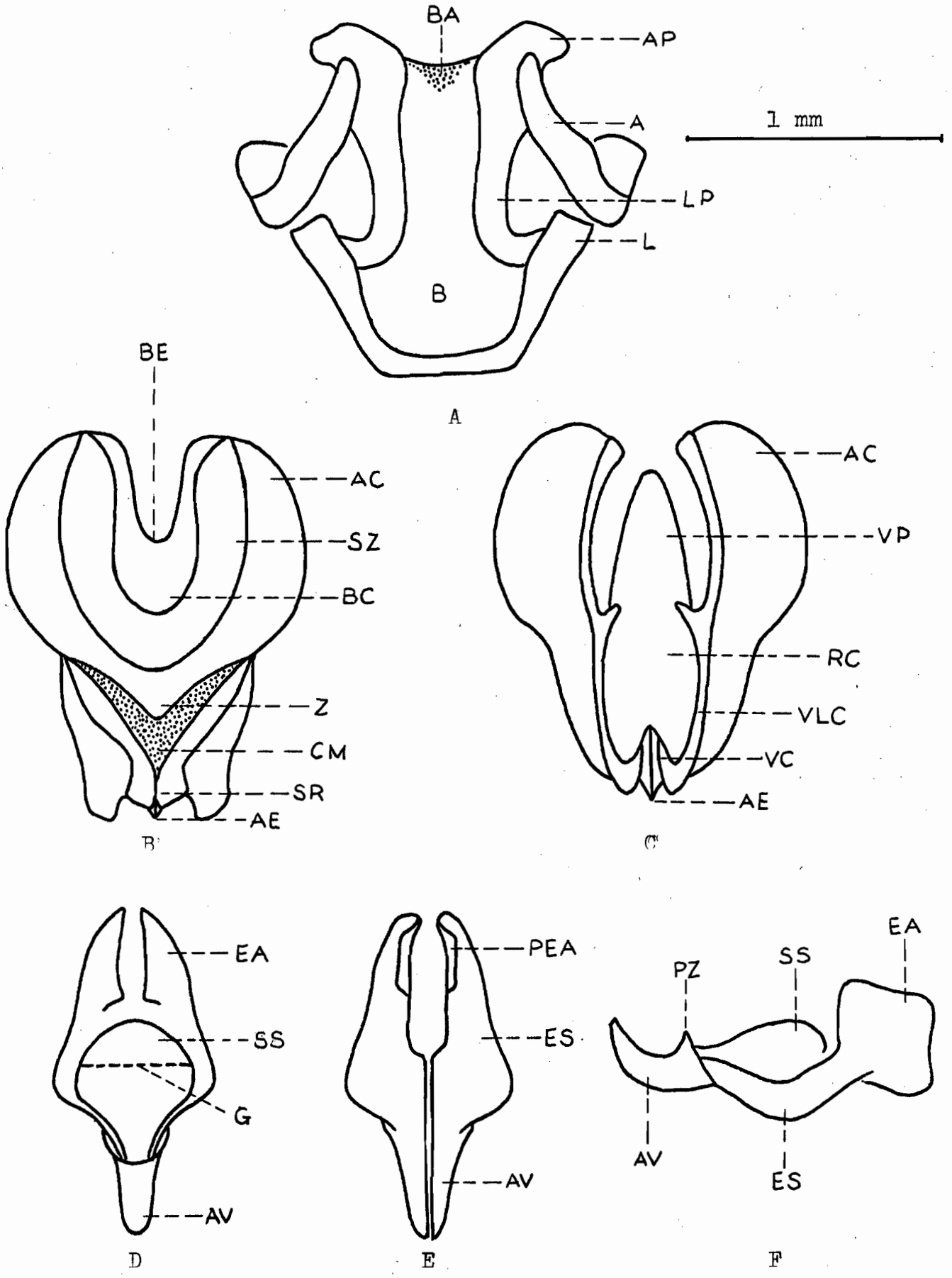
A.crenaticeps (Blanchard) fig. 8.



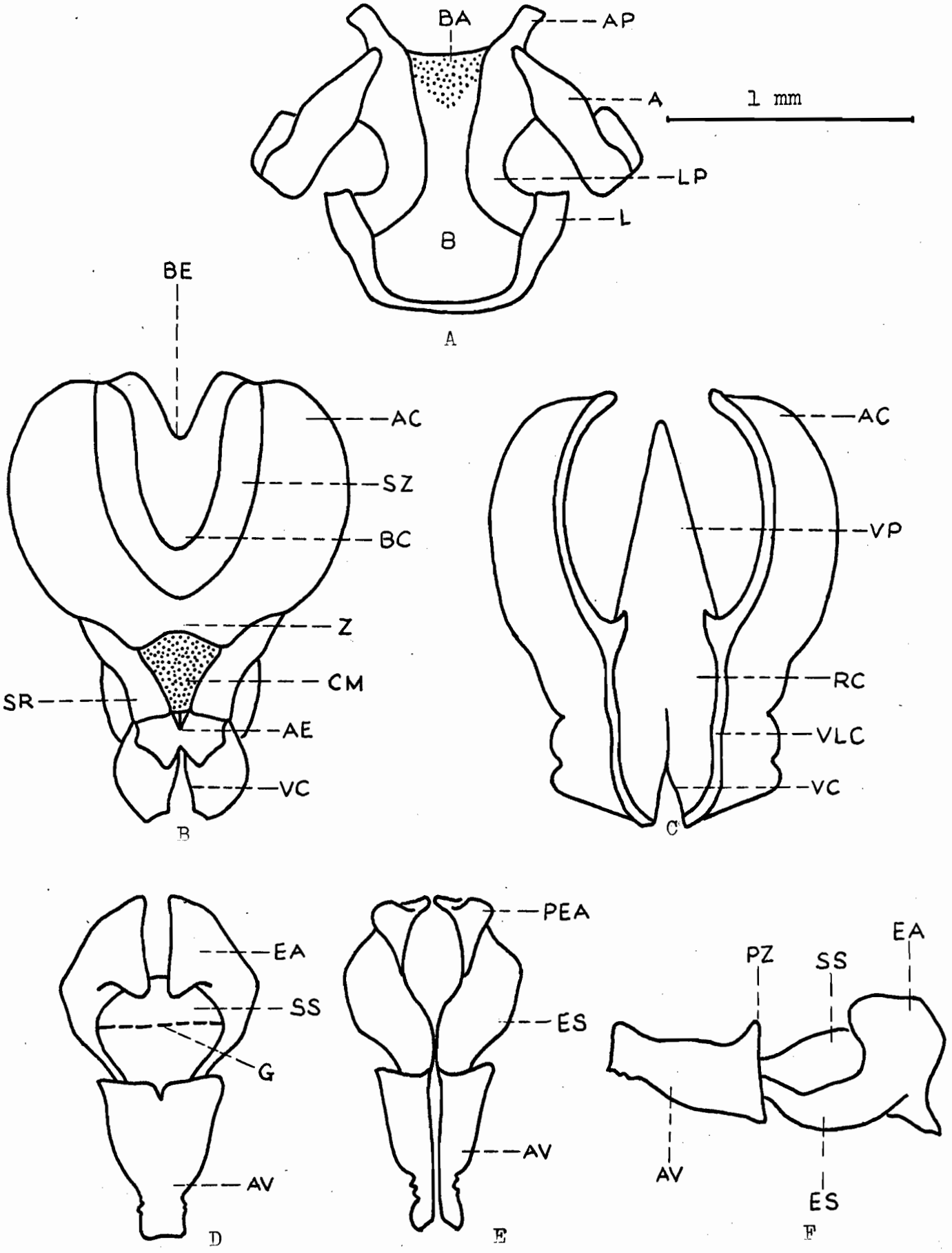
A.australiana Bolívar. fig. 9.



A.australis Rehn. fig. 10.



A.aberrans Karsch. fig. 11.



A.rufopunctata Bolívar.

fig. 12.

1 m m

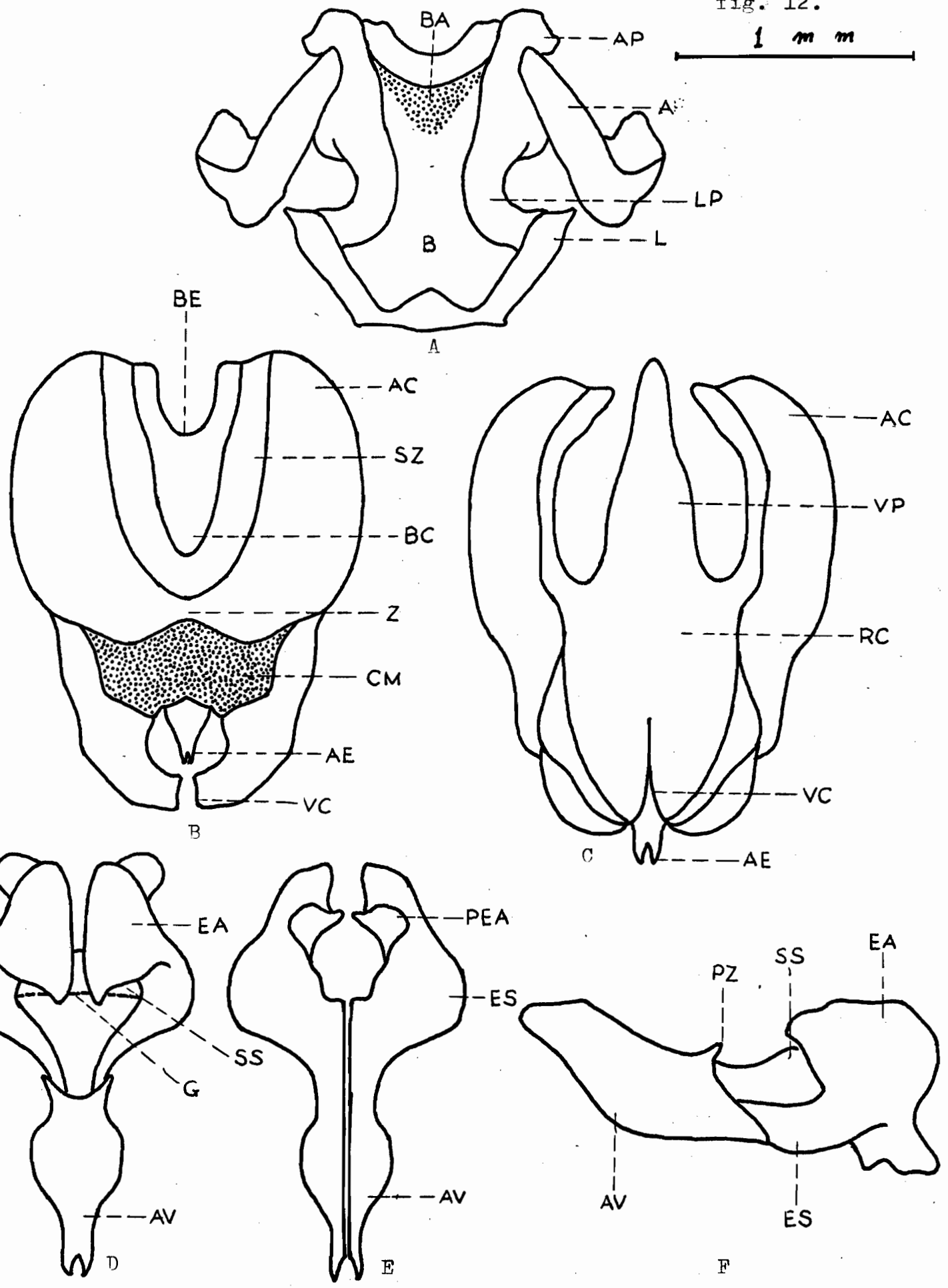
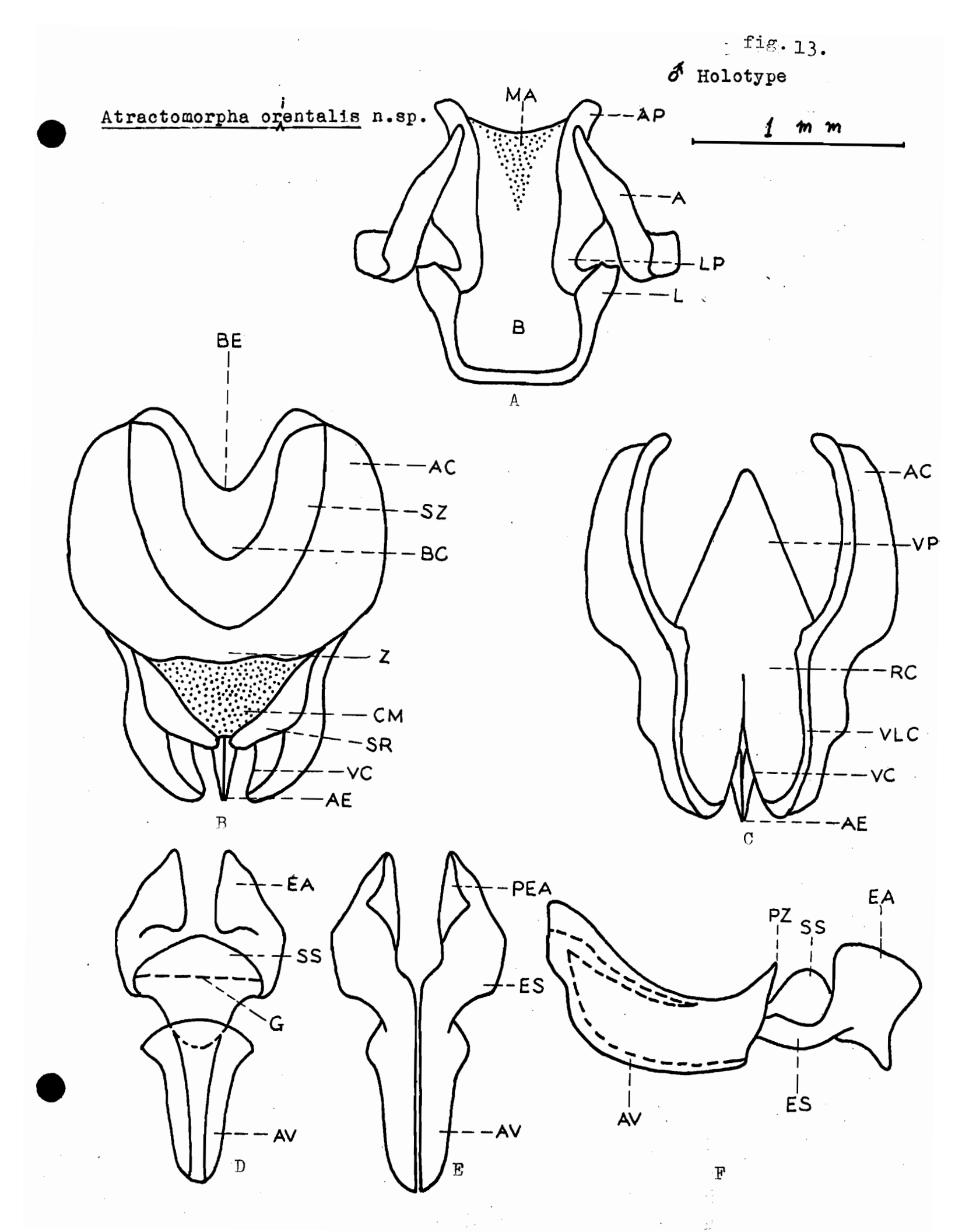


fig. 13.

♂ Holotype

Atractomorpha orentalis n.sp.



Atractomorpha orientalis n.sp.

♀ Allotype

fig.13a

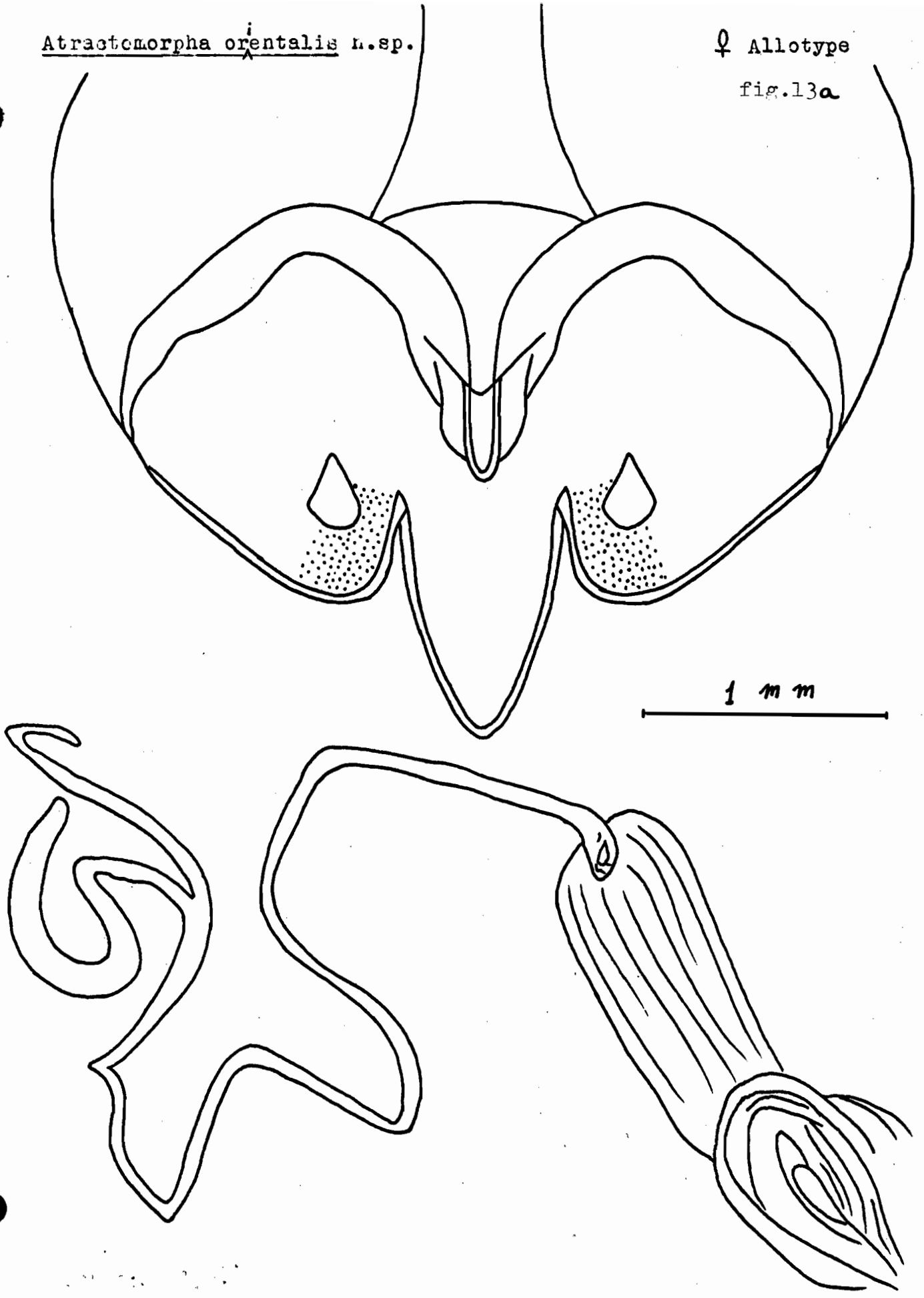
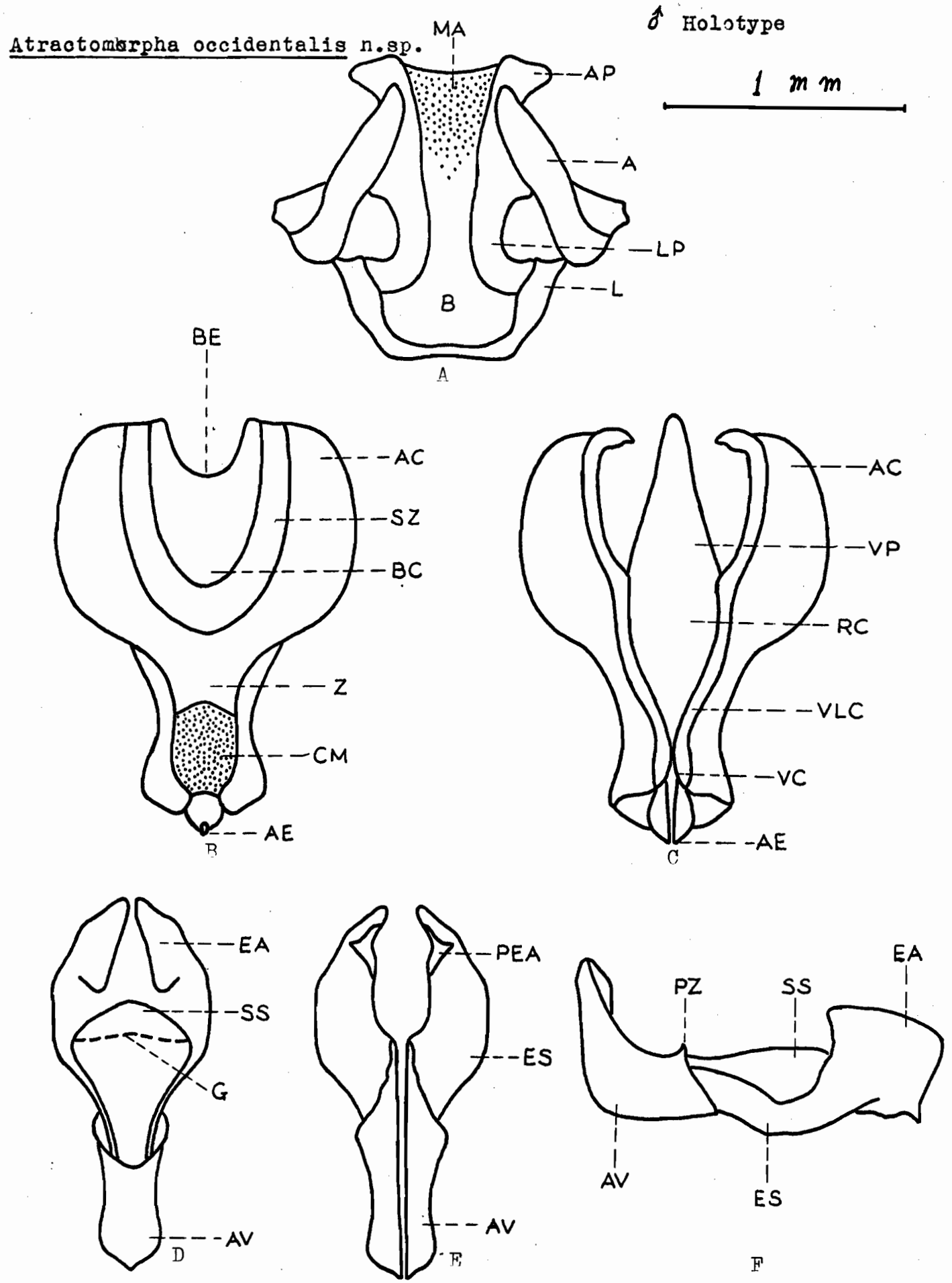


fig. 14.

♂ Holotype

Atractomorpha occidentalis n.sp.



1 mm

Atractomorpha occidentalis n.sp.

♀ Allotype

fig.14a

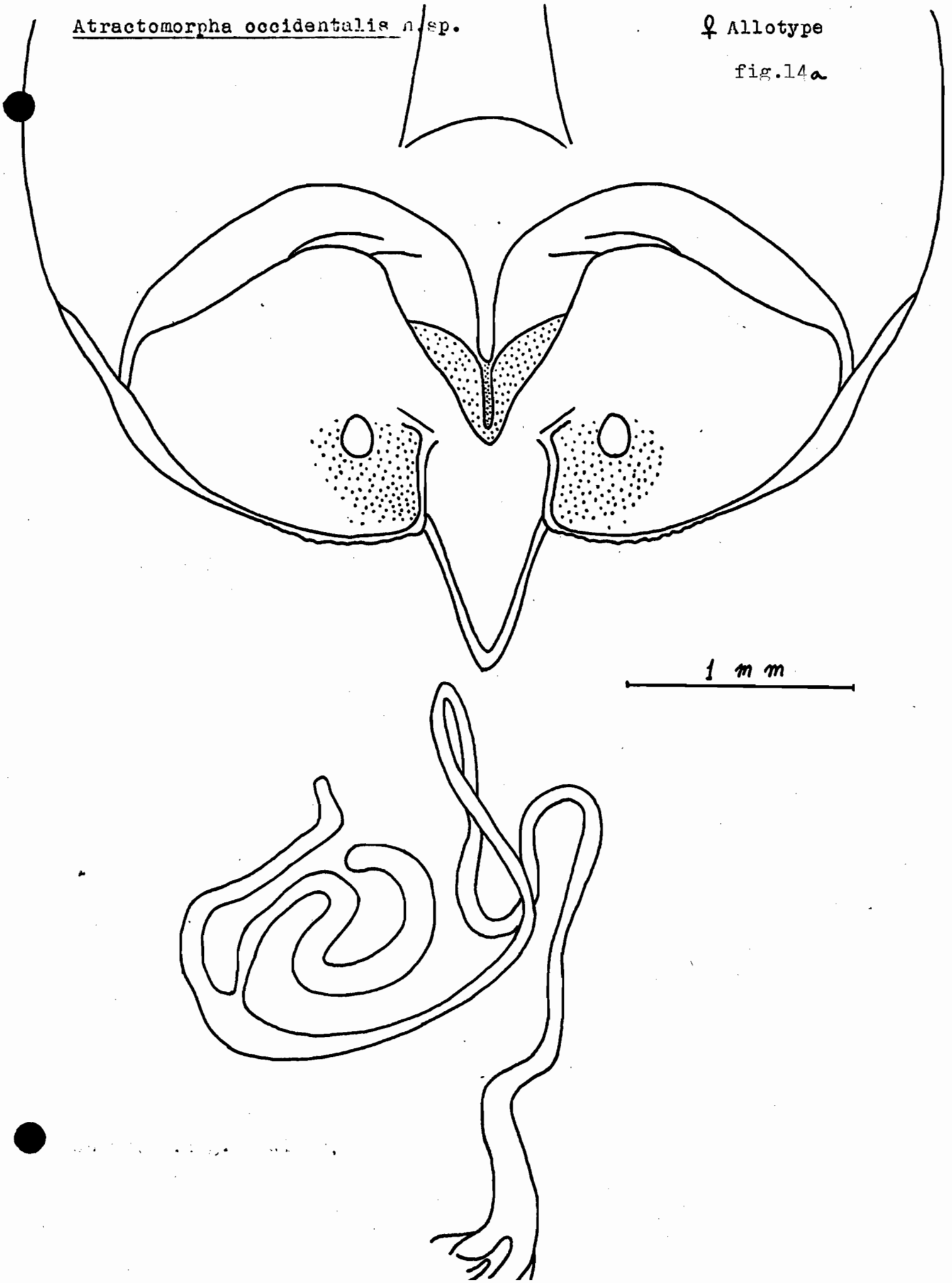


Plate 1.

Atractomorpha occidentalis, sp.n.

♂ holotype

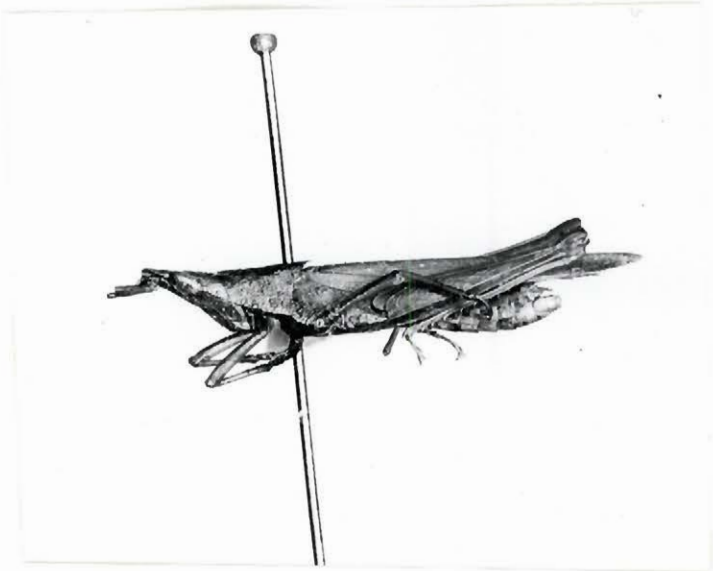
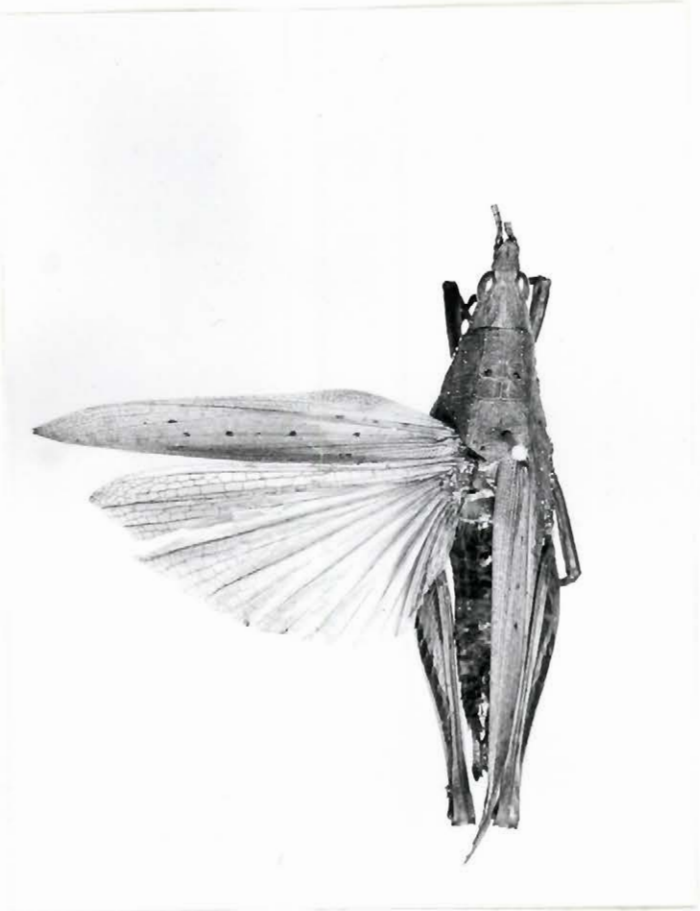


Plate 2

Atractomorpha occidentalis, sp.n.

♀ allotype



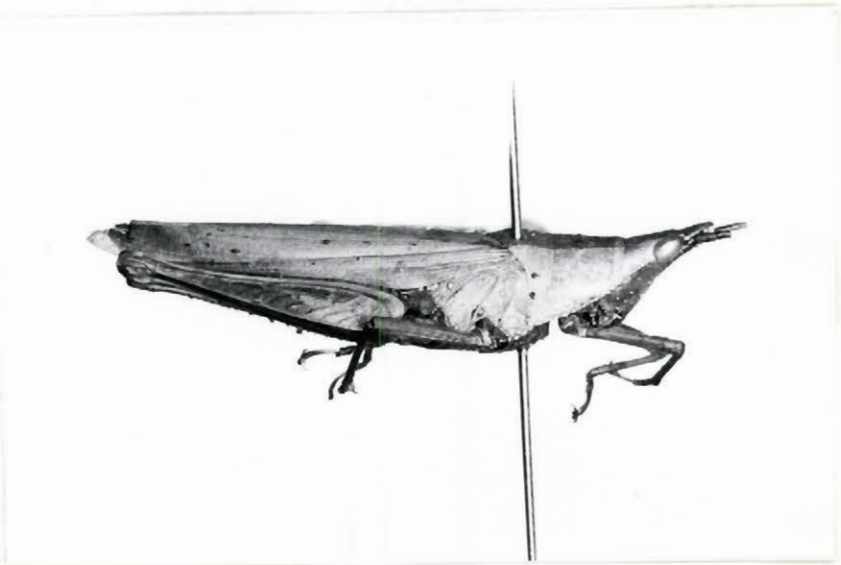
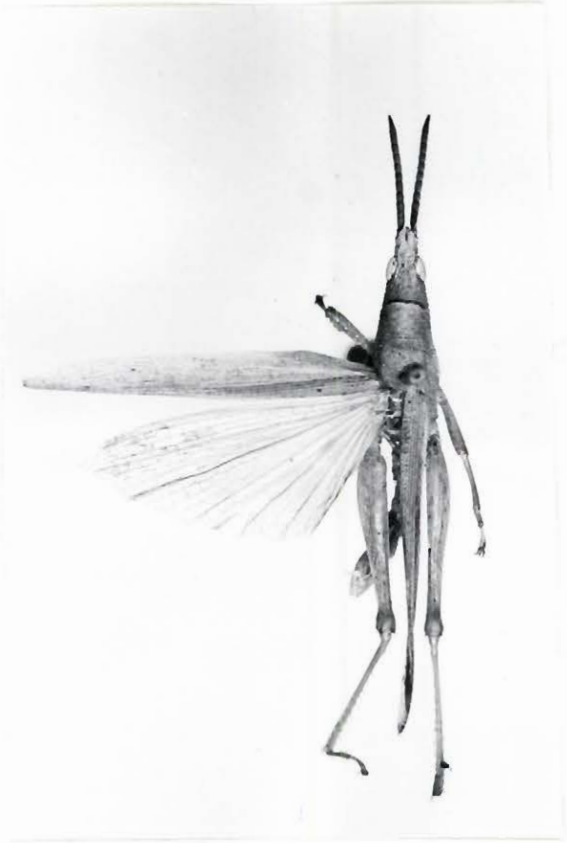


Plate 3

Atractomorpha orientalis, sp.n.

♂ holotype



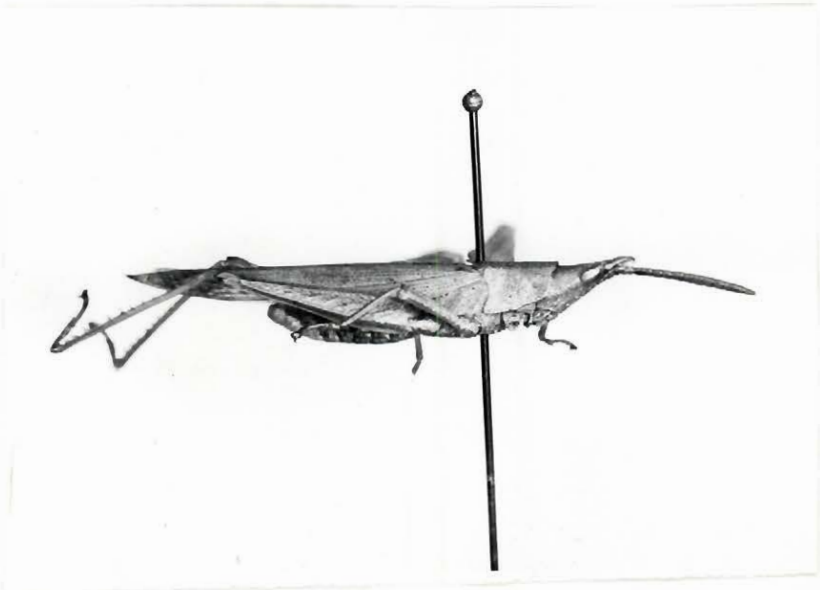


Plate 4

Atractomorpha orientalis, sp.n.

♀ allotype