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INSECTA MATSUMURANA

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FIVE SPECIES OF DIASPIDIDAE ASSOCIATED WITH PINACEAE IN CENTRAL NEPAL (HOMOPTERA: COCCOIDEA)

Scientific Results of Hokkaidô University Expeditions to the Himalaya, Entomology No. 25

By SADAO TAKAGI

Abstract

TAKAGI, S. 1977. Five species of Diaspididae associated with Pinaceae in Central Nepal (Homoptera: Coccoidea). *Ins. matsum. n. s.* 11: 1–30, 3 tabs., 19 figs.

Five species of Diaspididae, including 4 new species, are described from Central Nepal, and a new genus is erected to accept 1 of them: *Leucaspis coniferarum* Hall and Williams, on *Pinus* sp.; *Aleucaspis salla* n. g., n. sp., on *Pinus wallichiana*; *Parlatoria abieticola* n. sp., on *Abies spectabilis*; and *Parlatoria tsugicola* n. sp. and *Lepidosaphes tsugaedumosae* n. sp., on *Tsuga dumosa*. The 2nd instar males of *Leucaspis coniferarum*, *Aleucaspis salla* and *Parlatoria tsugicola* are described.

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Introduction

Nepal and Japan lie at the opposite ends of the floristic Sino-Japanese region, and their Coccoidea faunas are expected to show a relationship corresponding with their floral connection. Some years ago I had the chance to study a small collection of Coccoidea from Nepal, and this experience reinforced my conviction that we need knowledge of the Coccoidea of the Himalaya in order to proceed with the study of the Japanese Coccoidea. It may be desirable to work on the Coccoidea of the Sino-Japanese region as a whole, but it is now far from actualities.

In 1975 I stayed about 3 months in Central Nepal as a member of a party organized by the Himalayan Committee of Hokkaidô University, and engaged in collecting Coccoidea. Trips were made during August to October around Kathmandu Valley, to Langtang Valley and Gosainkund, and finally to the jungle of Terai near Birganj.

The result of the trips was not satisfactory to me. The monsoon lasted till the early October that year, and rains hindered me to some extent in searching for Coccoidea. Another possible reason for my dissatisfaction may have been too great my expectation. But it was still mysterious to me that I could not collect any Coccoidea from abundant native orchids in spite of all my effort to find them. One of my plans in Nepal was to make investigations on Coccoidea pests of various economic plants, but it was also carried only partly. Indeed, my stay in Nepal was too short to realize all this at once.

The collection made during my stay is, nevertheless, too large to work on within a few years. I hope, therefore, to publish my studies of Nepalese Coccoidea based on the collection in separate papers and for years, according to Coccoidea taxa or host plant taxa, sometimes together with Coccoidea from Japan or other parts of the world. Here I begin publication with 5 species of Diaspididae associated with Pinaceae.

The host plants of the scale insects described below are pine, fir and hemlock-spruce. I collected scale insects twice on pine, at Godavari and Ramche. I refer the host plant at Godavari to *Pinus wallichiana* (=*P. excelsa* Wall.), consulting "Flora of Phulchoki and Godavari" (Bull. Dept. Med. Pl. 2, Ministry of Forests, H.M.G. of Nepal, Kathmandu, vi+144+xxi pp., 1969). The host plant at Ramche may also be referable to this species. The fir and hemlock-spruce should be *Abies spectabilis* and *Tsuga dumosa*.

As to conifers other than Pinaceae, junipers are abundant in Central Nepal in alpine and subalpine zones and were examined for Coccoidea. Larch was also once examined. But I could not find any Coccoidea on them. I collected 1 species of *Pseudaulacaspis*, probably *P. cockerelli*, on yew. I will give an account of it in another paper.

The holotypes of the new species described in this paper are deposited in the collection of the Entomological Institute, Hokkaidô University, Sapporo.

Acknowledgements

I wish to thank the Authorities of the Government of Nepal for permitting us to carry out the investigations. We are especially indebted to Dr. Prithu N. Rana and Dr. Keshab C. Sharma, Entomology Division, Department of Agriculture,

Lalitpur, Kathmandu. I wish also to express my gratitude to many Nepalese people who helped us.

I am grateful to Mr. Hiroji Fushimi and Mr. Yuji Maruo, Japanese geologists then in Kathmandu, for giving us great help in various ways.

The main part of host plant specimens were sent for identification to Dr. Hiroo Kanai, National Science Museum, Tôkyô. I am thankful to him for his kindness in taking the troublesome work.

I wish to express my appreciation to the other members of the party, Dr. Tatsuichi Tsujii, the leader, Dr. Hisashi Abe, Dr. Hiromichi Higuchi, Dr. Haruo Kamiya, Dr. Tsuneo Nakasuga, Mr. Masahiro Haruki, and Mr. Toshihiro Kogo.

Miss Helen M. Brookes, Waite Agricultural Research Institute, The University of Adelaide, Australia, who recently stayed in Sapporo, kindly read part of the manuscript and gave me helpful advice.

Description and discussion

Leucaspis coniferarum Hall and Williams
(Fig. 1 and 2)

Ramche, Bagmati Zone, Nepal, alt. 1700 m, on the needles of *Pinus* sp., Sept. 15, 1975, coll. S. Takagi (material 75NPL–199).

Mounted specimens: 3 adult females, 4 2nd instar female exuvial casts, 1 2nd instar male, and 1 1st instar exuvial cast. A prepupa is completed within the skin of the 2nd instar male specimen.

Adult female elongate and narrow, without distinct segmentation, on slide 3.0–3.3 times as long as wide, attaining over 1 mm in length. Dorsal derm beset with crowded points, on pygidium sclerotized around anal opening and in some spots (6–8 on each side); ventral derm on thorax and abd. i and ii spinulose, and on the succeeding 3 segments irregularly pustulate, in median region. Pygidium rounded along free margin. Median lobes conical, blunt apically, set apart from each other by a space a little wider than one of them. Second lobes similar to the median, at times less prominent. Third lobes merged into pygidial margin. About a dozen small dorsal ducts scattered along pygidial apex, their orifices are as large as the bases of neighbouring setae. Anal opening much larger than median lobe, situated towards base of pygidium. Plates and perivulvar disc pores wanting. Antennae each with 2 or 3 short straight setae and 1 much smaller seta. Anterior spiracles each with 3 or 4 quinquelocular disc pores; posterior spiracles without disc pores.

Exuvial cast of 2nd instar female 3.0–3.5 times as long as wide, about 1.2 mm in length. Pygidium rounded apically, with 2 pairs of lobes well developed, stout, and rounded apically, the median lobes set apart from each other by a space a little wider than one of them. Third and 4th lobes each reduced to a low, broad process. Plates well fimbriate, occurring anteriorly beyond 4th lobe. Marginal macroducts 1 between median lobes, and 7 or 8 on each side. More or less smaller dorsal macroducts scattered submarginally and submedially.

Second instar male similar to 2nd instar female, differing mainly by having

much more numerous macroducts. Antennae each with 3 very short setae and 5 or so minute processes (setae ?). Anterior spiracles each with 2 quinquelocular disc pores.

Exuvial cast of 1st instar elongate, 0.60 mm long and 0.28 mm wide. Antennae 5-segmented, 5th segment as long as 1st to 4th segments united, annulate, composed of a basal part and a much longer terminal part. A pair of well sclerotized processes (lobes) at posterior extremity of body. A pair of comparatively large ducts (macroducts) marginally between the processes; 5 similar marginal ducts on each side, replaced anteriorly by a few much smaller ducts; a pair of small submedian ducts on dorsum at posterior 1/3.5 of body.

This species was originally described by Hall and Williams (1962) from Pakistan as associated with *Pinus longifolia* and *Pinus excelsa*. I had no difficulty in the present identification on the basis of their description. Disagreements between the description and the Nepalese specimens are subtle, and may reflect geographical variations.

Aleucaspis n. g.

Type-species. *Aleucaspis salla* n. sp.

Pupillarial. Adult female elongate-elliptic, segmentation indistinct. Derm membraneous. Pygidium roundish along apical margin, with lobes and plates. Lobes more or less conical, the median pair set apart. Plates more or less reduced, without microduct. Dorsal macroducts strewn along pygidial margin, short, the orifice with a thick sclerotized rim. Anal opening about middle of pygidium. Perivulvar disc pores in 4 groups. Antennae each with a single developed seta. Anterior spiracles with quinquelocular disc pores.

Exuvial cast of 2nd instar female elongate, without distinct segmentation. Pygidium rounded along free margin, with lobes and plates well developed. Lobes more or less spatulate; median lobes set apart; lateral lobes not divided. Plates short and broad, not projecting beyond lobes, fimbriate, each with a microduct. Marginal macroducts of pygidium short and broad, the orifice with a thick sclerotized rim and with its axis approximately parallel to pygidial margin. Anal opening situated about middle of pygidium. Antennae each with a single developed seta.

Second instar male very similar to 2nd instar female, differing mainly by having slender submedian dorsal ducts.

Exuvial cast of 1st instar oval. Antennae 5-segmented; 1st to 4th segments short; 5th segment as long as 1st to 4th segments united, and annulate. A pair of prominent sclerotized processes (lobes) at posterior extremity, set apart, with a pair of fimbriate plates between them; a pair of smaller processes laterally. A pair of slender ducts between the apical processes; similar marginal ducts occurring around body.

This genus, represented only by the type-species, is very similar to *Leucaspis* in general features, but differs from the latter as follows: –

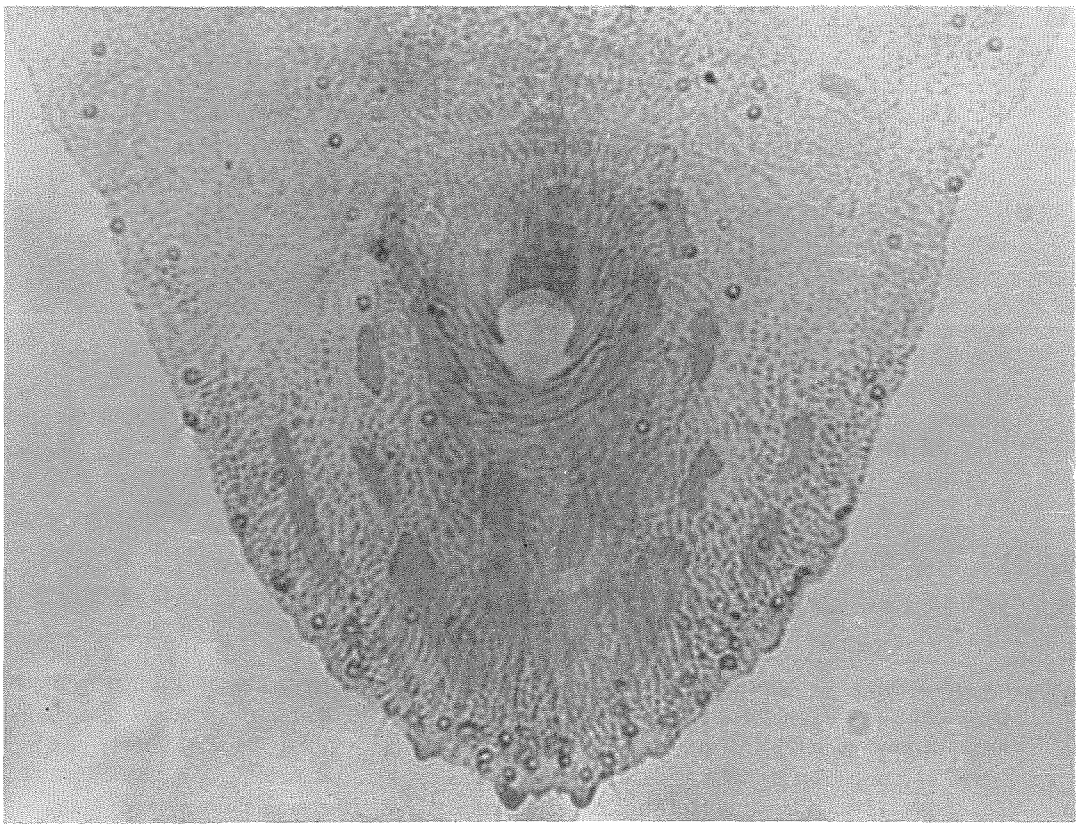


Fig. 1. *Leucaspis coniferarum* Hall and Williams. Adult female: pygidium. 75NPL–199.

1) In the adult female the antennae bear only 1 developed seta. The perivulvar disc pores are arranged in 4 groups, of which the groups of one side are widely separated from those of the other side.

2) In the 2nd instar female the antennae bear only 1 developed seta, and *the pygidial plates are glanduliferous* (i.e., *each with a microduct*).

3) In the 1st instar the body is oval, and the marginal ducts are slender.

So far as I am aware, all these characters are found in *Parlatoria* and its allied genera (or Parlatoriini) but not in *Leucaspis* and its close relatives (or Leucaspidini). I am much inclined, therefore, to the opinion that *Aleucaspis* is a pupillarial form of the Parlatoriini. A difficulty about this opinion lies in that the plates of the adult female are non-glanduliferous. The plates are, however, much degenerative in the adult female in comparison with the 2nd instar. The type-species may be a peculiar form of *Leucaspis*, but in the opinion here adopted it is a parlatoriine in a remarkable convergence to *Leucaspis*.

Aleucaspis salla n. sp.
(Fig. 3–6)

Godavari, Mt. Phulchoki, Bagmati Zone, Nepal, alt. ca. 1600 m, on the needles

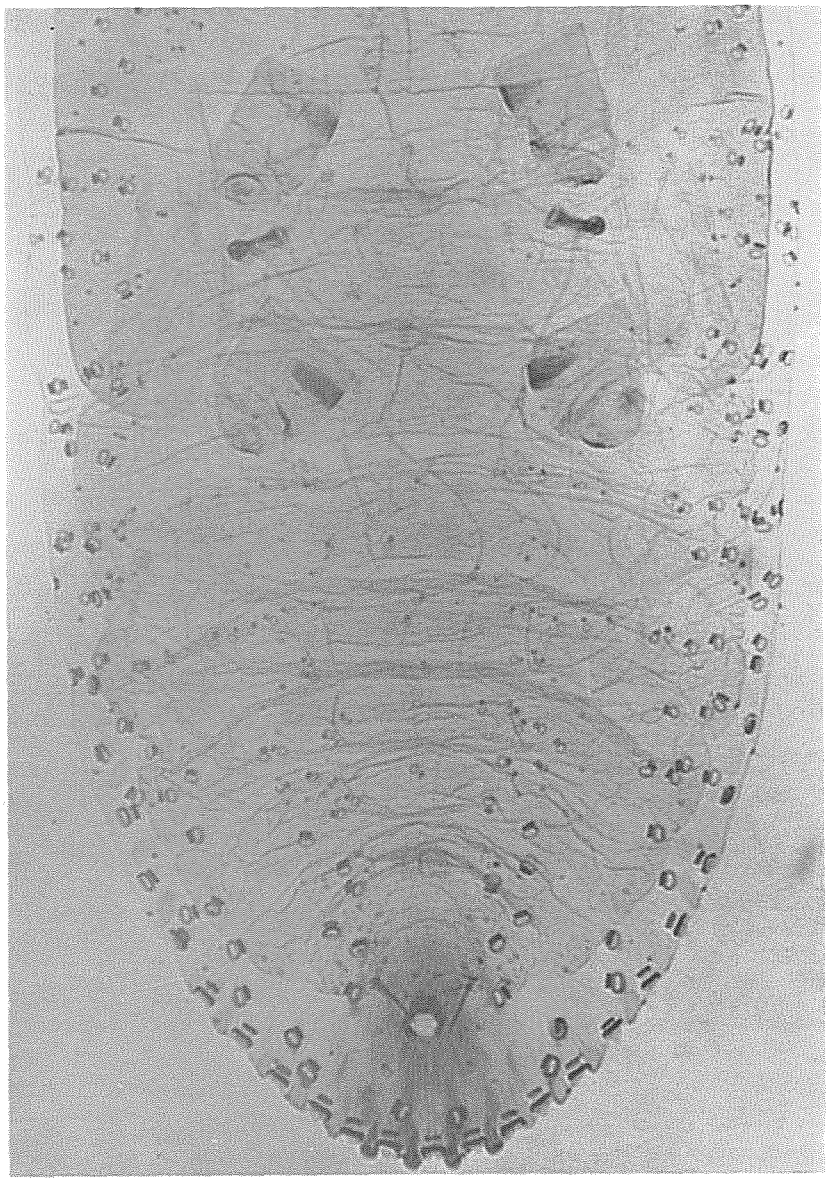


Fig. 2. *Leucaspis coniferarum* Hall and Williams. Second instar male: metathorax and abdomen. A prepupa is completed within the skin, a little removing anteriorly. (The head of the 2nd instar male is broken by the emerging prepupa.) 75NPL–199.

of *Pinus wallichiana* (local name: salla), Aug. 18, 1975, coll. S. Takagi (material 75NPL–27).

Mounted specimens: 6 adult females (1 of them is the holotype), 9 2nd instar female exuvial casts, 1 2nd instar male, and 15 1st instar exuvial casts. The adult female specimens other than the holotype are in very poor condition, with a shrunken body after oviposition. The 2nd instar male specimen is also poor

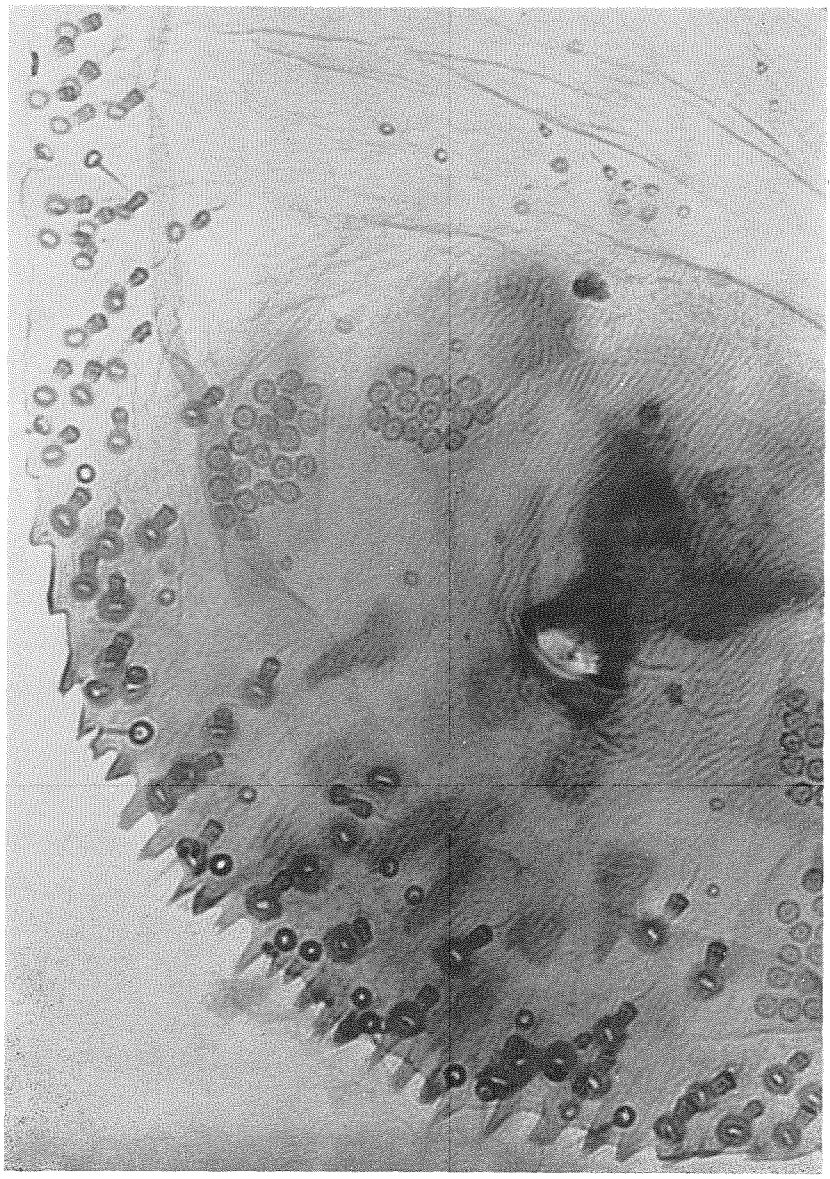


Fig. 3. *Aleucaspis salla* n. sp. Adult female: pygidium. 75NPL–27.

except for the pygidium.

Adult female on slide about twice as long as wide, attaining over 1 mm in length. Derm membraneous except for dorsal surface of pygidium, which is well sclerotized in a large spot just in front of the anal opening and in some smaller spots. Ventral derm spinulose laterally to beak, and also in median region between beak and pygidium. Pygidium broad. Three pairs of pygidial lobes well sclerotized, conical, the median lobes widely set apart (in the holotype one of the

Fig. 4. *Aleucaspis salla* n. sp. Adult female. 75NPL–27.

median lobes is divided into 2 small processes). Plates variable in size and shape, usually not much elongate, pointed or a little frayed. Dorsal macroducts irregularly strewn along pygidial margin, variable in number, occurring anteriorly as far as abd. iii, becoming smaller, giving way to an irregular row of more or less

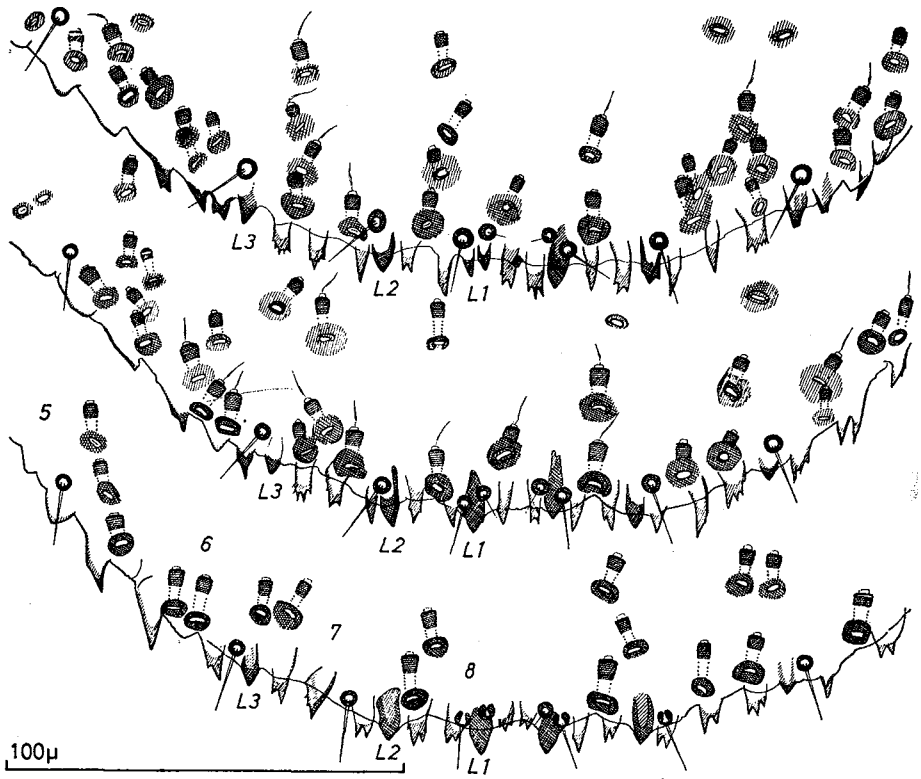


Fig. 5. *Aleucaspis salla* n. sp. Adult female: pygidial margin in dorsal view. 75NPL–27.

smaller ducts (mostly microducts), which runs through the basal 2 abdominal segments to the thoracic region along the margin, with rudimentary gland tubercles interspersed. Some dorsal microducts in median region of prepygidial abdomen. Ventral microducts strewn between anterior spiracles around beak, as many as 60. Perivulvar disc pores 10–18 anterolaterals, 17–26 posterolaterals. Antennae a stout tubercle with a short seta, at times with a minute seta visible. Anterior spiracles each with 1 or 2 disc pores; posterior spiracles without disc pore.

Exuvial cast of 2nd instar female 2.5–3.3 times as long as wide, about 1.5–2 mm long. Pygidium with 3 pairs of lobes distinct, each lobe flat apically, with a slight subapical notch on either or outer side; 4th lobes more or less deformed and somewhat plate-like in shape. Other characters as given in the generic description and Fig. 6, E.

Second instar male and 1st instar larva as in the generic description and Fig. 6, A–D.

Second instar exuvial cast of female brown, broadly black medially on anterior half, whitish marginally on posterior half. Scale of male with 1st instar exuvial cast terminal, blackish, and with secretion white, glabrous.

"*Leucaspis* sp." recorded by me (1975) from Larjung, Nepal, as associated with *Pinus roxburghii* and on the basis of 1 2nd instar specimen and 3 1st instar exuvial

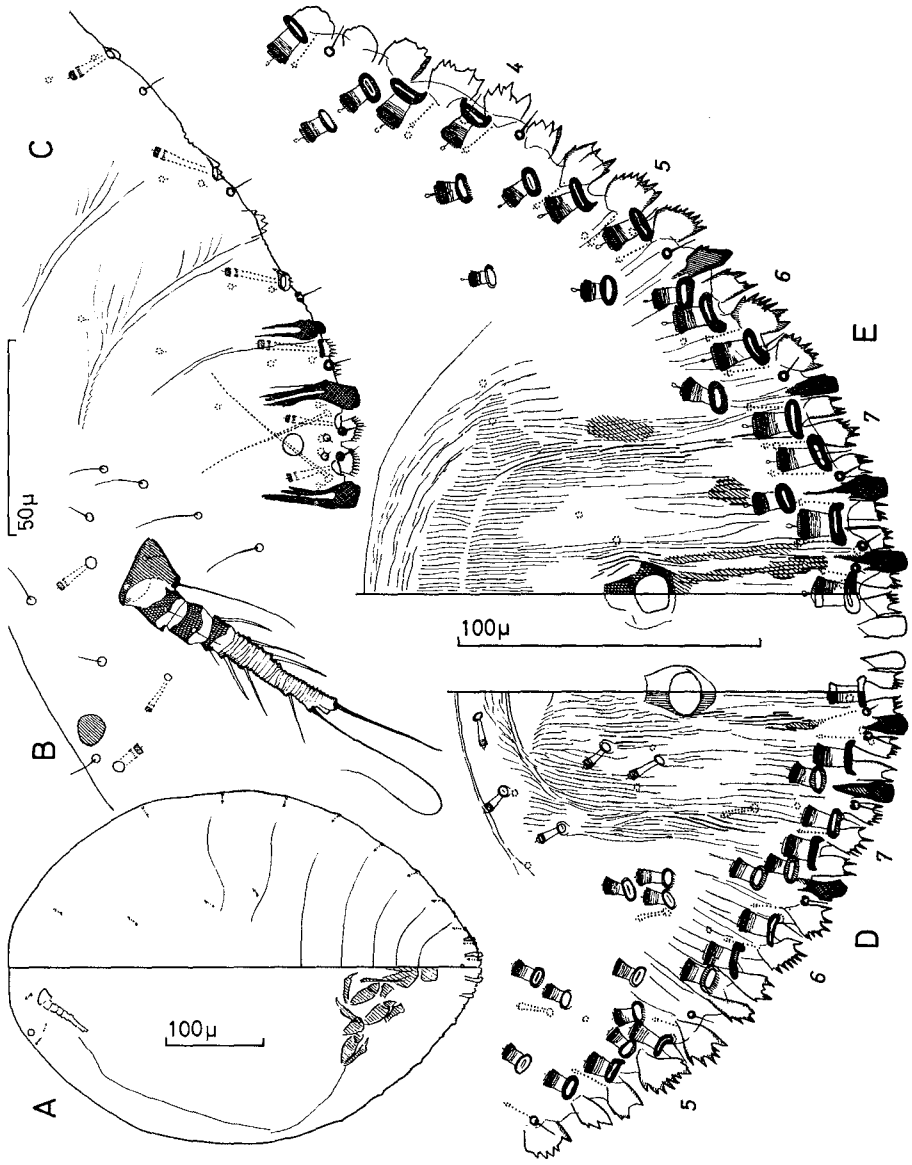


Fig. 6. *Aleucaspis salla* n. sp. First instar larva, exuvial cast: whole cast (A); antenna, with part of head (B); and apex of abdomen (C). Second instar male: pygidium (D). Second instar female: pygidium (E). 75NPL–27.

casts is not a *Leucaspis* species, but belongs to *Aleucaspis*. The 2nd instar specimen is, though not good in condition, similar to the 2nd instar male of the type-series of *Aleucaspis salla*, so far as pygidial characters are compared. The plates appear to be glanduliferous, and the antennae are seemingly unisetose. The 1st instar exuvial casts also show characteristics of *Aleucaspis salla*.

Fig. 7. Ghora Tobela, Langtang Valley, Bagmati Zone, Nepal, alt. ca. 3000 m. Habitat of *Parlatoria abieticola* and *Parlatoria tsugicola*. *Quercus semecarpifolia* forest is succeeded by conifer forest of *Abies spectabilis* and *Tsuga dumosa* on the damp north-facing slope. 75NPL–264 and 75NPL–262 were collected in the stand shown at the centre of the photograph.

Parlatoria abieticola n. sp.
(Fig. 8–10)

Ghora Tobela, Langtang Valley, Bagmati Zone, Nepal, alt. 3200 m, on the leaves of *Abies spectabilis*, Sept. 23, 1975, coll. S. Takagi (material 75NPL–264).

Syn Gomba, near Gosainkund, Bagmati Zone, Nepal, alt. 3440 m, on the leaves of *Abies spectabilis*, Oct. 2, 1975, coll. S. Takagi (material 75NPL–296).

Mounted specimens: over 100 adult females, and exuvial casts. The adult females are considerably grown up, but still without visible eggs within the body. The description is based on 53 adult females (1 of them is the holotype) and 20 2nd instar female exuvial casts from 75NPL–264 and 37 adult females and 27 2nd instar female exuvial casts from 75NPL–296.

Adult female obovate, meso- and metathorax and basal abdominal segments gently lobed out laterally, pygidium rounded along free margin. Derm membraneous except for a broad median region of dorsal surface of pygidium. Five small submarginal dorsal bosses on each side of body, the anteriormost situated between abd. i and ii. Derm pockets absent. Pygidium with 3 pairs of lobes; median lobes parallel, separated from each other by width of one of them, each lobe more or less spatulate, roundish apically, entire or with a slight subapical notch on

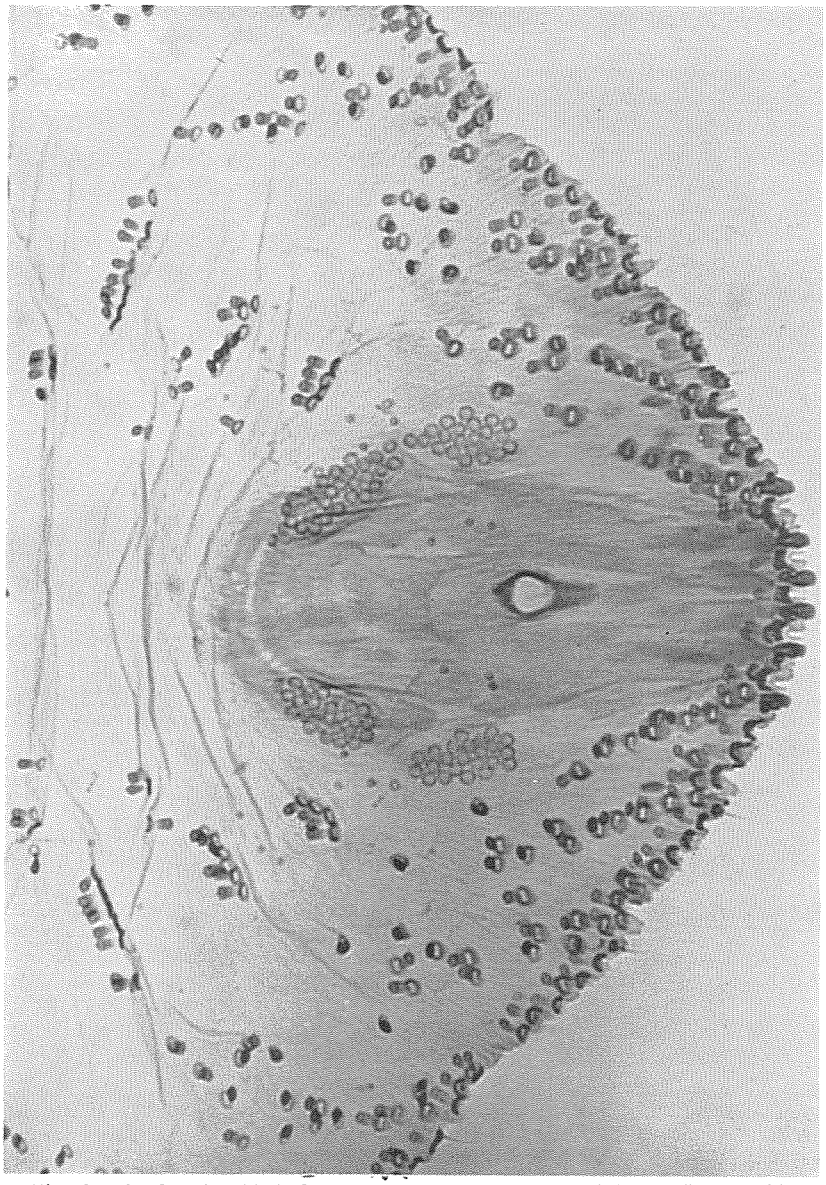


Fig. 8. *Parlatoria abieticola* n. sp. Adult female: pygidium. 75NPL–264.

outer side; 2nd and 3rd lobes a little smaller than median lobes, similar to the latter in shape; 4th lobes reduced to marginal serrations, but well sclerotized. Plates between lobes tending to be little fimbriate; plates occurring laterally to 3rd lobe broad and low, serrate, merged into pygidial margin towards base of pygidium. Submarginal gland tubercles on prothorax (6–19, mean 12, in 75NPL–264; 4–13, mean 8, in 75NPL–296), mesothorax (1–6), metathorax (1–7), and prepygidial abdominal segments, much obscure and turning to reduced marginal plates on the abdominal segments except i. Numerous dorsal macroducts in a broad submarginal

Fig. 9. *Parlatoria abieticola* n. sp. Adult female. 75NPL–296.

zone on abdomen, almost strewn on each segment, a few on lateral lobe of metathorax; submedian dorsal macroducts arranged in well-defined segmental rows on abd. i–v (sometimes confounded with submarginal macroducts on anterior segments) and often also on metathorax (Table 1); a few median dorsal macroducts on 1 or more of these segments (Table 2); ventral macroducts on lateral lobes of

Fig. 10. *Parlatoria abieticola* n. sp. Adult female: pygidium (A). Second instar female, exuvial cast: pygidial margin in dorsal view (B). 75NPL–296.

meso- and metathorax and abd. i; macroducts of both sides and both surfaces 413–560 (mean 488) in 75NPL-264, 327–438 (mean 393) in 75NPL–296. Perivulvar disc pores usually in 4 groups, occasionally with an irregular small median group (Table 3); total 81–124 (mean 105.3) in 75NPL–264, 72–122 (mean 96) in 75NPL–296. Antennae each with a single seta. Anterior spiracles each with 4–12 quinquelocular disc pores (mean 7.2 in 75NPL–264, 8 in 75NPL–296); posterior spiracles without disc pore.

Exuvial cast of 2nd instar female obovate, usually ca. 1.4 times as long as wide, length 0.83–0.97 mm (mean 0.91 mm) in 75NPL–264, 0.81–0.93 mm (mean 0.88 mm) in 75NPL–296. Pygidium with 3 pairs of lobes developed, 2nd and 3rd lobes notched or serrate on sloping outer margin. Plates tending to be merged into pygidial margin laterally to 3rd lobe, quite reduced laterally to deformed 4th lobe. Marginal macroducts absent between median lobes, 3–6 on each side, the mesalmost being opened between median and 2nd lobes; submarginal dorsal macroducts 1–6 on each side; macroducts of both sides 10–21 (mean 14) in 75NPL–264, 12–21 (mean 16) in 75NPL–296.

Scale of female (likely not yet completed) round to oval, exuvial casts peripheral in position, 1st instar cast brown, 2nd instar cast yellow, margined with brown, secretion white. Occurring on the underside of leaves. (Scale of male not found.)

Differences are found in some features between the specimens from Ghora Tobela and those from Syn Gomba, but the differences are all quantitative so far as observed. These local forms, both associated with *Abies spectabilis*, may rightly be referred to the same species. However, the difference in the number of macroducts is so remarkable in the adult females (Fig. 14), that it may need an explanation. One of the differences between these forms concerns the length of the exuvial cast of the 2nd instar female: though barely significant statistically, the mean values are somewhat different between these forms, which, however, do not show a parallel difference in the number of macroducts occurring in the casts (Fig. 15). The collecting sites of these forms differ in altitude by 240 m. The tendency towards differentiation in the size of 2nd instar casts, coupled with the absence of a parallel differentiation in the number of macroducts, suggests a difference in growth during the 2nd instar, and one possibly due to the different altitudes. The numbers of ducts and pores in the adult females may have some relation with the growth in the 2nd instar. If this is the case, the difference in the adult females between the Ghora Tobela and Syn Gomba forms may be at least to some extent ecophenotypic.

This species, together with *Parlatoria tsugicola* n. sp., finds no close relatives among the known species of the genus. These 2 species are similar to *Parlatoria banksiae* (Maskell) in having well-developed submedian series of macroducts, but are quite different from the latter in the characters of the pygidial margin.

Parlatoria tsugicola n. sp.
(Fig. 11–13)

Ghora Tobela, Langtang Valley, Bagmati Zone, Nepal, alt. 3200 m and 2970 m, on the leaves of *Tsuga dumosa*, Sept. 23, 1975, coll. S. Takagi (material 75NPL–262 and 75NPL–266).

Mounted specimens include over 150 teneral adult females. The description is based on 120 adult females (25 from 75NPL–262; 95 from 75NPL–266, 1 of them is the holotype), 93 2nd instar female exuvial casts (24 from 75NPL–262; 69 from 75NPL–266), and some 2nd instar males (from 75NPL–266).

This species is very similar to the preceding species, *Parlatoria abieticola* n. sp., but differs in the following morphological characters: –

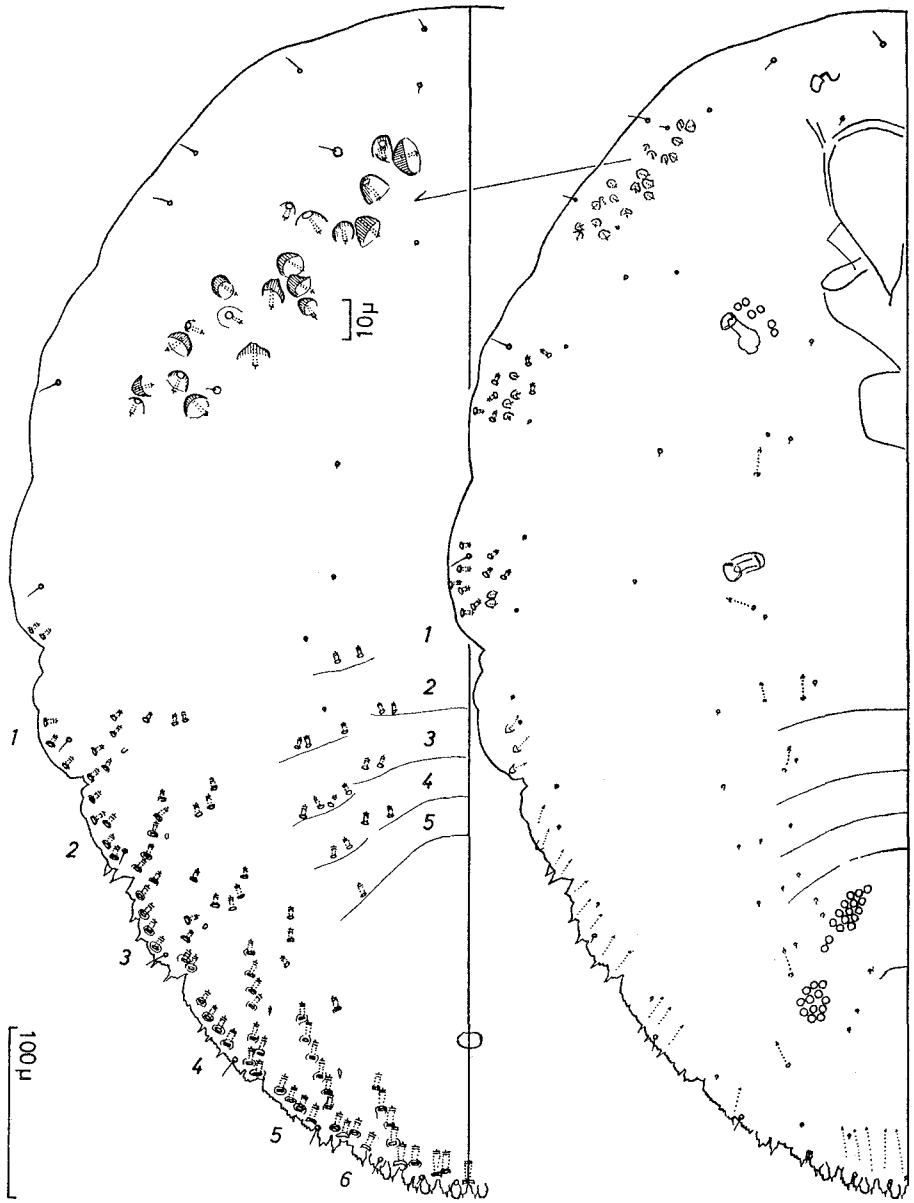


Fig. 11. *Parlatoria tsugicola* n. sp. Adult female. 75NPL–266.

1) In adult female, macroducts fewer (Fig. 14). Total macroducts 184–274 (mean 224) in 75NPL–262, 141–270 (mean 203) in 75NPL–266. Submedian dorsal macroducts usually absent on metathorax (Table 1). Median dorsal macroducts occurring rather rarely (Table 2).

2) In adult female, perivulvar disc pores fewer (Fig. 14; Table 3). Total 38–76 (mean 58) in 75NPL–262, 32–71 (mean 52) in 75NPL–266.

3) In adult female, disc pores associated with anterior spiracle fewer: 3–9

Fig. 12. *Parlatoria tsugicola* n. sp. Adult female: pygidium. 75NPL–266.

(mean 6.3) in 75NPL–262, 2–9 (mean 6.1) in 75NPL–266. Difference in means between *P. abieticola* and *P. tsugicola* is significant statistically.

4) In 2nd instar female, macroducts fewer. Total 6–10 in 75NPL–262, 6–14 in 75NPL–266.

5) Exuvial cast of 2nd instar female smaller, 0.72–0.82 mm in 75NPL–262, 0.66–0.83 mm in 75NPL–266.

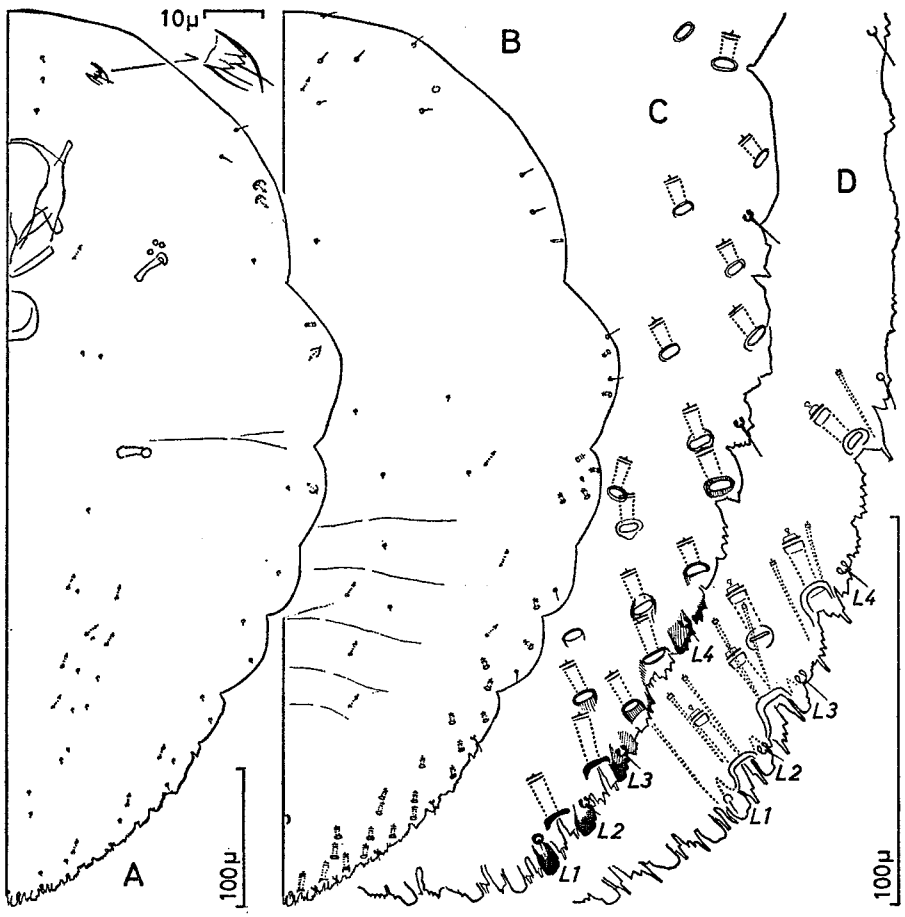


Fig. 13. *Parlatoria tsugicola* n. sp. Second instar male: body in ventral and dorsal view (A and B); and pygidial margin in dorsal view (C). Second instar female, exuvial cast: pygidial margin in dorsal view (D). 75NPL–266.

Table 1. Number of submedian dorsal macroducts in adult female *Parlatoria abieticola* and *Parlatoria tsugicola*, mean in parentheses. (In *P. abieticola* macroducts of the submedian series are sometimes confounded with submarginal macroducts; in such cases the division between submedian and submarginal macroducts is somewhat arbitrary.)

Species	*P. tsugicola*		*P. abieticola*	
Material	75NPL-262	75NPL-266	75NPL-264	75NPL-296
Locality	Ghora Tobela			Syn Gomba
Metathorax	0-1(0.0)	0-1(0.0)	0- 6(1.8)	0- 4(0.8)
Abd. i	0-5(1.4)	0-6(1.5)	7-16(10.9)	1-13(8.0)
Abd. ii	0-7(3.2)	0-7(3.1)	9-19(13.0)	5-15(9.8)
Abd. iii	1-7(4.8)	1-8(4.4)	6-19(11.7)	6-14(9.4)
Abd. iv	2-7(4.1)	1-7(3.6)	7-14(9.4)	2-11(7.2)
Abd. v	1-4(2.2)	1-5(2.1)	3-11(6.2)	2- 7(3.8)

Table 2. Number of median dorsal macroducts in adult female *Parlatoria abieticola* and *Parlatoria tsugicola*, percentage in parentheses.

Species	*P. tsugicola*		*P. abieticola*	
Material	75NPL-262	75NPL-266	75NPL-264	75NPL-296
Locality		Ghora Tobela		Syn Gomba
Metathorax	0(100)	0(100)	0(98) 1(2)	0(100)
Abd. i	0(100)	0(100)	0(85) 1(15)	0(95) 1(5)
Abd. ii	0(100)	0(98) 1(2)	0(58) 1(38) 2(4)	0(68) 1(21) 2(11)
Abd. iii	0(76) 1(24)	0(93) 1(6) 2(1)	0(32) 1(53) 2(15)	0(76) 1(24)
Abd. iv	0(92) 1(8)	0(88) 1(12)	0(43) 1(42) 2(13) 3(2)	0(66) 1(34)
Abd. v	0(100)	0(100)	0(96) 1(4)	0(100)

Table 3. Number of perivulvar disc pores in adult female *Parlatoria abieticola* and *Parlatoria tsugicola*, mean in parentheses.

Species	*P. tsugicola*		*P. abieticola*	
Material	75NPL-262	75NPL-266	75NPL-264	75NPL-296
Locality		Ghora Tobela		Syn Gomba
Medians	0- 4(1.1)	0- 4(0.9)	0- 5(0.6)	0- 4(1.1)
Anterolaterals	10-19(14.7)	6-19(13.3)	17-36(26.5)	11-29(22.2)
Posterolaterals	8-22(13.7)	6-19(12.4)	16-34(26.0)	14-41(24.9)

Second instar male differs from 2nd instar female in having more macroducts. Antennae sometimes with 1–3 supplementary setae.

Female scales not completed in the examined generation; old scales of the preceding generation elongate ovate, exuvial casts terminal, yellowish brown, secretion white. Scale of male elongate, about 2.5 times as long as wide, secretion white. Both male and female occurring on the underside of leaves.

In comparison with *P. abieticola*, *P. tsugicola* is characterized by the numerical reduction of macroducts (in the adult female and the 2nd instar female) and disc pores (in the adult female). On the other hand, it shows no reduction of gland tubercles (in the adult female): number of gland tubercles on the prothorax 3–17 (mean 10) in 75NPL–262, 4–21 (mean 11) in 75NPL–266. It is characterized also by the smaller exuvial cast of the 2nd instar female. Measurements of the length of the tentorial frame in arbitrarily selected adult females of both species also give smaller values to *P. tsugicola*, which is, then, assumed to be smaller than *P.*

abieticola in the size of the full-grown adult female.

The morphological differences so far found between *P. abieticola* and *P. tsugicola* concern the numbers of the macroducts and disc pores and the body size. Such quantitative differences alone may not suffice to show that the two forms are distinct species, though the total number of macroducts in particular gives a distinct gap between them. This gap is quite large when the specimens of both species from Ghora Tobela are compared (Fig. 14).

The collected materials of *P. abieticola* and *P. tsugicola* show an obvious developmental difference. The materials of *P. abieticola* carry moderately grown adult females, of which the scales are well formed, though probably not yet completed, with the secretionary part occupying about half or more of the whole scale length. The materials of *P. tsugicola* are in an earlier developmental stage of the adult female, the scales being composed mainly of the larval casts, at most with a narrow secretionary part along the posterior margin of the 2nd cast. This also applies to the materials collected on the same day at Ghora Tobela, alt. 3200 m, in a mixed stand of *Abies spectabilis* and *Tsuga dumosa* (75NPL–264 and 75NPL–262). They looked so dissimilar, when collected, owing to the time lag in development, that I felt them quite different.

However, these differences may not exclude the possibility that *P. abieticola* and *P. tsugicola* belong in reality to a single species and that the morphological and developmental differences between them are simply ecophenotypic and due to their host plants. Conclusive evidence as to their specific status should be based on an experimental study. Some differences found between them, however, appear to me too large to be included within infraspecific variations.

Lepidosaphes tsugaedumosae n. sp.
(Fig. 16 and 17)

Syabru, Bagmati Zone, Nepal, alt. 2260 m, on the leaves of *Tsuga dumosa*, Sept. 21, 1975, coll. S. Takagi (material 75NPL–251).

Mounted specimens include about 90 adult females, which are all without visible eggs within the body. The description is based on 50 adult females (1 of them is the holotype) and 15 2nd instar female exuvial casts.

Adult female elongate fusiform (the examined specimens are about twice or more as long as wide), with a constriction between meso- and metathorax; meso- and metathorax and abd. i–iv well lobed out laterally; pygidium rather narrow, roundish rather than trapezoid along free margin. Derm membraneous except for a broad median dorsal area and other smaller areas of pygidium. Bosses absent. Pygidium with 2 pairs of lobes developed. Median lobes separated from each other by a space as wide as or narrower than one of them, each lobe about as long as wide, rounded apically, with a notch on each side, and with a pair of linear basal scleroses (paraphyses). Second lobes bilobulate, the inner lobule at least about 2/3 as wide as median lobe, rounded apically, often with a faint notch on outer side, and with linear basal scleroses well developed as on median lobe; outer lobule much smaller than the inner, with basal scleroses more or less reduced. Third lobes merged into pygidial margin, each suggested by a low sclerotized prominence. Marginal gland spines of pygidium occurring in pairs. Prepygidial gland spines conical or tubercular and submarginal on thorax and abd. i, becoming elongate and marginal on posterior

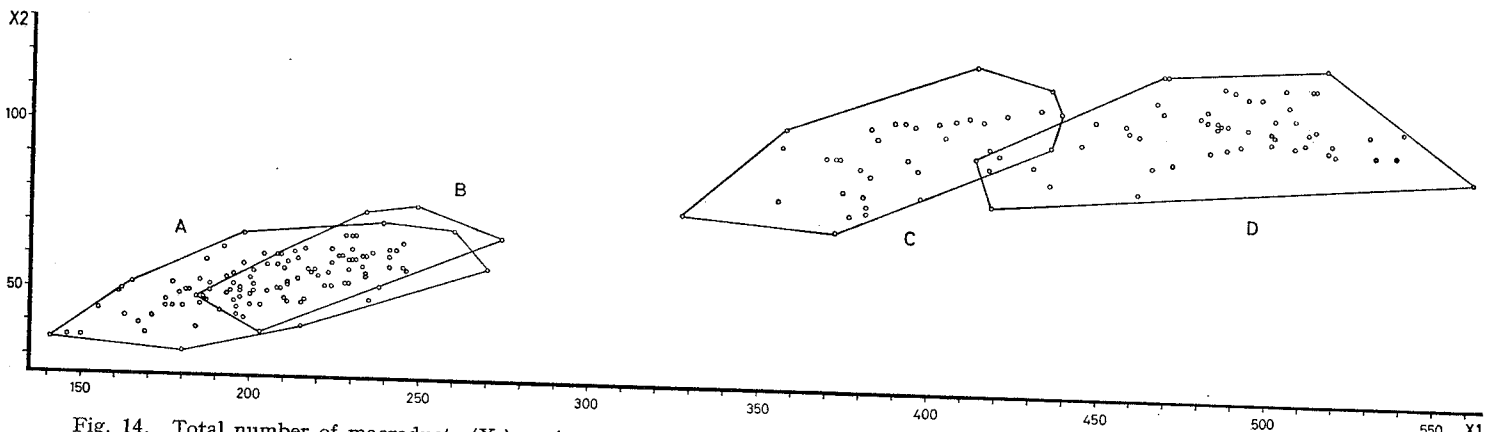


Fig. 14. Total number of macroducts (X_1) against total number of perivulvar disc pores (X_2) in adult female *Parlatoria tsugicola* (A and B) and *Parlatoria abieticola* (C and D). A: 75NPL–266 (Ghora Tobela, 2970 m). B: 75NPL–262 (Ghora Tobela, 3200 m). C: 75NPL-296 (Syn Gomba, 3440 m). D: 75NPL-264 (Ghora Tobela, 3200 m). Four specimens overlap at 2 plotted points in *P. tsugicola*. Regression lines fitted to the scatter diagrams except D are as follows: –

A: $X_2=0.22\,X_1+7.3$ B: $X_2=0.30\,X_1-9.2$ C: $X_2=0.30\,X_1-21.9$

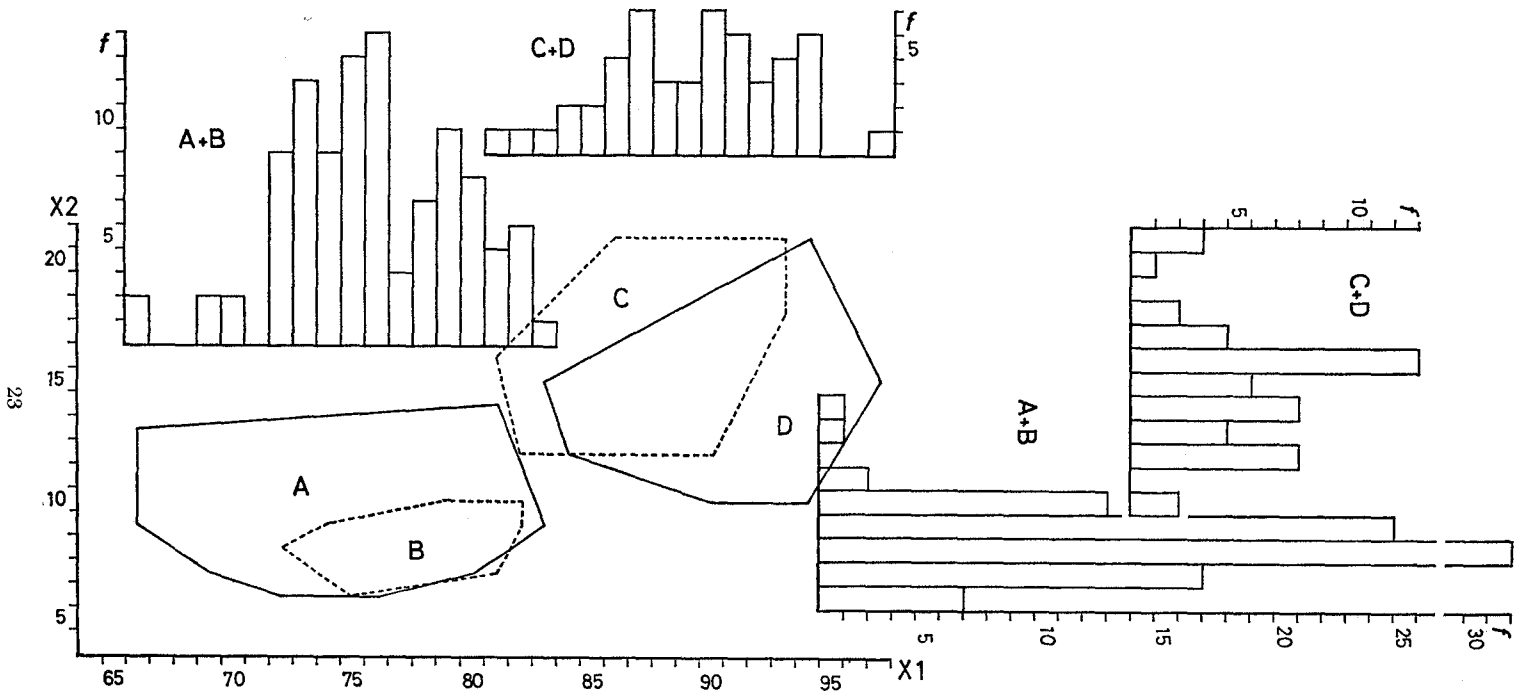


Fig. 15. Length of exuvial cast (X_1) (unit: 10 micra) against total number of dorsal macroducts (X_2) in 2nd instar female *Parlatoria tsugicola* (A and B) and *Parlatoria abieticola* (C and D). A–D: see under Fig. 14. Many specimens overlap in scatter diagrams, so that polygons constructed from the scatter diagrams, supplemented by histograms, are given. The number of dorsal macroducts has no evident correlation with the cast length in each species ($r=0.0453$, $n=93$ in A+B; $r=0.0216$, $n=47$ in C+D).

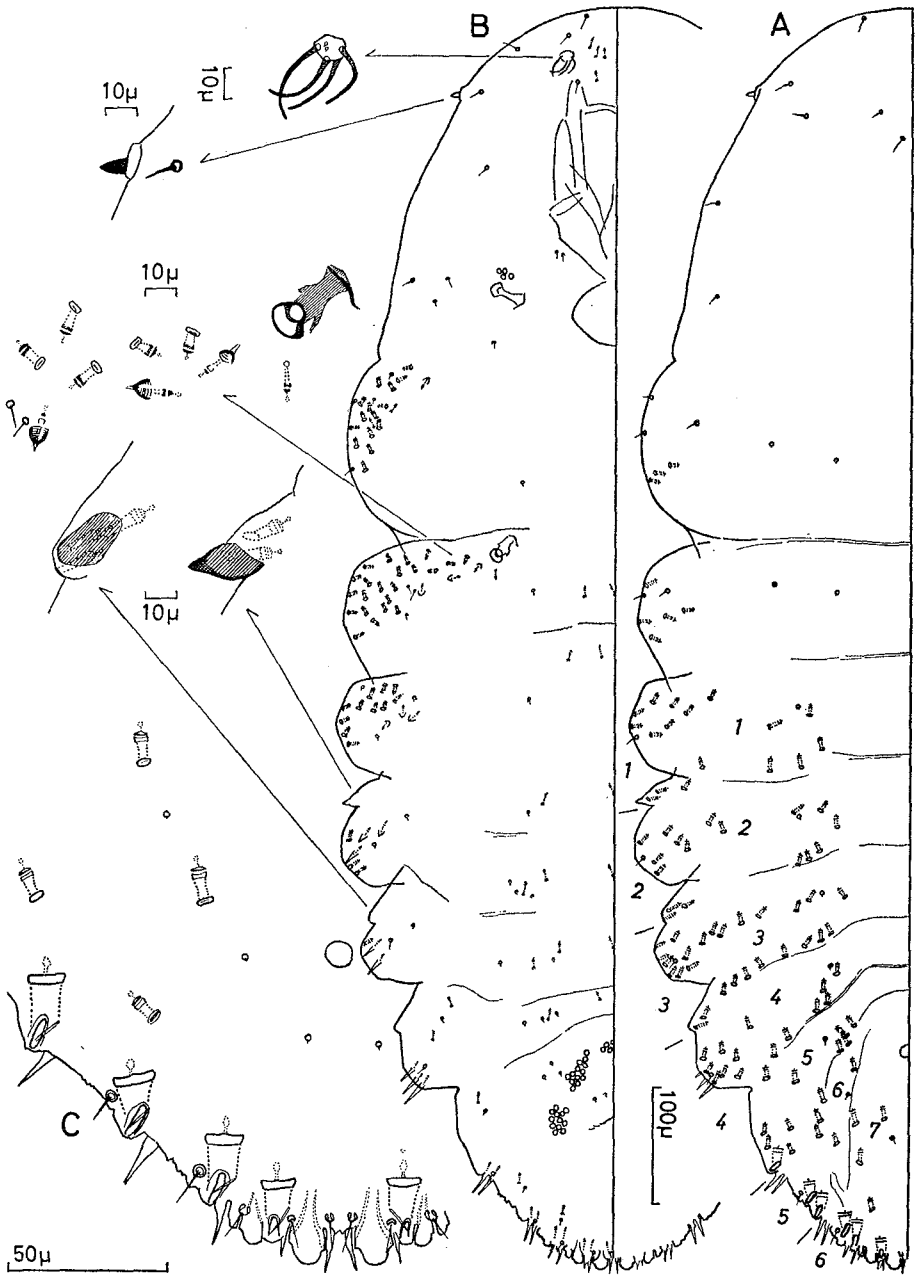


Fig. 16. *Lepidosaphes tsugaedumosae* n. sp. Adult female (A and B). Second instar female, exuvial cast: pygidium in dorsal view (C). 75NPL–251.

segments; 0–2 on mesothorax, 1–5 on metathorax, 2–6 on abd. i, 1–5 on abd. ii, 2–5 on abd. iii, and 1–4 on abd. iv. Marginal macroducts 6 on each side of pygidium. Dorsal macroducts much smaller than marginal macroducts, but not filiform;

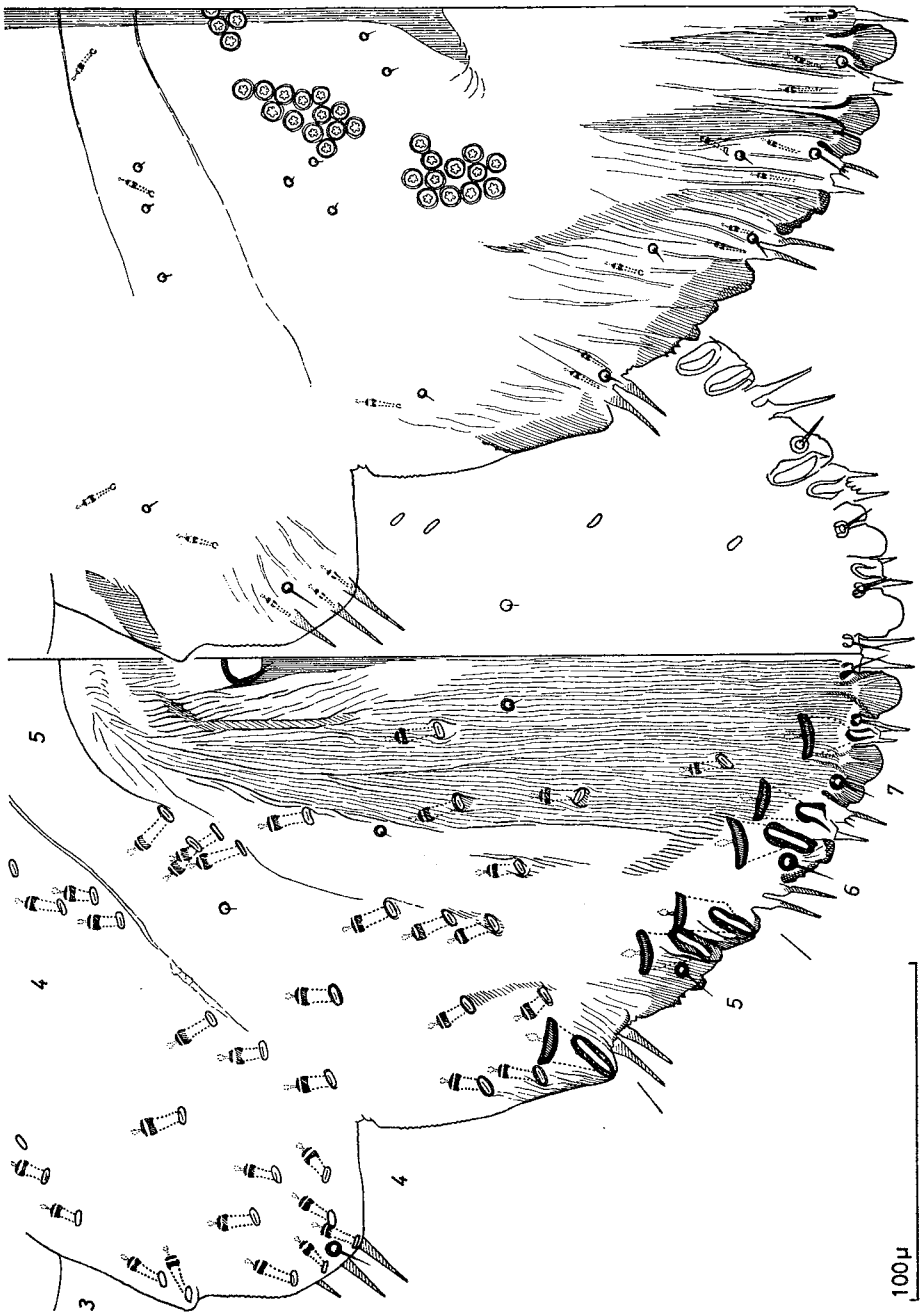


Fig. 17. *Lepidosaphes tsugaedumosae* n. sp. Adult female: pygidium. 75NPL–251.

submedian macroducts on abd. i–vii, those on each of abd. i–iv in a segmental row along posterior margin of segment and an infrasegmental row; 5–10 in combined region of abd. vi and vii, 1 of them situated just anteriorly to 2nd lobe. Similar

ventral macroducts rather abundant on lateral lobes of meso- and metathorax and abd. i. Three lateral tubercles on each side of abdomen (appearing as if situated on bases of abd. ii, iii and iv, but originally belonging to abd. i, ii and iii, respectively), somewhat sclerotized, each with 1–3 macroducts opened on dorsal side. Perivulvar disc pores in 5 groups; 3–9 (mean 6.6) medians, 12–24 (17.0) anterolaterals, and 5–20 (14.7) posterolaterals; total 54–82 (69.6). Anal opening near bottom of pygidium. Head with 7–20 (mean 12.1) microducts scattered between antennae. Antennae flat, each with 4 long, curved setae. A sharp, strongly sclerotized spur-like process at place of eye, usually directed laterally or more or less anteriorly, at times directed posteriorly. Anterior spiracles each with 2–10 (mean 6.1) trilocular disc pores; posterior spiracles without disc pores.

Exuvial cast of 2nd instar female fusiform, about twice as long as wide, about 0.9 mm in length. Pygidium rather trapezoid in outline, with 2 pairs of developed lobes. A pair of marginal gland spines between median lobes (on abd. ix), a single marginal gland spine on each of abd. ii–viii; 1 tubercular gland spine usually present on each of meso- and metathorax and abd. i within margin. Four single marginal macroducts on each side of pygidium. Much smaller dorsal macroducts occurring as follows: 1 submedian at times present on abd. vi; 1 submedian and 1 submarginal usually present on abd. v and also on abd. iv; 1 submedian at times present and 1 submarginal and 1 marginal always present on abd. iii; 1 submarginal and 1 marginal on abd. ii and also on abd. i. One ventral macroduct on abd. i near margin; 3–5 macroducts on metathorax within margin, mostly ventral; 1–3 macroducts on mesothorax, and at times 1 macroduct on prothorax, within margin and ventral. Antennae each with 2 setae.

Scale of female elongate, attaining about thrice as long as wide and about 4 mm in length; exuvial casts terminal, yellowish brown; secretionary part dirty brown, little or slightly expanded laterally, only slightly convex dorsally, with obscure traces of growth. Occurring on the underside of leaves, the width of the scale occupying a little over the width of a lateral half of the leaf. Fresh scales often covered with white waxy powder (originated from the epidermis of the leaf ?). (Scale of male not found.)

This species is close to the Japanese *Lepidosaphes pseudotsugae* Takahashi and another Nepalese species, *Lepidosaphes piniroxburghii* Takagi; all these species are associated with Pinaceous plants. It differs from the latter 2 species in adult female characters mainly as follows: –

1) In *L. pseudotsugae* the head is strewn with microducts between the antennae, whereas in *L. piniroxburghii* with many ducts on both dorsal and ventral surfaces. In *L. tsugaedumosae* the microducts of the head are restricted to the interantennal area as in *L. pseudotsugae*, but tend to be more numerous than in the latter.

2) In *L. pseudotsugae* the lateral spurs of the head (modified eyes) are directed anteriorly, and in *L. piniroxburghii* posteriorly. In *L. tsugaedumosae* these spurs are often directed laterally (57%), but sometimes more or less anteriorly (29%) or more or less posteriorly (10%); in a few cases they are lacking (4%). This division is in some cases rather arbitrary, but the percentages given in parentheses may give an idea of the tendency.

3) In *L. pseudotsugae* the disc pores associated with each anterior spiracle range from 9 to 27 (mean 16.5), and in *L. piniroxburghii* 3–7 (mean 4.6, standard error=0.36, $n=12$). In *L. tsugaedumosae* these disc pores are 2–10 in number (mean 6.1, standard error=0.15, $n=100$).

4) In *L. pseudotsugae* the macroducts occur on the mesothorax and succeeding segments, but are lacking in the dorsal submedian region of the anterior 4 of these segments. In *L. piniroxburghii* the macroducts occur as anteriorly as the prothorax (except the minute dorsal ducts of the head), extending into the submedian region on each segment. In *L. tsugaedumosae* macroducts are usually lacking on the prothorax and are not found in the submedian region of the meso- and metathorax. The pygidial dorsal macroducts in *L. tsugaedumosae* are nearly as numerous as in *L. piniroxburghii* and fewer than in *L. pseudotsugae*. In the number of prepygidial macroducts *L. tsugaedumosae* is intermediate between the other 2 species.

5) In *L. pseudotsugae* gland spines are usually absent on the mesothorax and sometimes also on the metathorax and 1st abdominal segment, whereas in *L. piniroxburghii* they occur as anteriorly as the mesothorax. In *L. tsugaedumosae* they are often lacking on the mesothorax. The marginal gland spines of the pygidium occur in pairs in *L. piniroxburghii* and *L. tsugaedumosae*, whereas singly on the 6th and 7th abdominal segments in *L. pseudotsugae*.

6) In *L. pseudotsugae* the prepygidial abdomen is provided on each side with 3 lateral processes sclerotized into spurs, whereas in *L. piniroxburghii* they are unsclerotized tubercles. In the degree of sclerotization of these processes *L. tsugaedumosae* is intermediate between the former 2 species.

7) *L. tsugaedumosae* is intermediate between the other 2 species in the number of the perivulvar disc pores.

8) In *L. piniroxburghii* the pygidial lobes, especially the median lobes, appear to be squat in comparison with those of *L. pseudotsugae*. *L. tsugaedumosae* is similar to *L. piniroxburghii* in this respect.

L. tsugaedumosae and *L. pseudotsugae* were examined for the 2nd instar females by exuvial casts. In this stage, *L. pseudotsugae* is characterized by having many dorsal macroducts. In *L. tsugaedumosae* the macroducts are much fewer.

In some pygidial characters of the adult females this new species resembles *L. piniroxburghii*, but in other characters it is more or less intermediate between *L. piniroxburghii* and *L. pseudotsugae*. Comparisons in the numbers of ducts, disc pores, and gland spines are summarized in Fig. 18 and 19.

The resemblance among the 3 species is very close, the differences among them being mostly in the number of ducts, disc pores and gland spines. So far as the characters of the adult females enumerated above are concerned, these species form a sequential series, with *L. tsugaedumosae* intervenient between the other species. This series is probably identical with or more or less close to the evolutionary sequence which has produced these species. The pygidial gland spines occur in pairs in *L. piniroxburghii* and *L. tsugaedumosae*; in *L. pseudotsugae* they are single on the 6th and 7th abdominal segments, though rarely paired on the 6th. The single pygidial gland spines may have derived from the paired gland spines by a reductive change. If this is true, the possibility that *L. pseudotsugae* represents the primitive extreme of the series is excluded. This does not immediately mean that the sequence should be *piniroxburghii*→*tsugaedumosae*→*pseudotsugae*, for the

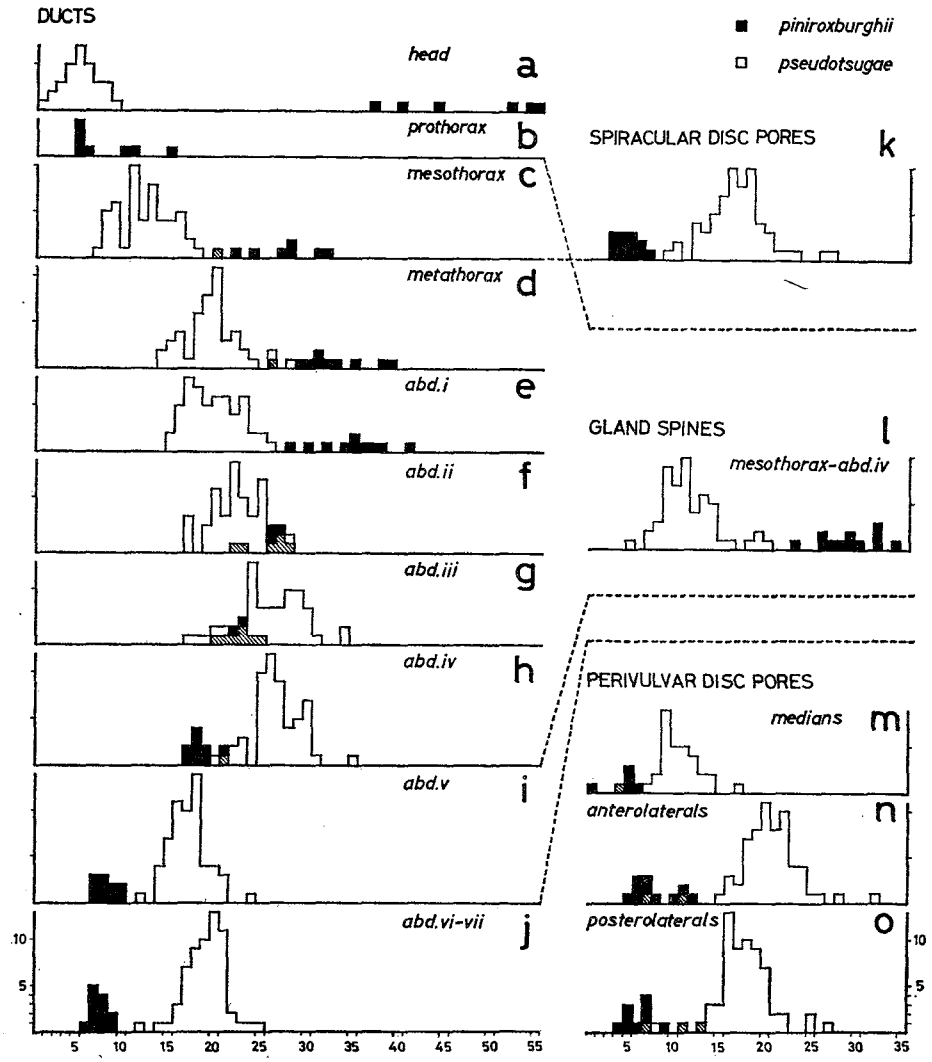
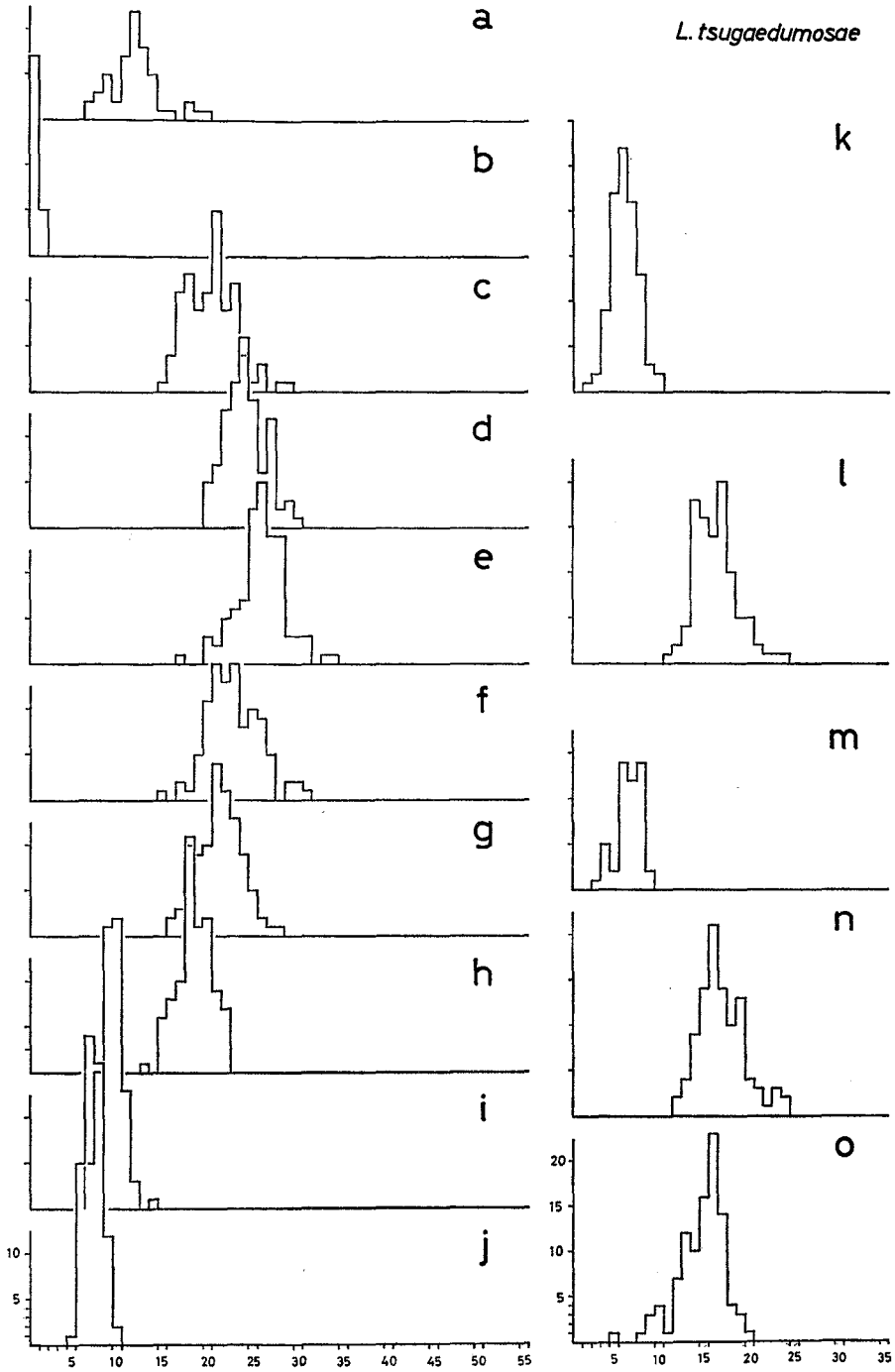


Fig. 18. 'Cross-overs' of adult female characters between *Lepidosaphes piniroxburghii* from Nepal (Larjung, on *Pinus roxburghii*) and *Lepidosaphes pseudotsugae* from Japan (Ôdai-ga-hara, on *Pseudotsuga japonica*). Number of all ducts on head (on both dorsal and ventral surfaces); number of macroducts on one side (on both dorsal and ventral surfaces) of thoracic and abdominal segments; number of disc pores associated with each anterior spiracle; number of prepygidial gland spines on one side of body; number of perivulvar disc pores in one group. (The lateral tubercles of the prepygidial abdomen and the basalmost pore prominence of the pygidium are regarded to belong to abd. i–iv respectively so that, for example, dorsal macroducts occurring just anteriorly to the basalmost pore prominence of the pygidium are counted as belonging to abd. iv. Macroducts associated with the lateral tubercles and the marginal macroducts of the pygidium do not count.) Black: *L. piniroxburghii*; white: *L. pseudotsugae*; hatched: overlap of the 2 species. (From Takagi, 1975.)

Fig. 19. Adult female characters of *Lepidosaphes tsugaedumosae* (75NPL–251) in comparison with Fig. 18. a–o: see Fig. 18.


L. tsugaedumosae
a
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5 10 15 20 25 30 35

former 2 species are identical in the supposed primitive character that the pygidial gland spines are all in pairs. That is, there is also the possibility that the sequence is double, originating at *L. tsugaedumosae.*

The changes of characters in the 3 species are not simply successive, but they result in a complicated pattern of antipodal characters between *L. piniroxburghii* and *L. pseudotsugae* – 'cross-overs' of characters (Fig. 18). Above all, these species are different in the abundance of macroducts, and this must be related with the formation of scales. *L. pseudotsugae* is characterized by having comparatively numerous macroducts on posterior segments; its completed female scale is unusually large in comparison with the insect body under it and is broadly expanded posteriorly (see Takagi and Tippins, 1972, Fig. 5). On the other hand, *L. piniroxburghii* is unusual in having many dorsal ducts on anterior segments. When I described *L. piniroxburghii,* I failed to take notes of its scale. This species occurs on pine needles, so that its scale must be narrow. Such being the case, I am very much inclined to the opinion that these species represent the opposite trends of specialization. *L. tsugaedumosae,* the intervenient species, may represent or more or less approach the common ancestral form of *L. pseudotsugae* and *L. piniroxburghii.*

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