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A REVISION OF THE SUGARCANE SCALE INSECT ASPIDIOTUS GLOMERATUS GREEN, WITH DESCRIPTIONS OF A NEW GENUS AND A NEW SPECIES (STERNORRHYNCHA: COCCOIDEA: DIASPIDIDAE)

By SADAO TAKAGI

Abstract

TAKAGI, S. 2019. A revision of the sugarcane scale insect *Aspidiotus glomeratus* Green, with descriptions of a new genus and a new species (Sternorrhyncha: Coccoidea: Diaspididae). *Ins. matsum. n. s.* 75: 81–94, 5 figs.

Aspidiotus (*Targionia*) *glomeratus* Green, 1903, a pest of sugarcane in the Indian Subcontinent and currently known under the name *Melanaspis glomerata*, is revised on the basis of two samples collected in lowland Nepal and India. A new genus, *Gannaspis*, is proposed for it and another species, *G. miscanthi*, n.sp., which occurs in the Ryûkyû Islands, Japan, on *Miscanthus sinensis*. *Melanaspis inopinata* (Leonardi, 1913) was collected in northwestern India on *Pistacia khinjuk*, and is adopted for a comparison with the *Gannaspis* species. It is compared also with the description of *Melanaspis pistaciae* Hosseininaveh et al., 2016, a closely similar form occurring in Iran. Notes are made on *Melanaspis nothofagi* Hardy and Williams, 2018, described from New Caledonia.

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Introduction

The armoured scale insect belonging to the tribe Aspidiotini and generally known under the name *Melanaspis glomerata* is a pest of sugarcane in the Indian Subcontinent. It should have been native to some area in India, but it occurs now broadly in the Subcontinent in association with sugarcane cultivation. It was originally described under the name *Aspidiotus* (*Targionia*) *glomeratus* by Green in 1903, though it is not certain that he recognized *Targionia* as a good taxon, whether generic or subgeneric. Fernald (1903) in her catalogue, however, listed the species as *Targionia glomerata* (Green), and this name was used occasionally thereafter. MacGillivray (1921) transferred the scale insect to *Aonidiella*, whereas McKenzie (1938) in his study on *Aonidiella* excluded the species from the genus. Lindinger (1943) made a list of 'Schildlausnamen' for emending 'Fulmeks Wirtsindex 1943', without giving, however, any explanation for the genus-species combinations he adopted. In this list he mentioned 16 species including *Aspidiotus glomeratus* as members of *Melanaspis*, but ten of them were referred to other genera thereafter. In spite of all this, the name *Melanaspis glomerata* has generally been adopted since that time in many publications in applied field as well as in taxonomic catalogues and species lists.

It seems to me that no one has ever examined the generic position of this scale insect on the basis of real material since Green described the species, and that the description and illustration given by Green are the only available ones of the species based on an actual taxonomic observation.

In my surveys of scale insects in tropical Asia I concentrated on collecting from wild plants, because the wild fauna of this insect group was generally not well known in this region. Moreover, orchards and plantations as well as home gardens were excluded from my surveys except for limited cases where I was accepted by any persons concerned of those grounds, owners or others, whom I met there by chance. As a result, my collection remains very meagre in scale insects associated with cultivated plants, and this is the case also with sugarcane.

However, a sample of a sugarcane-associated aspidiotine species I collected in lowland Nepal and another sample of the same species collected in India and granted to me have been available for the present study. In comparing these two samples with Green's description and illustration I have been convinced that the samples should represent nothing other than *Aspidiotus glomeratus*. I reproduce in this paper Green's description and illustration of the species, the description at the end of Introduction and the illustration in Fig. 1. Having been published in the early twentieth century, they are naturally not sufficiently detailed. However, his illustration clearly depicts the features of the pygidial margin, which generally provide a good basis for identification. Furthermore, no other aspidiotine scale insects which may be confused with *Aspidiotus glomeratus* have been recorded from sugarcane in Asia.

There has been available for my study another aspidiotine species which was collected on *Miscanthus sinensis*, another poaceous grass, in the Ryûkyû Islands, Japan. It is very close to *A. glomeratus* and undoubtedly congeneric with the latter. These two species do not belong to any of the genera in which *A. glomeratus* was placed in the past, so far as those genera are understood in the current concepts. I have failed to find any other established genus to which they may be transferred. In the present paper, therefore, I propose a new genus for accepting these two species, of which the one occurring in

the Ryûkyû Islands is also described as new. The new genus is distinct from *Targionia* and *Melanaspis* not only in their morphological characters but also in their geographical distributions.

Description of Aspidiotus glomeratus in Green, 1903

Aspidiotus (*Targionia*) *glomeratus*, sp. nov.

Female puparia crowded and adhering together in such a manner that it is difficult to isolate a single individual. Form irregularly circular, slightly convex. Colour smoky-brown or grayish-black. Pellicles large, shining black; normally concealed beneath a covering of the fuliginous secretion. Ventral scale whitish, stout, entire. Diameter 2.50 mm.

Male puparium similar to that of female, but much smaller and more oval. Long diameter 1 mm.

Adult ♀ of normal oval form (pl. xviii, fig. 1); cephalothorax evenly rounded, spiracles without parastigmatic glands, surrounded by a concentrically wrinkled area. Pygidium (fig. 1, *a*) deltoid. Lobes six, prominent, well defined, with evenly rounded edges; the thickened bases extending inwards (fig. 1, *b*). Four claviform thickened processes (paraphyses) extending inwards between the lobes, two on each side. Margin beyond the lobes strongly but irregularly serrate. Pectinate squames between the lobes. No circumgenital glands. A strong chitinous bar—interrupted in two places—extending across base of pygidium. Genital aperture anterior to anal. Numerous oval pores, with thickened chitinous rims, on both dorsal and ventral surfaces, connected with long filiform ducts. Length 1.50 to 1.75 mm. Breadth 1.20 to 1.40 mm.

Adult ♂ not observed.

Habitat: Beneath the sheathing bases of leaves of sugarcane (*Saccharum officinale*) in association with *Aclerda japonica*, Newst. Collected by Dr. Geo. Watt (Reg. No. 11830-9). No locality given.

Descriptions of the taxa

Gannaspis, n.g.

Type species. *Aspidiotus* (*Targionia*) *glomeratus* Green, 1903.

Etymology. Composed of *ganna* (meaning sugarcane in Hindi) and *aspis* (shield in Greek).

Recognition characters

Adult female at full growth broadly obpyriform, with prepygidial region rounded and membranous, and with pygidium produced, deltoid in outline, and sclerotized especially strongly on a broad apical area. Spiracles with no accompanying disc pores. Dorsal surface of pygidium with subbasal intersegmental furrow (assumed to occur between fourth and fifth abdominal segments) interrupted to form submedian and submarginal portions. Anal opening ovate, situated posteriorly to centre of pygidium and in a narrow elongate sclerotized area of derm; vulvar opening much anterior to anal. Dorsal ducts of pygidium long filiform, with orifice small, sclerotized around rim; forming oblique rows arising on pygidial margin and running along supposed mesal borders of fourth to sixth abdominal segments, the sclerotization of derm on apical area of pygidium extending anteriorly along each of these rows; scattered in a broad apical

area of pygidium; forming a loose cluster in intermediate area anterolaterally to anal opening; and arranged along submarginal portion of subbasal intersegmental furrow. Ventral ducts of pygidium shorter, scattered in a broad submarginal area. Trullae (pygidial lobes) distinct in three pairs, robust, broadly roundish on apical margin; median trullae largest, separated from each other by a space much narrower than one of them, each basally with an elongate sclerosis extending anteriorly. Margin of pygidium beyond third trullae rugged with pointed or blunt processes on sixth and fifth abdominal segments, and also on the fourth for a short distance. Fimbriate or simple spines (plates) in spaces between trullae, not extending beyond apices of trullae, 2 between median trullae and also between the median and second, 3 between the second and third. Elongate scleroses arising at basal corners of trullae, between trullae, and even also on margin beyond third trullae, but not all of them clear in sclerotization and stable in occurrence.

Remarks

The genus *Gannaspis* may be distinguished from *Melanaspis* Cockerell, in which the type species has long remained, by adopting the following characters as generic. (Comparing Fig. 2 and 3 with Fig. 5 may be helpful for recognizing the differences between the two genera.) 1) The dorsal surface of the pygidium is not divided into well-defined plate-like areas. 2) The dorsal ducts of the pygidium are scattered in a broad apical area, in the intermediate area anterolaterally to the anal opening, and along the submarginal portion of the subbasal intersegmental furrow in addition to their oblique segmental rows arising on the margin and extending anteriorly. 3) Not all elongate scleroses arising on the margin of the pygidium are clear in sclerotization and stable in occurrence. These scleroses may be homologous with those generally called paraphyses in other genera. They are, however, not developed to form a well-defined pattern in this genus. In the second instar female, there is an elongate sclerosis between the median and second trullae and also between the second and third. In the exuvial cast these scleroses are often not clearly observable probably partly because the cast is heavily sclerotized throughout. In *Melanaspis* the paraphyses are clear and in a stable pattern not only in the adult female but also in the exuvial cast of the second instar female (Fig. 5).

The type species was originally described under the name *Aspidiotus* (*Targionia*) *glomeratus*, and it was mentioned as *Targionia glomerata* in the Fernald catalogue (1903). It differs from the species currently referred to *Targionia* Signoret in the arrangement of the dorsal ducts on the pygidium, in the paraphyses not developed in a clear and stable pattern, and in having membranous processes (plates) between the trullae.

The genera *Melanaspis* and *Targionia* should have been Gondwanic in distribution in their early stages of evolution. In terms of the present-day geography, they should have expanded from South America and Africa into North America, the Mediterranean region, and western Asia. In my studies on Asian scale insects I have come across no species of these genera except for a few ones of *Melanaspis*, which are, however, American or western Eurasian in their natural distributions. *Melanaspis inopinata* (Leonardi, 1913), one of such species, is adopted here for showing morphological differences between *Melanaspis* and *Gannaspis*. Pygidial characters in the adult and second instar females of this species are illustrated in Fig. 5, which was drawn from material collected at Solan, alt. ca.1500m, Himachal Pradesh, India, on *Pistacia khinjuk* branches, Oct. 24, 1978. *M. inopinata* has been recorded from a broad area ranging from western Asia to the Mediterranean region but, so far as I am aware, there has been made no record of it from

India, where its occurrence should be due to introduction. (For notes on *M. inopinata* in comparison with the recently described *Melanaspis pistaciae*, see Supplementary notes 1.) The occurrence of *Gannaspis* in the Ryûkyû Islands, Extreme Eastern Asia, suggests that the genus is a taxon quite different from *Melanaspis* and *Targionia* biogeographically. *Aulacaspis madiunensis* (Zehntner) and *A. takarai* Takagi are noteworthy in this connection. They are closely related to each other, both occurring on sugarcane and wild poaceous grasses. *A. madiunensis* now occurs broadly in the tropics in association with sugarcane cultivation, but in natural distribution it should have been restricted to a much narrower area in tropical Asia (not necessarily excluding India). *A. takarai* is known only from the Ryûkyû Islands, where it is associated with some wild poaceous grasses and only recently also with sugarcane (Azuma, 1977). These cases of *Gannaspis* and *Aulacaspis* agree in the fact that the closely related forms are distantly separated in their natural distributions, one of them occurring in some restricted area in tropical Asia and the other in the Ryûkyû Islands. Provided this agreement is not incidental, these pairs of species should have had a background of geohistorical and climatic changes in common during their evolutionary courses. *Aulacaspis*, a large genus in the Diaspidini, is Asian in natural distribution so far as its main body is concerned. It has expanded its range into Australia through chains of mangroves (Takagi and De Faveri, 2009, 2011; Takagi, De Faveri, and Martin, 2011) and into western Asia and Africa through grasslands (Takagi, 2015), but it has no native species in the Americas.

The exact taxonomic relationship of *Gannaspis* to other Aspidiotini remains unknown. An aspidiotine species occurring in New Caledonia has recently been described under the name *Melanaspis nothofagi*. Whether it is a real member of *Melanaspis* or not, it reminds us that our knowledge is still insufficient on scale insects occurring in the Asia-Pacific region and extremely meagre on the fauna of this insect group in Wallacea, which may be a key region for clarifying the possible rôle of Gondwanic elements in the evolution of the Asian fauna. (For further notes on *M. nothofagi*, see Supplementary notes 2.)

Gannaspis glomerata, n.comb.
=*Aspidiotus* (*Targionia*) *glomeratus* Green, 1903
=*Melanaspis glomerata*, in authors
(Fig. 2; Fig. 3, A–D, F, G)

Material examined

Two samples collected on sugarcane, *Saccharum officinarum*: at Birganji, alt. ca.160m, Narayani, Nepal, Oct. 24, 1975; at Padegaon, Aurangabad, Maharashtra, India, Feb. 1977. The collection locality in Nepal is situated in the Terai lowland bordering the Gangetic Plain, and about 1200km distant from the locality in India. Adult females examined: 10 specimens from Birganji and 14 from Padegaon.

Recognition characters (*adult female*)

Prepygidial region of body (head to third abdominal segment) with numerous small ducts along margin; ducts occurring on head to first abdominal segment short, strewn submarginally on ventral surface, replaced on second and third abdominal segments with filiform ones, these being nearly as long as ventral ducts of pygidium, scattered marginally to submarginally on ventral surface and marginally on dorsal surface. Anterior

and posterior spiracles each with about 10–18 filiform ducts scattered anterolaterally. Subbasal intersegmental furrow of pygidium with submedian portion sclerotized on both anterior and posterior margins; submarginal portion less developed, often reduced to a slender line, accompanied with about 4–10 ducts arranged along. About 5–11 ducts in a loose cluster on intermediate area of pygidium anterolaterally to anal opening. No ducts immediately laterally to anal opening. A small sclerotized discoid or boss present submarginally just mesally to segmental row of dorsal ducts of fifth abdominal segment, usually elliptical in outline.

Gannaspis miscanthi, n.sp.
(Fig. 3; Fig. 4, E, H, I)

Material examined

Five samples collected on Tokuno-Sima [Tokuno-Shima] and Okinawa, Ryûkyû Islands, Japan, all on *Miscanthus sinensis*.

Tokuno-Sima. Tate, Nov. 18, 1989 (Sample 1).

Okinawa. Naha, Oct. 23, 1961; locality unknown, Apr., 1963, T. Isobe; Sueyosi [Sueyoshi], Naha, Mar. 16, 1983 (Sample 4); Tinen [Chinen], Mar. 18, 1983.

Female tests black, occurring on the upper side of leaves, crowding together at the junction of the blade and sheath.

The present study is based mainly on a number of adult females mounted from Sample 4 and 15 specimens from Sample 1. Holotype, adult female, from Sample 4; deposited in the collection of Systematic Entomology Laboratory, Hokkaidô University, Sapporo.

Recognition characters (*adult female*)

Second and third abdominal segments with filiform ducts scattered along margin on both dorsal and ventral surfaces. Anterior and posterior spiracles each with about 3–8 filiform ducts scattered anterolaterally. Subbasal intersegmental furrow of pygidium with submarginal portion divided into 2 parts both well sclerotized; a few or several, at times 5–7, ducts associated with this portion. A few ducts usually present immediately laterally to anal opening; about 4–12 ducts forming a loose cluster on intermediate area anterolaterally to anal opening.

Remarks

Gannaspis miscanthi is very similar to *G. glomerata* in pygidial characters and especially in the features of the pygidial margin. It is distinct and easily distinguishable from the latter in lacking the following features which have been observed in *G. glomerata*: the numerous short ducts which are strewn submarginally on the ventral surface through the prosoma, the metathorax, and the first abdominal segment; the sclerotized boss which occurs submarginally on the dorsal surface of the pygidium on the supposed mesal border of the fifth abdominal segment.

It should be added that there are no strongly sclerotized discoids or bosses in the prepygidial region not only in *G. miscanthi* but also in *G. glomerata.* There are, in these species, three membranous or weakly sclerotized spots on each side of the body instead, one occurring submarginally on the supposed prothorax and also on the first abdominal segment and the other one in the posterolateral corner of the third abdominal segment. These spots, when fully developed, are larger than the boss occurring on the pygidium

of *G. glomerata* and often bisectional (Fig. 3, D) in structure. They may be termed prepygidial bosses, but not all of them are always well formed or plainly discernible.

Supplementary notes

Supplementary notes 1: Identification with Melanaspis inopinata

Hosseininaveh et al. (2016) recognized a new species of *Melanaspis* on the basis of molecular and morphological features and described it under the name *M. pistaciae* Hosseininaveh and Kaydan. In preparing morphological descriptions, they examined a total of 30 adult females of this species, all collected in the province of Kerman, Iran, on branches and trunks of *Pistacia vera*, and compared them with 12 adult females of *M. inopinata* also collected in Kerman from *P. vera*. According to them, *M. pistaciae* is very similar to *M. inopinata*, but is distinguishable from the latter in having: 1) the median, second, and third trullae (pygidial lobes) distinctly notched once on the mesal margin (not notched mesally in *M. inopinata*); 2) the fifth abdominal segment on each side of the pygidium strewn along the margin with 21–31, mean 26, dorsal macroducts (13–19, mean 16, in *M. inopinata*); 3) the pygidium 0.3 times as long as the whole body (0.2 times in *M. inopinata*), the pygidium being measured from the apices of the median trullae to the anterior margin of the median sclerotized area lying transversely on the base.

In the specimens collected at Solan, India, on *Pistacia khinjuk* and identified with *M. inopinata* in the present study (see the text), the second and third trullae are smooth on the mesal margin, whereas the median trullae are variable, being smooth or notched once mesally. This variation is continuous, the notch being often weak or obscure. In a rough evaluation, however, a distinct mesal notch has been found in nearly 20% of the examined median trullae (sample size: 100). Fig. 5 shows an example of the pygidium with the median trullae both distinctly notched mesally. Difference 1 adopted by Hosseininaveh et al. is, therefore, applicable to not all of the specimens from Solan so far as the median trullae are concerned.

In the *M. inopinata* specimens from Solan, the fifth abdominal segment is strewn with 7–17, mean 12.1, dorsal macroducts marginally (sample size: 84). Difference 2, therefore, is true of the Solan specimens, which have those macroducts distinctly fewer than in *M. pistaciae*. They differ, however, from the Kerman specimens of *M. inopinata*, too, in having those macroducts fewer apparently significantly so far as the mean values are concerned. This fact suggests the possibility that those macroducts are not invariable in number in *M. pistaciae*, too. In diaspidid species, the tubular ducts and disc pores are variable in number among samples not unusually, and sometimes to a considerable degree and apparently in association with varying environmental conditions.

Difference 3 appears to be problematical. Excepting pupillarial forms, diaspidid adult females greatly increase in body size after exuviation but almost exclusively in the size of the prepygidial region, so that they change greatly during their growth in the relative value of the pygidium to the prepygidial region or the whole body in length or other measurements. It is meaningless, therefore, to make any comparison by the use of such a ratio without specifying the stage or stages of growth concerned. The Solan sample of *M. inopinata* includes several small adult females, which are apparently at the stage shortly or immediately after exuviation, and many larger ones, of which most

appear to be in the stage of full growth, attaining 1.8mm at maximum in body length. Through all these adult females the ratio of the pygidium to the whole body in length varys from 0.43 (1/2.3) to 0.19 (1/5.1). This observed range completely covers the values adopted for distinguishing *M. pistaciae* (collected on 26 Aug. to 20 Sept.) from *M. inopinata* (on 22 Oct.) in the province of Kerman. It is reasonable, therefore, to assume that the different values applied to the Kerman forms signify no more than different growth stages prevailing in different seasons.

After all, the morphological differences adopted by Hosseininaveh et al. for distinguishing between *M. pistaciae* and *M. inopinata* are not fully convincing. *M. inopinata* has been recorded from a broad geographical range and from diverse plants. Further researches may be necessary not only for clarifying whether *M. pistaciae* is a good taxon but also for examining if there are under the name *M. inopinata* any other forms which should be distinct taxonomically.

Under all these circumstances, the identification of the Solan form with *M. inopinata* adopted in the present study should be maintained.

Supplementary notes 2: Melanaspis nothofagi from New Caledonia

Hardy and Williams (2018) described *Melanaspis nothofagi* from New Caledonia on the basis of a single adult female collected from *Nothofagus aequilateralis* (Nothofagaceae), a native plant of the island. It is isolated from the other species of *Melanaspis* in geographical distribution. Provided it is native to New Caledonia, it may suggest that the genus was once represented well in Australasia (see *Remarks* under *Gannaspis*, n.g.).

On the other hand, *M. nothofagi* may be open to criticism as to its generic position. So far as described and illustrated, it is extraordinary for a member of *Melanaspis* in having long hair-like setae on the prosomatic margin and a single linear paraphysis arising between the bases of the median trullae (pygidial lobes).

M. nothofagi or, more exactly, the specimen examined for describing the species exhibits another feature which may demand some consideration, that is, a single cluster of disc pores occurring anterolaterally to the vulvar opening on each side. It is not easy to know from the illustration in the original description whether this cluster is positioned on the pygidium (fig. 13, b) or on the segment immediately anterior to the pygidium (a). According to new information from the authors, the cluster is positioned very close to the vulva and seems to represent the normal anterolateral group of perivulvar disc pores. However, there are no other groups in the specimen. Provided this cluster is stable in occurrence in *M. nothofagi* (though this condition is not predictable from the single specimen), it may be adopted as a noticeable feature of the species, but still it should represent no more than an evolutionary survival or revival of a once complete set of perivulvar disc pores. The possibility also may not be excluded that it is not a stable feature in *M. nothofagi* but an atavistic abnormality in the examined individual. In this case, it has no taxonomic value at all.

In the Pacific region, at least five other species of *Melanaspis* have been recorded from some other islands lying in the midst of the Pacific Ocean or off the eastern coast of the Asian Continent. They are not native to those islands, but all of them are American in origin and two of them have been introduced also to many other areas of the world.

Acknowledgements

Dr Douglas J. Williams read through the manuscript. He gave me some advice about my usage of certain words. He 'identified *Melanaspis glomerata* a few times from India and always thought it belonged to a different genus'. I think this is a good support to the new genus.

Dr Nate B. Hardy and Dr Williams informed me about the position of the disc pore cluster in *Melanaspis nothofagi*.

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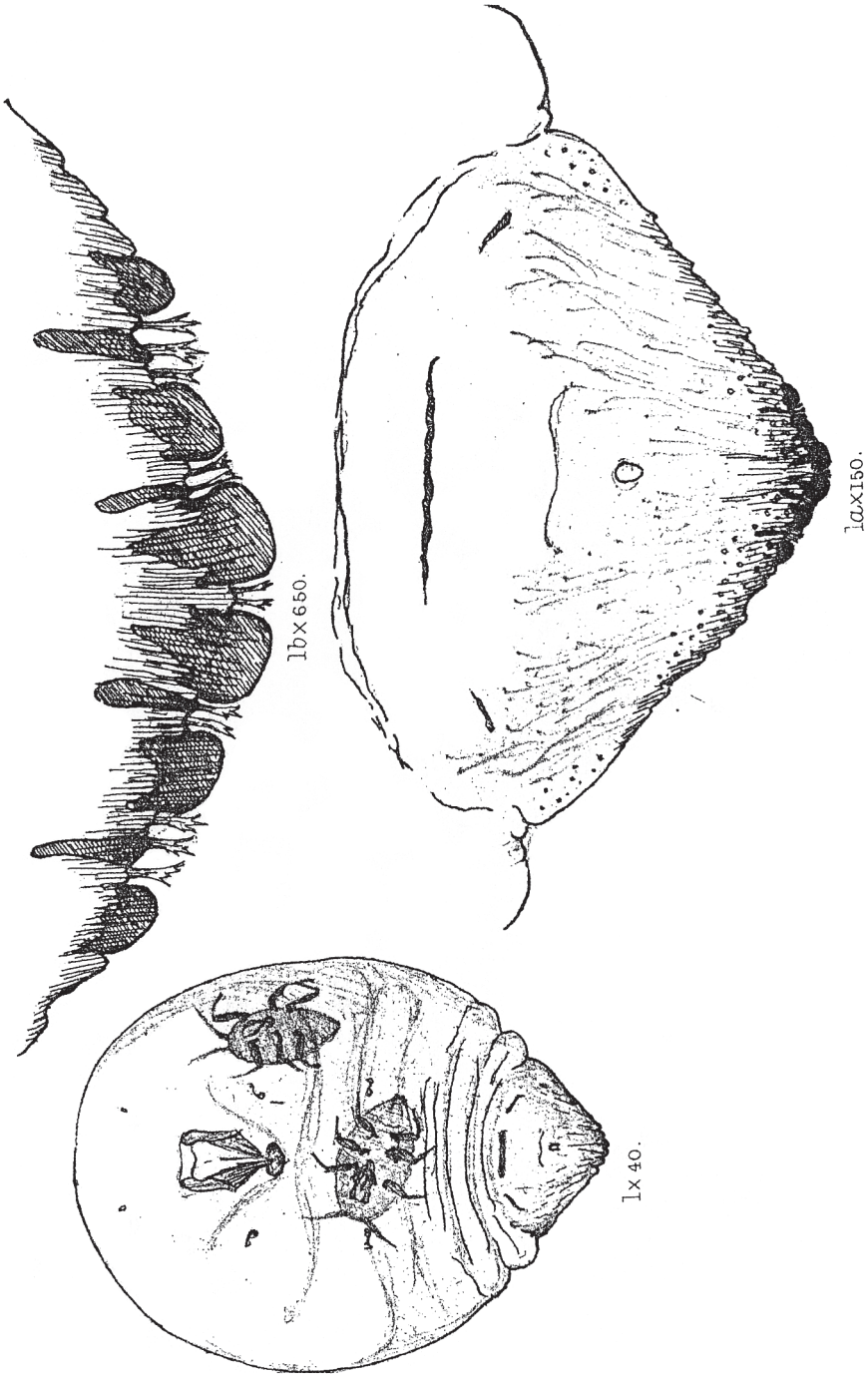

Fig. 1. *Aspidiotus glomeratus*, adult female. Body; pygidium; extremity of pygidium. Reproduced from Green, 1903, Plate XVIII, enlarged.

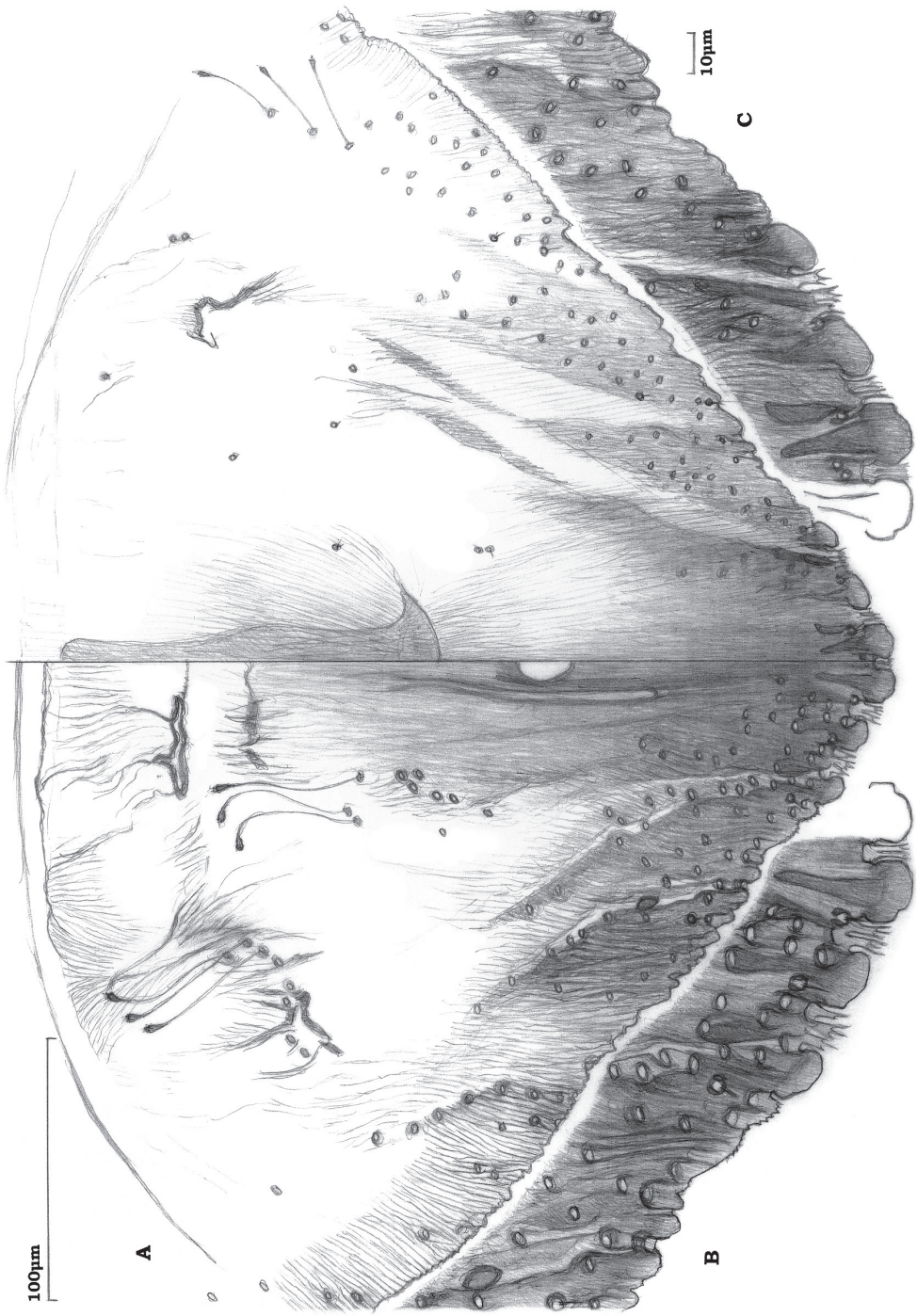

Fig. 2. *Gannaspis glomerata*, adult female, Birganji, on sugarcane. A, pygidium; B, pygidial margin, dorsal surface; C, pygidial margin, ventral surface. Scale bars: 100µm for A; 10µm for B, C.

Fig. 3. *Gannaspis miscanthi*, adult female, Naha (Sample 4), on *Miscanthus sinensis*. A, pygidium; B, pygidial margin, dorsal surface; C, pygidial margin, ventral surface; D, bisectional spot (see *Remarks* under *Gannaspis miscanthi*, n.sp.) on first abdominal segment. Scale bars: 100µm for A; 10µm for B, C; 10µm* for D.

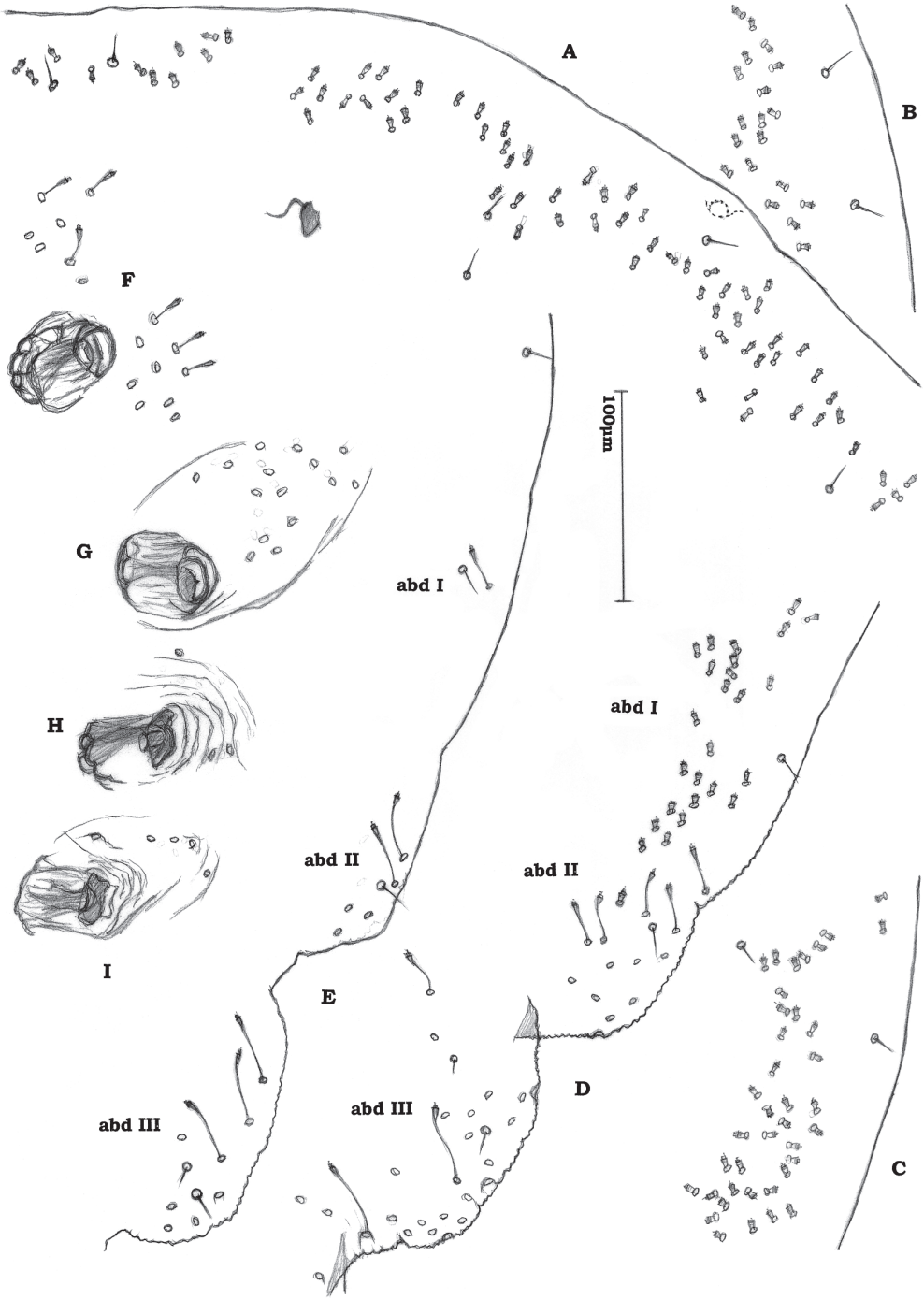

Fig. 4. *Gannaspis glomerata*, adult female, Birganji, on sugarcane (A–D, F, G). A–D, ducts along body margin on ventral surface: A, head; B, prothorax; C, metathorax; D, first to third abdominal segments. F, anterior spiracle; G, posterior spiracle. *Gannaspis miscanthi,* adult female, Naha (Sample 4), on *Miscanthus sinensis* (E, H, I). E, ducts along body margin on ventral surface of first to third abdominal segments; H, anterior spiracle; I, posterior spiracle. Scale bar for A–I.

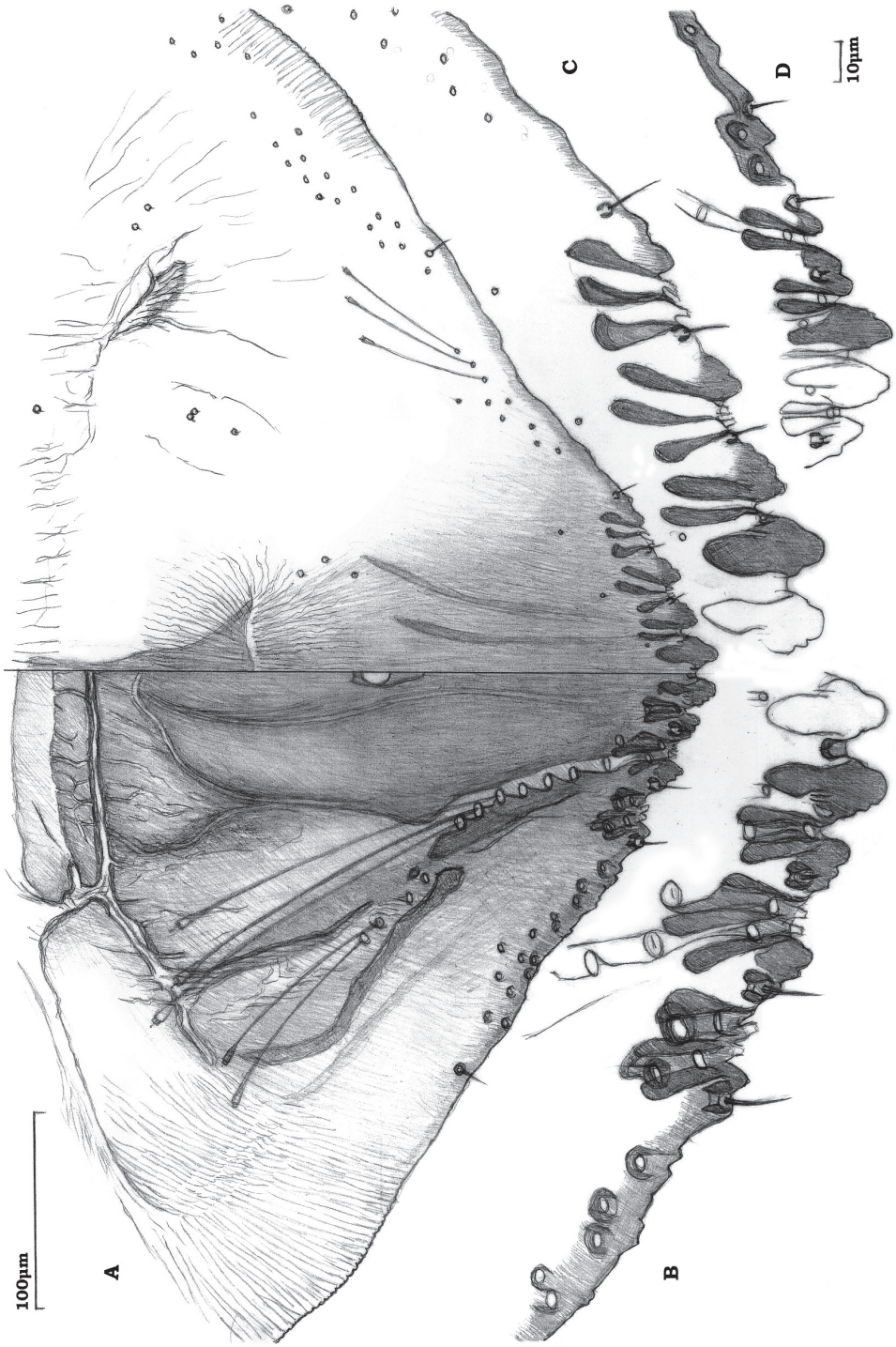

Fig. 5. *Melanaspis inopinata*, adult female (A–C), exuvial cast of second instar female (D), Solan, on *Pistacia khinjuk*. A, pygidium; B, pygidial margin, dorsal surface; C, pygidial margin, ventral surface; D, pygidial margin, dorsal surface. Scale bars: 100µm for A; 10µm for B–D.