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DOES AFRICASPIS (HOMOPTERA : COCCOIDEA : DIASPIDIDAE) OCCUR IN ASIA ?

By SADAO TAKAGI, THO YOW PONG, and KHOO SOO GHEE

Systematic and Ecological Surveys on Some Plant-Parasitic Microarthropods in Southeast Asia, Scientific Report No. 3

Abstract

TAKAGI, S., THO, Y.P. and KHOO, S.G. 1988. Does *Africaspis* (Homoptera : Coccoidea : Diaspididae) occur in Asia ? *Ins. matsum. n. s.* 39 : 1-34, 26 figs. (21 pls.).

Cameronaspis, n.g., and *C. linderae* (occurring on *Lindera*), *C. pustulifera* (on "*Henslowia*" and *Euodia*) and *C. adinandrae* (on *Adinandra*), n. spp., are described from the Cameron Highlands, Peninsular Malaysia. *C. adinandrae* is also recorded from Nepal (collected near Kathmandu on *Eurya*). *Africaspis orchidarum*, originally described from the Philippines, is transferred to *Cameronaspis*. The second instar males of the three Malayan species of *Cameronaspis* and six species of *Africaspis* are studied. Based mainly on this instar, *Cameronaspis* belongs to the chionaspidine stock and *Africaspis* to the fioriniine. The resemblance between the two genera in the adult female is attributed to convergence. The occurrence of *Africaspis* in Asia and Australia turns dubious. Remarkable polymorphism occurs in the second instar male in both genera.

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INTRODUCTION

In 1986, from late September to the end of November, surveys were made in Semenanjung Malaysia [Peninsular Malaysia] jointly by Japanese and Malaysian members in connection with the project "Systematic and Ecological Surveys on Some Plant-parasitic Microarthropods in Southeast Asia". As a result a good amount of scale insect material was collected. A smaller collection of this insect group was also obtained in 1985 in the course of preliminary trips made for the materialization of the project in Malaysia.

The great part of the material thus collected in Semenanjung Malaysia belong to the family Diaspididae. The number of diaspidid species collected is estimated at about 300. In consideration of the short time spent for the surveys this suggests the presence of a very rich fauna of scale insects in Semenanjung Malaysia and in Southeast Asia in general. Other families of the Coccoidea in the material are, however, represented by much fewer species. It will be many years before a large part, if not all, of this material can be studied and reported upon. The nominiferous specimens [holotypes] of all new species to be described on the basis of the material will be deposited in the collection of the Forest Research Institute of Malaysia [FRIM]. Other specimens will be divided principally between FRIM and Entomological Institute, Hokkaidô University, Japan.

We begin our report with this short paper dealing with only three diaspidid species from the material. This is due mainly to progress of work on the material, but not without intention and significance. Connections of the Southeast Asian diaspidid fauna to the African one have been suggested by some genera common to both regions. *Aspidiotus* was once supposed to "belong to the region about the Indian Ocean" (Ferris 1941), but later shown by Balachowsky (1956) to have another centre in the Ethiopian Region. One species described as from the Philippines was deemed "definitely to belong to the genus *Africaspis* of which eleven species have been described from Africa" (Ferris 1955). Hall and Williams (1962) described a new species from Malaya as belonging to *Mitulaspis* and stated: "It is surprising that the only two known species of this genus should have been found in such widely separated areas [Malaya and Uganda]. One suspects that other species remain to be discovered but whether in South East Asia or in Africa or both is a matter for conjecture".

In this paper it will be shown that the supposed occurrence of *Africaspis* in Southeast Asia is erroneous and that the resemblance is due to convergence from stocks which are remotely related so far as based on larval characters. The case here may arouse due attention to convergence in the adult female and also to the usefulness of larval characters, especially of the second instar male, in certain groups of the Diaspididae. Both have so much been neglected in diaspidid systematics. This short paper, therefore, may not be unsuitable for starting with, well exemplifying problems and confusions which may probably often be encountered in the study of rich tropical scale insects.

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for the grant of permission for the joint surveys. We are grateful to Dr Salleh bin Mohd Nor, Director, FRIM, who permitted some of the staff members to join the surveys and extended facilities for the surveys. We are thankful to Mr K.M. Kochummen, a botanist in FRIM, who joined the surveys and identified a lot of host plants. Thanks are also due to the staff members of Entomology Division, FRIM, and Prof. Yong Hoi-Sen, University of Malaya, for their help during the surveys.

Dr I.M. Millar, Plant Protection Research Institute, Pretoria, has very kindly made available some material of *Africaspis* kept in the National Collection of Insects. Without his co-operation this work could not have been completed.

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A REVIEW OF AFRICASPIS

The genus *Africaspis* was erected by MacGillivray (1921) for the reception of two African species: *Diaspis chionaspiformis* and *Chionaspis cassiae*, which, however, was later synonymized with the former. In 1946 Hall referred 11 species to the genus, which, so far as based on these species, "is almost certainly African in origin, and is widely distributed throughout eastern and southern Africa".

Ramakrishna Ayyar (1930) recorded "*Pinnaspis chionaspiformis*" (=*Africaspis chionaspiformis*) from South India. Part of his material was previously recorded by Green (1919) under the name *Hemichionaspis chionaspiformis*. Ferris (1955) described a new species, *Africaspis orchidarum*, on the basis of material taken at quarantine in California on orchids originating in the Philippines. He also referred *Neopinnaspis harperi* to *Africaspis*. This species was originally described from material collected in California, but later recorded from Japan and Taiwan. Borchsenius (1966) in his catalogue of the world Diaspidoidea referred *Chionaspis rotundiloba* to *Africaspis*; this species was originally described from Australia.

In 1967 Munting revised the genus *Africaspis* and recognized 13 species, which are "apparently indigenous to Africa", as members of the genus. He also examined specimens of *Africaspis orchidarum* collected at Hawaii on an orchid originating in Singapore and retained the species in the genus "though somewhat reluctantly because of its distribution and the atypical shape of the median lobes". Ben-Dov (1973) added to the genus two new species from southern Africa and, on the basis of material taken at quarantine, another new species, *A. wilkeyi*, from Australia.

Thus 15 species have been recognized as members of *Africaspis* occurring in Africa and one of them was recorded also from South India. Four other species known from other parts of the world have also been referred to *Africaspis*. The assignment of *Neopinnaspis harperi* to *Africaspis* is, however, erroneous. Actually *Neopinnaspis* belongs to the Lepidosaphedini (Takagi 1970), while *Africaspis* to the Diaspidini. Therefore, three non-African species remain: *A. orchidarum* from Southeast Asia and *A. rotundiloba* and *A. wilkeyi* from Australia.

There have been found in the material from Semenanjung Malaysia three species which are close to and apparently congeneric with *Africaspis orchidarum*. In connection with the problem of the generic position of these Asian species the following seven African species of *Africaspis* have been examined. Exuvial casts of the first instar have been available for all these species and specimens of the second

instar male for six of them.

Africaspis caffra. Elandshoek, Transvaal, S. Africa, on *Acacia* sp., 14-vi-1965, J. Munting.

A. chionaspiformis. Zomba, Nyasaland, on African mahogany, 29-xii-1908.

A. commiphorae. Langjan Nature Reserve, Northern Transvaal, S. Africa, on *Commiphora* sp., 16-iv-1972, H.P. Insley.

A. gala. Vryburg, Northern Cape, S. Africa, on *Acacia karroo*, 14-x-1964, D.P. Annecke.

A. muntingi. Windhoek, S.W. Africa, on *Acacia* sp., 2-ix-1969, C.G. Coetzee.

A. scutiae. Mafeking, Transvaal, S. Africa, on *Ziziphus* sp., 10-iii-1967, G. De Lotto.

A. terminaliae. Otjiwarongo District, S.W. Africa, on *Terminalia sericea*, 28-x-1969.

These species all agree in having five-segmented antennae in the first instar. The terminal segment is the longest, but variable in relative length to other segments according to species (about as long as the two or three preceding segments united). The second instar males of five species (*A. chionaspiformis, A. gala, A. muntingi, A. scutiae* and *A. terminaliae*) agree in having "communal ducts" (the term according to Tippins 1970) on the sixth abdominal segment. This character suggests a close relation to *Pseudaulacaspis, Fiorinia*, etc.

The Malayan forms which are related to *Africaspis orchidarum* are quite different in larval characters from the African species examined. *Africaspis orchidarum*, therefore, should be removed from *Africaspis*. In the following lines a new genus is proposed for the Malayan species and *A. orchidarum*. The description is, however, based exclusively on the Malayan species.

Description of new taxa

Cameronaspis, n. g.

Nominiferous species [type-species] : *C. linderae*, n. sp.

Adult female. Body elongate, fusiform ; meso- and metathorax and abd 1-4 moderately lobed laterally ; pygidium rather narrow. Derm membranous except for pygidium ; pygidium dorsally along posterior border of abd 5 with a linear transverse sclerosis mesally to submedian macroducts on each side (except in *C. adinandrae*) and a similar one between submedian and submarginal series of macroducts [these scleroses should not be confused with intersegmental furrows] ; pygidium ventrally with aliform sclerotized area extending anteriorly beyond level of posterior extremities of posterolateral groups of perivulvar disk pores ; a submarginal dorsal boss present on prosoma (in supposed region of prothorax) and abd 1 and 3 each. Lls well developed, appressed together, with lateral margin slanting to outer base and notched several times, united basally by an elongate sclerosis, which extends anteriorly beyond bases of Lls. P2 [pore prominence between L1 and L2] obsolete (thus L2 set quite close to L1) or represented by a small membranous process. L2a represented by a pointed sclerotized process, with an elongate sclerosis arising from its inner base dorsally (in *C. linderae* and *C. pustulifera* this sclerosis

is confounded with the basal sclerotized area of the lobule and the sclerotized rim of the orifice of the associated macroduct); L2b small or obsolete. P3 [pore prominence associated with L3] sclerotized and angular, laterally with L3 represented by a smaller process or serrations. P4 also a sclerotized angular process, with L4 suggested by serrations. Marginal macroducts: 1 on abd 7, opened in P2 or, when P2 is obsolete, situated anteriorly to L2a, associated with the sclerosis arising from the latter, and with orifice surrounded by a stronlgy sclerotized ring; 2 on abd 6 and 5 each, the ones associated with P3 and P4 with orifice surrounded by a well-developed sclerotized ring; 1 at posterolateral corner of abd 4. Submedian and submarginal dorsal macroducts in well-defined, single rows, few in number, occurring on abd 3-5 (submedian macroducts absent on abd 3 in *C. linderae* and *C. pustulifera*). Lateral macroducts occurring anteriorly as far as abd 1 or metathorax. Marginal gland spines of pygidium occurring on abd 5-8, well developed except on abd 8 [between L1 and L2], usually single (always single on abd 7 and 8), those on abd 5 and 6 often with 2 or 3 microducts running through and with apex divided accordingly [suggesting a fused origin]. Prepygidial lateral gland spines occurring anteriorly as far as abd 1 or 2 or metathorax. Spiracular disk pores trilocular. Perivulvar disk pores in 5 groups. Anus situated towards base of pygidium. Antennae with 1 seta.

Second instar male. Body membranous, with segmentation obscure. Pygidium with membranous or slightly sclerotized marginal processes, but with no well-differentiated, strongly sclerotized lobes. "Cup-like ducts" (the term according to Boratyński 1953) occurring on abd 2-7 marginally; submarginal cup-like ducts also present, 1 or more according to species. Well-developed gland spines occurring posteriorly to anterior spiracle, laterally to posterior spiracle, and submarginally on abd 1. Antennae with 1 seta.

First instar larva (female and male). Antennae (Fig. 19B) 6-segmented, terminal segment longest, as long as 3 preceding segments united or at least longer than 2 preceding segments united. A pair of enlarged dorsal ducts, with inner end 8-shaped, present on head. A "suranal duct" (the term according to Howell and Tippins 1977) present on each side of anus.

Composition and distribution. The three Malayan species were collected all on the Cameron Highlands on wild plants. One of them was also collected in Nepal. *Africaspis orchidarum*, which is apparently referable to *Cameronaspis*, is known only from material taken at quarantine on orchids (including a horticultural hybrid) originating in the Philippines and Singapore.

Relationship. The zygotic median lobes in the adult female, the occurrence of cup-like ducts in the second instar male, and the presence of suranal ducts in the first instar larva show in combination that *Cameronaspis* is related to *Chionaspis*, *Aulacaspis*, *Pinnaspis*, etc. The appressed median lobes and the linear scleroses occurring along the posterior border of the fifth abdominal segment in the adult female remind us of *Pinnaspis* species. Indeed, when Ferris (1955) described *Africaspis orchidarum*, he compared *Africaspis* with *Pinnaspis*. However, what he pointed out is, in reality, the resemblance of *Cameronaspis* to *Pinnaspis*, but not of *Africaspis*. In fact, many species of *Africaspis* bear little resemblance to *Pinnaspis*.

The known distribution of *Cameronaspis* falls within the range of *Pinnaspis*, and the two genera may in reality be closely related. *Cameronaspis* differs from

Pinnaspis in the second lobes represented by sclerotized pointed processes and with a dorsal sclerosis arising from the base. In two species (*C. linderae* and *C. pustulifera*) this sclerosis is confounded with the basal sclerotized area of the second lobes and the strongly sclerotized rim of the orifice of the macroduct associated with it. *Cameronaspis* in comparison with *Pinnaspis* is also characterized by the orifices of other marginal macroducts (especially those associated with the pore prominences of the fifth and sixth abdominal segments) strongly sclerotized on the rim likewise. A similar appearance of the pygidial margin is produced by strongly rimmed orifices of marginal macroducts in *Africaspis*, combined with appressed median lobes and pointed second lobes in some species including *A. chionaspiformis*, the nominifer of the genus. However, other species of *Africaspis* are not so similar to *Cameronaspis* as stated later. These genera are quite different in larval characters as stated above.

Cameronaspis linderae, n. sp.

Material. Semenanjung Malaysia : Cameron Highlands. Near Arcadia Villa, alt. ca. 1500 m, 30-xi-1985 ; Gunong Jasar, alt. ca. 1600 m, 17-x-1986. On *Lindera reticulosa* [Lauraceae]. Females and males occurring on the undersurface of the leaves. Female tests pyriform, gently convex dorsally, covered by the thin upper epidermal layer of the leaves. Male tests white, covered by flocculent secretion. Mounted specimens examined include 45 adult females (one the nominifer) and more than 20 second instar males.

Adult females (Figs. 4, 14 & 17A). Pygidium nearly straight marginally on each side, with linear scleroses both mesally to submedian macroducts and between submedian and submarginal series of macroducts on abd 5. Lls appressed together except for a short apical length, straight on slanting outer margin. L2a well represented, ventrally with a pair of slender paraphyses. L2b present though small. P2 obsolete ; marginal macroduct of abd 7 situated anteriorly to L2a. Submedian macroducts : 1-4 on abd 4 and 5 each. Submarginal macroducts : 3-7 on abd 3, 2-6 on abd 4, and 1-6 on abd 5. Lateral macroducts : 3-11 on metathorax, 10-23 on abd 1, 9-18 on abd 2, 2-11 on abd 3, 1-3 (usually 2) on abd 4. Submedian dorsal microducts present on prepygidial abdominal segments, few on each segment. Lateral gland spines : 1-5 on abd 1, 4-9 on abd 2, 5-10 on abd 3, 4-9 on abd 4. Anterior spiracle with 10-23 disk pores ; posterior spiracle with 6-23 (rarely without disk pores). Perivulvar disk pores : 14-26 in median group, 22-45 in the anterolateral, and 16-34 in the posterolateral.

Second instar female (Fig. 19A). Similar to adult female in pygidial margin. Marginal macroducts : 1 on abd 4-7 each.

Second instar male (Fig. 20). Cup-like ducts : 6 marginal, 1 on abd 2-7 each ; 3 submarginal, 1 on abd 3-5 each. Other dorsal ducts small, occurring mainly in sumedian region on metathorax to abd 7 and in lateral region on base of abdomen. Between the posteriormost marginal cup-like ducts there are 2 pairs of small membranous processes, the outer pair with a microduct running through. Between the posteriormost and penultimate marginal cup-like ducts there is a prominent, pointed process, which bears a microduct. A similar process on each of the 2 preceding segments (abd 5 and 6) ; a similar, but more or less reduced one on abd 4, sometimes reduced to a small gland spine. Anteriorly to this, on or near margin, 2

small gland spines; anteriorly to these, a similar one. Well-developed gland spines usually as follows: 3 posteriorly to anterior spiracle, 2 laterally to posterior spiracle, and 4 on base of abdomen, the posteriormost gland spine of the last group smaller than the others. Anterior spiracle with 2-6 disk pores; posterior spiracle with 1-4.

Cameronaspis pustulifera, n. sp.

Material. Semenanjung Malaysia: Cameron Highlands. Gunong Jasar, alt. ca. 1600 m, on "*Henslowia*" sp. [Santalaceae], 1-xii-1985; near Arcadia Villa, alt. ca. 1500 m, on *Euodia latifolia* [Rutaceae], 13-x-1986; Tanah Rata, ca. 1300 m, on "*Henslowia*" sp., 14-x-1986. Adult females were found on the leaves of "*Henslowia*" and on the leaves and twigs of *Euodia latifolia* (mounted specimens are from twigs); males occurring on the leaves of these host plants. The female, when occurring on the leaf, causes a white pustulous growth on the leaf tissue. The growth is nearly elliptical or pyriform when completed, enclosing the insect body and test. On the twigs of *Euodia latifolia* the female tests are covered by the thin upper epidermal layer of the host plant. Male tests strongly tricarinate. Mounted specimens examined include 59 adult females and about 15 second instar males. Nominiferous specimen [holotype] (adult female), from "*Henslowia*" sp., Tanah Rata.

Adult female (Figs. 5, 15 & 17B). Very similar to adult female of *C. linderae*, differing only in the numbers of external secretory organs (Figs. 1-3): macroducts, gland spines and disk pores (except anterior spiracular disk pores) tending to be fewer than in *C. linderae*. However, not all the differences are significant. Lateral macroducts significantly fewer on abd 2 and 3; total number of lateral macroducts of both sides 44-76 (in *C. linderae* 73-96; 113 in 1 specimen). Submedian macroducts: 1-4 (rarely 0) on abd 4 and 5 each. Submarginal macroducts: 2-7 on abd 3, 1-5 (rarely 0) on abd 4, and 1-4 (rarely 0) on abd 5. Lateral macroducts: 1-9 on metathorax, 6-16 on abd 1, 7-12 on abd 2, 2-7 on abd 3, 1 (rarely 2) on abd 4. Lateral gland spines: absent (except for occasional presence of 1 gland spine) on abd 1; 1-5 on abd 2, 3-8 on abd 3, and 3-7 on abd 4. Anterior spiracle with 9-35 disk pores; posterior spiracle with 1-14 (rarely no disk pores). Perivulvar disk pores: 12-28 in median group, 14-37 in the anterolateral, and 9-32 in the posterolateral. Submedian dorsal microducts very few on prepygidial abdomen.

Second instar female. Hardly distinguishable from second instar female of *C. linderae*.

Second instar male (Fig. 21). Cup-like ducts: 6 marginal on abd 2-7, the second and third from the anterior (supposed to belong to abd 3 and 4) are set close together; these and the posteriormost are large cup-like ducts, while the others are smaller; a submarginal one is present near the marginal duct of abd 5, smaller than the large ones. Other dorsal ducts are small, occurring mainly in median to submedian region on mesothorax and succeeding segments and in 4 nearly transverse submarginal rows on meso- and metathorax and base of abdomen. Well-developed gland spines: 3 posteriorly to anterior spiracle, 2 laterally to posterior spiracle, and 4 on abd 1, the posteriormost gland spine of the last group being very small. Posteriorly to this group there are 3 single small gland spines on or near margin, the posteriormost occurring between cup-like ducts of abd 3 and 4. Posteriorly to these cup-like ducts there is a series of membranous processes on pygidial margin, some

of them with a microduct running through. Anterior spiracle with 2-4 (usually 3) disk pores; posterior spiracle without disk pores.

Remarks. This species is recognized as distinct mainly on account of the second instar male which is remarkably different from that of *C. linderae* in the cup-like ducts and the marginal processes of the pygidium. It is, however, not easy to distinguish individual adult females between these species. The forms occurring on "*Henslowia*" and *Euodia latifolia* cannot be distinguished both in the adult female and in the second instar male.

Cameronaspis adinandrae, n. sp.

Material. Semenanjung Malaysia: Cameron Highlands. Tanah Rata, alt. ca. 1300 m, on *Adinandra sarosanthera* [Theaceae], 20-x-1986. Females and males occurring on the twigs and the undersurface of the leaves; female tests covered by the thin upper epidermal layer of the host plant. Male tests white, flocculent. Mounted specimens examined are all from twigs and include 29 adult females (one the nominifer), not all of which are in good condition, and 1 second instar male.

Adult female (Figs. 6, 16 & 17C). Pygidium slightly roundish on margin, without linear scleroses mesally to submedian macroducts of abd 5. Lls appressed together except for a short apical length, a little roundish on slanting lateral margin. P2 present, though small and membranous. L2a reduced to a small pointed process, dorsally with a clavate sclerosis, ventrally without distinct paraphyses; L2b obsolete or suggested by a slight prominence. Submedian macroducts: 1 present on abd 3 in about 50% cases examined; 1 or 2 present (rarely absent) on abd 4 and 5 each. Submarginal macroducts: 1-5 on abd 3, and 1-3 on abd 4 and 5 each. Lateral macroducts: rarely 1 or 2 present on mesothorax; 2-8 present on metathorax, 6-10 on abd 1, 3-9 on abd 2, 3-6 on abd 3; rarely a single macroduct present on abd 4. Lateral gland spines: absent on abd 1, 0-2 on abd 2, 1-4 on abd 3, 2-4 on abd 4. Anterior spiracle with 8-22 (43 in a case) disk pores; posterior spiracle with 2-10. Perivulvar disk pores: 13-26 in the median group, 19-38 in the anterolateral, 16-30 in the posterolateral. Submedian dorsal microducts usually absent on prepygidial abdomen.

Second instar female (exuvial cast). Similar to adult female in pygidial margin. Four marginal macroducts present, 1 on abd 4-7 each; 4 much smaller ducts occurring on margin on the 4 preceding segments (metathorax to abd 3).

Second instar male (Fig. 22). The single specimen available shows 22 cup-like ducts on one side and 25 on the other in the marginal to submarginal region of abd 2-7. These ducts are all large. Small dorsal macroducts arranged nearly as in *C. linderae*. There are on the pygidial margin glanduliferous processes, which are not so prominent as in *C. linderae*. Well-developed gland spines: 3 on one side and 4 on the other posteriorly to anterior spiracle, 2 laterally to posterior spiracle, and 4 on base of abdomen, the posteriormost gland spine of this group smaller than the others. Anterior spiracle with 2 disk pores; posterior spiracle without disk pores.

Remarks. This species is distinguishable from *C. linderae* and *C. pustulifera* by the roundish median lobes and the much reduced second lobes. It is hardly distinguishable in the numbers of the spiracular and perivulvar disk pores, but differs in the macroducts and gland spines tending to be fewer (Figs. 1-3). It is clearly distinguishable in the second instar female and the second instar male.

Some mounted adult females of this species are at hand from Nepal (Nagarjun, near Kathmandu, alt. 1470 m, on *Eurya cerasifolia* [Theaceae], 12-x-1983; associated with a fungus, probably of the genus *Septobasidium*, on the branches). They closely agree with the adult females from Malaya. They may slightly differ from the latter in the numbers of some secretory organs, but the specimens available are not sufficient for a statistical comparison.

A NEW COMBINATION

Cameronaspis orchidarum, n. comb.

Africaspis orchidarum Ferris, 1955: 23 [Philippines, on an orchid of the genus *Vanda* and an undetermined orchid]; Munting, 1967: 23 [Singapore, on *Aranda deborah*].

So far as based on Ferris' drawings, this species agrees with *C. adinandrae* in having a distinct pore prominence between the median and second lobes, but otherwise does not seem to be particularly close to the latter. This species is uniquely characterized by "the anterior spiracles with a very large cluster of extremely small pores".

AFRICASPIS AND CAMERONASPIS

Convergence

As stated above *Africaspis* is deemed to belong to the fioriniine stock whereas *Cameronaspis* is a chionaspidine, and the resemblance if any in the adult female between the two is attributable to convergence. The resemblance between *A. chionaspiformis* (Figs. 7 & 17D), the nominifer of *Africaspis,* and the *Cameronaspis* species is fairly close so far as the state of the pygidial margin is concerned. However, the resemblance between the two genera is not always so close when other species of *Africaspis* (Figs. 8-13 & 18) are taken into consideration. In *Africaspis* the median lobes are generally squat, and in many species separated from each other except basally. In *Cameronaspis* these lobes are well produced, appressed together, and serrate laterally. In *Africaspis* the pygidium is broad, and in many species the macroducts are abundant. In *Cameronaspis* the pygidium is much less broad and the dorsal macroducts are few. Most species of *Africaspis* differ from *Cameronaspis* in the basal zygosis of the median lobes scarcely produced anteriorly and in lacking linear scleroses on the border of the fifth abdominal segment (in some species, however, there is a pair of thick scleroses at the corresponding positions). Hence the convergence is incomplete.

It is not always easy to find significance for generic or specific characters of diaspidids in relation with their life. The females of *Cameronaspis* are cryptic, burrowing under the plant epidermis (in Nepal *C. adinandrae* was collected from under fungal mat). The female of *C. pustulifera* even causes a peculiar growth on the leaf tissue affected and is enclosed within the growth. In the *Cameronaspis* females the structure of the pygidial margin and the reduced number of the dorsal macroducts probably have significance in relation with their cryptic life. Though information is not sufficient for a generalization, it seems that in *Africaspis* the female tests are exposed on the branches of the host plants in the dry climate of southern and eastern Africa. *Africaspis* and *Cameronaspis* may, in reality, represent

forms quite different in the way of life.

Polymorphism in the second instar male

Africaspis and *Cameronaspis* are quite different in the second instar male. This stage is also remarkably variable in each of these genera. The three Malayan species of *Cameronaspis* are especially different in the cup-like ducts, and this seems to correspond to the structure of their tests. In *C. pustulifera* the male test is strongly tricarinate, and the median carina and the lateral carinae seem to be formed respectively by the large cup-like ducts occurring at the apex of pygidium and by those on the margin of third and fourth abdominal segments. *C. linderae* and *C. adinandrae* have more large cup-like ducts, which are especially abundant in the latter. In both species the second instar males are covered by flocculent secretion, and this may be due to the many large cup-like ducts which are located close together. A question may arise as to the significance of such different forms in the second instar male, because there seems to be no good reason to believe that the life of the male scale insect is so diverse. In this respect the case of *C. linderae* and *C. pustulifera* is especially noteworthy. They are sibling species in the adult females, while their second instar males are remarkably different in the cup-like ducts and marginal appendages and also in the structure of the test.

The second instar males examined of *Africaspis* represent some types. In *A. caffra* (Fig. 23) the second instar male is similar to the second instar female and the adult female in the structure of the pygidial margin. It differs from the second instar female mainly in having numerous ducts.

The other five species examined agree in having communal ducts on the sixth abdominal segment. Among them *A. chionaspiformis* (Fig. 24) has well-developed median lobes, which are, however, not zygotic as in the adult and second instar females. Other marginal structures of the pygidium are reduced, and there are no marginal gland spines.

In *A. gala, A. muntingi* (Fig. 26), *A. scutiae* and *A. terminaliae* (Fig. 25) there are only simple processes on the pygidial margin where lobes, pore prominences and gland spines are expected to occur. Thus the pygidial appendages are much reduced and modified when compared with those of the adult and second instar females.

In the genus, *A. caffra* is primitive in the fact that the median lobes of the adult female are widely separated from each other except basally. In this species the sexual dimorphism in the second instar is the least remarkable among the six species examined. This may not be a mere coincidence.

The diaspidid second instar may be useful not only for the phylogeny of the forms concerned but also for the study of phenotypic manifestation in organismal evolution (Takagi 1987). Polymorphism in this instar will give a promising clue in this respect. The cases studied here suggest that it is not rare in the Diaspidini.

Does Africaspis occur in Asia ?

Now that *Africaspis orchidarum* is removed from *Africaspis,* the occurrence of the genus outside Africa (and Madagascar) may be open to doubt. Ramakrishna Ayyar's (1930) record of *A. chionaspiformis* from South India ("On *Tephrosia purpurea* [a perennial herb] in Tinnevelly and Coimbatore") is accompanied with no

description nor drawing based on his material, so that it cannot be accepted without reexamination of the material. In fact, no good description of the species was available in his time. There may be some reason to believe that the climate of humid tropical Asia is foreign to *Africaspis* which is largely limited to southern and eastern Africa in distribution.

Chionaspis rotundilobis, which was described from "N. Queensland : on *Eucalyptus*" (Laing 1929), was removed to *Africaspis* by Borchsenius (1966), but no reexamination of the species has yet been made. Ben-Dov (1973) in describing *Africaspis wilkeyi* as from Australia ("collected from unidentified seed pods intercepted at the quarantine Seattle, Washington, U.S.A.") states that it "resembles *orchidarum* Ferris [*Cameronaspis orchidarum*] and *parinarii* (Hall) by the clavate shape of the basal sclerosis of the median lobes". *A. parinarii* itself "departs from all its congeners in the shape of the median lobes which are regularly crenate, and is the only species in which supplementary pores anterior to the normal perivulvar pores, may be found" (Munting 1967). Convergence may be everywhere. Then another question : Does *Africaspis* occur in Australia ?

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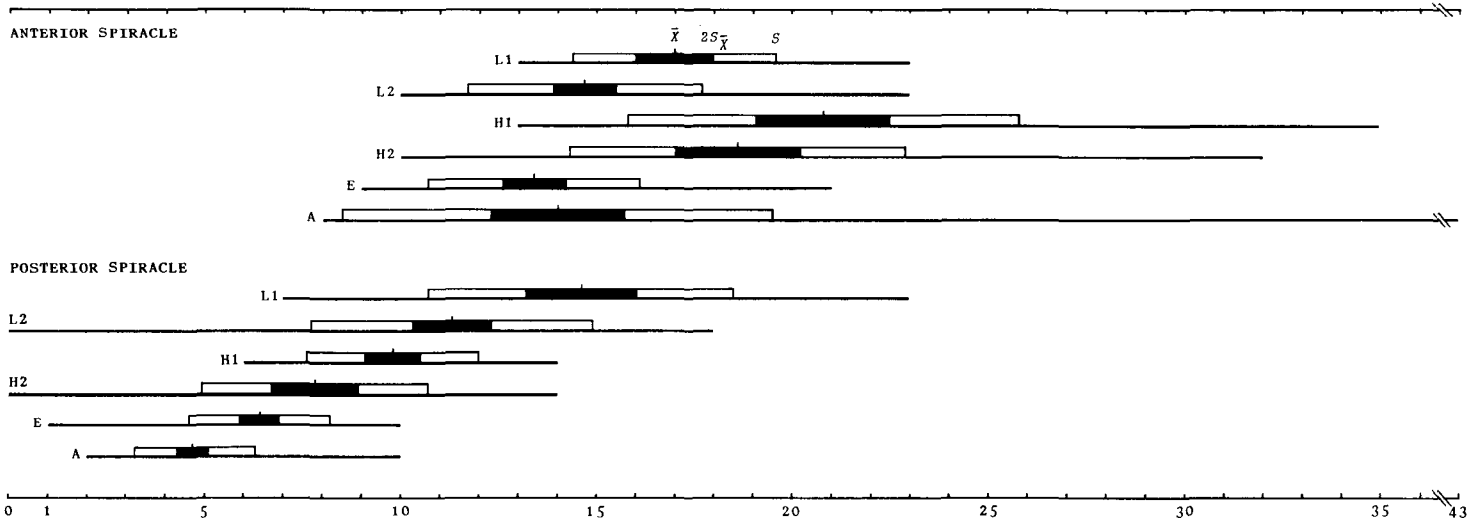

Fig. 1. Number of spiracular disk pores in the 3 Malayan species of *Cameronaspis*. L1 : *C. linderae* from near Arcadia Villa ; L2 : *C. linderae* from Gunong Jasar ; H1 : *C. pustulifera* from Gunong Jasar, "*Henslowia*" sp. ; H2 : *C. pustulifera* from Tanah Rata, "*Henslowia*" sp. ; E : *C. pustulifera* from near Arcadia Villa, *Euodia latifolia* ; A : *C. adinandrae*.

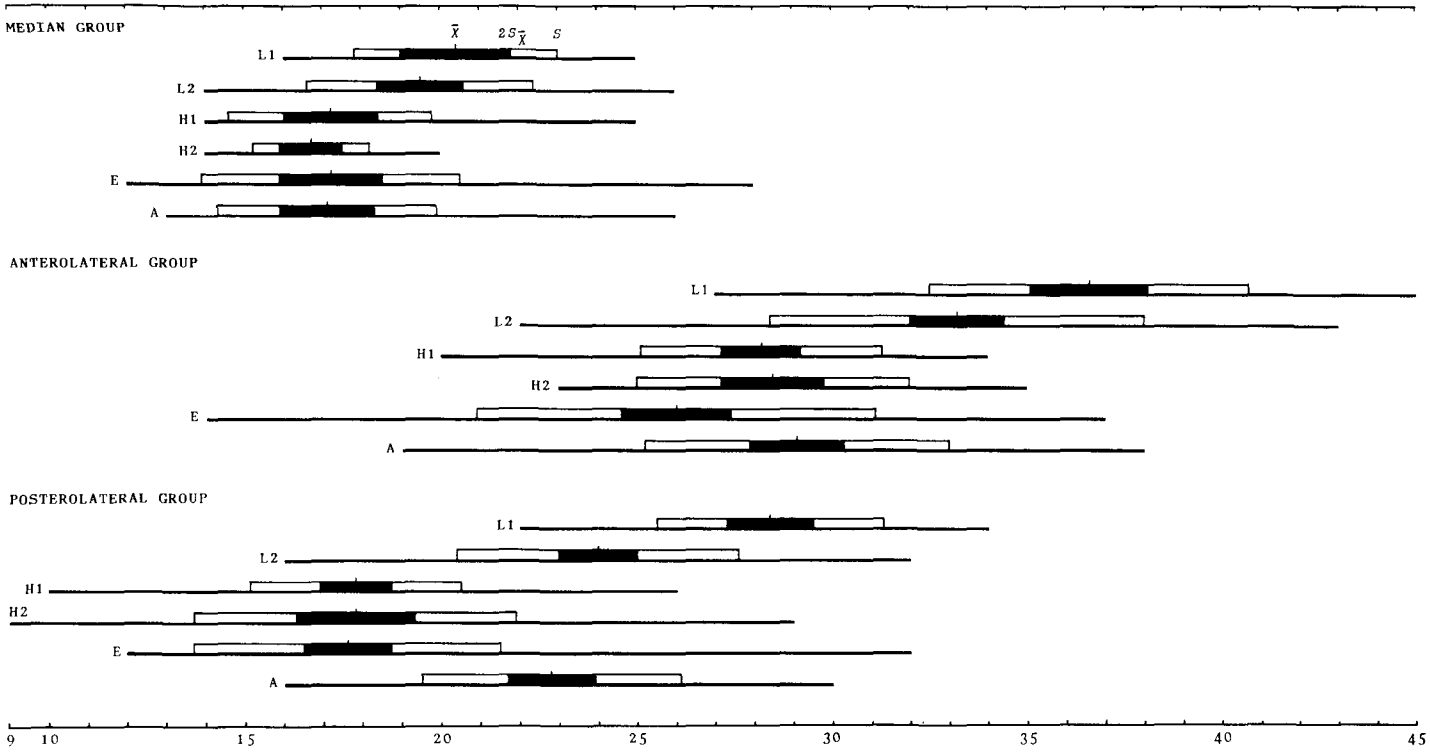

Fig. 2. Number of perivulvar disk pores in the 3 Malayan species of *Cameronaspis*. Symbols for samples: see under Fig. 1.

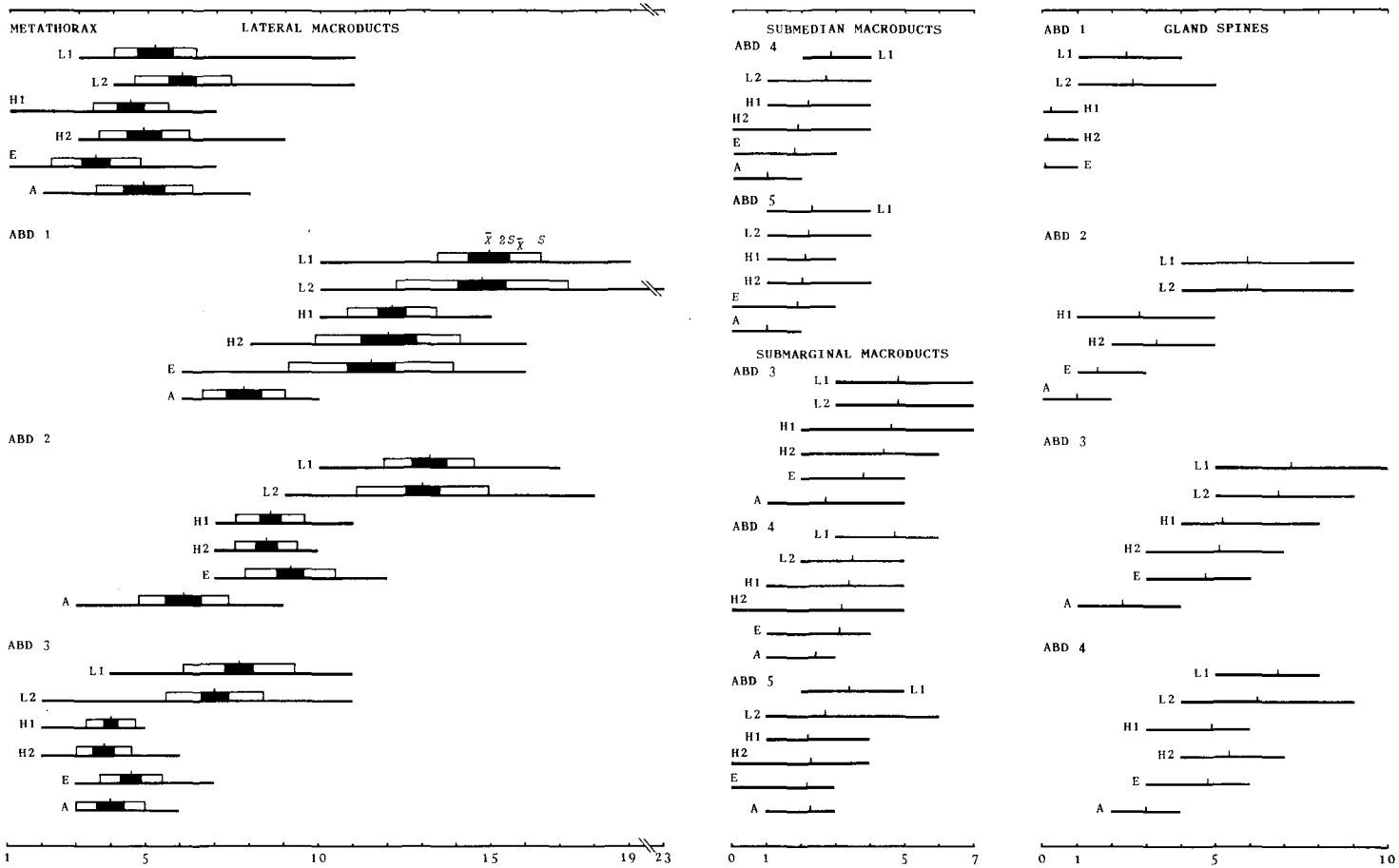

Fig. 3. Numbers of macroducts and gland spines in the 3 Malayan species of *Cameronaspis*. Symbols for samples: see under Fig. 1.

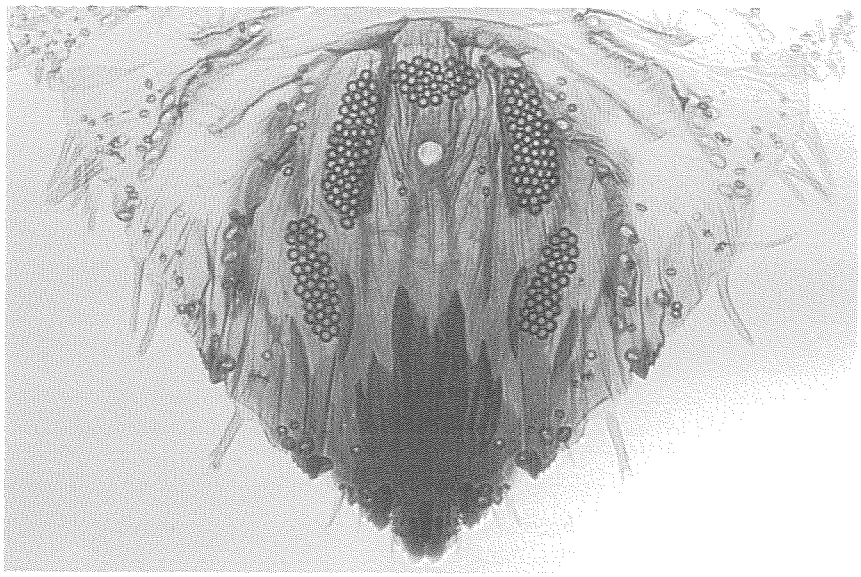

Fig. 4. *Cameronaspis linderae*, adult female : pygidium. Near Arcadia Villa.

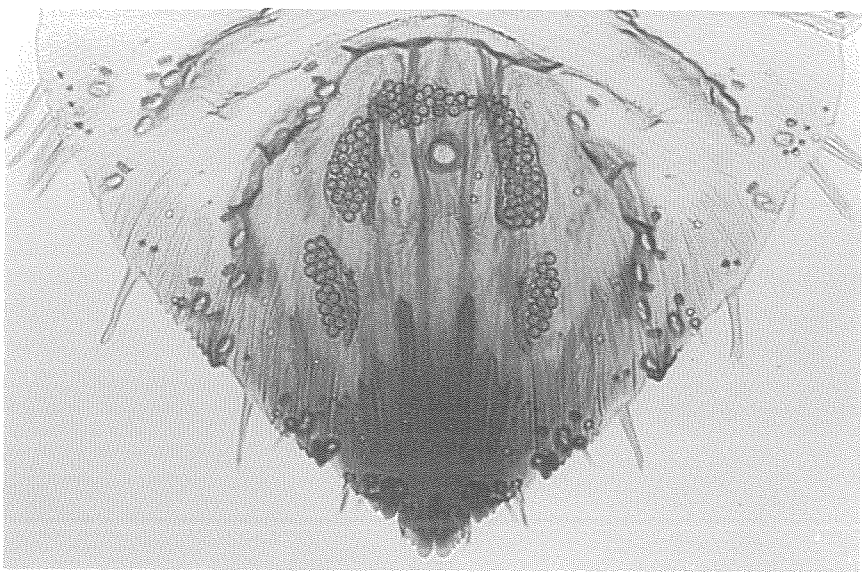

Fig. 5. *Cameronaspis pustulifera*, adult female : pygidium. Gunong Jasar, "*Henslowia*" sp.

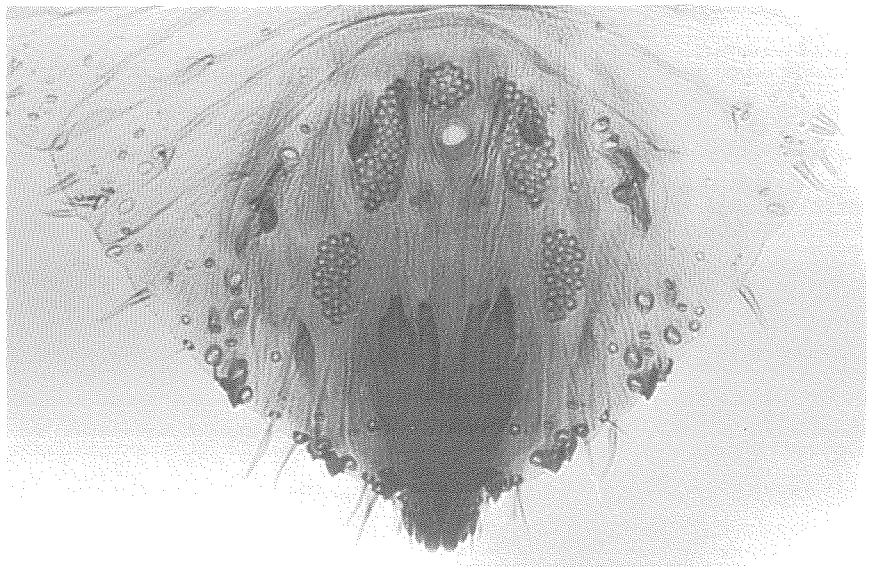

Fig. 6. *Cameronaspis adinandrae*, adult female : pygidium.

Fig. 7. *Africaspis chionaspiformis*, adult female : pygidium.

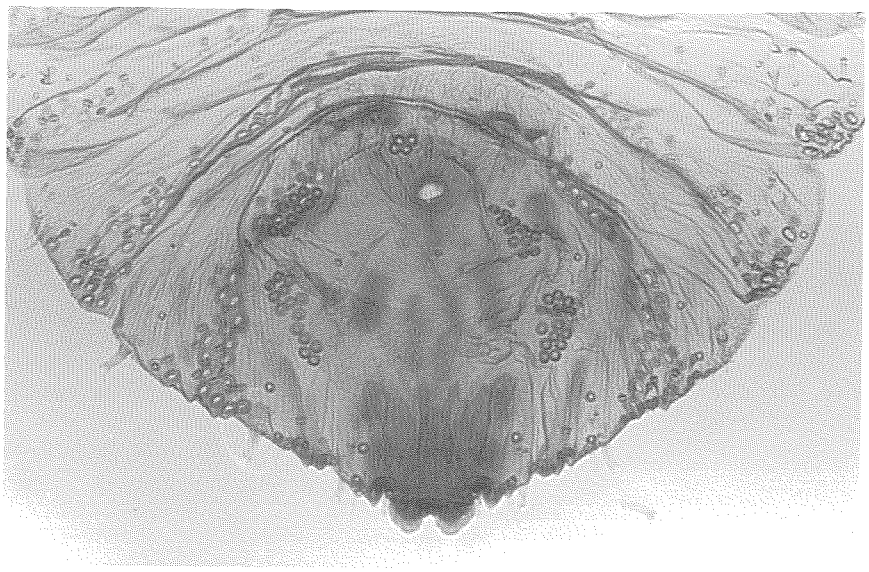

Fig. 8. *Africaspis caffra*, adult female : pygidium.

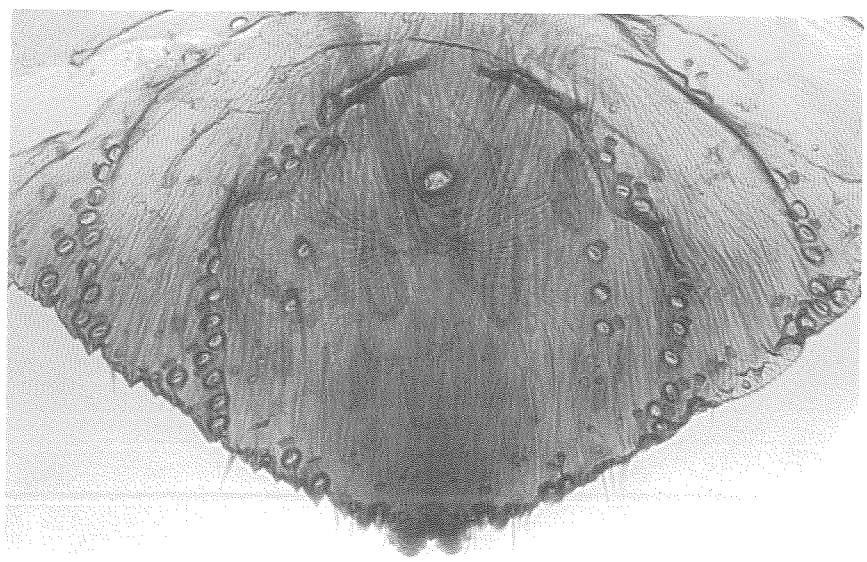

Fig. 9. *Africaspis comniphorae*, adult female : pygidium.

Fig. 10. *Africaspis scutiae*, adult female : pygidium.

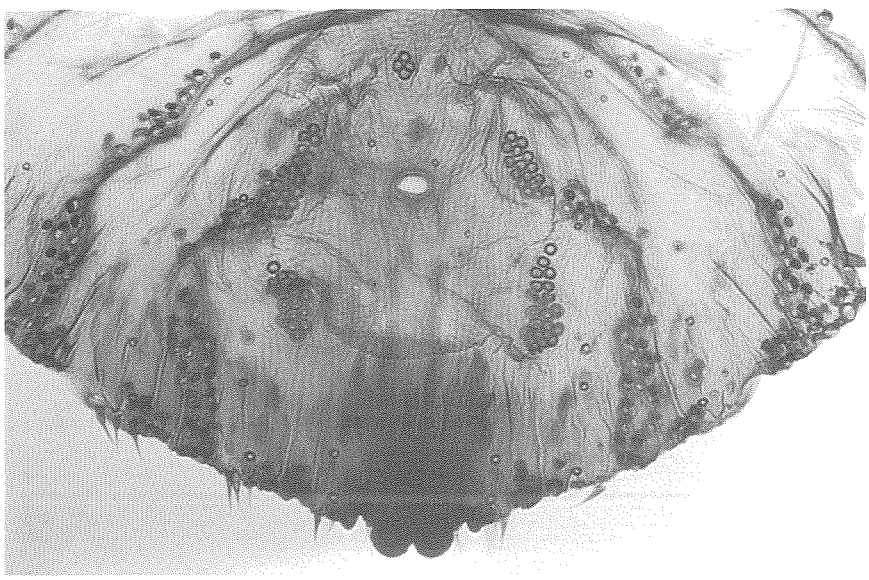

Fig. 11. *Africaspis muntingi*, adult female : pygidium.

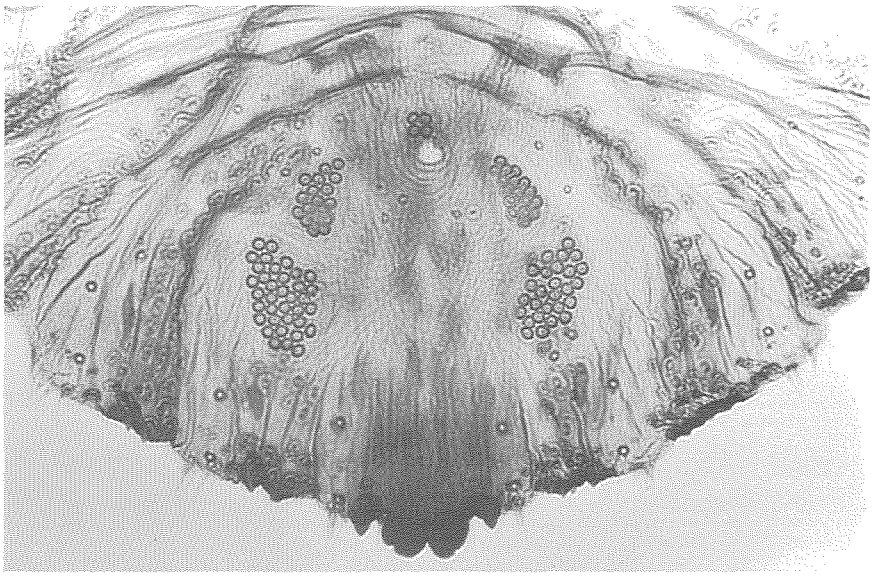

Fig. 12. *Africaspis terminaliae*, adult female : pygidium.

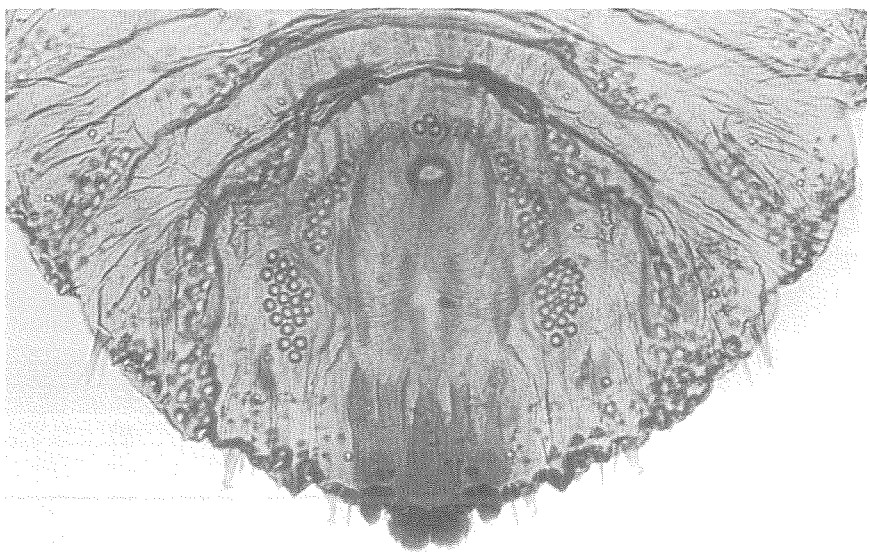

Fig. 13. *Africaspis gala*, adult female : pygidium.

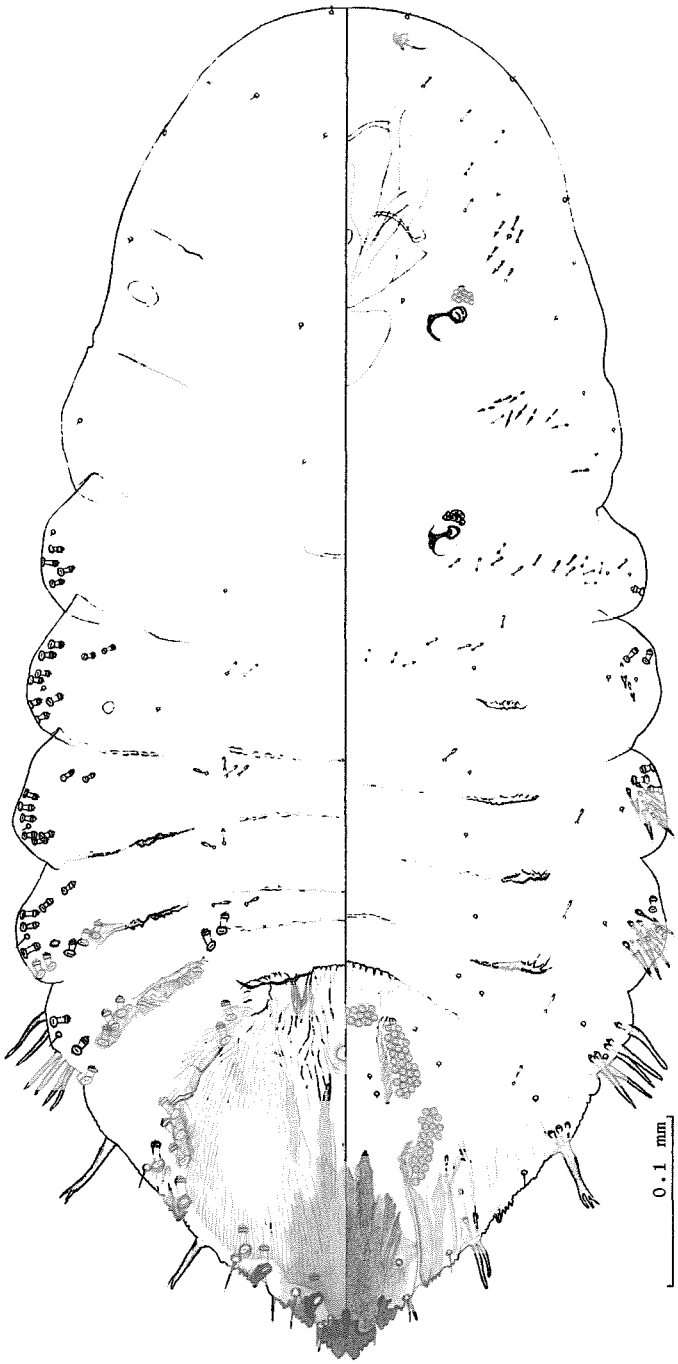

Fig. 14. *Cameronaspis linderae*, adult female. Gunong Jasar.

Fig. 15. *Cameronaspis pustulifera*, adult female. Tanah Rata, "*Henslowia*" sp.

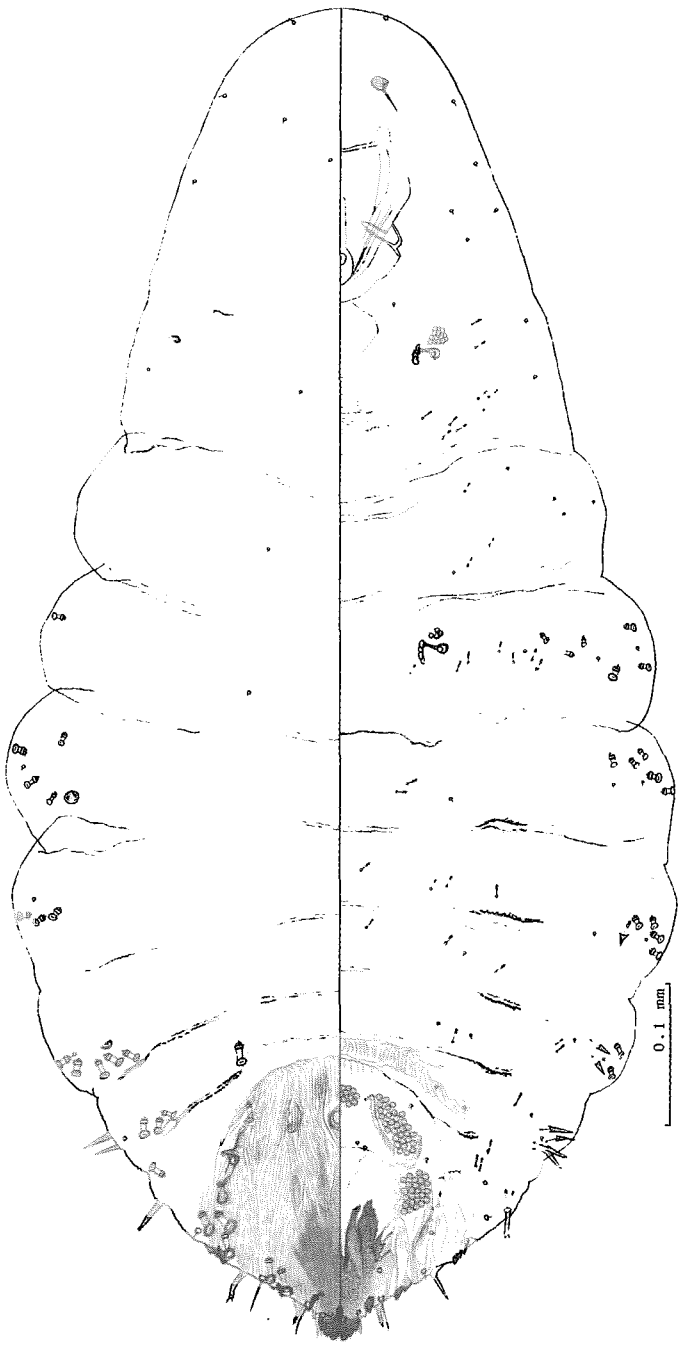

Fig. 16. *Cameronaspis adinandrae*, adult female.

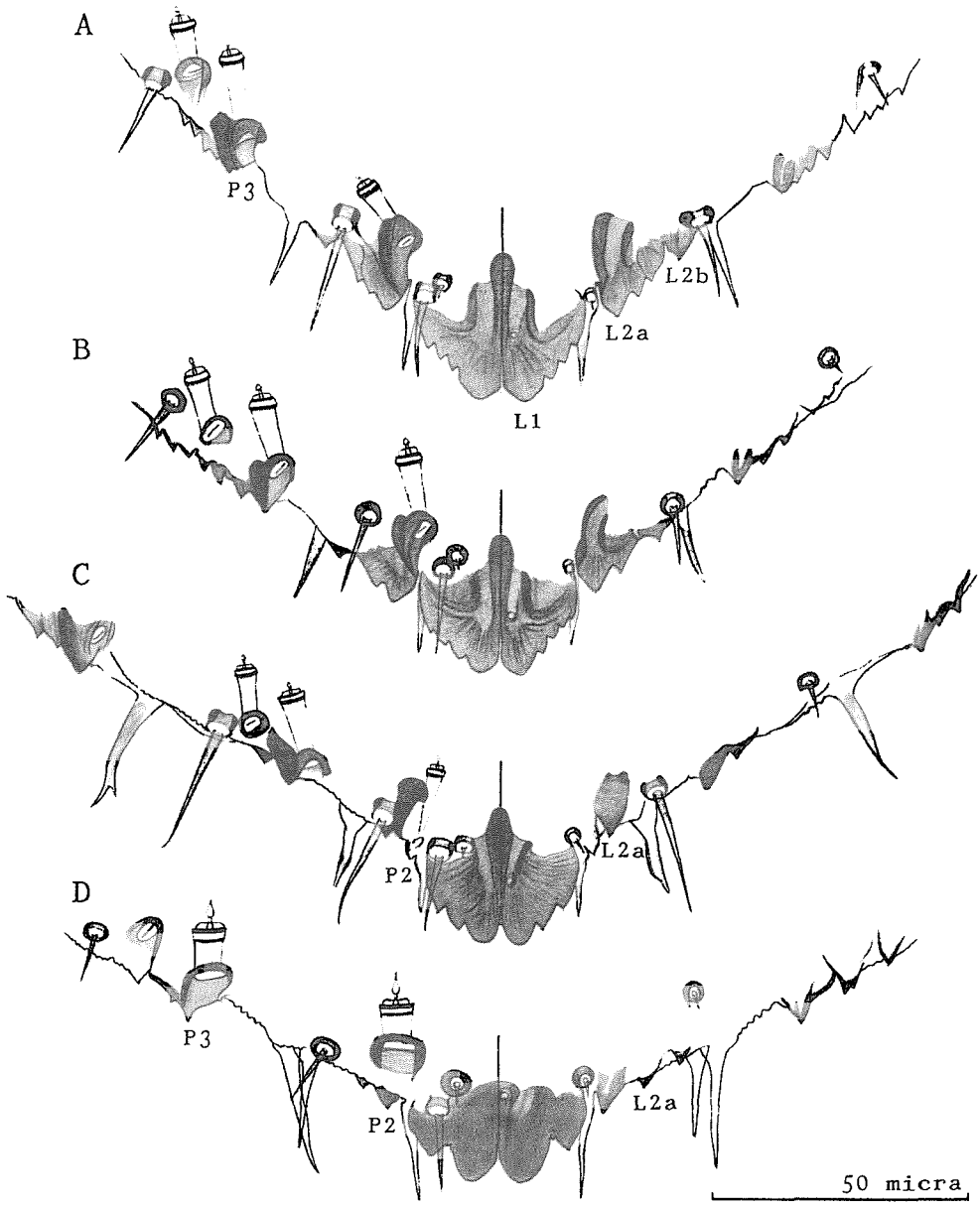

Fig. 17. Adult female : apex of pygidium. A : *Cameronaspis linderae* from near Arcadia Villa ; B : *C. pustulifera* from Gunong Jasar, "*Henslowia*" sp. ; C : *C. adinandrae* ; D : *Africaspis chionaspiformis*.

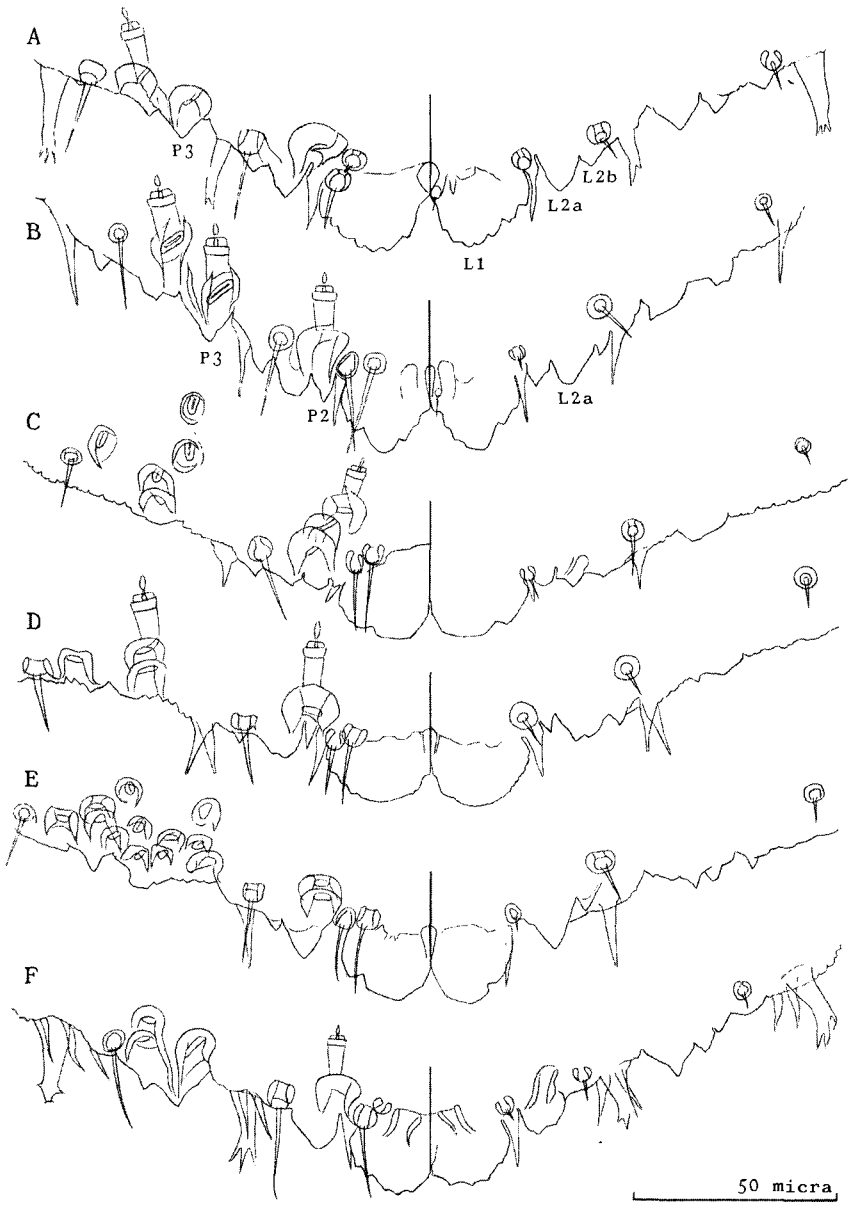

Fig. 18. Adult female : apex of pygidium. A : *Africaspis caffra* ; B : *A. commiphorae* ; C : *A. scutiae* ; D : *A. muntingi* ; E : *A. terminaliae* ; F : *A. gala*.

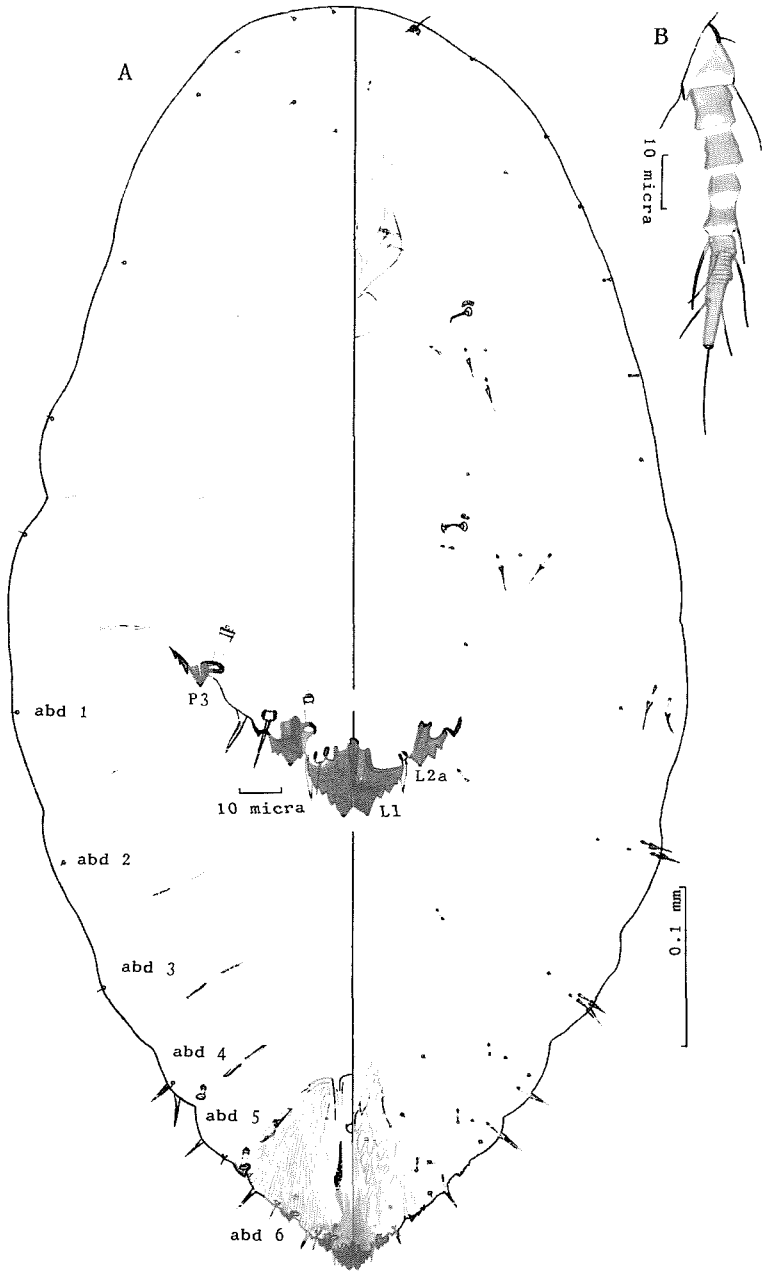

Fig. 19. *Cameronaspis linderae* from Gunong Jasar. A : second instar female ; B : first instar female (exuvial cast), antenna.

Fig. 20. *Cameronaspis linderae*, second instar male. Gunong Jasar.

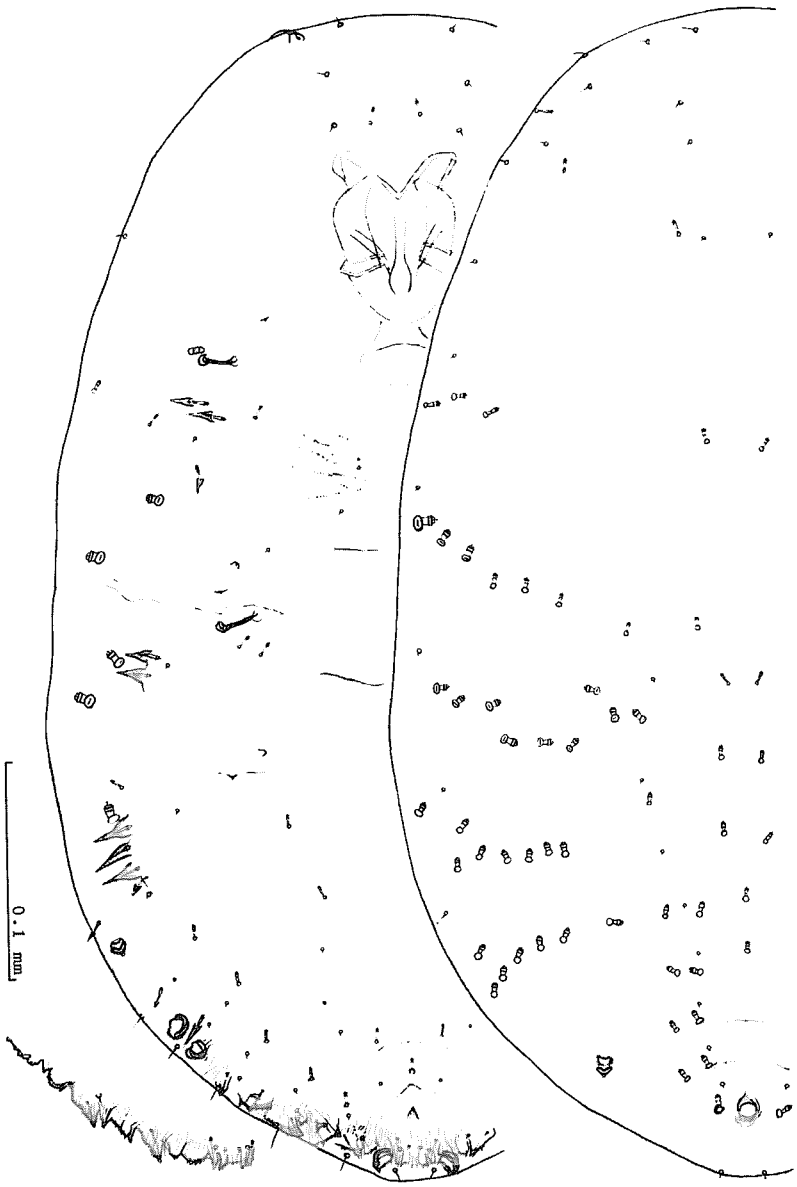

Fig. 21. *Cameronaspis pustulifera*, second instar male. *Euodia latifolia*.

Fig. 22. *Cameronaspis adinandrae*, second instar male.

Fig. 23. *Africaspis caffra*, second instar male.

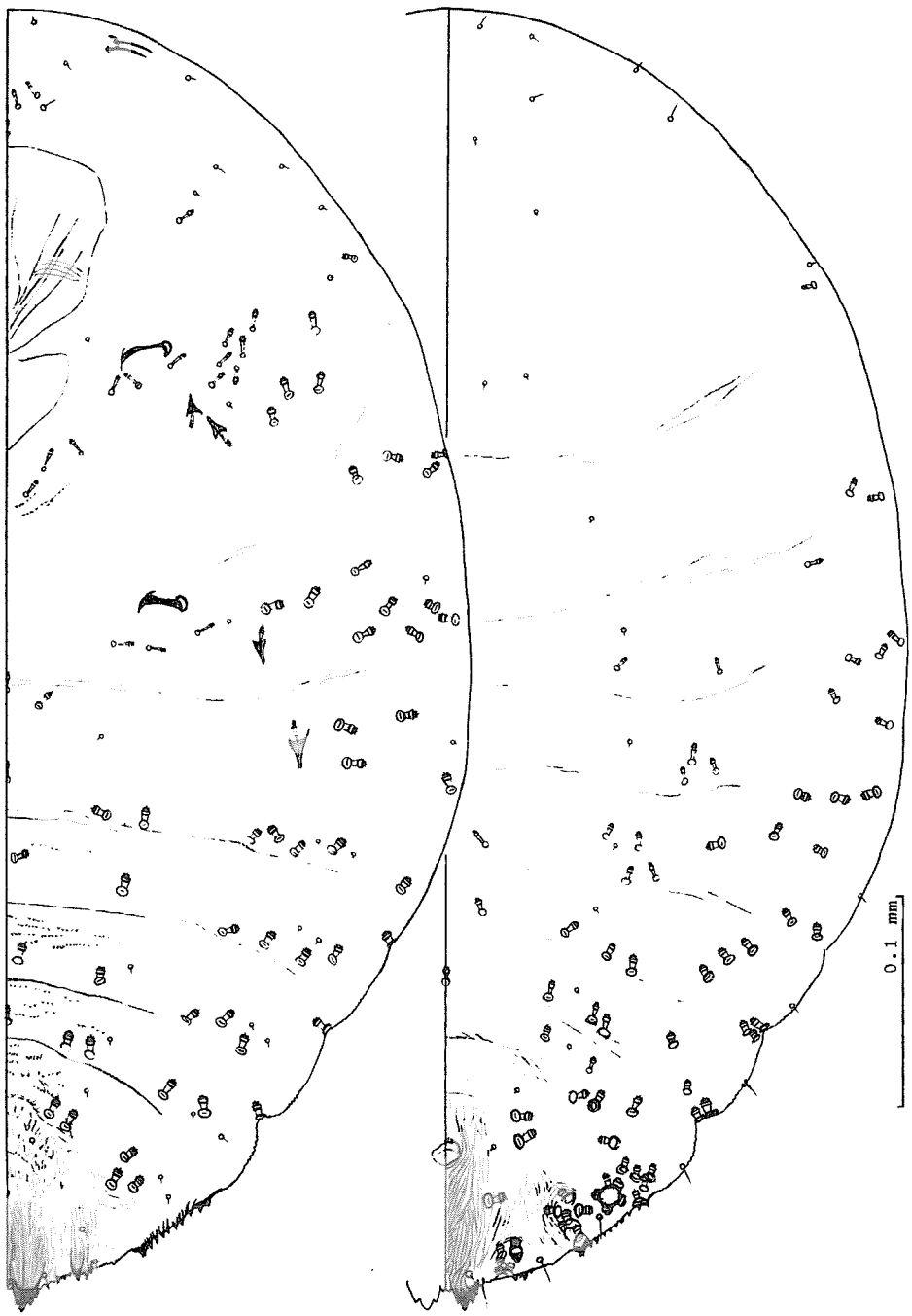

Fig. 24. *Africaspis chionaspiformis*, second instar male.

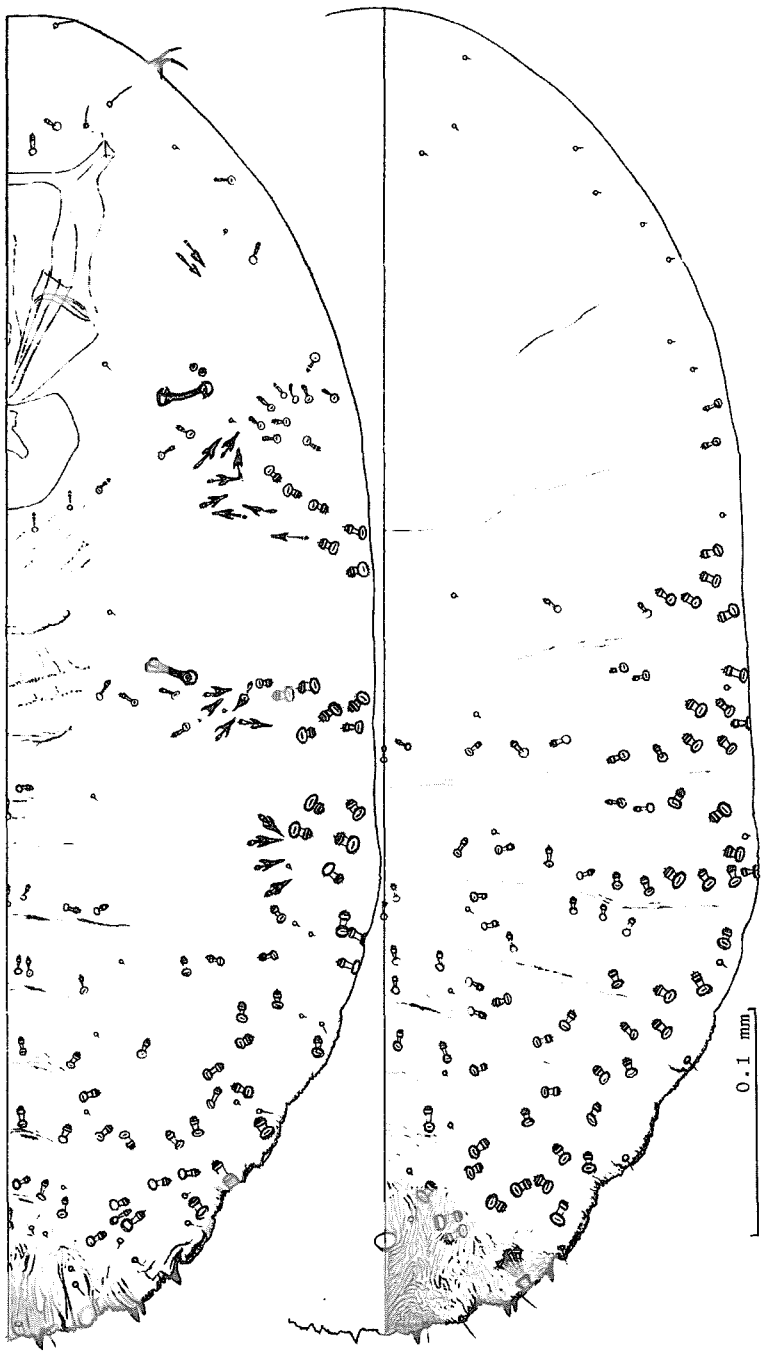

Fig. 25. *Africaspis terminaliae*, second instar male.

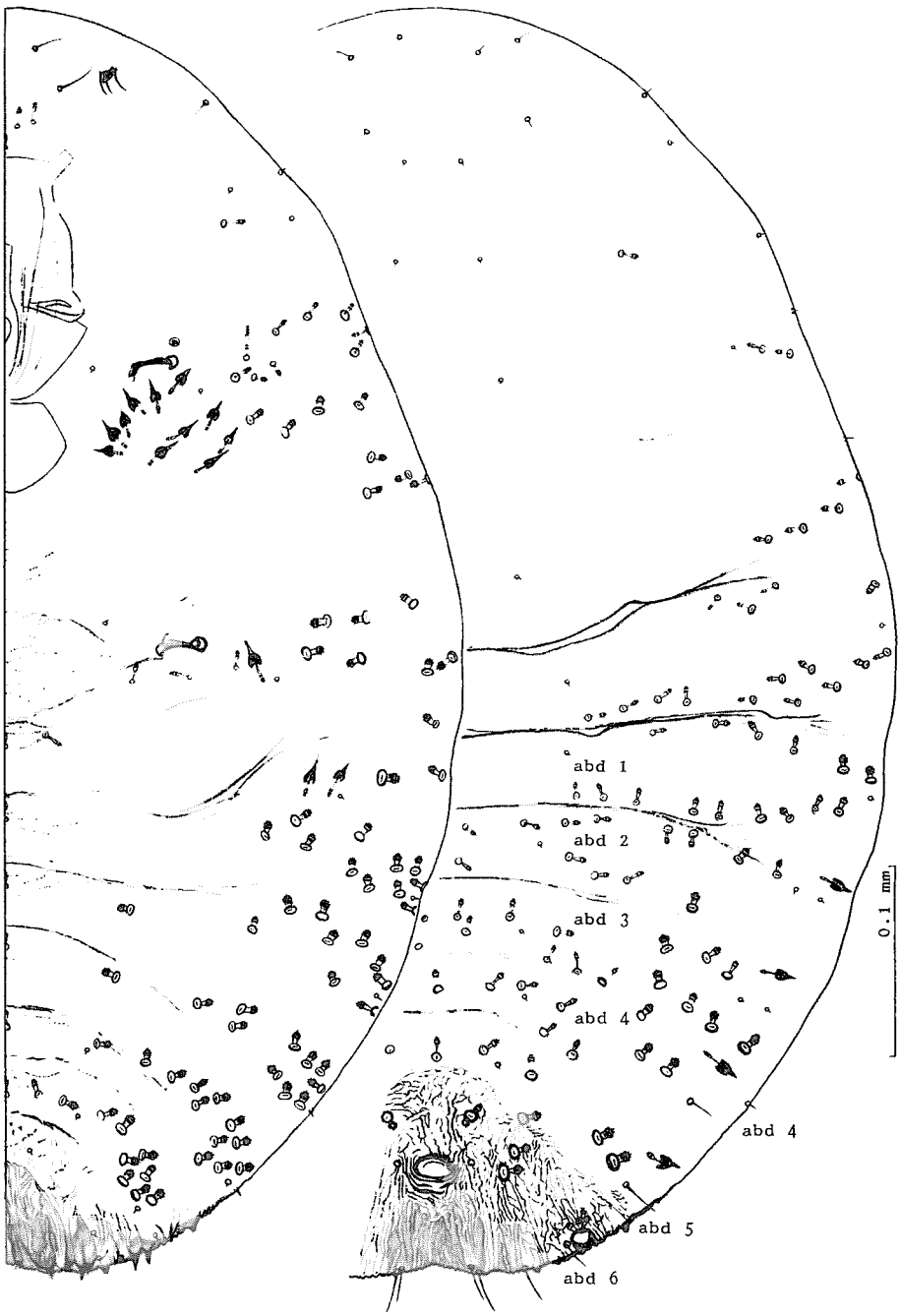

Fig. 26. *Africaspis muntingi*, second instar male.