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**THE ACUMINATA SPECIES-GROUP OF UNASPIIS,
WITH PARTICULAR REFERENCE TO
THE PERIVULVAR DISC PORES
(STERNORRHYNCHA: COCCOIDEA: DIASPIDIDAE)**

By SADAŌ TAKAGI

Abstract

TAKAGI, S., 2023. The *acuminata* species-group of *Unaspis*, with particular reference to the perivulvar disc pores (Sternorrhyncha: Coccoidea: Diaspididae). *Ins. matsum. n.s.* 79: 55–79, 4 tables, 11 figs.

Three species of *Unaspis* occurring in tropical Asia and another one in northeastern Asia are dealt with: *U. acuminata* (Green), broadly distributed in tropical Asia, *U. atricolor* (Green), occurring in Sri Lanka and South India, *U. pallidicolor*, n.sp., described from Sabah, Borneo Island, and *U. turpiniae* Takahashi, described from Taiwan and occurring also in southern Japan. These species agree particularly in having the perivulvar disc pores occurring in ‘the *acuminata*-formula’: $4(6-6)(4-4)=24$, or in variations of this formula. They are ovoviviparous, and, therefore, assumed to have no function of the perivulvar disc spores. In spite of this, these disc pores persist, occurring exactly or nearly in the definite pattern. Speculation is made on the original formation and phenotypic reappearance of this static trait.

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INTRODUCTION

In the present study, four species of *Unaspis* are dealt with: *Chionaspis acuminata* Green, 1896, originally described from Pundaluoya, Ceylon, as occurring on *Ardisia* sp., was redescribed and figured by Green (1899) on the basis of the original material and a further collection made at the same locality from an unidentified shrub. This species was designated by MacGillivray (1921) for the type-species of his new genus *Unaspis*. Since that time, *Unaspis acuminata* (Green) has been recorded mainly from tropical Asia and from a broad range of plants. In the present study, samples collected in Nepal, South India, Malaya, and the Philippines and from diverse plants are identified with *Unaspis acuminata* on the basis of Green's redescription and figure.

At the end of his redescription of *C. acuminata*, Green (1899) states: 'A form collected at Kandy [in Ceylon] has the female puparium dark chocolate brown [while in *C. acuminata* 'Colour pale brownish fulvous, sometimes dark brown']. The median lobes of pygidium are rather smaller and shorter than in typical examples, and more distinctly serrate on their free edge.' This form was called *C. acuminata atricolor* by Ayyar, and later described by Green (1922) under this name (which is, therefore, attributable to the latter author) on the basis of material collected at Maha Illuppalama, Kandy, on *Carrisa* sp. and recorded from South India on *Carrisa*, *Tamarindus*, and *Ficus*. Rao (1949) described this form as a distinct species, '*U. atricolor* (Green)'. I have found this species in my collection from South India.

Another form, which is very close to *U. atricolor* but apparently different from the latter, occurs in Sabah (northeastern Borneo) and is described in this paper as a new species, *U. pallidicolor*.

Unaspis turpiniae, originally '*U. acuminata* Green var. *turpiniae*' (Takahashi, 1934), was described from material collected at 'Kahodai near Hassenzan' [these locality names correspond to 佳保台, 972m, and 八仙山, with the summit 2366m; the altitude of the collection spot was not mentioned, but the spot should have been in montane conditions around an altitude of 1000m], Formosa [Taiwan], as occurring on *Turpinia formosana*. This scale insect has also been recorded from southern Japan on *Turpinia ternata*.

These four species are very similar to each other in the characters of the adult females. They agree particularly in having the perivulvar disc pores occurring with a considerable concentration in the numerical pattern 4(6-6)(4-4)=24, called in this paper 'the *acuminata*-formula'. This pattern of arrangement of perivulvar disc pores may occur in other parts of the genus, too. The matter here concerns the outstanding frequency of this formula in contrast with those of the other arrangements in the same samples (see section IIa).

Probably all of these species are ovoviviparous, so that their perivulvar disc pores should have no function (in this connection, see Takagi, 2022), and the persistent occurrence of this organ with a concentration in a definite pattern, thus affording a static trait, may need an explanation.

Abbreviations. In descriptions, explanations of figures, tabular indications, etc., the abbreviations 'prth', 'msth', 'mtth' are used for the pro-, meso-, and metathorax, and 'abd I-VIII' for the first to eighth abdominal segments.

Depository of the type-slide. The type slide of *Unaspis pallidicolor*, n.sp., is deposited in Entomology Division, Forest Research Institute of Malaysia, Kepong, Kuala

Lumpur, Malaysia.

Figures of adult females (Fig. 1-8) are drawn from teneral specimens (that is, individuals in a stage shortly after exuviation). At full growth the body has the cephalothorax much elongated and sclerotized, the sclerotization being especially remarkable in *U. turpiniae*. In *Table 1a and 1b*, []: number of individuals examined.

I. SAMPLES EXAMINED

Ia. *Unaspis acuminata* (Green)

The samples referred to *U. acuminata* in the present study were collected in Nepal: in Bagmati (sample NPL-1~4), Gandaki (NPL-5), Narayani (NPL-6~9, 13), Kosi (NPL-10, 11), and Lumbini (NPL-12, 14), the first five samples were collected in the Midland of Nepal and the others in the Terai lowland bordering India; in South India: in Tamil Nadu (IND-1~3) and Kerala (IND-4~7); in Malaya (MLY-1 and 2); and in the Philippines: Palawan Is. (PLP-1) and Luzón Is. (PLP 2~4). Samples were collected mostly from the leaves ('fol') of host plants, but at times from the twigs ('ram') (when necessary, the abbreviation 'fol' or 'ram' is added to sample number). The host plants of the samples NPL-5 and IND-2, 3, 5~7 were not identified.

NPL-1: Chisopani, 2330m, on *Euonymus echinatus*, Celastraceae, 22.X.1983. NPL-2: Langtang Valley, 2300m, on *Xylosma controversum*, Salicaceae, 29.IX.1975 [in 1975, surveys were continued in the Langtang Valley up to Kyanjin Gompa, 3700m, and on another day were made up to an altitude above 4000m on the southern slope of Langtang Lirung, a peak of the Great Himalayas, but no further samples of the species were obtained around those higher altitudes]. NPL-3: Bokajunda on the way from Ramche to Dunche, 1910m, on *Xylosoma controversum*, 16.IX.1975. NPL-4: Dunche, 1770m, on *Xylosma controversum*, 19.IX.1975. NPL-5: Chotepatan, 800m, 10. X.1983. NPL-6: Bhainse, 570m, on *Reissantia arborea*, Celastraceae, 19.X.1975. NPL-7: Bhainse, 570m, on *Reissantia arborea*, 19.X.1975. NPL-8ram: Bhainse, 570m, on *Reissantia arborea*, 20.X.1975. NPL-9: Adhabar, 320m, on *Reissantia arborea*, 21.X.1975. NPL-10: Dharan, 300m, on *Leea* sp., Vitaceae, 23.XII.1983. NPL-11fol, -11ram: Dharan, 300m, on *Reissantia arborea*, 25., 29.XII.1983. NPL-12: Gaidakot, 180m, on *Reissantia arborea*, 16.XII.1983. NPL-13: Adhabar, 150m, on *Reissantia arborea*, 19.XII.1983. NPL-14: Nawal Parasi, 60m, on *Reissantia arborea*, 15.XII.1983.

IND-1: Coonoor, 1820m, on *Microtropis?* sp., Celastraceae, 26.XI.1978. IND-2: Anaimalai, 750m, 3.XII.1978. IND-3: Coimbatore, ca.400m, 3.XII.1978. IND-4: Dhoni Forest, Palghat, 400m, on *Hydnocarpus* (?) sp., Flacourtiaceae, 7.XII.1978. IND-5, 6: Periyar Sanctuary, 21.XII.1978. IND-7: Trivandrum [now called Thiruvananthapuram], 23.XII.1978. [No material has been available from Ceylon or Sri Lanka, where *Chionaspis acuminata* was originally described. The localities of IND4~7 are close to Sri Lanka geographically and probably similar to some localities of the latter in ecological circumstances (climates; fauna and flora).]

MLY-1: Mt. Jasar, Cameron Highlands, 1300~1400m, on *Glyptopetalum quadrangulare*, Celastraceae, 17.X.1986. MLY-2. Beserah Forest Reserve [seaside forest], Kuantan, Pahang, on *Salacia macrophylla*, Celastraceae, 6.VII.1990.

PLP-1: Tarusan, Batarasa, on *Olex imbricata*, Olacaceae, 19.VIII.1993. PLP-2: Bagac, Bataan, on *Drypetes* sp., Euphorbiaceae, 27.VIII.1994. PLP-3: Banahao, Quezon, on *Alangium multiflorum*, Alangiaceae, 4.XII.1992. PLP-4: Pagbilao, Quezon, on

Siphonodon pyriformis, Celastraceae, 3.XII.1992.

Ib. *Unaspis atricolor* (Green)

Coimbatore, Tamil Nadu, South India, on *Tamarindus indica*, leaves, Leguminosae, 1.XII.1978.

Ic. *Unaspis pallidicolor*, n.sp.

Sepilok, Sandakan, Sabah (northeastern Borneo), on an undetermined plant, leaves, 31.X.1988.

Id. *Unaspis turpiniae* Takahashi

Siro-Yama [Shiroyama], Kagosima [Kagoshima], Kyûsyû [Kyûshû], Japan, on *Turpinia ternata*, leaves, Staphyleaceae, 5.VII.1961.

II. WAX-SECRETING ORGANS

Ila. *Acuminata*-formula of perivulvar disc pores.

In the four species, except for two samples of *U. acuminata*, NPL-1 and 2, the perivulvar disc pores occur in agreement with the formula $4(6-6)(4-4)=24$ (Fig. 2, I) or in its variations, which are usually slight so far as the numbers of disc pores in individual groups are concerned, so that the mean values of the total numbers in samples concentrate around 24 (Table 1). There are some different formulae of perivulvar disc pores in each sample, but the *acuminata*-formula alone is outstanding in the number of individuals which bear that formula, and the other formulae are represented by one or a few to several individuals usually (Table 2). This pattern is stable throughout the four species of the *acuminata*-group. It seems that the formation of the *acuminata*-formula represents the stem process in the morphogenesis concerning the perivulvar disc pores in the four species, and other formulae are brought about as the results of some changes of the process, which occur probably incidentally to environmental conditions and cause either increase or decrease, or both, in the total number of disc pores in a sample.

In Samples NPL-1 and -2, the group-formation of perivulvar disc pores is incomplete: in NPL-1, 1 or 2, at times 0 or 3, disc pores occurring in the median group, 1-3, at times 4 or 5, in each anterolateral group, and always 0 in the posterolateral groups (which are absent accordingly); in NPL-2, 1 or 2 in the median group and also in each anterolateral group, and always 0 in the posterolateral groups. In general, such sets of perivulvar disc pores are interpreted to mean that the occurrence of perivulvar disc pores there is rudimentary, while the rudimentary occurrence of perivulvar disc pores is usual or normal in some other species of *Unaspis* and certain other diaspidids.

Many if not all species of *Unaspis* should be ovoviviparous, and in such species the presence of perivulvar disc pores and the occurrence of their variations should have no adaptive significance; in fact, generally in such species, the perivulvar disc pores are often rudimentary, being irregular in occurrence, or even disappearing largely or entirely. I have observed within the bodies of some full-grown adult females of *U. acuminata* and *U. atricolor* newly hatched crawlers together with their discarded egg-envelopes scattered nearby. The view may be adopted that all the species of the *acuminata* group are ovoviviparous. In the examined samples of these species, especially in larger ones, the strict state of the *acuminata*-formula occurs in considerably large proportions (*ca.*

40~80%). Many of the examined samples are small in size, so that, in Table 1, the proportions of the occurrence of the *acuminata*-formula are not given for them because of their possible low statistical reliability. The proportions in these samples, however, generally keep the levels of at least 20~40%, and in Sample NPL-12~14 they rise to the levels of 50~60%. I am inclined to believe that these values reflect real tendencies and are adoptable as actual ones in these samples, because they are far from contradictory in understanding the general tendency in the occurrence of the *acuminata*-formula.

In the present state of our knowledge, it is not understandable why in these species the perivulvar disc pores persist and even tend to hold on to a definite formula with its variations. We may assume that any static trait should originate through adaptive selection, and thereafter should be set and stabilized in an interrelated (e.g., modular) system of endogenous factors. In the course of ontogeny, however, the phenotypic formation of even a stable trait should be done undoubtedly under the influence of the environment where the individual lives, sometimes bringing about a variation in the realized phenotype. In an environment unusual for the species, the mechanism for the stability will be largely disturbed as shown by the cases of Samples NPL-1 and 2, which, as a result, produce rudimentary states of perivulvar disc pores. Such patterns of the perivulvar disc pores are observable as usual or normal traits in some other species of *Unaspis* apparently in association with ovoviviparity.

Samples NPL-1 and 2, together with NPL-3 and some others, were all collected within the same geographical region, Midland Nepal; NPL-2, 3, and 4 were obtained from the same plant species, *Xylosma controversum*. The environmental change with which these samples encountered was apparently not of geographical nature, nor associated with the host plants, but should have been brought about by different altitudes accompanied by different climatic conditions.

As a general tendency among the samples collected in Nepal (Table 1), the strict state of the *acuminata*-formula is realized in higher proportions at lower altitudes and, at the same time, at lower latitudes. The proportions attain at the highest value (ca. 80%) in both of the samples from the Malay Peninsula, where MLY-1 was obtained from a mountainous district and MLY-2 from a seaside locality. In these cases, the emergence of the *acuminata*-formula in the large proportion was not disturbed by the difference in altitude, nor in host-association; in the view adopted here, it must have been realized in some climatic condition of Southeast Asia prevailing in both localities—high humidity. It should be added that in *U. pallidicolor*, too, which was collected in the lowland of Borneo, an island where the climatic conditions may not greatly be different from those in the Malay Peninsula, the strict state of the *acuminata*-formula is realized in a considerably large proportion (76%).

The observations stated above may be explained as follows: the *acuminata*-formula was originally formed—probably in the scale insect ancestral to all the four species—in adaptation to the equatorial zone under the humid-tropical climate, then lost its adaptive significance in association with the acquiring of ovoviviparity, but its phenotypic potential persists, being carried in an interrelated system of endogenous factors, and re-emerges as a trait which is stable or considerably so in the humid climate. All this may be no more than mere speculation, having no secure basis in the present state of our biological knowledge. Above all, no explanation can be given for the question why and how the *acuminata*-formula was originally formed in adaptation to high humidity. However, in my perspective or hope, local variations similar or parallel to those observed

through the samples of *U. acuminata* collected in the Himalayan Region, South India, and Southeast Asia will be found by making a detailed examination on sufficient material from Sri Lanka, an island inhabited by *Unaspis acuminata* (and *U. atricolor*) under the influence of the equatorial climate and provided with littoral vegetations and forest-clad mountains, the highest peak surpassing 2500m.

Iib. Other wax-secreting organs

The wax-secreting organs given in Table 1 except for the perivulvar disc pores exhibit obvious increases in Sample NPL-1 and -2. In disagreement with the perivulvar disc pores these organs should hold their functions, and the numerical increases of them, especially of the macroducts, should have adaptive significance under the climates in the higher localities.

It should be mentioned here that the total number of the macroducts occurring on the abdomen given in Table 1 does not include the marginal macroducts of the pygidium ($1 + 2 + 2 + 1 = 6$ marginal macroducts on each side of the pygidium in the interpretation adopted here). Furthermore, the dorsal macroducts situated inward on the surface of abd I-V tend to be reduced in size in various degrees, at times to the size of a microduct, so that arbitrariness was not always excluded in recognizing and counting macroducts. This was also true as to the macroducts occurring on the metathorax, on which good macroducts occur on the posterolateral corner of the segment, and other ones, occurring anteriorly to them, tend to be smaller in various degrees. Here, too, arbitrariness was not completely excluded in recognizing and counting macroducts. The numbers of macroducts given in Table 1 may, therefore, be not necessarily exact, showing no more than the tendencies of macroducts in their occurrence in sizes sufficient for recognition. In *U. turpiniae*, it is not easy to count exactly macroducts and gland spines as well as the spiracular disc pores on the cephalothorax, which is heavily sclerotized at full growth, so that the numbers of these organs in Table 1 are based on teneral individuals, which are available in a limited number.

III. RECOGNITION CHARACTERS OF THE SPECIES

In this section, features for recognizing the species of the *acuminata*-group are almost limited to the trullae, which may be fairly characteristic specifically except between *U. acuminata* and *U. turpiniae*, which are not easily distinguishable from each other by the use of the trullae alone. *U. turpiniae* may be recognized, above all, in the cephalothorax especially thickly sclerotized at full growth, having many small unsclerotized patches on the dorsal surface of the head clear and distinct. Furthermore, in this species, none of the dorsal macroducts of the pygidium are particularly elongated in comparison with the others, and this character is useful in recognizing the species irrespective of stages in growth of the adult female body. Among the four species, differences are expected in other features, especially in the numbers of some wax-secreting organs, but these features may be variable in number locally, too. Local variations are unknown in *U. atricolor*, *U. pallidicolor*, and *U. turpiniae*, all these species

being known in the present study from single localities, so that such features are not to be adopted for comparison.

In all the species the trullae are well developed in three pairs, the median ones being non-zygotic and the lateral ones biolobulate. Laterally to the third trullae, the pygidial margin is occupied by three broad serrate processes on abd V; the margin of abd IV with a similar series of serrate processes. A similar serrate process occurs on abd III ventromarginally in the four species, and in *U. atricolor* and *U. pallidicolor* also on abd II. Dorsal macroducts occurring over pygidium, scattered rather than arranged in definite segmental rows.

So far as examined, the perivulvar disc pores occur in the *acuminata*-formula [4(6-6)(4-4)=24] or its variations, which are usually not greatly different from the formula in the total number of pores.

The female tests are elongate, gradually broader posteriorly, with a distinct median ridge; brownish in various tones.

IIIa. *Unaspis acuminata* (Green)

Ia, samples examined. Table 1, numbers of the main wax-secreting organs in the adult females. Table 2, perivulvar disc pores in formulae. Fig. 1~5, adult females. Fig. 9, second-instar male.

Recognition characters (adult female). Median trullae not or little sunken into apex of pygidium, as large as and similar in shape to the lobules of lateral trullae or a little smaller than mesal lobule of second trulla, oblong, and smooth or slightly serrate on mesal margins. Second and third trullae with both lobules well developed, a little expanding towards apex ('wedge-shaped' in Green, 1899). Median trullae and mesal lobules of lateral trullae each basally with a pair of long slender scleroses converging anteriorly.

Remarks. In the present study, samples collected broadly in tropical Asia and at various altitudes are referred to this species. Many of them are generally similar to each other in the adult females. Exceptions are made by two samples, NPL-1 and -2, which were collected at the highest altitudes in my collection-records of the species and under local conditions probably unusual for the species and, therefore, are interpreted to represent unusual or abnormal phenotypic forms. I have little doubt as to my assumption that all these specimens including the two unusual samples occurring at the higher altitudes represent one and the same species, and that they should be conspecific with '*Chionaspis acuminata*' redescribed and figured by Green (1899) on the basis of specimens including the type-series from Pundaluoya, Ceylon, and from *Ardisia*. Green did not show on his plate XLV a small gland spine occurring just laterally to each of the median and second trullae; these gland spines may have been too minute to observe by the use of a microscope of his time.

The samples examined in the present study except for NPL-1 and -2 agree with Green's figure in having the perivulvar disc pores occurring in the arrangement called in this study 'the *acuminata*-formula' [4(6-6)(4-4)=24] or in its slight variations. The pygidium of *Chionaspis acuminata* on Pl. XLV in Green (1899) has the perivulvar disc pores occurring in the arrangement 4(7-6)(4-5)=26, showing a slight increase (+1) in one of the anterolateral groups and also in one of the posterolateral groups as compared with the strict state of the *acuminata*-formula.

IIIb. *Unaspis atricolor* (Green)

Ib, sample examined. Table 1, numbers of the main wax-secreting organs in the adult female. Table 2, perivulvar disc pores in formulae. Fig. 6, adult female. Fig. 10, second-instar male.

Recognition characters (adult female). This species may be recognized among the species of the *acuminata* group by the antennal seta having a trace of fusion of 2 setae always visible; median trullae a little sunken basally into apex of pygidium, smaller than mesal lobule of second trulla, divergent, distinctly serrate on mesal margins; second and third trullae with lobules well developed, expanding apically, the mesal lobule basally with a pair of long slender scleroses converging anteriorly; median trullae with basal scleroses less developed. Test blackish brown ('dark chocolate brown' in Green, 1899).

Remarks. Green (1899) described this form concisely and exactly. I felt no difficulty in identifying the examined sample from South India as belonging to *U. atricolor*, which I treat as a distinct species in agreement with Rao (1949).

IIIc. *Unaspis pallidicolor*, n.sp.

Ic, sample examined. Table 1, numbers of the main wax-secreting organs in the adult female. Table 2, perivulvar disc pores in formulae. Fig. 7, adult female. Fig. 11, second-instar male.

Recognition characters (adult female). This species is closely similar to *U. atricolor*, but may be recognized in having the median trullae more deeply sunken into the apex of the pygidium, as large as the mesal lobule of the second trulla, roughly serrate on the diverging mesal margins, with the basal scleroses more developed than those of the second and third trullae. Second and third trullae with lobules rather oblong. Test pale brownish.

Remarks. This form is very similar to *U. atricolor*, but regarded here as a distinct species on the basis of the differences mentioned above. However, in the present study, these forms are represented by the single samples from the localities so distantly separated from each other and, therefore, the possibility that they represent geographical variations within the same species may not entirely be excluded. These species are named on the basis of the colour of the female test. The diaspidid female tests, however, are at times variable in the tone of their colour even in the same colony. In the stage of the second-instar male, *U. atricolor* has outstanding frimbriate processes on the abdomen (Fig. 10), while the corresponding processes are not developed so remarkably in the available sample of *U. pallidicolor* (Fig. 11). In *U. acuminata*, however, these processes are variable in development among samples or, as a possibility, even among individuals (Fig. 9; compare with Fig. 13 in Takagi, 2022).

IIId. *Unaspis turpiniae* Takahashi

Id, Sample examined. Table 1, numbers of the main wax-secreting organs in the adult female. Table 2, perivulvar disc pores in formulae. Fig. 8, adult female.

Recognition characters (adult female). This species is very similar to *U. acuminata*, and was originally described as a variety of the latter, from which it was distinguished by the use of the following characters: '(1) Glands on the pygidium shorter; (2) A short usual gland spine present between the second and third lobes; (3) Cephalothorax chitinized in the old females; (4) Median lobes broadly rounded apically' (Takahashi, 1934). Among

these characters, the first and the third are adopted in the present study for distinguishing this species from *U. acuminata* (see the start of this section: III); the two species are not different in the second character (see *Remarks* under *Unaspis acuminata* in this section: IIIa), and the fourth is not adoptable, because the median trullae are somewhat variable in shape among the local samples of *U. acuminata*.

It is noteworthy that this form, so closely similar to *U. acuminata*, occurs in Taiwan and Kyûsyû, areas so distantly separated from the habitats of the latter.

CONCLUDING REMARKS

I have believed for a long time that in principle the perivulvar disc pores as well as other wax-secreting organs vary randomly in number in each sample or species, though probably within a definable range; in Darwinian principle, any taxon should be an adaptive unit and adaptation is realized by selection on random variation. It was an unexpected result to find in my numerical data (Table 1; 2) a high-rate occurrence of the strict state of the ‘*acuminata*-formula’ of those disc pores in each sample. My surprise undoubtedly owes to the fact that we are still ignorant about how the perivulvar disc pores can be adaptive in their arrangement into groups or, in a more adequate term, clusters and in their numbers in each of the clusters—median, anterolateral, and posterolateral clusters in the Diaspidini—and in total.

It was also beyond my supposition that at higher altitudes, at and over 2300m, the perivulvar disc pores are much disturbed in their formation into clusters, suddenly becoming rudimentary in occurrence, in spite of the fact that other wax organs, especially the macroducts, increase in number at the higher altitudes. This case of variation of the perivulvar disc pores may deserve careful consideration especially when a taxonomic interpretation is required for a sudden change in the state of this organ under a new environmental or ecological condition.

It should also be added here that the specimens I determined in the present study as members of *Unaspis acuminata* do not completely agree with the figures of *Unaspis acuminata* drawn by Ferris on the basis of ‘the specimens from *Euonymus revoluta* and from Ceylon, collected and determined by Green’ (Rao, 1949, p. 61) and published in Ferris (1936, Fig. 73) and in Rao (1949, Fig. 36). Above all, the figures drawn by Ferris have the perivulvar disc pores too numerous to represent a variation of the *acuminata*-formula. In addition, his figures do not clearly show the ‘wedge-shaped’ (Green, 1899) lobules of the lateral trullae. At present I have no basis to decide whether the figures drawn by Ferris represent another form or strain of *U. acuminata* or even another species. (Furthermore, in both of his figures, the antennae in the first instar are shown to have the terminal segment bisetose apically; this state suggests that the illustrated first instar belongs to another species of another higher taxon and that it got mixed with the *Unaspis* material on the slide. [In this connection, see Fig. 12, G in Takagi, 2022]). By the way, Tang (1986) described *Unaspis acuminata* from specimens occurring in Hainan Island, China, and on *Cycas revoluta*. His specimens again have rather numerous perivulvar disc pores (‘4 or 5 in the median, 6 to 9 in the anterolateral, and 5 or 6 in the posterolateral group’) and the median trullae ‘rather shrunken and sunken’.

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CORRECTION.

Takagi, S., 2022. Another mode of life in armoured scale insects (Sternorrhyncha: Coccoidea: Diaspididae). Ins. matsum. n.s. 78: 27-56. Caption under Fig. 15, p. 56.

INCORRECT. 'Appendix II. Matsuda (1927) on test construction'.

CORRECT. 'Appendix II: Matsuda (1927) on test construction'.

Table 1a. Numbers of the anterior and posterior spiracular disc pores and perivulvar disc pores per individual (totals of the organs occurring on both sides of the body) in the samples examined of *U. acuminata*, *U. atricolor*, *U. pallidicolor*, and *U. turpiniae*.

Rangs and means are given in the formula 'lowest-mean-highest values' except cases where the ranges or observed values alone are given; < >: proportion of individuals with perivulvar disc pores occurring in the *acuminata*-formula.

| Sample, altitude | Ant. Spir. disc pores | Post.spir. disc pores | Perivulv.disc pores |
|---------------------|-----------------------|-----------------------|------------------------------|
| <i>U. acuminata</i> | | | |
| NPL-1, 2330m | 13-20.3-36 [26] | 5-7.5-12 [22] | 3-6.0-11 [25] |
| NPL-2, 2300m | 9-12.4-15 [5] | 2-5.4-8 [5] | 3-4.6-6 [5] |
| NPL-3, 1910m | 4-6.4-10 [8] | 3-4.0-5 [8] | 20-23.8-26 [9] |
| NPL-4, 1770m | 10 [1] | 3 [1] | 23 [1] |
| NPL-5, 800m | 4-7.2-10 [22] | 2-4 [21] | 19-23.0-24 <9/22: 40.9%> |
| NPL-6, 570m | 4-6.9-10 [30] | 1-4 [28] | 22-24.1-26 <14/28: 50.0%> |
| NPL-7, 570m | 3-5.6-8 [41] | 1-4 [34] | 22-23.6-25 <15/36: 41.7%> |
| NPL-8(ram), 570m | 7-9.0-12 [13] | 2-4 [14] | 23-24.4-27 [15] |
| NPL-9, 320m | 4-5.9-8 [16] | 1-3 [18] | 20-23.1-24 [17] |
| NPL-10, 300m | 5-7.3-10 [18] | 1-4 [16] | 20-23.1-24 [18] |
| NPL-11fol, 300m | 2-5.3-8 [8] | 1-4 [6] | 21-23.3-25 [7] |
| NPL-11ram, 300m | 3-4.7-7 [15] | 1-3 [15] | 22-23.4-24 [16] |
| NPL-12, 180m | 4-5.0-6 [3] | 1 or 2 [2] | 24-24.3-24 [3] |
| NPL-13, 150m | 5-7.8-10 [12] | 1 or 3 [11] | 23-23.8-25 [16] |
| NPL-14, 60m | 3-6.9-10 [18] | 1-4 [17] | 23-25.3-26 [18] |
| IND-1, 1820m | 7-8.4-11 [10] | 2-4 [8] | 22-23.9-26 [13] |
| IND-2, 750m | 8-11.5-13 [10] | 2-4 [11] | 22-24.0-26 [11] |
| IND-3, 400m | 6-8.8-12 [8] | 2-4 [9] | 22-24.2-26 [11] |
| IND-4 | 8-13.3-18 [42] | 2-8 [43] | 19-24.3-31 <32/48: 66.7%> |
| IND-5 | 15 [1] | — | 25 [1] |
| IND-6 | 6-11.6-16 [10] | 2-6 [9] | 23-23.8-24 [10] |
| IND-7 | 5-8.8-17 [20] | 2-5 [20] | 24-24.3-26 <13/21: 61.9%> |

Continued to the next page.

Table 1a. Continued from the preceding page.

| | | | |
|------------------------|----------------|----------------------|------------------------------|
| MLY-1,1300-1400m | 4-10.4-14 [24] | 3-5 [28] | 22-23.8-24 <27/33: 81.8%> |
| MLY-2 | 4-6.4-10 [43] | 1-4 [47] | 18-23.6-24 <38/48: 79.2%> |
| PLP-1 [3] | 5-5.3-6 [3] | 2 [3] | 24-24.7-26 [3] |
| PLP-2 | 4-7.8-14 [20] | 2-4 [22] | 21-23.2-24 <11/28: 39.3%> |
| PLP-3 | 4-4.6-6 [4] | 2 [2], 3 [1] | 23-25.2-28 [5] |
| PLP-4 | 8-4.7-6 [23] | 1 [1], 2 [18], 3 [1] | 19-23.1-24 <13/25: 52.0%> |
| <i>U. atricolor</i> | 2-3.7-6 [14] | 2-4 [13] | 22-24.8-30 <8/16: 50.0%> |
| <i>U. pallidicolor</i> | 4-5.2-7 [18] | 1 [1], 2 [20] | 23-24.0-26 <16/21: 76.2%> |
| <i>U. turpiniae</i> | 8-9.6-12 [12] | 4-4.2-6 [12] | 16-23.5-26 <21/52: 40.4%> |

Table 1b. Numbers of gland spines and macroducts on the metathorax and abdomen (excluding the marginal macroducts of the pygidium).

| Sample, altitude | Gland spines on mtth | Gland spines on abd I-IV | Macroducts on mtth | Macroducts on abd |
|---------------------|----------------------|--------------------------|--------------------|-------------------|
| <i>U. acuminata</i> | | | | |
| NPL-1, 2330m | 4-10.4-13 [20] | 60-76.0-89 [21] | 16-24.7-30 [20] | 97-115.3-129 [20] |
| NPL-2, 2300m | 7-9.2-12 [5] | 60-67.6-72 [5] | 21-23.6-29 [5] | 105-119.8-130 [5] |
| NPL-3, 1910m | 3-4.7-10 [6] | 32-38.5-50 [4] | 10-11.3-12 [3] | 74-78.3-84 [3] |
| NPL-4, 1770m | 10 [1] | 39 [1] | 9 [1] | 75 [1] |
| NPL-5, 800m | 0 [1], 1-5 [17] | 31-35.6-45 [18] | 6-10 [18] | 64-74.9-81 [18] |
| NPL-6, 570m | 0 [1], 1-5 [27] | 31-35.7-42 [22] | 5-10 [28] | 65-74.3-80 [25] |
| NPL-7, 570m | 0[3], 1-5 [30] | 30-38.3-43 [27] | 5-11 [33] | 71-76.3-85 [25] |
| NPL-8(ram), 570m | 2 or 3 [14] | 32-39.1-45 [7] | 5-12 [10] | 73-76.2-80 [5] |
| NPL-9, 320m | 3-5 [18] | 32-36.0-40 [16] | 6-13 [17] | 69-76.2-83 [17] |
| NPL-10, 300m | 0 [13], 1 [1] | 34-41.1-48 [14] | 4-7 [15] | 65-75.5-84 [15] |
| NPL-11fol 300m | 0 [1], 2 [3] | 27-32.3-37 [6] | 6-8 [6] | 68-72.8-76 [6] |
| NPL-11ram 300m | 0[1],1-5[13] | 29-31.5-34 [13] | 5-8 [16] | 68-73.3-77 [13] |
| NPL-12, 180m | 2-4 [3] | 30-33.5-37 [2] | 6-9 [3] | 70-72.5-75 [2] |
| NPL-13, 150m | 2-6 [10] | 36-38.9-43 [10] | 6-10 [10] | 74-78.0-88 [8] |
| NPL-14, 60m | 0[5],1-3[12] | 27-37.0-41 [15] | 5-9 [17] | 70-75.0-86 [15] |

Continued to the next page.

Table 1b. Continued from the preceding page.

| | | | | |
|------------------------|-------------------------|-----------------|-----------------|---------------------|
| IND-1, 1820m | 0 [5], 1 [3], 2 [2] | 35-43.4-51 [10] | 4-11 [10] | 73-77.3-80 [10] |
| IND-2, 750m | 0 [14], 1 [4] | 40-45.9-53 [10] | 5-7 [10] | 74-80.1-84 [10] |
| IND-3, 400m | 0 [3], 1 [4], 3 [1] | 34-43.4-53 [8] | 5-8 [8] | 74-81.5-88 [8] |
| IND-4 | 0 [31], 1-3 [14] | 38-50.4-60 [42] | 4-9 [46] | 72-81.8-100 [44] |
| IND-5 | 0 [1] | 53 [1] | 6 [1] | 82 [1] |
| IND-6 | 0 [4], 1 [2], 2 [1] | 42-47.6-54 [5] | 6 [6] | 78-80.2-83 [5] |
| IND-7 | 0 [16], 1 [2], 2 [1] | 41-47.9-58 [19] | 5-7 [18] | 73-77.9-86 [18] |
| MLY-1, 1300-1400m | 0 [25], 1 [2] | 30-46.4-63 [23] | 4 - 8 [23] | 78-81.1-86 [20] |
| MLY-2 | 0 [45] | 29-40.9-52 [40] | 3-7 [41] | 69-75.9-85 [39] |
| PLP-1 | — | — | — | — |
| PLP-2 | 0 [16], 1 [6] | 38-42.8-50 [18] | 4-8 [17] | 74-77.1-80 [17] |
| PLP-3 | 0 [4] | 50 [1], 58 [1] | 7 [1], 8 [1] | 84 [1], 88 [1] |
| PLP-4 | 0 [23], 1 [2], 2 [1] | 29-33.0-36 [12] | 4-7 [10] | 66-70.6-74 [9] |
| <i>U. atricolor</i> | 0 [17] | 42-46.3-56 [10] | 9-10.6-14 [11] | 87-92.3-98 [10] |
| <i>U. pallidicolor</i> | 0 [21] | 29-33.5-38 [20] | 4-4.6-6 [17] | 64-68.3-72 [19] |
| <i>U. turpiniae</i> | 1-4.8-6 [12] | 40-44.6-19 [11] | 10-14.6-57 [12] | 77-80.5-88 [12] |

Table 2. Perivulvar disc pores in formulae in some samples of *Unaspis acuminata* and in the other three species of the *acuminata*-group.

In forming the formulae, differences owing to the body-sides are ignored [for example, the formula '4(7-6)(4-4)=25' and '4(6-7)(4-4)=25' are treated as the same]. n: number of individuals; F: *acuminata*-formula.

| | | | | | |
|------------------|----|------------------|----|------------------------|----|
| NPL-6 | n | MLY-1 | n | <i>U. atricolor</i> | n |
| 5(7-6)(4-4)=26 | 1 | 5(6-5)(4-4)=24 | 1 | 4(8-7)(6-5)=30 | 1 |
| 4(7-6)(4-4)=25 | 5 | F 4(6-6)(4-4)=24 | 27 | 4(8-7)(5-4)=28 | 1 |
| 3(7-7)(4-4)=25 | 2 | 3(8-6)(4-2)=23 | 1 | 4(6-6)(6-4)=26 | 1 |
| F 4(6-6)(4-4)=24 | 14 | 3(6-6)(4-4)=23 | 2 | 4(7-6)(4-4)=25 | 3 |
| 3(7-6)(4-4)=24 | 2 | 4(6-6)(3-3)=22 | 1 | F 4(6-6)(4-4)=24 | 8 |
| 4(6-5)(4-4)=23 | 2 | 4(6-5)(4-3)=22 | 1 | 3(6-6)(5-4)=24 | 1 |
| 3(6-6)(4-4)=23 | 1 | | | 3(6-6)(4-3)=22 | 1 |
| 4(6-4)(4-4)=22 | 1 | MLY-2 | n | <i>U. pallidicolor</i> | n |
| | | F 4(6-6)(4-4)=24 | 38 | 4(6-6)(6-4)=26 | 1 |
| IND-4 | n | 9(8-1)(3-2)=23 | 1 | 4(6-6)(5-4)=25 | 1 |
| 4(8-8)(6-5)=31 | 1 | 4(6-6)(4-3)=23 | 3 | F 4(6-6)(4-4)=24 | 16 |
| 4(6-6)(6-5)=27 | 1 | 3(6-6)(4-4)=23 | 2 | 4(6-6)(4-3)=23 | 1 |
| 6(6-5)(5-4)=26 | 1 | 4(6-4)(4-4)=22 | 1 | 4(6-5)(4-4)=23 | 2 |
| 4(7-6)(5-4)=26 | 2 | 4(6-6)(4-1)=21 | 1 | | |
| 4(6-6)(5-5)=25 | 2 | 3(6-4)(4-4)=21 | 1 | <i>U. turpiniae</i> | n |
| 4(9-6)(4-2)=25 | 1 | 2(4-4)(4-4)=18 | 1 | 7(7-4)(4-4)=26 | 1 |
| 4(6-6)(5-4)=25 | 3 | | | 4(7-6)(5-4)=26 | 3 |
| F 4(6-6)(4-4)=24 | 32 | PL-2 | n | 5(6-6)(4-4)=25 | 1 |
| 6(6-4)(4-4)=24 | 2 | F 4(6-6)(4-4)=24 | 11 | 4(7-6)(4-4)=25 | 4 |
| 3(6-6)(4-4)=23 | 1 | 4(8-6)(4-2)=24 | 1 | 4(7-5)(5-4)=25 | 1 |
| 2(6-6)(4-2)=20 | 1 | 4(7-6)(4-3)=24 | 1 | 4(6-6)(5-4)=25 | 2 |
| 4(4-4)(4-3)=19 | 1 | 4(6-5)(4-4)=23 | 3 | 6(7-4)(3-4)=24 | 1 |
| | | 3(7-6)(4-3)=23 | 2 | 5(6-5)(4-4)=24 | 1 |
| | | 3(6-6)(4-4)=23 | 4 | 4(7-6)(4-3)=24 | 1 |
| | | 4(6-5)(4-3)=22 | 1 | F 4(6-6)(4-4)=24 | 21 |
| | | 3(6-6)(4-3)=22 | 1 | 4(6-5)(4-4)=23 | 2 |
| | | 3(6-5)(4-4)=22 | 2 | 4(6-4)(5-4)=23 | 1 |
| | | 4(6-5)(4-2)=21 | 1 | 5(5-5)(4-4)=23 | 1 |
| | | 3(6-4)(4-4)=21 | 1 | 3(6-6)(4-4)=23 | 5 |
| | | | | 3(6-5)(4-4)=22 | 1 |
| | | | | 3(8-2)(4-3)=20 | 1 |
| | | | | 4(6-4)(4-2)=20 | 1 |
| | | | | 5(4-3)(4-4)=20 | 1 |
| | | | | 4(4-3)(4-4)=19 | 1 |
| | | | | 4(6-2)(4-2)=18 | 1 |
| | | | | 3(5-2)(3-3)=16 | 1 |



Fig. 1. *Unaspis acuminata* (Green), adult female, teneral. Sample NPL-1. Chisopani, 2330m, on *Euonymus echinatus*. A, body. B-D, antenna, examples. E, anterior spiracle. F, pygidial margin. G, lateral lobes of msth (part), mthh, abd I-III, ventral. H, dorsal macroducts on pygidium. Scale bars, 10µm for B-F; 100µm for A; 100µm* for G, H.



Fig. 2. *Unaspis acuminata* (Green), adult female, teneral. Sample NPL-14. Nawal Parasi, 60m, on *Reissentia arborea*. A, body. B-E, antenna, examples. F, anterior spiracle. G, pygidial margin. H, lateral lobes of msth (part), mth, abd I-III, ventral. I, perivulvar disc pores in the *acuminata*-formula. J, submedian and submarginal dorsal macroducts on abd IV and V. K, dorsal macroducts on pygidium. Scale bars, 10µm for B-G, 100µm for A, 100µm* for H-K.

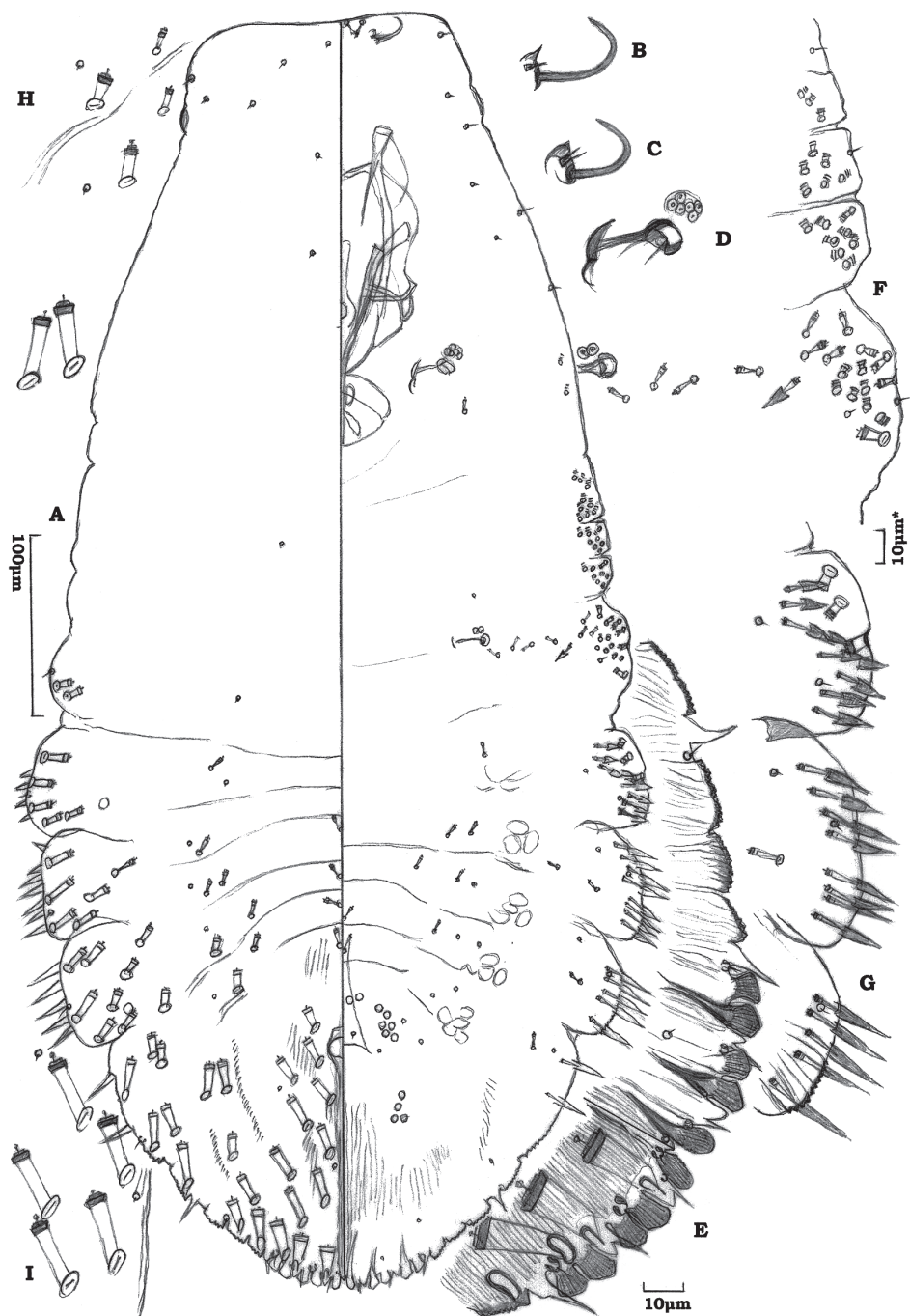


Fig. 3. *Unaspis acuminata* (Green), adult female, teneral. Sample IND-7. Trivandrum. A, body. B, C, antenna, examples. D, anterior spiracle. E, pygidial margin. F, lateral lobes of msth and mtth, ventral. G, lateral lobes of abd I-III, ventral. H, submedian and submarginal dorsal macroducts on abd IV and V. I, dorsal macroducts on pygidium. Scale bars, 10µm for B-E, 100µm for A, 100µm* for F-I.



Fig. 4. *Unaspis acuminata* (Green), adult female, teneral. Sample MLY-2. Beserah Forest Reserve, Kuantan, on *Salacia macrophylla*. A, body. B, antenna. C, anterior spiracle. D, pygidial margin. E, lateral lobes of msth (part), mtth, and abd I, ventral. F, lateral lobe of abd III, ventral. G, dorsal macroducts on abd IV and V. Scale bars, 10µm for B-G, 100µm for A.



Fig. 5. *Unaspis acuminata* (Green), adult female, teneral. Sample PLP-4. Pagbilao, Quezon, on *Siphonodon pyriformis*. A, body. B, C, antenna, examples. D, anterior spiracle. E, pygidial margin. F, lateral lobes of msth (part), mtth, and abd I, ventral. G, lateral lobe of abd III, ventral. Scale bars, 10µm, for B-E, 10µm* for F-G, 100µm for A.



Fig. 6. *Unaspis atricolor* (Green), adult female, teneral. Coimbatore, on *Tamarindus indica*. A, body. B-F, antenna, examples. G, anterior spiracle. H, pygidial margin. I, lateral lobes of msth (part), mth, and abd 1 and 2, ventral. J, dorsal macroducts on abd IV and V. K, dorsal macroducts, submarginal on abd V. L, dorsal macroducts on pygidium. Scale bars, 10µm for B-L, 100µm for A.

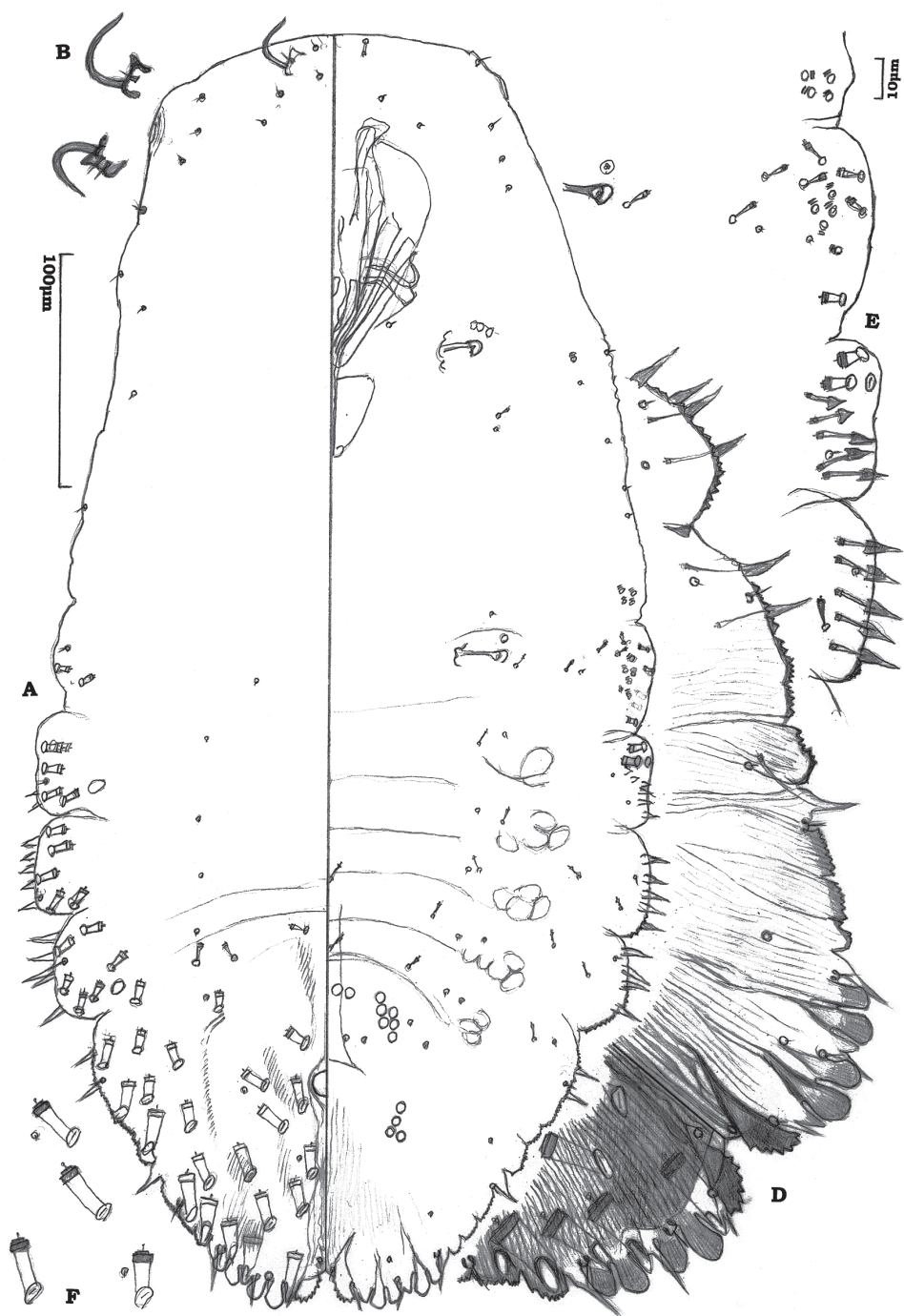


Fig. 7. *Unaspis pallidicolor*, n.sp., adult female, teneral. Sepilok, Sandakan. A, body. B, C, antenna, examples. D, pygidial margin. E, lateral lobes of msth (part), mtth, and abd I and II. F, dorsal macroducts on abd IV and V. Scale bars, 10µm for B-F, 100µm for A.

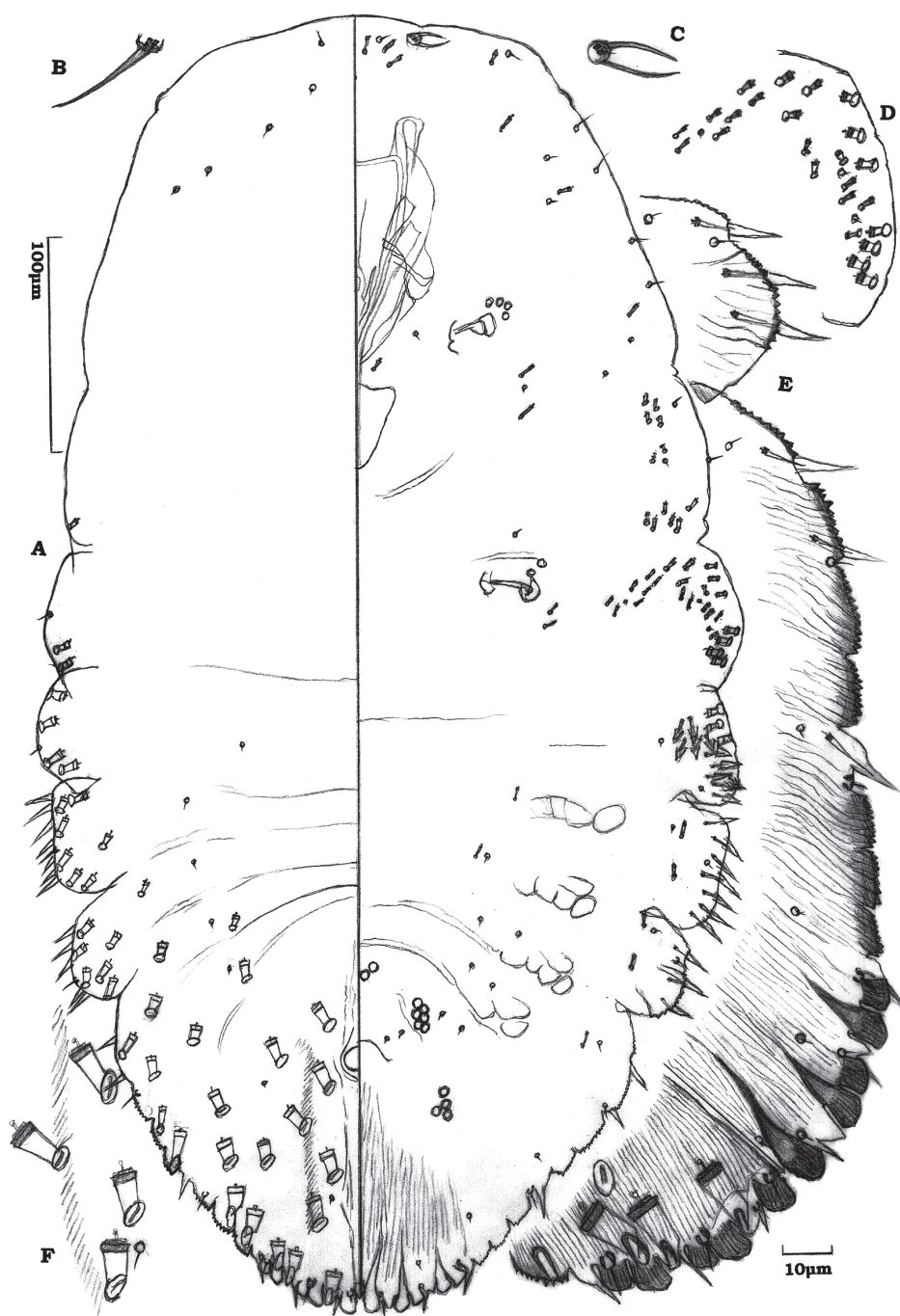


Fig. 8. *Unaspis turpiniae* Takahashi, adult female, teneral. Siro-Yama, Kagosima, on *Turpinia ternata*. A, Body. B, C, antenna, examples. D, mtth, ventral surface, lateral lobe. E, abd III and pygidium, ventral surface, margin. F, dorsal macroducts on pygidium. Scale bars, 10µm for B-F, 100µm for A.



Fig. 9. *Unaspis acuminata* (Green), second-instar male. Sample MLY-2. Beserah Forest Reserve, Kuantan, on *Salacia macrophylla*. A, body. B, C, antenna, examples. D, trullae. E, fimbriate processes. Scale bars, 10µm for B-D. 10 µm* for E, 100µm for A.



Fig. 10. *Unaspis atricolor* (Green), second-instar male. Coimbatore, on *Tamarindus indica*. A, body. B, C, antenna, examples. D, Body margin. Scale bars, 10µm for D, 10µm* for B, C, 100µm for A.

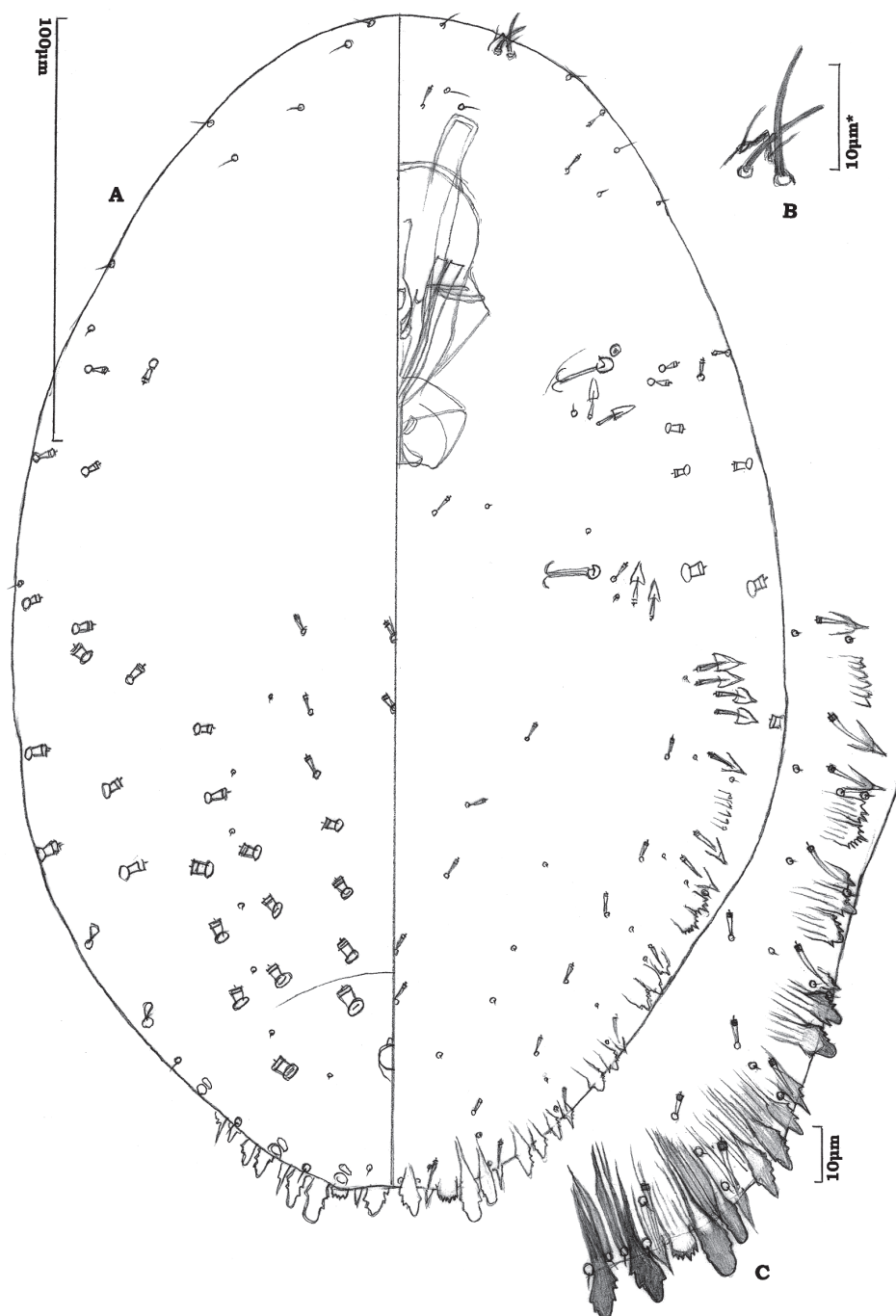


Fig. 11. *Unaspis pallidicolor*, n.sp., second-instar male. Sepilok, Sandakan. A, body. B, antenna. C, abdominal margin, ventral. Scale bars, 10µm for C, 10µm* for B, 100µm for A.

