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Walkeriana tosariensis, a new Monophlebine coccid, from *Casuarina Junghuhniana* Miq. in East-Java *)

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Among some coccids from Indonesia, received from Dr. L. G. E. KALSHOVEN, four large specimens were found which by their well developed ovisac showed some resemblance to *Icerya purchasi* MASK. After comparing the specimens with the photographs in MORRISON's Classification of the *Margarodidae* (1928) it appeared, however, that the wax covering of the body was more alike that of *Walkeriana floriger* (WALKER).

The old pinned specimens were not labelled, but Dr. KALSHOVEN remembered that they had been collected by Prof. ROEPKE on „tjemara” (*Casuarina*). Upon inquiry Prof. ROEPKE informed me that in 1910 he had collected a giant coccid on old stems of *Casuarina Junghuhniana* MIQ. in the Tengger Mts. (East-Java). The specimens were found on trees near the last bend of the road leading to Tosari, a well-known health-resort at an elevation of about 1750 m, where Europeans often used to spend their holidays. Some specimens had been sent to Mr. E. E. GREEN in Ceylon who replied that it was a species of *Walkeriana*, but that he wanted the larvae for a description of this new species.

Prof. ROEPKE, who lived at Salatiga (Central-Java), collected material of the larvae during a stay at Tosari in 1915. He had the intention to describe the new species himself, but due to pressure of other work it never happened. He asked me to describe the species, and kindly put at my disposal all material which he had still available. This material consisted of several adult females which had been preserved dry in glass tubes, and larvae preserved in alcohol. Further I received two photographs of the adult insects on the bark of *Casuarina* in natural size. The dry adult specimens were in a rather bad state of preservation, due to

*) Received February 28, 1957.

I am indebted to Prof. Dr. H. ENGEL, director of the Zoological Museum at Amsterdam, and especially to Dr. G. KRUSEMAN, Jr., curator of the Entomological Division, for accomodation in this Museum during my studies on coccids.

the wear and tear of time, and transporting many times. The larvae were well preserved in alcohol, but most specimens proved to be young adults; only 2 female larvae of the second and the third stage, and 2 male prepupae were present. Among the dry material there was also a piece of bark with 3 woolly cocoons which ROEPKE thought to be the male cocoons of his *Walkeriana*. This proved to be true. The exuviae of 3 male prepupae were found in these cocoons, and also the pupae which had emerged from them, but these newly emerged pupae were in a bad state of preservation.

During a visit to the U.S.A. in 1928 Prof. ROEPKE saw in the collections of the Bureau of Entomology at Washington the preparations which Mr. GREEN had made of the *Walkeriana* from Tosari. By the courtesy of Dr. HAROLD MORRISON I could examine these slides. One of them contained an adult female which was badly broken; the antennae were lacking and only one damaged leg was present. A second slide contained 3 newly born larvae in good condition, which had apparently been taken from the ovisac. Mr. GREEN had labelled his slides „*Walkeriana javanica*”, but he has never published this name nor a description of the species, as far as I know. The locality had been wrongly labelled as Salatiga, ROEPKE's place of residence. Prof. ROEPKE informed me that he has never found this species in another locality than the one near Tosari, mentioned above, though he had often looked out for it in other localities where *Casuarina Junghuhniana* occurs*). I have retained the name *Walkeriana tosariensis* under which ROEPKE intended to describe this new species.

The species has been left in the genus *Walkeriana*, though in the future it will probably be necessary to propose a new genus for it. In view of our present lacunary knowledge of the tropical *Monophlebinae*, it seems advisable to leave it for the present in the genus to which it was assigned by GREEN. It does not fit into any one of the genera in MORRISON's Classification of the *Margarodidae* (1928). Dr. MORRISON himself said about the present species (in litt. 18 Sept. 1953) that "the first stage larva is definitely closer to *Walkeriana* than to the other related genera, since it has the dorsal spines in clusters, each pretty well surrounded by a line of pores, rather than in longitudinal rows. So far as I know this insect has not been described. It probably rates a new genus on the ground of the development of a definite band of pores which produces a fully formed ovisac". About *Walkeriana senex* GREEN, MORRISON (1928) said that it should be excluded from the genus *Walkeriana* because of the development of an ovisac, and that it might possibly belong to his new genus *Hemaspidoproctus*. GREEN (1937), however, has kept his species *senex* in the genus *Walkeriana*. Our present species answers to the definition of the genus *Walkeriana* given by GREEN (1922), though the adult female and the first stage larva show more resemblance to the type species of *Hemaspidoproctus* MORRISON than to that of *Walkeriana* SIGN. (see: *Discussion*).

*) In the Leiden Museum of Natural History there is a sample of large Monophlebinae coccids from *Casuarina Junghuhniana*, collected by Jhr. W. C. VAN HEURN in 1936 in East-Java near the summit of Mt. Argapura (alt. ca. 3000 m), but these specimens belong to some *Drosicha*-species.



Plate 1

Egg.

Eggs, preserved in alcohol since 1915, have a pale brownish yellow colour, and a smooth surface; their dimensions are $1.0-1.2 \times 0.5-0.6$ mm. The eggs in the ovisac are embedded in a woolly mass of thin wax filaments (diameter ca. 1μ), and minute wax curls which are fragments of a spiral with a diameter of $3-4 \mu$.

FIRST STAGE LARVA (LARVA I).

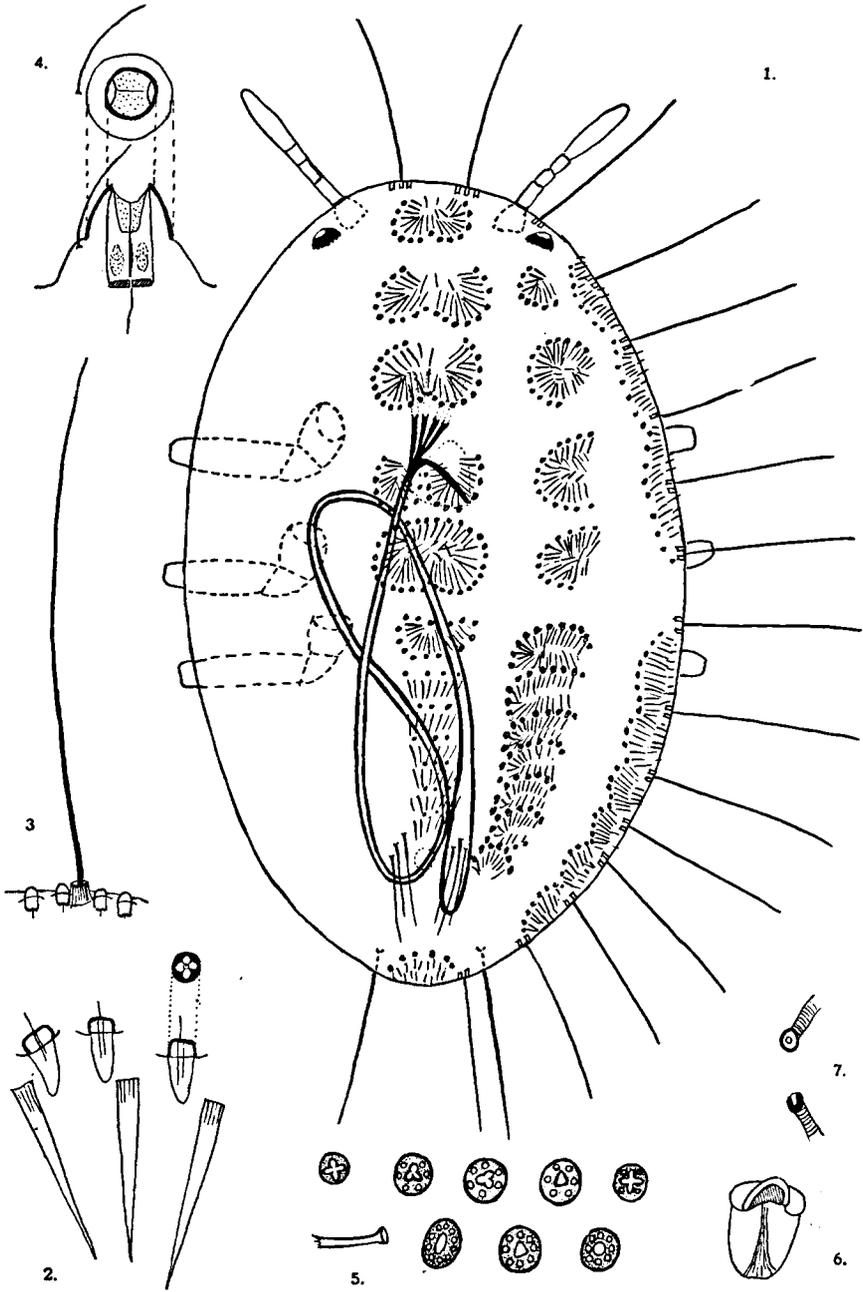
Of this stage only newly born specimens were available, taken from the ovisacs of the old females which had been preserved dry since 1910. Length of body $1.25-1.50$ mm, width 0.85 mm (on slide): colour yellowish. The body of the first stage larvae is provided with long wax filaments along the margin, and with some longitudinal rows of wax tubercles on the dorsum, as is visible on the photograph which shows the insects in natural size (pl. 1). The wax filaments are $4-5$ mm long, i.e. thrice as long as the body.

Eyes sclerotized, conical: base ca. $70-75 \mu$, height $40-50 \mu$ (fig. 8).

Antennae 5-segmented, length (on slide) $330-370 \mu$, average length of 9 antennae 351μ (fig. 12). The number of hairs on the antennal segments is as follows: I 3, II 2, III 3-4, IV 2-4; the apical segment (V) has 12-15 ordinary hairs, and 5 sensory ones, of which 2 or 3 are usually conspicuous, while the others are less distinct and often scarcely distinguishable from ordinary hairs (fig. 13). Among the ordinary hairs of the apical segment 2 are conspicuous by their length $100-130 \mu$; they are inserted on the middle of the segment or somewhat higher. The sensory hairs, which are found near the top of the apical segment, are slightly granulated and more or less bluntly pointed; they are thicker than the ordinary hairs, at least at their base, and usually somewhat curved. There seem to be present 2 small sensilla near the top of the antennae as described by ŠULC (1943) for *Phenacoccus aceris* SIGN., and by the present writer (1954) for *Puto antennatus* SIGN. These sensilla *) were observed in 11 of 12 antennae examined (fig. 13). The second antennal segment is provided with the usual sensorium near its top.

Legs slender, about equal in length (ca. 0.9 mm): see fig. 9. The tarsus, including the claw, is about of the same length as the tibia (tibia ca. 265μ , tarsus 200μ , claw 55μ). The tarsus has near its top a conspicuous sensorium (fig. 11), which VAYSSIÈRE (1926) has found in all Monophlebinae examined. Tarsal digitules seem to be absent; those of the claw (fig. 10) are stout at their base but taper into a fine point which is often lost by breakage. When the unguinal digitules are entire, they are 0.8 times as long as the claw. Sometimes they reach the tip of the claw, and in a few cases they are even longer, and bluntly pointed. The

*) In the adult female and the third stage larva (♀ and ♂), in which sensory hairs are also present on most of the other antennal segments, these sensory hairs are often accompanied by one or two of the said sensilla. The same was observed in an undescribed Monophlebinae coccid, collected in 1955 by Prof. Dr. P. BUCHNER in West-Java (Botanic Garden at Tjibodas, alt. ca. 1400 m).



hairs on the leg are shown in fig. 9. The coxa has 8—10 hairs, 5—6 of which are arranged along the distal rim. The trochanter is provided with one very long hair (200—240 μ), and 4 shorter ones; there are 2 sensoria on both sides. The femur has one very long hair (180—220 μ) just below that of the trochanter; further there are 8—10 shorter hairs, of which 4—5 along the inner side are spine-like. The tibia is provided with 14—17 hairs, of which about 7 along the inner margin are spine-like. The tarsus has 11—12 hairs of which 3—4 along the inner margin are usually spine-like.

The labium is short, and bluntly pointed, length ca. 170 μ , width at base 200 μ , or slightly more (fig. 15). The apical part has 10 hairs on each side, sometimes 11 or 12. Of these 10 hairs 3, or at least 2, are bluntly pointed but not dilated at their tips. On the basal part 2 hairs are observed on each side, and a pair of smaller ones near the base of the labium. The separation between the apical and the basal part is only faintly indicated. The rostral loop (fig. 1) is very long, from 2.65—2.95 mm when the mouth setae are withdrawn, so that the setae when fully protruded will reach about 5.3—5.9 mm beyond the tip of the labium. According to measurements by Mr. OEY of the Forestry Research Station at Bogor (Java) the bark of some old stems of *Casuarina Junghuhniana* had a thickness of 5—15 mm in the fissures, as Prof. F. K. M. STEUP kindly informed me. From these data it appears that on favourable spots the newly emerged larvae are probably able to reach the living tissues with their mouth setae. Of the 4 mouth setae the 2 outer ones are brown, sclerotized, and faintly barbed at their tips, while the inner ones are hyaline and tender.

The dorsal surface is provided with spines, and long hairs with a collar at their base (figs. 1—3, 17).

The spines are arranged in 5 longitudinal rows of separate spine groups, viz. one medial row (actually two which are largely fused), two intermediate, and two lateral rows (fig. 1). Each spine group is partly surrounded by a single line of quadrilocular wax pores, and the spines in each group are more or less converging towards one point (fig. 2). These spine groups are covered by wax projections in a later stage of development. The spine areas are most clearly defined, and most constant in number, on the abdomen. The medial series of spines on the abdomen shows one small spine group on the first segment, and 6 transversal rows of only 3—8 spines between this group and the anal opening. On thorax and head the medial series of spines has usually 5 double groups which are more or less fused along the middle line, especially on the thorax. The intermediate series has 7 distinct spine groups on the abdomen, and usually 4 such groups on thorax and head; there are about 30—40 spines in the groups on the first abdominal segments, but only 10—15 in the posterior groups. The lateral spine groups are largely fused, but they can be vaguely recognised by the bordering pore lines, especially on the abdomen. It seems that the large marginal hairs, mentioned below, are inserted between the lateral spine groups, as is clearly seen in the abdomen. Behind the anal opening there is sometimes a small, indistinct, medial spine group, and occasionally one or two of such groups are observed between the antennae.

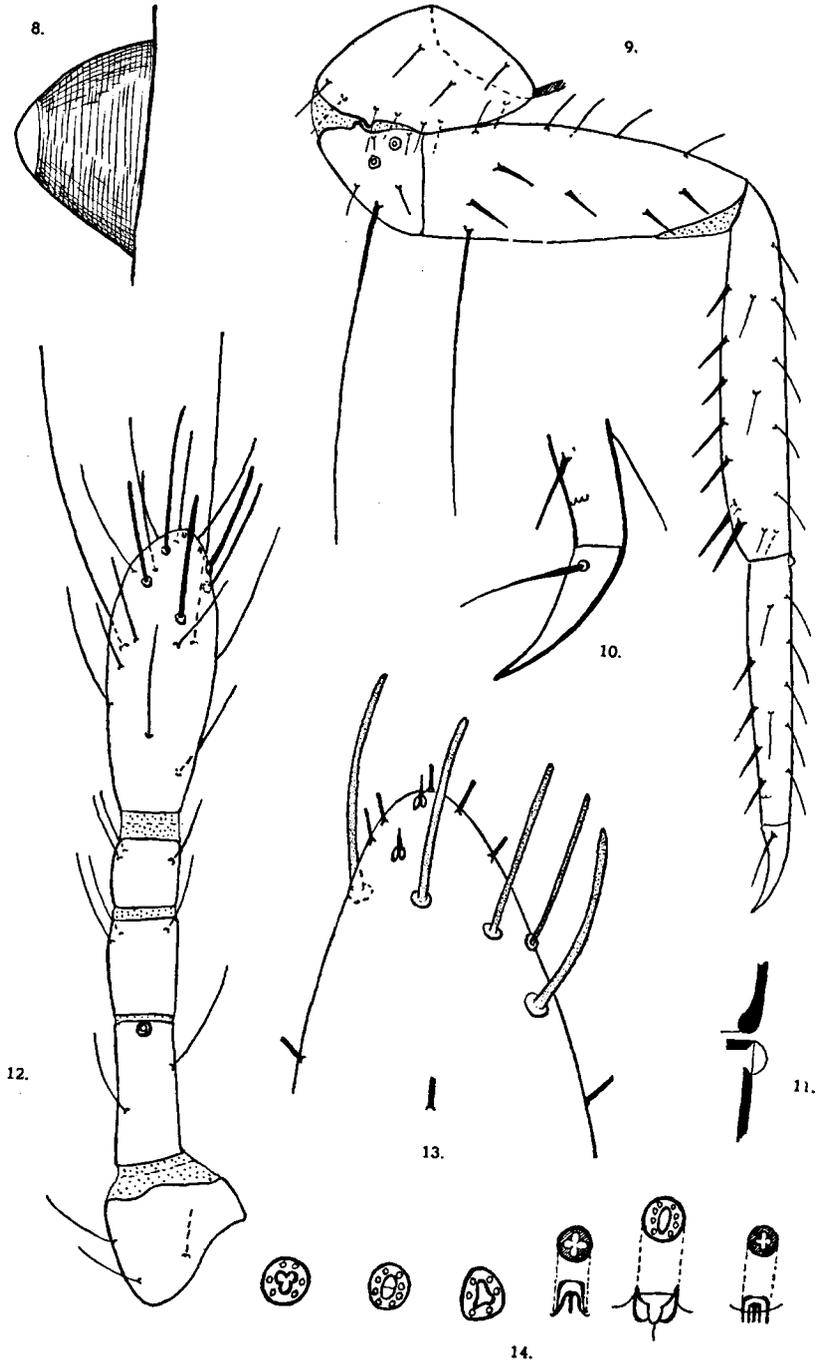
The spines in question are hollow excrescences of the cuticula without a basal socket or collar into which the spine is inserted; their basal parts are faintly striated in a longitudinal direction (fig. 2).

Along the margin of the body 15 long hairs (300—400 μ) are present on each side. These hairs have a distinct collar at their base (fig. 3), and are accompanied by a pair of large tubular glands as described below. It seems likely that these marginal hairs support the long wax filaments produced by the tubular glands. The anterior marginal hairs are slightly longer than the posterior ones. At the posterior end of the body there are 2 apical hairs inserted on the ventral margin which are not accompanied by tubular glands; they are somewhat stouter than the marginal hairs but about of the same length (ca. 350 μ).

A few collar hairs and spines, as described above, are also found between the spine groups (fig. 17). The hairs between the medial and intermediate spine groups are at most 100—150 μ in length, those between the intermediate and lateral groups 80 μ ; 3—5 longer hairs (165—235 μ) are observed on each side of the anal opening. A few isolated spines are found between the medial and intermediate row of spine groups, and still less between the intermediate and lateral row.

The dorsal cuticle is provided with disk-like wax pores, and a series of large tubular wax glands along the margin of the body. The disk pores are rather deeply invaginated; their height or depth is almost equal to the diameter (7—9 μ). Seen from above these disk pores show a central opening in the shape of a cross, triangle, or ellipsis (fig. 5). The majority of these pores belongs to the first type; they have 4 thick-walled pores, and are placed in a line surrounding the spine groups. The few wax pores, which are found between the longitudinal series of spine groups, have usually 3 thick-walled pores in the centre, surrounded by 6 smaller pores; the inner walls of the central pores are often indistinct or absent. Sometimes the central triangle takes the form of an ellipsis or circle, as is seen in the 8 large multilocular pores which surround the anal opening; in this case the ellipsis (circle or triangle) is surrounded by 8—10 small pores, but no pores are observed within the central ellipsis. It seems that all these types of wax pores are variations of the quadrilocular pores which surround the spine groups. By disappearance of one pore the central pore group becomes triangular, and by rounding off the angles the triangle becomes an ellipsis or circle. Sometimes quadrilocular pores are observed which are surrounded by 4 smaller pores; these are probably the first stage of passing into the triangular type.

About 60 large tubular glands, measuring 10—15 \times 20—25 μ , are arranged along the margin of the body, usually in pairs near the base of the large marginal hairs (fig. 1 and 3). Near the 2 foremost marginal hairs 6—8 of these glands may be present; on the margin of head and thorax sometimes single tubular glands are observed. The structure of the chitinous parts of these glands is shown by fig. 4. The tube is placed in a vaulted part of the derm which is provided with a small hair. Seen from above the tube shows a partition which divides it in 2 equal parts; MORRISON (1928) calls these structures bilocular tubular pores. The long marginal wax filaments of larva I are apparently produced by these tubular glands, which are absent in later stages of development (adult male not examined).



A structure of some taxonomic importance is the so-called anal tube, i.e. the terminal part of the intestine (fig. 16). Near the anal opening, which is not marked off from the adjacent derm by a sclerotic ring or thickening, the anal tube shows 8 short thick hairs with a blunt tip which is slightly fimbriated. Half way the tube there is a single row of 12—16 multilocular pores with about 12 loculi. At the inner end of the anal tube a double row of polygonal cells is found with about 50 cells in each row.

The abdominal spiracles (fig. 7) are very small (opening 1—2 μ in diameter), and difficult to trace. They are found dorsally near the margin of the body, in the spaces between the lateral spine groups of the abdomen, opposite to the marginal hairs. Seven pairs of abdominal spiracles were observed in 2 specimens in which these structures were clearly visible.

Ventral surface. Only few wax pores are found on the ventral surface, about 20—25 on the head (excluding those around the labium), the same number on the thorax, and less on the abdomen. Some of these pores have a central elliptical opening, surrounded by 6—8 smaller pores; in other pores the central opening is triangular (fig. 14). A few quadrilocular pores are also present, especially near the margin of the body. Only one prominent group of wax pores is found on the ventral surface. Around the labium are arranged about 30 deeply invaginated pores, of which the height is about twice the diameter (6—7 μ). If seen from above these labial pores show a central opening with 4 pores, arranged cross-wise; they seem to have the same structure as the other quadrilocular pores (fig. 15).

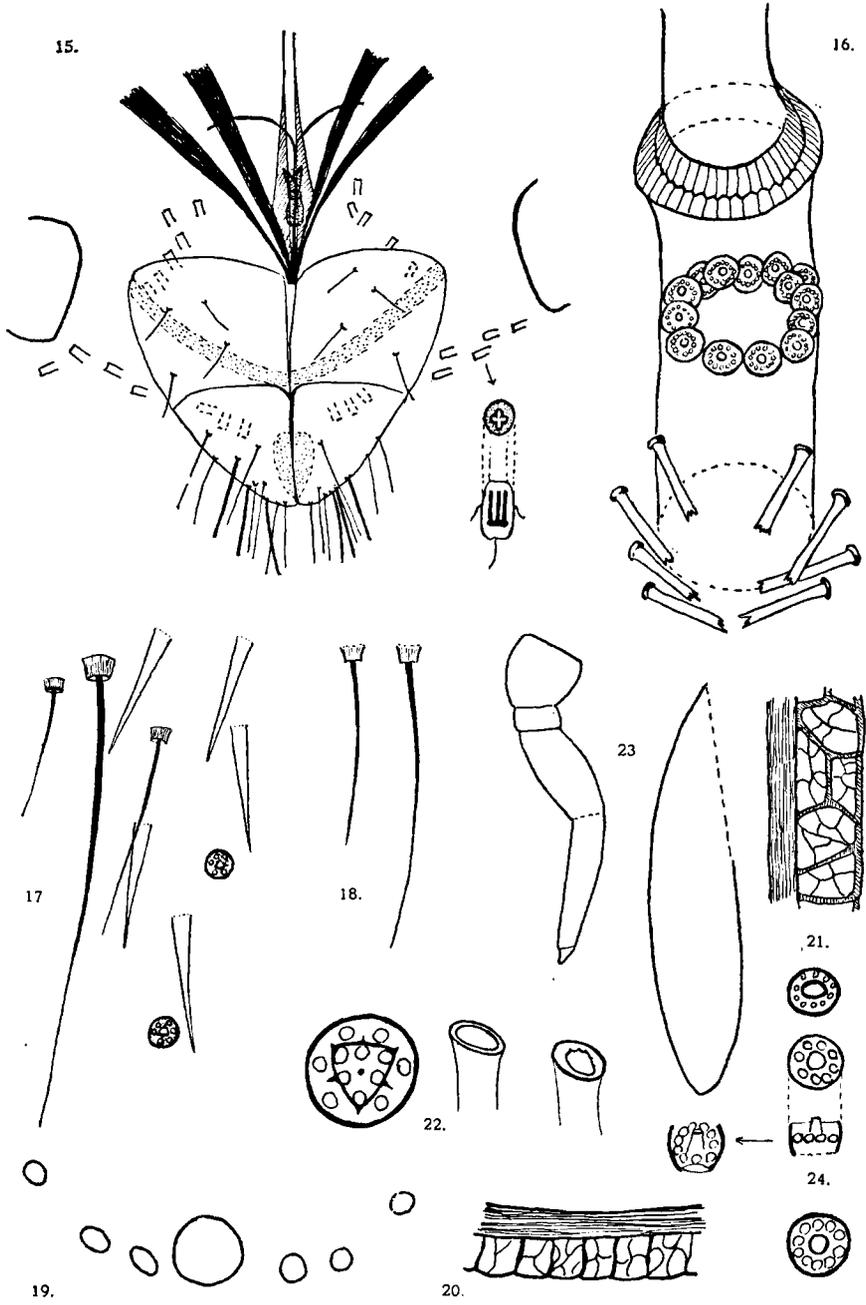
The venter is provided with hairs (length 40—150 μ) similar to those found on the dorsum, but the basal collar is usually less pronounced (fig. 18). On the abdomen these hairs are more or less regularly arranged in longitudinal rows; there are 8—10 hairs per segment. The apical hairs at the end of the abdomen were already mentioned above.

A medioventral circulus is present near the apex of the abdomen, about opposite to the anal opening. Its circumference is almost a perfect circle of ca. 50 μ diameter (fig. 1).

The thoracal spiracles show a so-called bar (fig. 6).

SECOND STAGE LARVA (LARVA II).

Only 2 damaged specimens of this stage, and 2 larvae I on the point of moulting, were found among the alcohol material of 1915. These specimens were, however, sufficiently preserved to show clearly the differences between the first and second larval stage. In larva II the antenna is 6-segmented (fig. 33) and stouter than the 5-segmented antenna of larva I. There are 5 sensory hairs on the apical segment, and one on the segments III—V. The bilocular tubular glands along the margin of the body, as found in larva I, are absent. The anal tube in larva II wants the fimbriated hairs around the anal opening, and the multilocular pores on the middle of the tube. The ring of polygonal cells at the inner end of the tube is present, but is quite different from that structure in larva I (see figs. 16 and 20). Only one row of polygonal cells is present, and the cells are already reticulated as in larva III and the adult female. Another important difference with regard to larva I is that the central circulus is flanked by 3 lateral circuli (fig. 19).



Dimensions of the examined specimens of larva II about 4.0×2.5 mm, antenna 450—500 μ , femur 300—350 μ , tibia 375—400 μ , tarsus 200—250 μ , claw 70—80 μ , central circulus 100—140 μ . Diameter of ring of polygonal cells in anal tube 80—100 μ , width ca. 14 μ . The dimensions of the examined larvae I on the point of moulting were about 3.5×2.3 mm.

On the photograph with a single adult female in natural size (pl. I) 3 larvae are visible with a length of about 2.5, 3.0, and 4.5 mm. The last one belongs probably to the second stage, and the first one to the first stage. In the smallest larva (2.5 mm) 8 small wax processes are observed along the margin of the body, and 5 at the end of the abdomen. In the largest larva (4.5 mm) 9 wax processes are seen along the margin of the body, and 7 at the end of the abdomen. The long lateral wax filaments are wanting or lost; the observed wax processes are placed on the spine groups.

PREADULT FEMALE (LARVA III ♀).

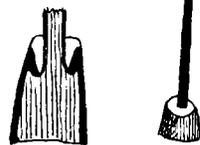
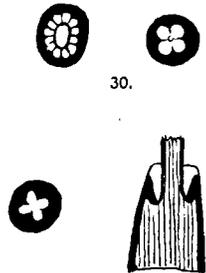
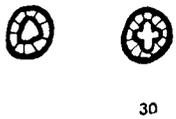
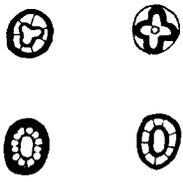
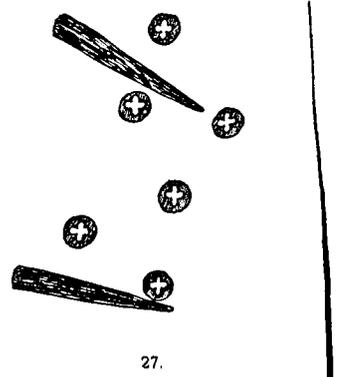
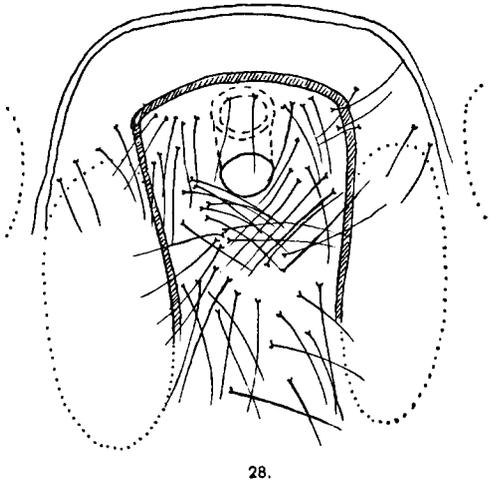
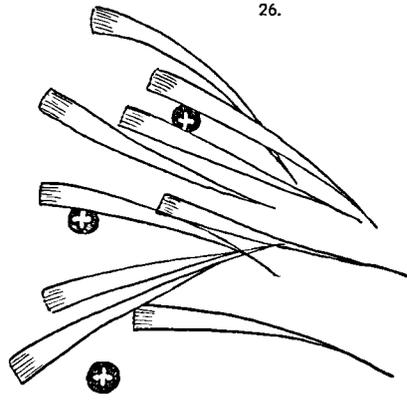
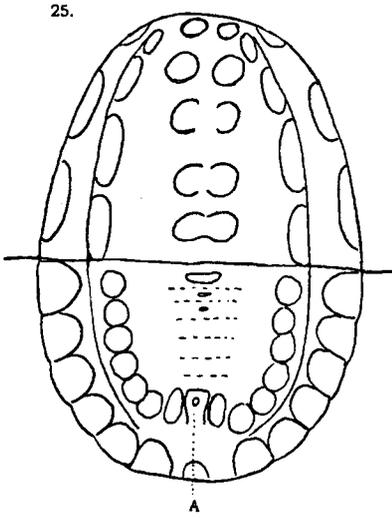
On closer examination of the larvae (preserved in alcohol since 1915) it became evident that most specimens were young adult females. Only 2 preadult females were found, and 3 exuviae of the same stage. As the 2 larvae are on the point of moulting (genital fissure, ovisac band, and claw of the following stage clearly visible), it is quite certain that they belong to the stage preceding the adult female. In view of KUWANA's careful study (1922) of the larval stages of *Drosicha corpulenta*, *pinicola*, and *howardi* (KUW.) I have identified these preadult females with the third larval stage; the paper of RAHMAN and LATIF (1945) on the development of *Drosicha stebbingi* GREEN leads to the same conclusion. The second larval stage was actually found after the M.S. was already completed (see description above).

The third larval stage is easily distinguished from the adult female by its 8-segmented antennae (fig. 33) which have a length of ca. 900 μ ; the antenna of the adult female is 10-segmented, and has a length of about 1450 μ (average of 10 specimens; variation 1250—1600 μ).

In the preadults at hand the body measures about 7×5 mm (on the slide), the claw 115 μ , the tarsus 300—350 μ , and the tibia 600 μ .

In structure this stage resembles the adult female closely, though the genital fissure and ovisac band are still absent, and the structure of the antenna different. Besides the sensory hairs on the apical segment, there is a sensory hair on each of the other antennal segments, excepting the basal one. Apart from the medioventral circulus, 5—6 smaller circuli are present on each side, arranged parallel to the margin of the abdomen. The bilocular tubular glands along the body margin, and the multilocular pores and fimbriated hairs of the anal tube, as described for the first stage larva, are wanting. The polygonal cells of the anal tube are present; their walls are reticulated (fig. 21).

The dorsal spine groups are surrounded by 3—5 rows of quadrilocular pores. There are probably 7 spine groups in the lateral and the intermediate series of the abdomen, and about 4 in the same series on head and thorax. The spine groups are slightly overlapping on the ventral surface, where they reach the line of the antennae and legs. Around



the anal opening about 50 long hairs are observed; the hairs along the body margin have about the same length (ca. 300 μ). The reticulated sclerotizations on the dorsal surface of the abdomen, as described for the adult female, are already present; this was also observed in larva II.

The ventral surface shows collar hairs of different length (30—140 μ), and multilocular pores with a central elliptical opening surrounded by about 10 smaller pores (fig. 21). Where spines are present, quadrilocular pores prevail. Between the tracts with quadrilocular and multilocular pores there are some pores with a triangular central opening. The labium could not be examined in the 2 available specimens; the abdominal spiracles were not observable.

PREPUPAL STAGE OF THE MALE (LARVA III δ).

Only 2 prepupae were found among the larvae preserved in alcohol; further 3 exuviae of the same stage were available which were found in the pupal cocoons mentioned below. In view of the studies of KUWANA (1922) and RAHMAN and LATIF (1945) on the development of *Drosicha*-species it is likely that our prepupa represents the third larval stage of the male.

The male prepupa (larva III δ) can be distinguished from the preadult female (larva III φ) by its elongate body, the 9-segmented antennae, the absence of mouth parts and dorsal spines, and further by the presence of numerous hairs and wax pores.

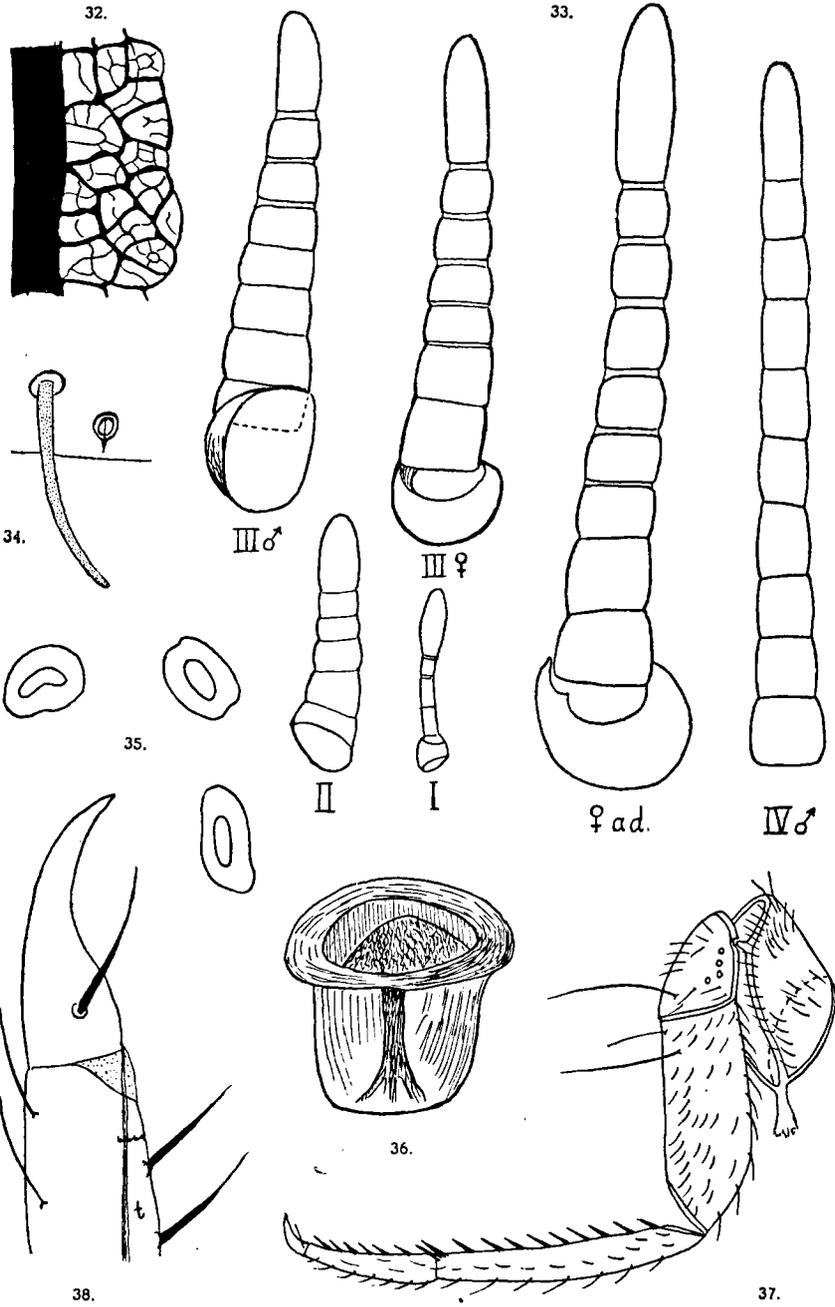
The body is twice as long as wide, measuring 5 \times 2.5 and 6 \times 3 mm in the two available specimens, as against 7 \times 5 mm in the preadult female. The 9-segmented antenna is about of the same length (900—1000 μ), and of the same structure as in the third larval stage of the female but somewhat thicker in its basal part (fig. 33). The mouth parts seem to be wholly absent; even no trace of the labium could be found.

The spine groups which support the wax projections in the female stage are absent; instead of them there are numerous hairs with a more or less developed collar. Some of these hairs, as those between the antennae, along the body margin and on the posterior abdominal segments, are quite long (350—500 μ), but the majority consists of small hairs (40—60 μ), interspersed with longer ones (150—200 μ). The number of hairs is as large as, or even larger than the number of wax pores. These wax pores, which serve to construct a cocoon before pupation, are about 3 times as numerous as in the preadult female. The pores have a triangular central opening surrounded by 6 smaller pores; in focusing more deeply 3 or 6 similar pores are observed within the triangle (fig. 22). The legs are like those of the preadult female, and show usually 3 sensoria on both sides of the trochanter.

In one of the prepupae the tracheae in the abdomen were visible so that the abdominal spiracles could be easily traced: 7 pairs were present (fig. 22). In the second specimen 6 marginal circuli were observed; the larger, median circulus was not visible, or only very indistinctly.

PUPAL STAGE OF THE MALE (LARVA IV δ).

Among the material which had been preserved in a dry state since



1910 there was a piece of *Casuarina*-bark with 3 pupal cocoons. These cocoons were composed of a white downy tissue of very fine long filaments (1.0—1.5 μ in diameter) which are apparently produced by the numerous wax pores of the prepupa. The cocoons were elliptical in shape, about 10 mm long and 5 mm wide.

In 2 cocoons pupation had already taken place; in the third one only the exuviae of the prepupa were found, the pupa had probably been lost during preparation. As the 2 available pupae had quite recently emerged, their cuticle was still hyaline and very tender so that it was not possible to make good microscopical mounts of them.

Length of body (on the slide) 3.1—3.5 mm; width ca. 2 mm. Wing-pads, which are still absent in the prepupa, are present; length 1.1—1.5 mm (fig. 23). Mouth parts wanting. In the 2 available pupae the legs are very short (ca. 1 mm); those of the prepupa are twice as long. The claw is rudimentary, tarsus and tibia seem to be fused (fig. 23). The antennae are 10-segmented, and have a length of about 2 mm (fig. 33). Only a few small hairs were found on the legs and antennae. The cuticle of the body is provided with several hairs and multilocular pores. The hairs on the dorsum and venter have a length of 50—85 μ ; longer ones are found at the anterior end of the body (250—300 μ), and at the end of the abdomen (150—200 μ). The multilocular pores have a conical central opening, surrounded by 8—10 loculi; their diameter is 10—12 μ (fig. 24).

The abdomen shows a slight emargination at the apex. In the 2 available specimens the eyes and thoracical spiracles are the only parts which are sclerotized and of a brown colour; the structure of the compound eye was not yet visible.

Unfortunately the adult male was not represented in ROEPKE's material. It is still unknown in *Walkeriana* SIGN. and the allied genus *Hemaspidoproctus* MORR., but a description of the adult male of *Aspidoproctus maximus* NEWST. is available (BRAIN 1915/16, MORRISON 1928).

THE ADULT FEMALE (♀ AD.).

The adult female can be distinguished from the preceding larval stages by its 10-segmented antennae (fig. 33), and by the presence of an ovisac band on the ventral surface of the abdomen. This band consists of a strip of closely set quadrilocular pores along the base and the margin of the abdomen; it is very conspicuous near the posterior legs on account of its great width.

The 2 smallest adult females at hand measure 6.5 × 5.0 mm (on the slide); the dimensions of 2 preadult females, on the point of moulting, are 7.0 × 5.0 mm. The dimensions of the 3 largest adult females are 10.5 × 7.5, 9.5 × 7.0, and 9.5 × 7.0 mm. It seems that the adult female on GREEN's slide (mentioned above) was still larger, but the specimen is badly broken, apparently by applying too much pressure on the cover glass. As the ovisac in the dried specimens may reach a length of about 25 mm, it is likely that mature females with a fully developed ovisac can attain a length of about 4 cm. Prof. ROEPKE believes that he had even seen living specimens which had a length of 5 cm.

The dorsal surface is convex (excepting its margin), and provided

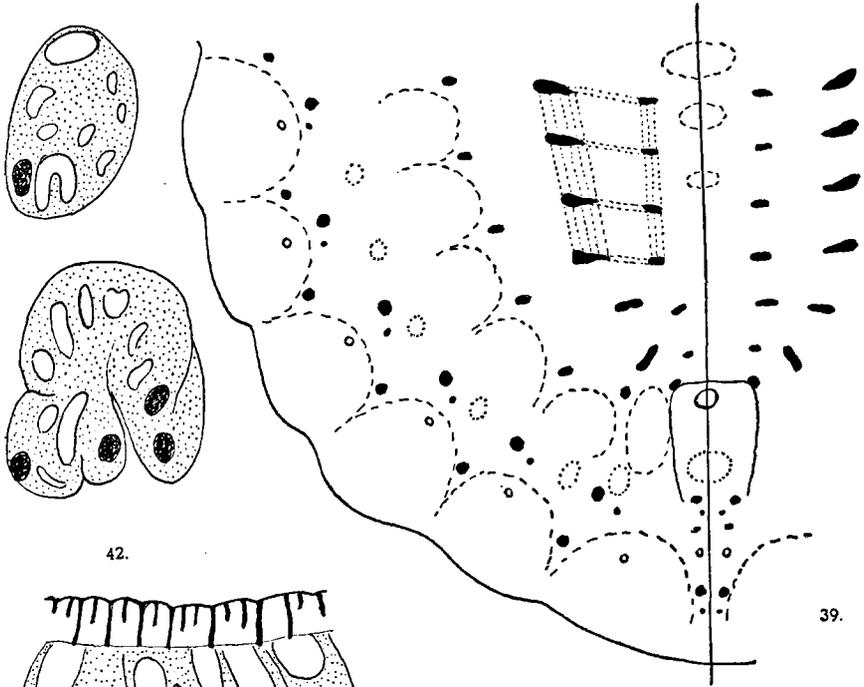
with several stout wax processes; the ventral surface is flat and smooth, with only a thin coating of wax. Among the dorsal wax processes there are 5 pairs of tubercles in the middle line of the anterior half of the body. Further 2 parallel series of flat curled wax processes are present which surround the margin of the whole body (pl. 1). Each marginal series consists of 10—20 flat processes which are faintly grooved in a longitudinal direction, and often provided with dark cross bands. The outermost series is placed on the flat body margin, the inner series at the base of the convex part of the dorsum. The marginal processes of the abdomen are distinctly separated, but those on thorax and head are partly fused so that their number is difficult to ascertain.

The upper side of the ovisac consists of 10—12 narrow plates: the lower side is flat and smooth. In specimens with a fully developed ovisac the body is tilted up so that its axis forms an angle of about 45° with that of the ovisac. The eggs in the ovisac are embedded in a downy mass which consists of very fine wax filaments ($1.0\text{--}1.5\ \mu$) and small pieces of wax spirals. The larvae seem to escape by a separation of the dorsal plates of the ovisac (Cf. Pl. 1).

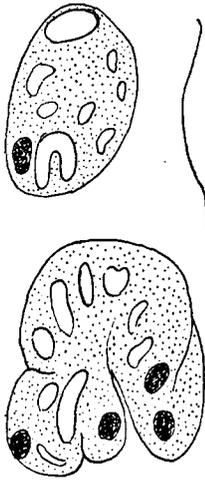
The grey wax of the dorsal processes and ovisac-plates is rather brittle, and often described as being of a chalky nature. This wax cannot be removed by boiling water, and is even difficult to destroy in a hot solution of caustic potash. Carbonate of calcium seems to be absent; no ebullition is seen when the wax is submerged in hydrochloric acid. After extraction of the wax in boiling benzene it appears that the dorsal wax processes and the plates of the ovisac have a non-waxy matrix which consists of a dense mesh-work of brownish filaments (diameter about $2\text{--}3\ \mu$). These filaments are more or less distinctly arranged. In the dorsal wax processes narrowly set parallel strands are formed by densely interlaced filaments, separated by looser tissue (fig. 50). In the dorsal plates of the ovisac coiled parallel filaments are united into bundles so that the structure reminds of wavy hair locks. It seems that this non-waxy matrix causes the brittleness (or "chalky nature") of the dorsal wax structures, and their resistance to destruction by a solution of caustic potash*). As only the ovisac band of quadrilocular pores can be responsible for the formation of the dorsal ovisac plates, we have to assume that these pores secrete the wax as well as the filaments of the non-waxy matrix. Sections have confirmed this supposition for the quadrilocular pores on the dorsum (fig. 43). The dark cross bands of the dorsal wax processes are formed by a denser accumulation of the non-waxy filaments.

A n t e n n a e 10-segmented (fig. 33); average length in 10 specimens $1450\ \mu$, variation $1250\text{--}1600\ \mu$. In some specimens the apical segment shows a faint constriction, or even a partition, so that the antenna seems to be 11-segmented. A large number of hairs is present on all these segments. On the apical segment 2 hairs near its top are conspicuous for their length, being as long as the segment itself; these hairs are present in all stages examined, excepting the pupa. All antennal seg-

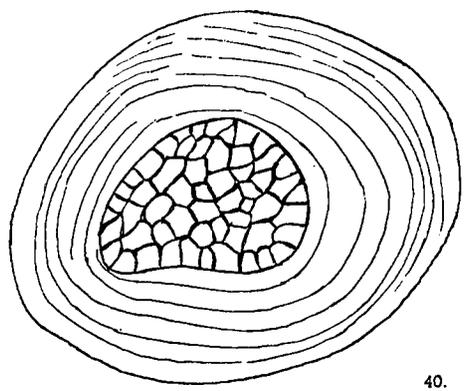
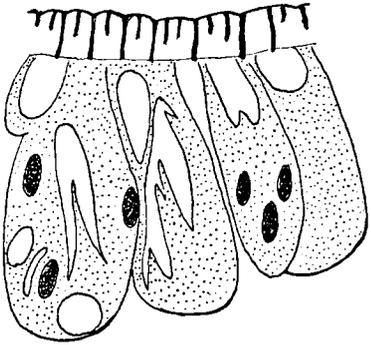
*) A similar non-waxy matrix is found in the dorsal wax processes of *Orthezia urticae* (L.), but the filaments are thinner and form an irregular meshwork. This was already observed by LIST (1887) who examined *O. cataphracta* SHAW (= *Arctorthezia cataphracta* OLAFS.).



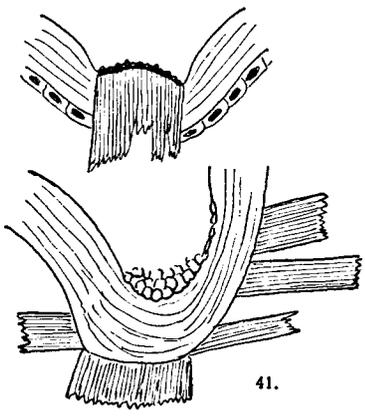
39.



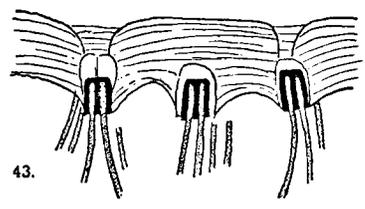
42.



40.



41.



43.

ments, with exception of the basal one, are provided with sensory hairs which are usually thicker than the ordinary hairs, slightly granulated, bluntly pointed, and somewhat curved. One, or sometimes two, of such sensory hairs are observed on segments II—IX, and 4—5 on segment X of which 2—3 are usually more conspicuous than the other ones. The second segment shows near its top a sensorium like most other coccids.

The eyes are conical and sclerotized, with a hyaline "cornea" at their top; diameter at base 140—160 μ , height 100—150 μ , diameter of "cornea" 40—50 μ .

In most of the available specimens the labium and mouth setae are absent or damaged; apparently these parts were torn off, when the insects were collected and detached from the bark. In 2 specimens the mouth setae are withdrawn, and wholly intact: the rostral loop reaches far behind the posterior legs and has a length of 4.5—5.0 mm, so that the protruded mouth setae will probably be able to pierce a bark which is about 10 mm thick.

The labium has about the same shape as in the larva (cf. fig. 15). It is divided into a basal and an apical segment; both segments are about of the same length (0.30—0.35 mm; in larva I about 0.08 mm). On each side of the apical segment 22—23 long hairs are present; some of these hairs seem to have blunt points, but as several hairs are broken this remains uncertain.

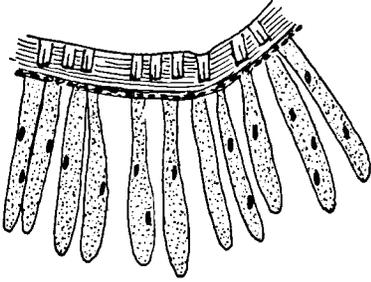
The legs are provided with many hairs, of which those on the inner side of tibia and tarsus are more or less spine-like (fig. 37). The trochanter shows 3—4 sensoria on each side, a few short hairs, and one which is very long. A similar long hair is found in the upper part of the femur, and placed just below that on the trochanter. Tarsal digitules are absent, those of the claw are short and pointed (fig. 38). A sensorium on the exterior side of the basal part of the tarsus, as figured for the first stage larva in fig. 11, is present. The tibia is about twice as long as the tarsus, and only slightly longer than the femur.

The dorsal surface shows a large number of spines, and only few hairs, but around the anal opening spines are absent and hairs abundant.

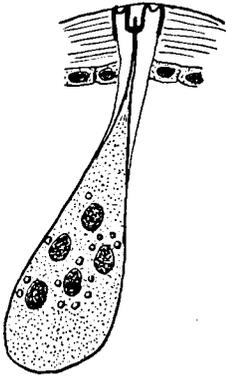
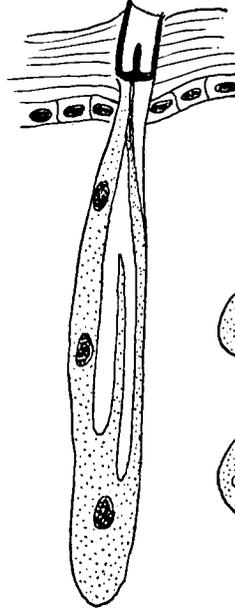
The spines are not inserted into a socket or alveolus like the collared hairs. Most spines are arranged in special groups or clusters which support the dorsal wax processes; in each group the spines are more or less pointing to the centre of the spine cluster. These spines are hyaline, long, and finely pointed, with a longitudinal striation at their base (fig. 26). The isolated spines, which are rather evenly spread between the wax processes, are shorter, more bluntly pointed, sclerotized, and without a striation at their base (fig. 27).

After removal of the wax processes it appears that the spine groups are placed on slightly bulging parts of the derm. These spine groups are most clearly defined on the abdomen, less on the head and thorax, where they are often partly fused. The abdomen shows 6 marginal spine groups on each side, further 2 intermediate series of 6—7 groups (the 7th group, at the sides of the anal region, is often inconspicuous), and small mediodorsal groups on the 2—3 first segments which usually support no wax processes (fig. 25). Along the margin of head and thorax 2 large spine groups are placed about opposite to the spiracles, and 2 small

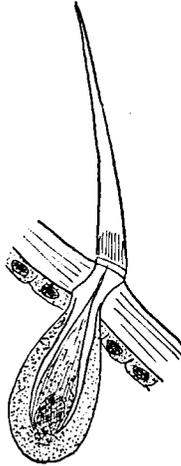
44.



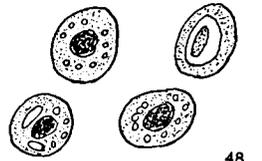
45.



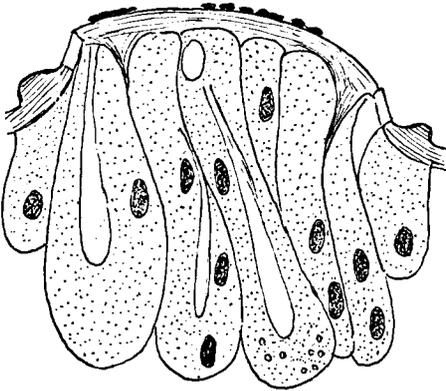
46.



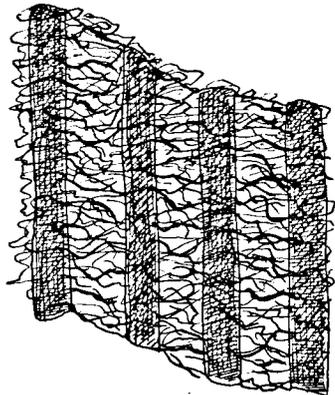
47.



48.



49.



50.

groups on either side of the antennae, so that the total number of marginal spine groups may amount to 20, viz. 4 pairs on head and thorax, and 6 pairs on the abdomen. In the intermediate series on thorax and head 4 spine groups are usually present; the anterior one is small and rounded, the 3 following ones are elongate and more or less fused into one long spine tract. The medial series on head and thorax shows 5 pairs of spine groups of which the posterior ones are more or less fused along the middle line. These spine groups support the five pairs of median wax tubercles in the anterior half of the body, as mentioned above. A diagram of the position of the spine groups is given in fig. 25.

On the dorsum hairs are sporadically scattered between the wax projections; they are inserted in a typically collared socket (fig. 29), and are from 100 to 250 μ long.

The anal area (fig. 28), which is quite devoid of spines, square-shaped, and sunken, bears 60—80 long hairs (400—500 μ). In the short anal tube the fimbriated hairs at the outer end, and the multilocular pores in the middle part of the tube, as described for the first stage larva, are lacking. The ring of polygonal cells at the inner end of the tube is present, but the cells show another structure than in the newly born larvae (cf. figs. 32 and 16), which is already the case in larvae II and III.

Six pairs of abdominal spiracles are observed on the inner side of the marginal spine groups; a seventh pair is found near the middle line (figs. 35 and 39). The diameter of these spiracles, including the sclerotized rim, is about 30—40 μ , their opening only 15 μ . It seems doubtful whether these dorsal spiracles, which are covered by the wax processes, are of any use in the respiration of the adult female.

Longitudinal series of segmentally arranged reticulated sclerotizations, surrounded by a clear area without hairs or gland pores, are observed on the dorsal side of the abdomen (figs. 39 and 40); some of these structures are also found on thorax and head. These sclerotized areas, which VAYSSIÈRE (1926) has called "organes grillagés", are parts of the derm where muscles are inserted, as is shown by sections (fig. 41).

The dorsal gland pores are, with few exceptions, of the quadrilocular type (fig. 30) which seems to be the most efficient one in wax production; the ovisac band, and the band of pores which produces the dorsal wax projections, are of this type. On the spineless anal area multilocular pores are present with a round or elliptical opening surrounded by 10—12 or more smaller pores. (fig. 30, upper row). Behind the anal area, where spines are scanty, some multilocular pores are found with a triangular or cross-shaped opening (fig. 30, bottom row). The large tubular glands along the body margin, as found in the first stage larva, are absent.

The anal lobes are obsolete; there are 3 collared hairs at their ventral side which are scarcely longer than the hairs of the margin of the body. **V e n t r a l s u r f a c e.** The spines of the marginal spine groups overlap the ventral surface up to the line of the antennae and legs, and the exterior outline of the ovisac band. The remainder of the ventral surface is provided with short, hyaline hairs (100—200 μ) which are rather scanty. The longest hairs on the abdomen are about 100 μ , on the thorax 170 μ , and on the head 200 μ ; longer hairs are found along the body margin (300—400 μ).

In regions where the ventral surface is occupied by spines, the derm shows quadrilocular pores similar to those on the dorsum, but with less sclerotized walls. Where spines are lacking multilocular pores are present with an elliptical central opening which is occasionally triangular or cross-shaped (fig. 31). On the abdomen within the ovisac band multilocular pores with an elliptical central opening are the prevailing type. The ovisac band along the margin of the abdomen consists of a band of closely set quadrilocular pores (fig. 31, 44 and 45); the band is conspicuous by its width behind the posterior legs. The multilocular pores with a triangular or cross-shaped opening, adjacent to the ovisac band, seem to be a transitional stage those with an elliptical opening.

A special feature of the ventral surface of the abdomen are a number of circuli or ventral cicatrices, which are arranged parallel to the body margin. These circuli are round or oval spots, clearly outlined, and without hairs or wax pores. In the present *Walkeriana* there is a large median circulus behind the genital fissure, which is flanked on both sides by a series of 5—6 smaller circuli (fig. 39). The total number of circuli is 11 or 13; those on the first abdominal segment are often very small or wholly lacking.

The thorax has 2 pairs of well developed spiracles with a bar (fig. 36) which are connected with a complicated system of several large tracheae.

Types in the Zoological Museum at Amsterdam; paratypes in the collections of the U.S. Dept. of Agriculture (Washington D.C.), and of the Commonwealth Institute of Entomology (London).

DISCUSSION.

Walkeriana tosariensis, as described above, answers to the description of the genus *Walkeriana* SIGN. given by GREEN (1922) in his work on the Coccidae of Ceylon (p. 444). GREEN himself had assigned our species to this genus, as was already mentioned in the introduction.

MORRISON (1927) established a new genus, *Hemaspidoproctus*, for GREEN's *Aspidoproctus cinereus* (type species) and *A. euphorbiae* which GREEN (1900, 1908) had formerly assigned to *Walkeriana*, but afterwards (1922) to *Aspidoproctus*. The genus *Hemaspidoproctus* is characterised by the possession of a half-marsupium ("ventral surface of the abdomen with a complete band of pores around the margin similar to the ovisac of *Icerya*, this band forming a pad of secretion over the enclosed area, and the enclosed derm invaginating towards the dorsal surface forming a half-marsupium"). MORRISON (1928) states that it is possible that *Walkeriana senex* GREEN, which produces a fully formed ovisac, may also be assigned to the genus *Hemaspidoproctus*, but that such assignment cannot be made definitie. GREEN himself (1937) has kept his species *senex* in the genus *Walkeriana* SIGN., though he transferred his species *cinereus* and *euphorbiae* to MORRISON's genus *Hemaspidoproctus*. Dr. MORRISON, after having examined GREEN's preparation of *Walkeriana tosariensis* and one of my own slides, expressed as his opinion that the present species *tosariensis* probably rates a new genus (*in litt.* 18 Sept. 1953).

The adult female of *Walkeriana tosariensis* differs from that of

W. floriger (WALKER), the type species, in the following features.*)

1) A fully developed ovisac (length 20—25 mm) is present in the mature female, but absent in *W. floriger*.

2) The tomentum of long glossy filaments, as described and figured by GREEN (1922) and SIGNORET (1875) for *W. floriger*, is absent in *W. tosariensis*; the dorsal aspect of both species differs considerably (Cp. pl. 1 with GREEN's and SIGNORET's habit figures of *W. floriger*).

3) "Large tubular bilocular pores in small clusters along the body margin", as described by MORRISON (1928) for the adult female of *floriger*, are absent in that of *tosariensis*, though present in the first stage larva.

4) The derm spines of *W. floriger* are swollen at their bases and blunt or somewhat dilated at their tops, which does not apply to *W. tosariensis*.

5) A bipartition of the labium is indicated in *W. tosariensis* by a transversal line, which is present in the adult female as well as in the first stage larva; the labium of *W. floriger* is unipartite.

6) *W. tosariensis* has 11—13 circuli, *W. floriger* only 3 (SIGNORET 1875, GREEN 1922, MORRISON 1928).**)

7) In *W. tosariensis* the polygonal cells at the inner end of the anal tube are arranged in 2—3 rows, while there is only a single row in *W. floriger* (cf. our fig. 32 with fig. 68 F in MORRISON 1928).

The first stage larva of *W. tosariensis* differs from that of *W. floriger* in the following features.

1) The 8 fimbriate-tipped hairs at the distal end of the anal tube are much longer in *W. tosariensis* (and *senex*) than in *W. floriger*, where they are short and thick (cf. MORRISON 1928, fig. 69).

2) The apical hairs at the end of the abdomen in *W. floriger* are longer than the marginal hairs (about 500 μ against 300—350 μ), while in *W. tosariensis* the difference in length is negligible (ca. 350 μ against 300—400 μ), which is also the case in *W. senex* (ca. 280 μ against 260—270 μ).

3) The group of deeply invaginated quadrilocular pores, found in *W. tosariensis* near the labium, was not observed in *W. floriger* (and *senex*).

4) The largest hair on the trochanter in *W. tosariensis* is about of the same length as the hair below it on the base of the femur. In *W. floriger* the trochanter hair is about twice as long as the corresponding hair on the femur.

5) The dorsal spine areas are more clearly outlined in *W. floriger* than in *W. tosariensis* (cf. MORRISON 1928, fig. 69A), but in GREEN's specimens (only 4 available) I saw little difference with those of *tosariensis*.

*) I am indebted to Drs. W. J. HALL and D. J. WILLIAMS (London) for the loan of GREEN's slides of *W. floriger* (Walker), *W. senex* Green, and *Hemaspidoportus cinereus* (Green) from the collections in the British Museum. Further the descriptions and figures of these species, as given by GREEN (1922) and MORRISON (1928), have been consulted.

***) *W. senex*, which has a fully developed ovisac like *W. tosariensis*, has at least 9 circuli according to GREEN (1922) In one of GREEN's slides, however, 13 circuli are quite distinctly observed, so that the number is the same as in *W. tosariensis*.

MORRISON (1928) mentions a double row of multilocular pores in the anal tube of the first stage larva of *floriger*. In GREEN's specimens this was not distinct; the row of these pores was only partly doubled. In *W. tosariensis* and *W. senex* there is only a single row of multilocular pores in the anal tube. The marginal hairs are well developed in the larva of *W. floriger*; though in MORRISON's fig. 69A (loc. cit.) they seem to be restricted to the posterior end of the body.

The adult female of *W. tosariensis* agrees with that of *W. senex* GREEN in the possession of a fully formed ovisac, 13 circuli, and a double row of polygonal cells in the anal tube, further in the absence of bilocular tubular ducts along the margin of the body. In *W. floriger* these tubular ducts are represented in small groups, opposite to the marginal hairs between the lateral spine areas. The multilocular pores in the anal area of *W. tosariensis* and *W. senex* are less crowded than in *W. floriger*, where they are not further apart than the diameter of the pores, and may even touch each other. In *W. tosariensis* and *W. senex* the 7 pairs of abdominal spiracles are located within the marginal dorsal spine areas of the abdomen, in *W. floriger* their position is between these spine areas. The first stage larva of *W. tosariensis* shows more resemblance to that of *W. senex* than to the larva of *W. floriger*. The species *tosariensis* and *senex* seem to be congeneric; in future they should be separated from the genus *Walkeriana*, whose type species is *W. floriger*. The adult females of the species *floriger*, *senex*, and *tosariensis* can be easily separated from each other by the shape of the dorsal spines; they are blunt or slightly dilated at the tip in *floriger*, drawn out into a long hair-like point in *senex*, and are only pointed in *tosariensis*.

Differences between *W. tosariensis* and *Hemaspidoproctus cinereus* (GREEN), type species of its genus, are as follows.

1) The dorsal spine clusters in the first stage larva of *W. tosariensis* are more clearly outlined than in *H. cinereus* (cf. MORRISON, 1928, fig. 74 B).

2) The adult female of *W. tosariensis* produces a fully formed ovisac, that of *H. cinereus* only a rudimentary ovisac or half-marsupium, as described above.

3) In *W. tosariensis* the setae at the inner side of tibia and tarsus are spine-like (as in *W. floriger*), which is not the case in *H. cinereus*.

There are, however, several similar features in the adult females of *W. tosariensis* and *H. cinereus*, viz. 1) Ovisac band of wax pores present. 2) More than 3 circuli, 11—13 in *W. tosariensis*, and 5—7 in *H. cinereus* *). 3) Large marginal bitubular pores absent in both species. 4) Labium bipartite. 5) Anal tube with a double row of polygonal cells at the inner end. 6) *H. cinereus* shows the two same conspicuous long hairs on trochanter and femur, as described for *W. tosariensis*.

In the first stage larva of *W. tosariensis* and *H. cinereus* we find in both species one single row of multilocular pores in the anal tube (in *W. floriger* a double row?), and the fimbriate-tipped hairs are much longer than in *W. floriger*.

*) MORRISON (1928, p. 123) mentions 5—7 circuli for the genus *Hemaspidoproctus*, but 3—5 for *H. cinereus* (p. 151). In a slide of *H. cinereus* from the Commonwealth Institute of Entomology in London (C.I.E. 2523/13390), which I could examine by the kind help of Drs. W. J. HALL and D. J. WILLIAMS, at least 6 circuli are present.

In MORRISON's system (1928) the species *tosariensis* belongs to the subfam. *Monophlebinae* MASK., tribe *Monophlebini* COCKLL., group 2, which comprises the genera *Walkeriana* SIGN., *Labioproctus* GREEN, *Hemaspidoproctus* MORRISON, and *Aspidoproctus* NEWST. The species *tosariensis* is more closely allied to the type species of *Hemaspidoproctus* than to those of the other genera mentioned, as is indicated by the absence of bilocular tubular glands, the structure of the anal tube, and the ovisac band in the adult female.

As was already mentioned, Dr. MORRISON is of opinion that the present *Walkeriana tosariensis* probably rates a new genus. About *W. senex* GREEN, which has a fully developed ovisac like *W. tosariensis*, MORRISON (1928, p. 123) states that it may be more closely allied to *Hemaspidoproctus* than to *Walkeriana*, or may represent a distinct and undescribed genus. In view of our present lacunary knowledge of the *Walkeriana*-group I have left the species *tosariensis* for the present in the old genus *Walkeriana*, established by SIGNORET in 1875, until by progress of our knowledge of these insects a more satisfactory classification will be possible. It is likely that the species *tosariensis* and *senex* GREEN, which are closely allied, have to be placed in a new genus.

NOTES ON SOME DETAILS OBSERVED IN SECTIONS OF THE ADULT FEMALE.

Prof. Dr. P. BUCHNER has made serial sections of a young female of *Walkeriana tosariensis* to examine the symbionts, upon which he reported as follows (*in litt.* 5 Dec. 1954):

„Zur Symbiose ist zu sagen, dass es sich um eine typische Monophlebinen-Symbiose handelt: grosse, paarige Mycetome, welche stark durch die dorsoventralen Muskeln zu sehr tiefer Lappung gezwungen werden, bewohnt von den für die Gruppe typischen stattlichen Schläuchen, welche vor der Eireifung zum Teil in kugelige Uebertragungsformen umgewandelt werden. Ausserdem ist ein zweiter Symbiont in Form zierlicher Schläuche vorhanden, die kleine da und dort zwischen die Riesenzellen, in denen die primären Symbionten untergebracht sind, eingesprengte Zellen bewohnen.

Solche zusätzliche Symbionten sind bei Monophlebinen häufig. Bisher waren sie allerdings nur von einigen *Iceryini* bekannt, ich fand sie aber ausser bei *Walkeriana* auch bei *Llaveiini*, und bei *Nautococcus* und *Aspidoproctus maximus*. Die Infektion der Eier geht am hinteren Pol vor sich. Genauer werde ich die Verhältnisse in einer in Vorbereitung befindlichen Studie über die Symbiose der *Margarodidae* beschreiben.“

I have examined myself a series of sections, from the abdomen of an adult female, in order to obtain a more correct idea of the structure of the cuticle than is possible by the examination of entire insects, in which the soft parts have been removed by means of caustic potash. Special attention was paid to the circuli, the wax pores, dorsal spines, and muscle insertions.

My thanks are due to Prof. L. H. BRETSCHNEIDER (Utrecht) for a series of sections, made from the abdomen of a young adult female. This series comprises 16 sections of 7.5 μ ; of about every 50 sections one was mounted. Unfortunately the circuli were absent in this series, though several other details were clearly visible. I am indebted to Prof. Dr. P. BUCHNER (Porto d'Ischia-Napels) for a complete series of 300

sections of 8 μ , made from the abdomen of another young adult female. In this series all circuli, except the foremost pair, were represented. The anal tube, which was absent in the first series, could also be examined. Both sectioned specimens had been preserved in alcohol since 1915; the specimen sectioned by Prof. BUCHNER had also been soaked in phenolum liquefactum for other purposes so that the tissues and cuticle were somewhat damaged. For a perfect series of sections properly fixed material from fresh specimens would have been needed.

In the first place the structure of the circuli was examined. According to MORRISON (1928) and FERRIS (1950) the function of these structures, which are only found in the Monophlebinae and Pseudococcidae, is unknown. These circuli, often called ventral cicatrices, are round or elliptical spots on the venter, without hairs and gland pores, and surrounded by a more or less sclerotized ring. In the Pseudococcidae the circuli are arranged along the medioventral line, but in the Monophlebinae in a curved series, parallel to the body margin, so that it is questionable whether these circuli are of the same structure and function.

ŠULC (1909) and FERRIS and MURDOCK (1936) have examined sections of the circulus in *Phenacoccus* and *Pseudococcus*. They state that the circulus has a glandular structure. ŠULC compares these structures with the stink glands of Heteroptera, FERRIS and MURDOCK suggest that they may have some connection with egg-production. PESSON (1939) examined the circuli of *Pseudococcus adonidum* L. and *Icerya purchasi* MASK. in sections, and made some experiments with the first mentioned insect. He states that the glandular product has the properties of a slime, stainable by mucicarmine. PESSON placed specimens of *Pseudococcus adonidum* on a glass slide, and observed under the microscope that the circulus is a protrusible gland ("glande exsertile"), by means of which the insect can attach its abdomen to the substratum.

I have repeated PESSON's experiment with specimens of *Pseudococcus maritimus* EHRH., taken from an *Opuntia* infested by these insects, and can corroborate his statements. A young specimen was placed on a glass slide, and observed under the microscope (magn. $\times 50$), after turning the slide topside down. Protrusion and retraction of the circulus could be clearly observed; it was applied to the glass like a sucking cup. After retraction of the circulus the insect still clung for a considerable time to the glass, apparently by means of its claw digitules whose terminal knobs act like small sucking disks. In the myrmecophilous genus *Hippeococcus* and some allied genera of the *Pseudococcidae* the claw digitules are provided with large sucking cups by means of which the insects can attach themselves to the attending ants (REYNE 1954).

Protrusion and retraction of the circulus was also observed with a pocket lens ($\times 6-10$), after the slide was placed in a vertical position. Before the circulus is applied to the glass the body is lowered, by bending the legs, and turning the abdomen downward. Protrusion of the circulus can be most easily observed, if a specimen is turned on its back. While the insect is swinging its legs, and curving its body, the circulus is almost invariably protruded during its endeavours to come down on its feet again. The protruded circulus is most conspicuous at the moment that the insect succeeds in turning on its side. From experiments with several specimens I got the impression that *Pseudococcus maritimus* relies princi-

pally on its claw digitules when moving on a smooth surface like glass, and that the circulus is only occasionally used during a rest.

In some cases traces of slime were observed on those parts of the glass to which the circulus had been applied. As is well known, the area of the circulus in *Pseudococcidae* and *Monophlebinæ* is often filled with a dark pigment, especially in old specimens. In sections this pigment appears as flakes on the outer surface (fig. 49); it seems to be the hardened slime which has been secreted by the glandular cells of the circulus.

In *W. tosariensis* the structure of the circuli was examined in sections; living specimens for observations were not available. At first I had interpreted the lateral circuli of this species as areas of muscle-insertion, similar to those of the dorsal side; in both cases hairs and gland pores are absent. A cleared specimen, in which the muscles had been stained by eosin, proved that this opinion was not correct. Small muscles were sometimes seen at the sides of the circuli which are also observed in sections; they are probably used during protrusion or retraction of the circulus. The larger muscles on the ventral side of the abdomen are always inserted on, or near, the sutures of the segments, as is shown by cleared specimens. Sections show that muscle-insertion in the abdomen is always accompanied by a depression of the cuticle, while the circuli are represented by flat elevations with a sloping wall on their sides (fig. 49). The dermal cells under the circulus are much enlarged and of a glandular nature. In the wall surrounding the circulus a strip of yellow chitin is always visible, while the remainder of the cuticle is stained blue by haematoxylin. The cuticle on the surface of the circulus is rather thick, fibrous and stratified. In several cases, however, a small part of this cuticle consists of yellow chitin, much thinner than the remainder, and apparently of a denser structure*). The flakes of hardened secretion, mentioned above, are always absent on these yellow parts. The large median circulus has the same structure as the smaller lateral ones, but secretion is more profuse; a large quantity of the secretory product accumulates under the cuticle, while the dermal cells seem to fade away.

With regard to the circuli of the *Pseudococcidae* and *Monophlebinæ* I have arrived at the following conclusions. 1) In *Pseudococcus* the circulus is an adhesive gland, as shown by PESSON (1939), and myself. 2) The dark pigment, which is often found on the surface of the circulus, is the hardened slime secreted by its glandular cells. 3) In *Walkeriana tosariensis* the large median circulus and the smaller lateral ones have the same structure, and probably also the same function. It is desirable to examine by experiments with living *Monophlebinæ*, as was done with *Pseudococcus*, whether their circuli are really adhesive glands, as may be expected from a comparison of their structure with that of *Pseudococcus*.

The cuticle of the dorsum is much thicker than that of the venter. The dorsal spines are hollow structures: the striation at their base is

*) This was very conspicuous in one of GREEN's slides of *Walkeriana senex*, mentioned above. All of the 13 circuli had a central disk of chitin, stained red by fuchsin, while the remainder of the circulus, with exception of its rim, was left unstained.

due to ridges on their external surface (fig. 47). VAYSSIÈRE (1926, p. 211) interpreted the dorsal spines in *Walkeriana* and *Aspidoproctus* as glandular spines ("poils glandulaires"), similar to those of the *Ortheziinae*. I doubt whether this interpretation is correct, and suppose that in both cases these spines only support the wax projections which are produced by the adjacent quadrilocular pores*). In both cases there is a very large dermal cell, with only one nucleus, at the base of the spine, which is probably the trichogenous cell. In *Walkeriana tosariensis* the nucleus of this cell is surrounded by a mass of protoplasm which tapers into a point directed towards the base of the hollow spine. The nuclear protoplasm is separated by a slit from the remaining protoplasm which lines the wall of the trichogenous cell (fig. 47). Small vacuoles, indicating secretory activity, were not observed in these cells. The dorsal wax projections are probably wholly produced by the band of quadrilocular pores which surrounds the spine group, while the spines themselves only support the wax structures. Where wax production is profuse, the wax is formed by quadrilocular pores, as is clearly seen in the ovisac band where these pores are densely crowded and the only type present. The question whether the dorsal spines in *Walkeriana tosariensis* produce any secretion cannot be definitely solved, as living species are not available.

In young adult females of *W. tosariensis* the dorsum between the spine groups is covered by a grey layer which consists of an equal mixture of white and dark dots. The white dots consist of wax, the dark ones of an entangled mass of greenish brown filaments as mentioned in the description of the adult female. Both products are secreted by the quadrilocular pores, but I failed to find two types of glands in the sections. The brown filaments are not solved by the xylene-treatment during embedding; in sections they appear to emerge from the quadrilocular pores (fig. 43). The filaments are abundant between the dorsal spine groups, and along the margin of the body; they seem to be absent on the venter, excepting the ovisac-band.

The segmentally arranged reticular sclerotizations on the dorsum, which VAYSSIÈRE (1926) has called "organes grillagés", are areas in which large muscles are inserted to the dorsal cuticle (figs. 39—41). Some of these muscles run in a dorso-ventral direction, other ones parallel to the surface of the body. On the ventral side the main muscles are inserted on, or near, the sutures of the segments.

The polygonal reticulated cells at the inner end of the anal tube are of a glandular nature, as is shown by the structure of their protoplasm (fig. 42).

In sections the gland pores are always closed at their bottom, so that the secretory product has to be filtered through it to reach the cavity of

*) LIST (1887) has given rise to the opinion that the dorsal spines of *Orthezia* have a secretory function. His observations of wax filaments projecting from an opening at the top of the spines were certainly faulty, further he overlooked the quadrilocular pores which are nowhere mentioned (See his figs. 16 and 21). Secretory spines without doubt exist in some coccids. In *Eriococcus devoniensis* GREEN the dorsal spines are enveloped by long wax rods, and in *Ripersia mesnili* BALACH. they are covered by a hollow wax replica of the lanceolate spine, as is shown by fresh specimens mounted in diluted glycerine. In these cases the wax is apparently secreted by the base of the spines, in which the chitin-layer is very thin.

the pore, where it takes its definite shape after hardening. The elongate cells, which are connected with the quadrilocular pores of the ovisac band, are multicellular; sometimes 7 nuclei were counted in one gland. The protoplasm of these glands usually contains several small vacuoles as a sign of their secretory activity (fig. 45); the same applies to the cells of the multilocular pores found on the venter within the ovisac band (fig. 46). The glands of the quadrilocular pores on the dorsum, and the polygonal wax pores of the anal tube, are also multicellular: their protoplasm often shows secretory vacuoles (figs. 48 and 42).

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EXPLANATION OF FIGURES.

The different stages are represented in the following figures. *Adult female*: pl. I, and figs. 25—50. *Larva I*: figs. 1—18. *Larva II*: figs. 19—20. *Larva III* ♀: fig. 21. *Larva III* ♂ (prepupa): fig. 22. *Larva IV* ♂ (pupa): figs. 23—24.

PLATE I. Adult females of *Walkeriana tosariensis* on the stem of *Casuarina Junghuhniana*; natural size. Photographs made by Prof. Dr. W. K. J. ROEPKE in 1910, when he collected the insects.

Upper photo. Four adult females with ovisacs. The lower specimen at the right shows near the tip of the ovisac some newly emerged larvae with long wax filaments; length of the larvae about 1.5 mm., of the filaments 5 mm.

Lower photo. A single adult female with ovisac. The dorsal wax projections and the ovisac are clearly visible. There is a slit along the middle line of the ovisac through which the newly born larvae can escape outside. Wax filaments of some of these larvae are seen at the tip of the ovisac. One cm above the adult female a large larva (larva II?) is visible; length about 4.5 cm. About one cm to the right of this larva there is a small specimen (probably larva I); length about 2.5 mm. On the dark hollow spot about 2.5 cm above the adult female, another small larva is faintly visible.

These details were seen on inspecting the original photograph with a pocket lens.

- FIGURE 1. Dorsal view of first stage larva (×65). The figure shows the position of the dorsal spine groups, rostral loop, marginal hairs (with bilocular tubular glands at their base), antennae, legs, eyes, and circulus (dotted; below the rostral loop). The spine groups on head and thorax are often irregular by fusing; that on the apex of the abdomen is usually absent or indistinct. Hairs, spines, and wax pores between the spine groups are omitted. The rostral loop lies in the interior of the body, the circulus on the ventral side. The figure is more or less schematic, and based on the examination of several larvae I.
- FIGURE 2. Part of a spine group on the first abdominal segment (intermediate series); 3 spines at the margin of the cluster with surrounding line of quadrilocular pores. These pores show on the outside a prop of some matter that was not destroyed by KOH. (×630).
- FIGURE 3. Marginal hair on frons with 4 bilocular tubular glands at its base. (×200).
- FIGURE 4. One of the bilocular tubular glands of fig. 3 (×630), as seen from the side, and from above. The contents of the tubular duct is probably shrivelled, as the larvae had been preserved in a dry state during more than 40 years before preparing them.
- FIGURE 5. Some types of dorsal wax pores (×630). *Upper row*, from left to right: (a) on thorax; one of the pores surrounding a spine group of the intermediate series, (b) on the thorax between the spine groups, (c, d) on the abdomen between the spine groups, (e) on head and thorax (this type is rare). *Lower row*: types of multilocular pores near the anal opening, outside the fimbriated hairs (one of these hairs is shown near the first pore).
- FIGURE 6. Thoracical spiracle, with bar; opening and bar shaded. (×200).
- FIGURE 7. Two of the abdominal spiracles (×630).
- FIGURE 8. Eye (×430).
- FIGURE 9. Hind leg (×200).

- FIGURE 10. Claw of hind leg ($\times 430$).
- FIGURE 11. Chitinous part of sensorium at base of tarsus ($\times 630$).
- FIGURE 12. Antenna ($\times 300$): membranous parts dotted.
- FIGURE 13. Top of an antenna with 5 sensory hairs and 2 sensilla ($\times 630$): of the ordinary hairs only the base is indicated.
- FIGURE 14. Six types of ventral wax pores ($\times 630$). From left to right: (a) between eye and fore leg, (b) near the eye, (c) near anterior spiracle, (d) between eye and fore leg, (e) near middle leg, (f) near margin of abdomen.
- FIGURE 15. Labium of larva I, seen from the ventral side ($\times 200$). Only the bases of the mouth setae, between which the chitinous parts of the salivary pump are visible, are figured. The labium is surrounded by ca. 30 high quadrilocular pores; one of these pores is figured in detail ($\times 630$). The 6 bluntly pointed hairs near the tip of the labium are drawn with a heavy line, but they are as slender as the other hairs. At the sides of the labium the coxae of the fore legs are visible. Parts below the surface are figured by a broken line or dotted.
- FIGURE 16. Anal tube of Larva I ($\times 630$). At the top of the figure the two rows of polygonal cells at the inner end of the tube are visible, and in the middle of the tube a single row of multilocular pores. Around the anal opening the 8 fimbriated hairs are shown.
- FIGURE 17. Larva I. Hairs, spines, and wax pores between the median and intermediate spine group of the first abdominal segment ($\times 430$).
- FIGURE 18. Larva I. Two hairs of the ventral surface ($\times 630$).
- FIGURE 19. Larva II. The circuli ($\times 65$).
- FIGURE 20. Larva II. Polygonal cells at the inner end of the anal tube ($\times 630$).
- FIGURE 21. Larva III ♀. Above: Polygonal cells of the anal tube, ($\times 630$). Below: a wax pore from the ventral surface ($\times 630$).
- FIGURE 22. Larva III ♂ (prepupa). At left a wax pore (ca. $\times 1350$), at right two abdominal spiracles ($\times 630$).
- FIGURE 23. Larva IV ♂ (pupa). At left hind leg ($\times 45$), at right wing pad ($\times 45$).
- FIGURE 24. Larva IV ♂ (pupa). Above: multilocular wax pore from the dorsal surface, with central pore prolonged into a conical tube ($\times 630$). At left of this figure the same pore, as seen in an oblique direction. Below: multilocular pore from the ventral surface ($\times 630$).
- FIGURE 25. Adult female. Diagram of the position of the dorsal spine groups ($\times 6$). The horizontal line indicates the separation between abdomen and thorax. The anal area and the anal opening (A) are also shown in the figure (cf. fig. 28).
- FIGURE 26. Part of a lateral spine group on the abdomen ($\times 430$).
- FIGURE 27. Spines between the marginal and intermediate spine groups of the abdomen ($\times 430$). These isolated spines are shorter, more sclerotized, and not directed towards a central point as those in the spine clusters which bear the wax projections (cf. fig. 26).
- FIGURE 28. The anal area with its long hairs ($\times 40$). The anal opening is shown by a full line, the anal tube (within the body) by a broken line. The dotted lines indicate the outline of adjacent spine groups (cf. fig. 25).
- FIGURE 29. A collared hair near the margin of the body ($\times 430$); the collar is shown more enlarged ($\times 630$) in longitudinal section in a separate figure.
- FIGURE 30. Some types of wax pores from the dorsal surface ($\times 630$). Upper row: at left a multilocular pore from the anal area, at right a quadrilocular pore from the edge of a marginal spine group. Bottom row: 3 types of pores found behind the anal area.
- FIGURE 31. Some types of pores from the ventral surface ($\times 630$). The 2 pores at left were observed between the antennae. The 2 pores at right are from the abdomen; upper figure, a quadrilocular pore from the ovisac band; lower figure a multilocular pore from the area enclosed by the ovisac band (for a longitudinal section of this pore see fig. 46).
- FIGURE 32. Polygonal cells in the anal tube of the adult female ($\times 630$).
- FIGURE 33. Outline of the antennae of all stages, excepting the adult male which was not available (fig. IV ♂ $\times 40$, other figs. $\times 65$); I—III refer to larvae I—III, III ♂ to the prepupa, and IV ♂ to the pupa of the male.
- FIGURE 34. Sensory hair and sensillum near top of sixth antennal segment of an adult female ($\times 630$).

- FIGURE 35. Three abdominal spiracles of the adult female ($\times 430$).
- FIGURE 36. Anterior spiracle on the thorax of an adult female ($\times 90$).
- FIGURE 37. Hind leg of adult female ($\times 40$).
- FIGURE 38. Claw of the same leg ($\times 200$); *t* = tendon.
- FIGURE 39. Dorsal surface of the abdomen of the adult female with reticulated sclerotizations, to which muscles are inserted ($\times 20$).
Black: Reticulated sclerotizations, arranged in longitudinal rows. The musculature of the 2 innermost rows is (partly) indicated by dotted lines.
Broken lines: Outline of dorsal spine groups.
Dotted circles: Central circulus with 6 lateral circuli; on the ventral surface of the abdomen.
Small circles (full lines): Abdominal spiracles, situated within the lateral spine groups (6 pairs), and one median pair
The anal area, and the ring of polygonal cells in the anal tube, are also shown by a full line (cf. fig. 28).
- FIGURE 40. One of the smaller reticulated sclerotizations of fig. 39 more highly magnified ($\times 430$).
- FIGURE 41. Two sections, vertical to the surface of reticulated sclerotizations, to show the insertion of muscles ($\times 200$).
- FIGURE 42. Polygonal cells of the anal tube with their glands ($\times 630$). *Lower figure*: section about parallel to the plane of the ring of polygonal cells. *Upper figure*: 2 transversal sections of the glands; the vacuoles point to a secretory function.
- FIGURE 43. Quadrilocular pores near the anal area; section vertical to the surface ($\times 650$). Greenish brown filaments, not destroyed by the xylene-treatment during embedding, are emerging from the quadrilocular pores; transversal sections also prove that these filaments arise from the quadrilocular pores.
- FIGURE 44. Section through the ovisac band, vertical to the ventral surface ($\times 200$). The quadrilocular pores of the ovisac band are connected with elongate glands.
- FIGURE 45. One of the glands of fig. 44 in longitudinal section, and 2 transversal sections of these glands ($\times 650$). The small vacuoles point to a secretory function.
- FIGURE 46. Elliptical wax pore in the area enclosed by the ovisac band, with its gland in longitudinal section ($\times 630$). Cf. fig. 31.
- FIGURE 47. Spine from a lateral spine group in longitudinal section ($\times 630$).
- FIGURE 48. Transversal section of the glands pertaining to the quadrilocular wax pores lining a lateral spine group ($\times 630$). Secretory activity is shown by the presence of small vacuoles.
- FIGURE 49. Section of one of the lateral circuli, vertical to the surface ($\times 430$). The elongate cells below, the surface of the circulus are apparently of a secretory nature. The hardened secretion has formed dark flakes on the surface of the circulus. The circulus is bordered by a strip of yellow chitin (white in the figure) which forms the sclerotized rim of this structure; all other parts of the circulus are stained blue by haematoxylin, but the sclerotized rim is left unstained.
- FIGURE 50. Piece of a wax projection from the dorsal side after extraction of the wax with boiling benzene ($\times 200$). The remaining mass consists of an irregular network of greenish brown filaments which are partly closely packed in longitudinal strips.