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HIPPEOCOCCUS A NEW GENUS OF PSEUDOCOCCIDAE FROM JAVA WITH PECULIAR HABITS

by

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In 1950 I received from Mr. D. Hille Ris Lambers a strange Pseudococcid from Java which had been collected by Mr. F. W. Rappard, a senior forestry officer, who regularly collects aphids for Mr. Hille Ris Lambers on his tours of duty. As this insect was a coccid, it was transmitted to me for examination. Its appearance is quite abnormal; the shape of its body reminds one almost of a large mite (fig. 4). The 6-segmented antennae have a dense vestiture of fine hairs, with exception of the 2 first segments which are very short. A tuft of 5 very long setae is present on the top of each of the anal lobes. The ungual digitules are extremely large and very flat. It was only after close study that the insect was recognized as a Pseudococcid. It has 2 pairs of ostioles in the usual position, a circulus on the ventral side of the second abdominal segment, and a few trilocular pores on both sides of the body.

As I suspected an abnormal mode of living, I asked Mr. Hille Ris Lambers to write to Java for further particulars, and more material. To comply with this request Mr. Rappard has collected abundant material and communicated his field notes on these insects, which he calls "ant-riders" from their peculiar habit of climbing upon the black ants by which they are closely attended, as soon as these ants are disturbed, to have themselves transported in this way.

The material at hand contains 3 different instars which seem to represent first and second stage larvae, and immature adult females. Of the latter stage only 3 specimens are available. Eggs or embryos were not observed in these specimens, but in one of them the oviduct and its exterior opening (one segment behind the posterior ostioles) is faintly visible in the chitinous preparation (fig. 28). The body of this stage (III) has a length of 1.8

-2.2 mm (measured on the slide), the length of stage II is 1.4-1.8 mm, of stage I 1.0-1.4 mm. In the second stage 2 types of larvae were found; one type has only a few trilocular wax pores like the adult female, but the other type also tubular and multilocular glands. I suppose that the latter type represents the male larva, and that the tubular and multilocular glands serve to prepare a cocoon for the pupal stages. As mature females (with eggs or embryos), adult males, and pupal stages are absent in the abundant material at hand, it seems likely that these stages are not to be found among the ants on the trees, to which Mr. Rappard has directed his special attention. Perhaps we have to look for them in, or near, the ants' nests which have not been examined.

An extract from Mr. Rappard's field notes is given below. Collected: 1) On *Ficus variegata* Bl. on the estate Gondang (900 m above sea-level, Yang Mts., East Java), 21.VII.1950). 2) On suckers of *Eugenia* sp. and *Litsea confusa* K. et V. at Gaden (East Java), on the slopes of Mt. Kawi, 1400 m above sea-level, in moist virginal forest consisting principally of oaks, 13.II.1951. 3) In the same locality on the stems of *Rubus* sp. Some parts of the *Rubus*-stems were occupied over a length of 15 cm by a dense crowd of black ants which covered the sucking coccids. 4) Observed in the same locality at the outskirts of the wood on *Eupatorium* sp. (no material collected). 5) On Mt. Kelet (near Mt. Kawi, East Java), 1400 m above sea-level, on the outskirts of evergreen wood, on the suckers of an unidentified tree, 8.VIII. 1951.

With a pocket lens (12 ×) small brown spots were seen on the shoots of *Eugenia* and *Litsea* which were probably due to the punctures of the coccids. These insects are dark brown to greenish brown (the smaller larvae yellowish to yellowish brown), their legs and antennae light brown. The colour of the greenish specimens became more pronounced after submersion in alcohol. The insects are very agile and run quickly; their bodies are gleaming, and without any trace of wax.

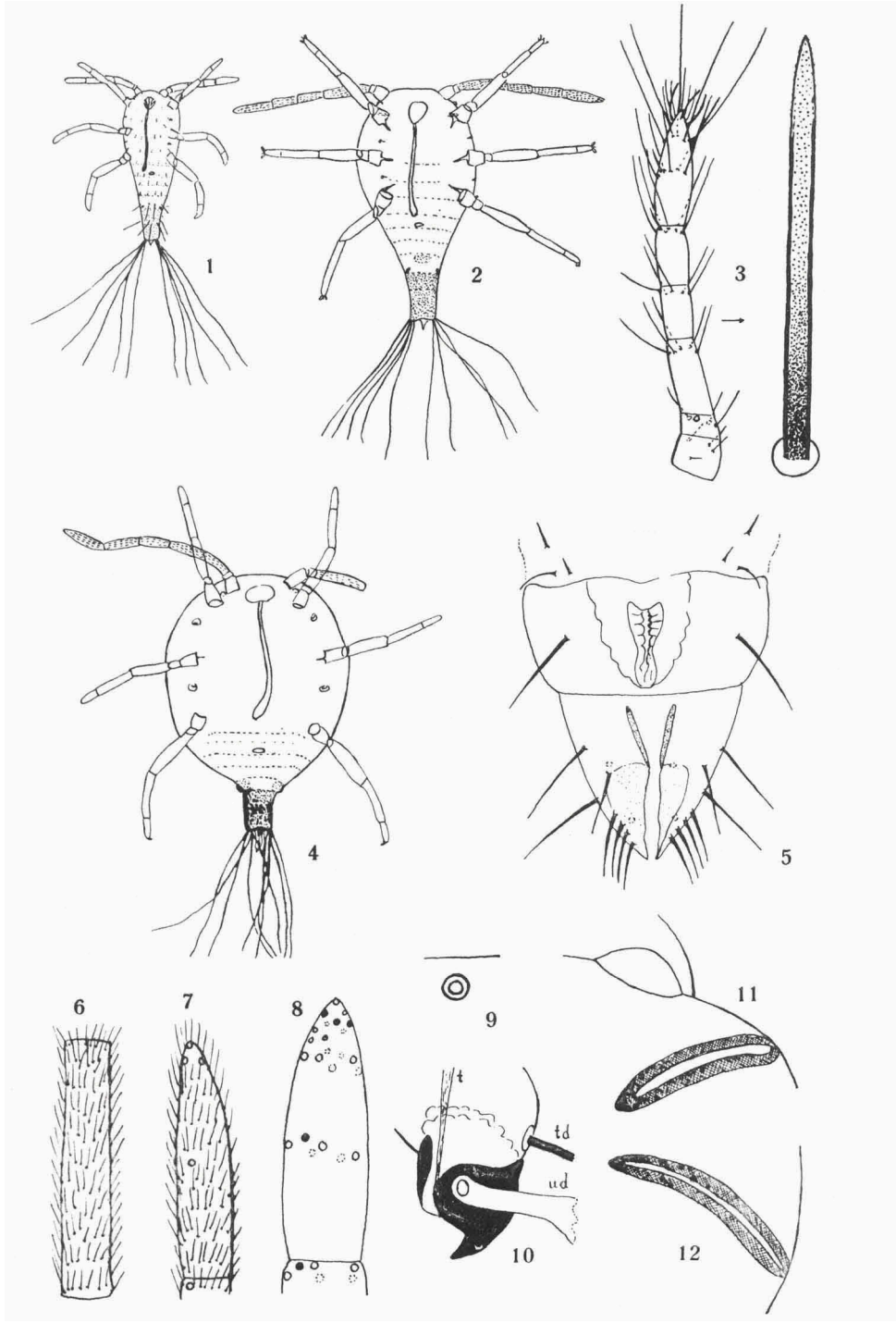
Some black ants, while running away, were captured with the coccids sitting crosswise on their thorax (fig. 29). To other ants 4-5 larvae were clinging (they were still seen in that position when the alcohol material arrived in Holland). Some shoots of *Eugenia* and *Litsea,* with a large number of ants carrying coccids, were cut off and dropped in a large collecting bottle. When these shoots were examined shortly afterwards (during a halt) the coccids were no longer seen, but on closer inspection it appeared that they had descended from the ants and were sucking on the shoots concealed by their attendants.

As Mr. Rappard did not make any mention of honey-dew secretion by

the coccids which probably allures the ants, we asked him to pay attention to this subject. In answer to this request he reported the following observations, made on Mt. Kelet, at an altitude of about 1400 m, in August 1951. Many thousands of these coccids were found on the suckers of an unidentified tree, attended by several hundreds of black ants; sometimes the shoots were covered over a length of more than 20 cm by a dense crowd of ants and coccids. The coccids had usually a clear drop of liquid at the tip of their abdomen between widely diverging silvery hairs (apparently the anal hairs), but the ants seemed to show little interest in this liquid. With their antennae they drummed incessantly on a certain spot of the coccid, even after it had climbed upon the ant. No secretion of fluid was seen on the spot in question. Occasionally an ant opened its jaws to grasp the abdomen of the coccid and passed its jaws over it, but it was not clear for what purpose.

From these notes it appears that the coccids are rather polyphagous as they have been found on *Ficus* (Moraceae), *Litsea* (Lauraceae), *Eugenia* (Myrtaceae), *Rubus* (Rosaceae) and *Eupatorium* (Compositae). The attending black ants in all cases observed seem to belong to the same species. Through the kindness of Dr. W. J. Hall (London) they were identified by Mr. G. E. J. Nixon as *Dolichoderus* (*Hypoclinea*) sp. near *tuberifer* Emery. A large sample of these ants, preserved in alcohol, showed that most specimens were carrying coccids (especially their younger stages) which were clinging to the legs, antennae, and other parts of the body. The dispersal of the younger stages of this coccid is certainly much favoured by their habit of climbing upon the attending ants.

As the coccid in question showed by its shape of body some resemblance to the myrmecophilous genera *Xenococcus* from India, and *Eumyrmococcus* from China, as described by Silvestri (1924, 1926), I applied to Prof. G. F. Ferris, who in recent years collected a large number of scale insects in China, for an identification of the genus of the Java species. Prof. Ferris kindly examined my sketches of the Java species, and mentioned, besides the genera *Xenococcus* and *Eumyrmococcus,* the genus *Allomyrmococcus* Takahashi of which at the moment he could find no reference. He stated, however, that he had never seen representatives of any of these genera. As the latter genus is not mentioned in Neave's Nomenclator Zoologicus (1939-1950), and not in the Zoological Record (1935-1950), I asked Mr. Hille His Lambers to write to his former correspondent Dr. R. Takahashi in Japan for further information. Some months later we received two publications in which Takahashi (1941, 1950) describes his new genera *Allomyrmococcus* (1941), *Paramyrmococcus* (1941), and *Malaicoccus* (1950). These genera, which are allied to each other, show the same large flat ungual



Figs. 1-12. *Hippeococcus rappardi* nov. gen., nov. spec. For explanation see p. 237.

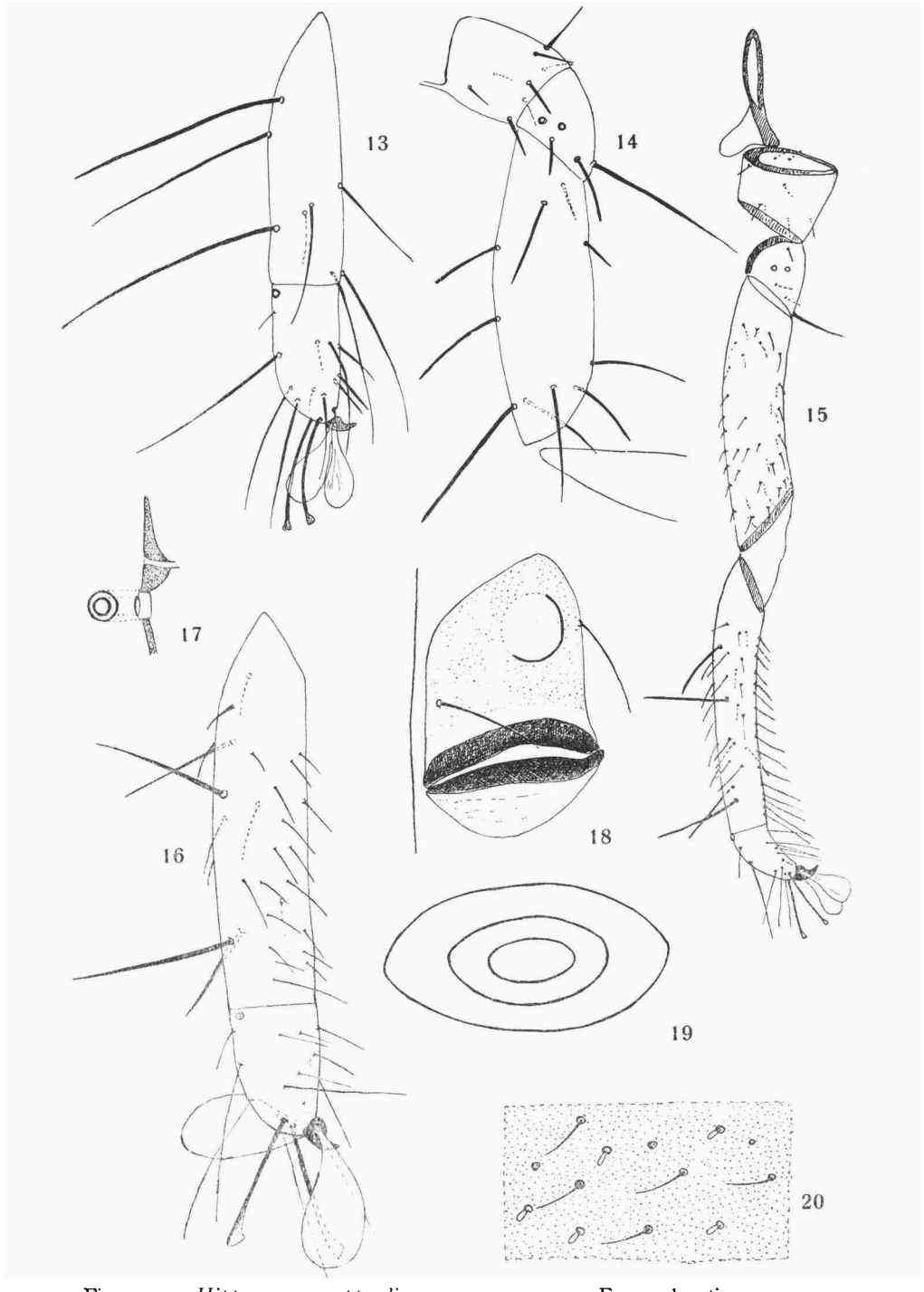
digitules as the Java species, but Takahashi makes no mention of their transport by the attending ants, which are a *Dolichoderus* sp. in the case of *Allomyrmoccus* and *Paramyrmococcus,* and a *Polyrhachis* sp. in the case of *Malaicoccus.*

The Java species is certainly more closely allied to the genera of Takahashi than to those of Silvestri which have short spine-like ungual digitules, and differ in other respects. Our species does not fit into one of Takahashi's genera, though it comes near *Paramyrmococcus.* This was also the opinion of Dr. W. J. Hall (London) to whom some specimens of stages I and II were sent. For this reason I propose a new genus for it, named *Hippeococcus.* With our present fragmentary knowledge of these peculiar coccids from Eastern Asia it is not possible to give a definite opinion on their systematic relationships. The distinctive features may be largely adaptive characters, due to myrmecophily; the adult males are still unknown, even in the case of *Hippeococcus* where male larvae occur. The present species is named *rappardi* after Mr. Rappard, who collected the insects and made several observations on them in their natural habitat.

Hippeococcus nov. gen.

Adult female. Body gleaming, without a coating of wax, densely covered with small hairs of the ordinary type and very small hairs which are spatula-shaped; abdomen tapering. Antennae 6-segmented, densely covered

Fig. 1. First stage larva, ventral surface. Hairs on antennae and legs omitted.
Fig. 2. Second stage larva, ventral surface. Hairs on body and legs omitted.
Fig. 3. First stage larva. Antenna and antennal hair. Cf. figs. 8 and 9.
Fig. 4. Adult female, ventral surface. Hairs on body and legs omitted.
Fig. 5. First stage larva. Labium, ventral side.
Fig. 6. Adult female. Third antennal segment.
Fig. 7. Adult female. Apical antennal segment; position of the sensory hairs on the two last segments indicated by circlets.
Fig. 8. First stage larva. Position of hairs on the two last antennal segments; black dots indicate sensory hairs.
Fig. 9. First stage larva. Sensorium near top of second antennal segment.
Fig. 10. First stage larva. Claw with base of ungual digitules (*ud*) and tarsal digitules (*td*). The claw can be partly withdrawn into a kind of pocket by the tendon *t.*
Fig. 11. First stage larva. Anterior ostiole and eye.
Fig. 12. First stage larva. Posterior ostiole. Due to narrowing of the abdomen the posterior ostioles have shifted to the sides, or even to the ventral surface of the body (cf. figs. 32, 33).
Figs. 1, 2, 4, × 20; 3, × 90 and 630; 5, × 430; 6, 7, × 90; 8, × 200; 9, 10, 11, 12, × 630.



Figs. 13-20. *Hippeococcus rappardi* nov. gen., nov. spec. For explanation see p. 239.

with small hairs, except the two basal segments. Legs with a small recurved claw, and very large flat claw digitules; tarsal digitules stoutly knobbed. Anal lobes with a tuft of 5 or 6 long setae. Anal ring without pores, with 6 anal hairs. Very few gland pores of the trilocular type, and still less of an unilocular type; other types absent. Two pairs of ostioles with sclerotized rim. A circulus on the ventral side of the second abdominal segment.

Type species *H. rappardi* nov. spec. Types in the Rijksmuseum van Natuurlijke Historie at Leiden.

Hippeococcus rappardi nov. spec.

First stage larva (fig. 1)

Length of body 1.0-1.4 mm, width 0.3-0.6 mm (measured on the slide). Pale brown or yellowish brown, without wax coating.

Antennae 6-segmented (fig. 3), 0.6-0.7 mm in length; of the normal Pseudococcid type, with whorls of 5 hairs on the segments III-VI; the dense vestiture of fine hairs on the 5 distal segments, as found in the following stages, is still absent. Segment I with 4 short hairs (one very small). Segment II with the usual sensorium near its top (fig. 9), and 3 hairs which are longer than those on segment I. The basal segments I and II are very short in comparison to the others. Segment III has a whorl of 5 hairs (ca. 90 μ in length) near its top, which are longer than those on segment II. Segments IV and V show the same condition, but the hairs are somewhat longer than on segment III. Segment V shows a short sensory hair near its top. On segment VI a lower whorl of 5 long hairs and a short sensory hair are present, further an upper whorl of 5 longer hairs (200-230 μ), and an apical group with 3 short sensory hairs and 7-9 short hairs of the ordinary type (fig. 8). The antennal hairs are stiff setae with

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Fig. 13. First stage larva. Tibia and tarsus of hind leg.
Fig. 14. First stage larva. Coxa, trochanter, and femur of the same leg.
Fig. 15. Adult female. Hind leg.
Fig. 16. Second stage larva. Tibia and tarsus of hind leg.
Fig. 17. Second stage larva. Sensorium near top of tarsus.
Fig. 18. Second stage larva. Eye with sclerotized plate (dotted) and anterior ostiole.
Fig. 19. Outline of circulus in the 3 described stages. The outermost figure refers to the adult female, the middle one to the second stage larva, and the innermost figure to the first stage larva.
Fig. 20. Adult female. Cuticle on dorsal surface of metathorax, with numerous minute waits, 2 trilocular pores, 1 unilocular pore, 5 ordinary hairs, and 5 spatulate hairs.
Figs. 13, 14, 16, × 200; 15, × 90; 17, 19, × 630; 18, 20, × 430.

a hyaline, slightly roughened top, and a darker base (fig. 3). The same type of hairs is found on the body and the legs. The top of these hairs is rather blunt, acuminate, but in the apical hairs (as those on the last antennal segment, the tibia, tarsus, and posterior abdominal segments) drawn out into a long and fine point. The sensory hairs are short and unconspicuous, rather sharply pointed, and slightly curved; the 2 lower ones are straight; their position is shown in fig. 8.

In the legs the tarsus is about half as long as the tibia (fig. 13); both are provided with some long hairs (135-175 μ). The tarsus has stoutly knobbed tarsal digitules and very large flat claw digitules (fig. 13). The latter are apparently used by the coccids to hold fast on the body of the ants which transport them. By their specialized claw digitules, and by their agility, these coccids are able to make use of their swift attendants as a means of conveyance. It seems that the basal part of the small recurved claw can be withdrawn into a kind of pocket (fig. 10), and that only the digitules are used while climbing upon the smooth ants. There is a sensorium on the basal end of the tarsus at the exterior side, as in most other Pseudococcidae (cf. figs. 13 and 17); it is also mentioned by Silvestri (1924, 1926), but not by Takahashi (1941, 1950).

The lips of the ostioles and the last 2 abdominal segments are sclerotized; the anterior ostiole lies close to the eye (figs. 11, 12, 32, and 33).

The abdominal segments (figs. 32 and 33) are provided with transversal rows of 10-14 stiff setae (length ca. 50 μ) which are hyaline and slightly rough at their tip, but somewhat darker in the basal part. Similar setae are found on the antennae (fig. 3) and legs. The ventral setae of the penultimate and antepenultimate abdominal segments are much larger than the others (220-260 μ); this applies also to the dorsal setae of the penultimate segment.

The arrangement of the setae on antennae and body shows a primitive condition in comparison with the following stages, as would be expected in the first larval stage.

The anal lobes are obsolete. Each lobe has on its top a tuft of 5 long setae (fig. 1) which are as long as the body (1.0-1.3 mm); 2 of these setae are found on the dorsal side, 2 on the ventral side, and one laterally.

Anal ring without pores, almost membranous, with 6 ribbon-shaped anal hairs (of ca. 200 μ) which are slightly twisted.

Labium of the same type as in other Pseudococcidae (fig. 5); the rostral loop reaches the second abdominal segment.

A small medio-ventral circulus (15-20 μ) is found near the posterior edge of the second abdominal segment (figs. 1, 19 and 33).

Spiracles without special details (fig. 35).

The only gland pores present are a few trilocular pores of obscure structure; not more than one or two could be found on each abdominal tergite. The insects are without any coating of wax, and soon shrivel if removed from the moist atmosphere of the primeval forest.

Larvae preserved in alcohol have often their abdomen curved upward; it is not known to me whether this is also the case in living specimens.

Second larval stage of the female (fig. 2)

Dimensions of body 1.4-1.8 × 0.6-1.0 mm. Length of antennae 1.1-1.3 mm.

This stage differs from the first stage larva in the following respects.

1) The 4 distal segments of the antennae are densely covered with fine hairs (fig. 2) which have replaced the stiff setae found in the first stage; the 5 sensory hairs are found in the same position as in larva I.

2) The transversal rows of stiff setae on the dorsum of the first stage larva have been replaced by fine hairs like those found on the antennae (fig. 30), but the 4 long setae on the ventral side of the penultimate and antepenultimate segment of the abdomen are still present (fig. 31). The last abdominal segment shows several small hairs besides the large setae on the anal lobes. The sclerotization of the last abdominal segments is more pronounced than in the first stage larva.

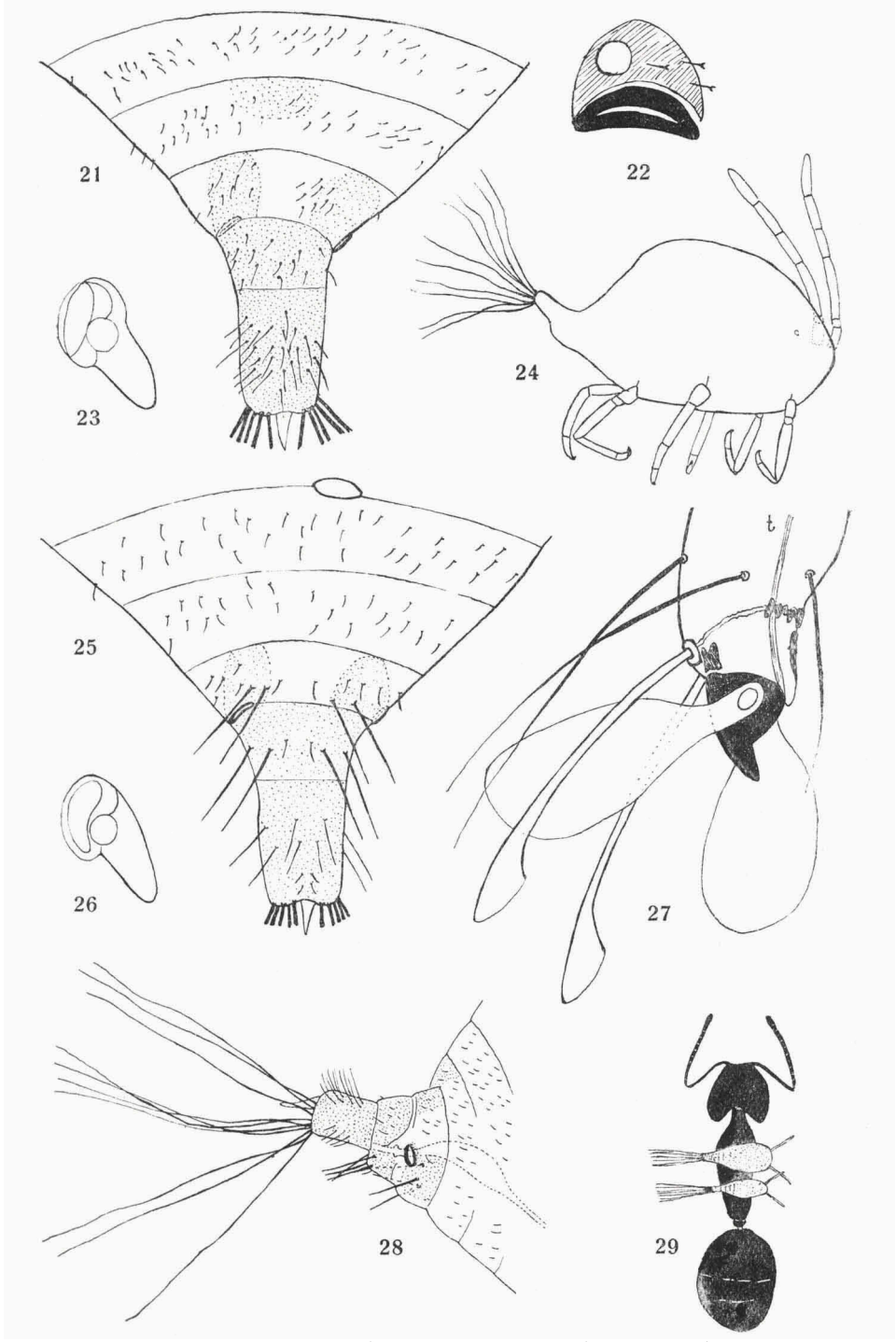
3) The eye is surrounded by a sclerotized plate which is connected with the sclerotized rim of the anterior ostiole (fig. 18).

4) Tibia and femur have about four times as many hairs as in the first larval stage (fig. 16). The ratio tarsus: tibia is 1 : 2.5-3.0.

Second stage larva of the male

Among 19 specimens of the second stage 4 were provided with multilocular and tubular glands in addition to the few trilocular pores which are the only gland pores present in the other specimens (fig. 38). I suppose that these 4 specimens are male larvae, and that the multilocular and tubular glands serve to prepare a sort of cocoon for the pupal stages.

These glands are distributed over the whole surface of the body with exception of the sclerotized posterior segments. On each of the first 3 abdominal segments 6-14 multilocular pores and 5-10 tubuliferous pores were counted. In one case 22 multilocular and 13 tubular glands were observed on the mesothorax. The tubular glands are principally found on the dorsum and the sides of the body. They have an abnormal structure (fig. 38). The distal end of the tubule is thick-walled, and a filament at the proximal end seems to be absent; dimensions 6-7 × 3 μ. The multilocular



Figs. 21-29. *Hippeococcus rappardi* nov. gen., nov. spec. For explanation see p. 243.

pores are found on both sides of the body; they have a diameter of 8 μ, and 12 loculi.

Dimensions of the male larvae examined 1.5-1.6 × 0.8-0.9 mm; antennae 0.8 mm. They are perhaps somewhat smaller than the female larvae II, but the only real difference observed is the presence of multilocular and tubular glands. The adult male and the pupal stages are still unknown.

Adult female (fig. 4)

Only 3 young specimens (without eggs or embryos) were available for examination. Dimensions (on slide) 1.8-2.2 × 1.3-1.4 mm, height 1.3 mm; length of antennae 1.3-1.6 mm. The smallest specimen (1.8 × 1.3 mm; antennae 1.3 mm) had just moulted.

Specimens in alcohol, seen from the side, show that the body is almost hemispherical, and that the last 3 abdominal segments are slightly turned upwards and the antennae kept raised (fig. 24). The interior of the body shows a white greenish granular mass.

This stage is distinguished from the ♀ larva II by its greater width, and by the vestiture of the body. In addition to the fine hairs (of ca. 25 μ), found in the preceding larval stage, there are also short spatula-like hairs (6 μ) and small warts on the cuticle (fig. 20).

Fig. 21. Adult female. Abdomen, dorsal surface. In figs. 21, 25, and 30-33 the long hairs on the anal lobes are not shown; only their bases are indicated. The anal hairs are also omitted. Besides the small hairs on the abdominal segments there are about 10-12 hairs on each segment which are somewhat larger, about twice the size of the others. They seem to correspond to the hairs present in the first stage larva, but the position is somewhat irregular. As the difference is not clearly seen at lower magnification, it is not shown in figs. 21, 25, 30, and 31.

Fig. 22. Adult female. Eye with sclerotized plate and anterior ostiole. The eye-plate probably rises above the surface of the body as in the adult female of *H. wegneri* (fig. 52), of which a large number of unmounted specimens were examined, in addition to the microscopical preparations.

Fig. 23. Adult female. Posterior spiracle.

Fig. 24. Adult female, lateral view. The antennae and the tip of the abdomen are kept raised; drawn from a specimen, preserved in alcohol.

Fig. 25. Adult female. Abdomen, ventral surface. Cf. fig. 21.

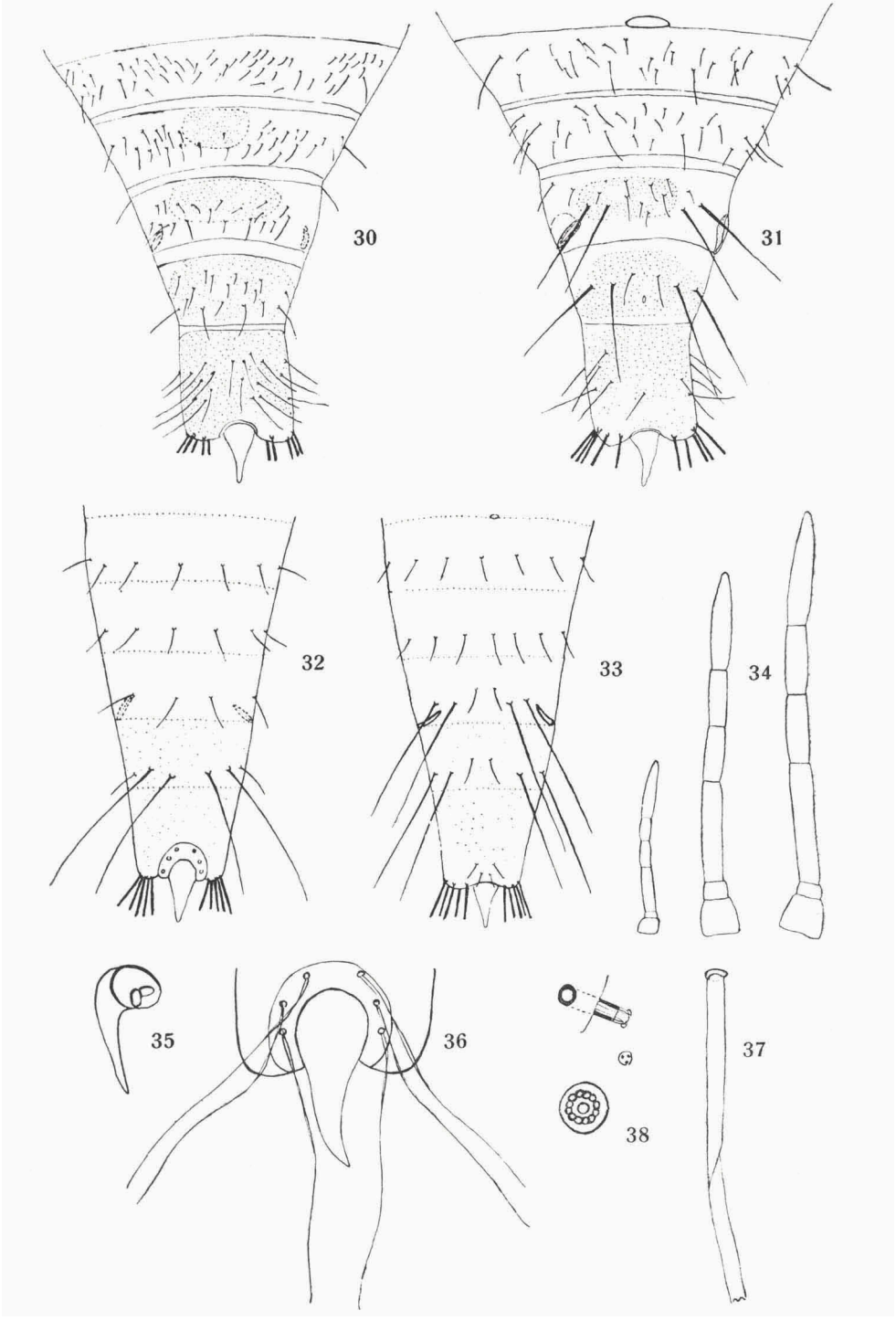
Fig. 26. Adult female. Anterior spiracle.

Fig. 27. Adult female. Apical part of tarsus with tarsal digitules, and claw with large ungual digitules. The claw can be partly withdrawn into a kind of pocket by the tendon *t*.

Fig. 28. Adult female. Tip of abdomen, lateral view. The oviduct is indicated by a broken line.

Fig. 29. Two larvae which have climbed upon the thorax of one of the attending ants (*Dolichoderus* sp.) which ran away after being disturbed.

Figs. 21, 25, × 90; 22, 23, 26, × 200; 24 × 20; 27, × 430; 28, × 40; 29, × ca. 10.



Figs. 30-38. *Hippeococcus rappardi* nov. gen., nov. spec. For explanation see p. 245.

In the legs (fig. 15) the tibia is more than 3 times as long as the tarsus (average in fore legs 3.8, middle legs 3.5, hind legs 3.1); in larva II the ratio is at most 1 : 3.0, in larva I it is about 1 : 2.0.

The other features are about the same as in the ♀ larva II. For the sake of completeness the following diagnosis is given of the adult female.

Body gleaming, without wax coating, hemispherical. Abdomen tapering, with last segments turned upwards, and a tuft of 5 long setae (1.0 mm or more in length) on the top of the anal lobes (figs. 4 and 24).

Antennae 6-segmented (figs. 4, 6, and 7) with the 4 distal segments densely covered by fine hairs; length about 1.4-1.5 mm. Segments I and II are the shortest; III and VI the longest, IV and V subequal; segment II is very short, at most 50 μ, segment III ca. 400 μ.

In the legs (fig. 15) the tibia is at least 3 times as long as the tarsus. Tarsal digitules distinctly knobbed. Claws small, with very large flattened ungual digitules (fig. 27).

Dorsal surface. Two pairs of ostioles in the usual position, with strongly sclerotized rims (fig. 22). Last two abdominal segments sclerotized. Cuticle covered with fine hairs (15-25 μ), small spatula-like hairs (ca. 6 μ), and very small warts; only a few trilocular, and very few unilocular pores present (fig. 20). No cerarii. Anal ring without pores, almost membranous, with 6 ribbon-shaped anal hairs (of ca. 200 μ) which are slightly twisted (figs. 36 and 37). Dorsal aspect of abdomen shown in fig. 21.

Ventral surface. With a small circulus near the posterior edge of the second abdominal segment (figs. 19 and 25). Labium of the common Pseudococcid type, as figured for the first stage larva in fig. 5. Rostral loop reaching the hind legs. Spiracles without special details (figs. 23 and 26). Body vestiture as found on the dorsum, but 4 long setae are present on the penultimate and antepenultimate segment of the abdomen (fig. 25). Wax

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Fig. 30. Second stage larva. Abdomen, dorsal surface.

Fig. 31. Second stage larva. Abdomen, ventral surface.

Fig. 32. First stage larva. Abdomen, dorsal surface. On the anal ring only the bases of the anal hairs are indicated. In figs. 21 and 25 the anal ring is not shown, as it was in a vertical position, which was also the case in figs. 30 and 31.

Fig. 33. First stage larva. Abdomen, ventral surface.

Fig. 34. Outline of antennae in first stage larva (left), second stage larva (middle), and adult female (right).

Fig. 35. First stage larva. Anterior spiracle.

Fig. 36. Adult female. Anal ring with anal hairs.

Fig. 37. Adult female. Base of twisted anal hair.

Fig. 38. Second stage larva of the male. Tubular gland (upper figure), trilocular pore, and multilocular pore (lower figure).

Figs. 30, 31, 32, 33, × 90; 34, × 40; 35, 37, 38, × 630; 36, × 200.

pores on ventral surface absent, except very few trilocular pores. Ventral aspect of abdomen shown in fig. 25.

Summary and discussion

The 3 stages, described and figured in this paper, have the following characters in common.

1) Abdomen much narrowed towards the apex.

2) A tuft of 5 long setae (1.0-1.3 mm) on the top of each anal lobe.

3) Anal ring membranous, without pores, with 6 ribbon-shaped anal hairs (of ca. 200 μ) which are slightly twisted.

4) Lips of the 2 pairs of ostioles strongly sclerotized.

5) A small medio-ventral circulus near the posterior edge of the second abdominal segment.

6) No wax coating, no cerarii. Only a few trilocular wax pores present on both sides of the body (but in the ♂ larva II also several multilocular and tubular glands).

7) On the ventral side of the penultimate and antepenultimate segment of the abdomen 4 long setae (150-260 μ).

8) Antennae 6-segmented. Segment II very short, segment I at least twice as long as segment II. Segments III and VI are the longest, segments IV and V are subequal and shorter than the adjacent ones. In the second and third stages the 4 distal segments are densely covered by small hairs.

9) Tarsus much shorter than the tibia, with a small recurved claw, stoutly knobbed tarsal digitules and very large flattened ungual digitules.

The myrmecophilous genera *Xenococcus* and *Eumyrmococcus* of Silvestri (1924, 1926) are distinguished from the present genus *Hippeococcus,* and also from the genera *Allomyrmococcus, Paramyrmococcus* and *Malaicoccus* of Takahashi (1941, 1950), by the presence of claws with short spine-shaped digitules, further by the absence of trilocular pores and ostioles, and by their association with ants of the genus *Acropyga.* Our genus *Hippeococcus* is allied to *Allomyrmococcus* and *Paramyrmococcus,* especially to the latter. In *Paramyrmococcus,* however, the tufts of 5 long setae on the anal lobes are absent. Unfortunately Takahashi (1941) published no figures of *Paramyrmococcus,* so that it is somewhat difficult to form an opinion of the appearance of this genus.

The systematic position of the genus *Hippeococcus* among the Pseudococcidae is at present obscure; this applies also to the genera of Takahashi mentioned above. The males, which are still unknown, will perhaps throw some light on this question. Prof. Dr. P. Buchner, well known as an

authority on the mycetome of Homoptera, has examined a larva of *Hippeococcus rappardi* by dissection and staining with borax-carmine. He states (in litt.) that no typical unpaired mycetome is present, as found in the genus *Pseudococcus* (*P. citri* Risso, *adonidum* L., *nipae* Mask., *diminutus* Leon., and *brevipes* Ckll.). For a definite conclusion Prof. Buchner has still to make sections of our insects. After studying sections of the larvae he informed me that a mycetome was absent, further that he failed to find mycetocytes in the fat body, and yeast cells in the lymph. Sometimes it appeared as if minute rods were present, but it was not possible to arrive at a definite conclusion, since living specimens and adult females were not available.

After these lines were written, I learned from Dr. L. G. E. Kalshoven, who recently returned to Holland, that he and the late Dr. P. van der Goot were well acquainted with these coccids and their peculiar habit of climbing on the attending ants. Dr. Kalshoven had found the insects on the N.W. slope of Mt. Gedeh (in W. Java) at Tapos (about 1000 m above sea-level) on a *Citrus* sp. (Rutaceae), and on the same mountain also in the Botanical Garden at Tjibodas on a *Diospyros* sp. (Ebenaceae), near the house of the curator, at an altitude of 1450 m. About the specimens collected on 24.XII.1940 near the raingauge at Tapos he had noted: Living specimens light yellowish; antennae turned upward and slightly backward; tip of abdomen raised, with about 10 long hairs; on young leaves of a *Citrus* sp.

Dr. Kalshoven remembered that van der Goot had somewhere published a short note on this insect. I have found this note in a report of the conference held by the Entom. Society of the Netherlands Indies at Buitenzorg on 12 Sept. 1929 (Entomologische Berichten, vol. 8, pp. 65 and 113). In July 1929 van der Goot discovered on the northern top of Mt. Salak (W. Java) a peculiar coccid at an altitude of 2200 m. This scale insect had already been observed in 1909 in the Tengger Mts. (East Java) by Edw. Jacobson who also noticed the peculiar association with the ant *Dolichoderus gibbifer* Em. Since 1912 van der Goot had seen this insect on several occasions in East Java in the Tengger Mts., and also in West Java near Garut and Buitenzorg (at present called Bogor), but never in Central Java [1]) (on Mt. Merbabu. Mt. Ungaran, and the Dieng Plateau). It was only found in

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1) It appears that this statement is not correct. Prof. Dr. W. Roepke, who like Dr. van der Goot was connected with the Experimental Station at Salatiga (Central Java) about 1915, informed me that he and van der Goot have often observed the "ant-riders" in Central Java, e.g., on Mt. Merbabu (on *Crotalaria striata*?). Living specimens were kept in the laboratory at Salatiga, from which the Javanese artist Kades

mountainous districts at an elevation of 1200 m and more, especially on the weed *Erechtitis valerianifolia* Rafin. (Compositae), but it had also been observed on bamboo (Gramineae). It was always associated with a large black ant, *Dolichoderus gibbifer* Em. When the insects were disturbed, e.g., by cutting a twig, the scale insects, especially the younger ones, climbed by means of the large sucking cups on their legs upon the thorax of the ants, and had themselves transported in this way. Larger specimens were also transported by the ants with their jaws. Van der Goot had never found adult females with eggs or embryos within their body. It was suggested to him that the adult females might occur in the soil, but on Mt. Salak he failed to find them.

I have also found a note on these insects by Edw. Jacobson (Notes from the Leyden Museum, 1911/12, vol. 34, p. 121) which is worth quoting in full. "*Dolichoderus gibbifer* Emery, var. *gibbosior* Forel. Ich traf diese Ameisen in grosser Menge auf bestimmten Pflanzen, wo sie Schildläuse besuchten. Das Sonderbare dabei war, dass die meisten Ameisen über und über mit Schildläusen bedeckt waren. Grosse und kleine Läuse krochen auf dem Körper der Ameisen umher oder hatten sich an ihre Beine geklammert. Auf diese Weise wurden sie von dem einen Zweig zum andern und auch auf andere Pflanzen derselben Art befördert. Bis jetzt hatte ich bei andern Ameisen noch nie diese Art des Transportes ihres "Milchviehs" beobachtet". The species observed may be the same as that collected by Mr. Rappard in East Java, viz., *Hippeococcus rappardi,* but material or figures of Jacobson's insects are no longer available.

Van der Goot as well as Jacobson state that the insects have not been identified. Apparently they were still unnamed more than 40 years after their discovery.

Dr. Kalshoven found a drawing of *Hippeococcus* among the papers and notes left by van der Goot which he kindly put at my disposal. It is reproduced in figs. 39-41. From these figures it appears that the species observed by van det Goot is not the same as *Hippeococcus rappardi* described in the present paper. In van der Goot's species the anal lobes are very pronounced and elongate, and the vestiture of the last two abdominal terga differs considerably from that of *H. rappardi* (cf. figs. 39 and 40 with fig. 21).

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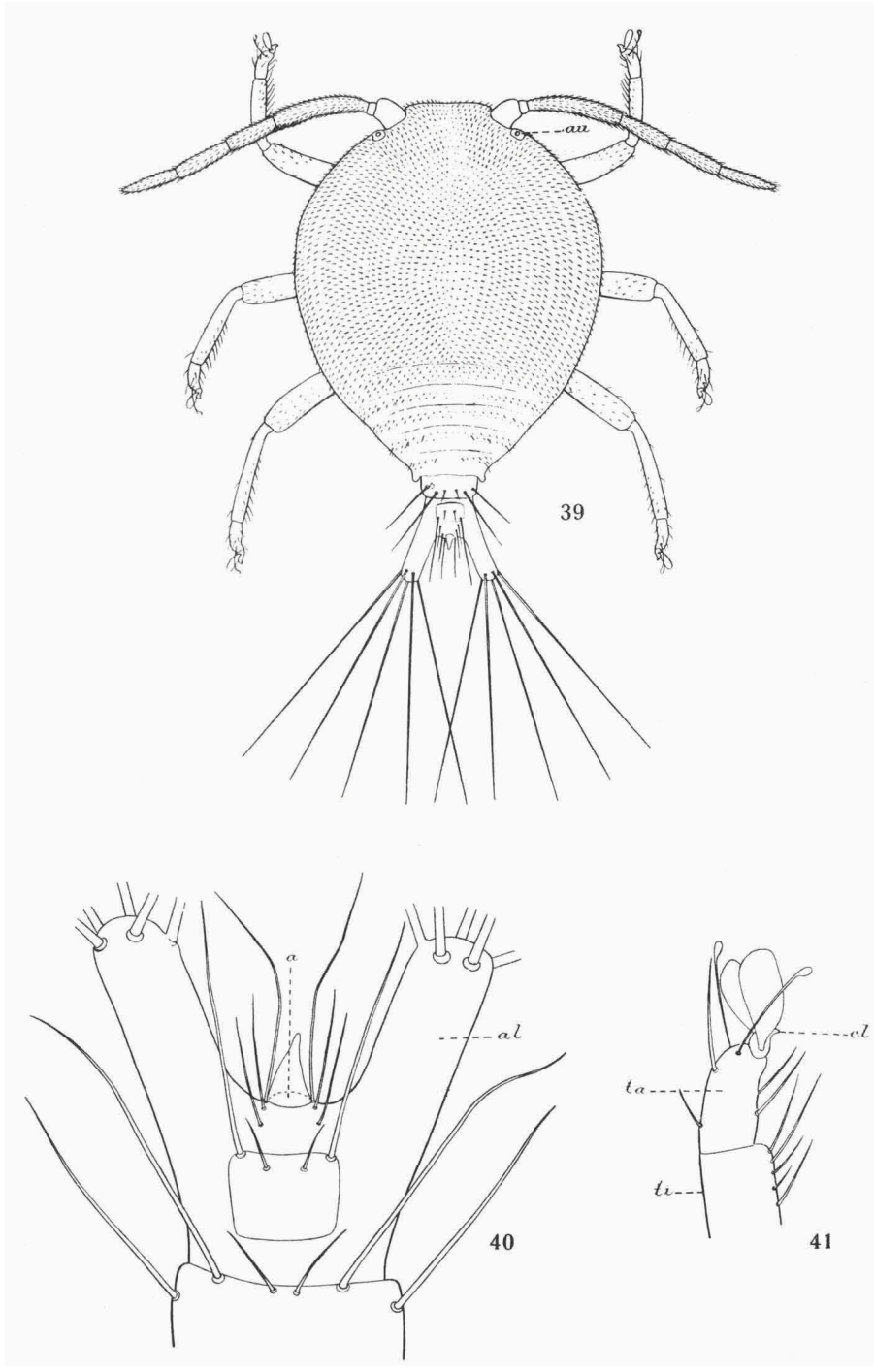
has made beautiful pen-drawings under the direction of van der Goot. One of these drawings, showing an ant with *Hippeococcus* on its back, is still in the possession of Prof. Roepke. It is reproduced in fig. 53; the detail figures are no longer available. The caption of this drawing reads as follows: "*Dolichoderus gibbifer* worker, flying with coccids. Getassan (Central Java). Van der Goot. Kades del." Getassan (alt. ca. 1100 m) is a locality near Mt. Merbabu and Salatiga.



Figs. 39-41. *Hippeococcus montanus* nov. spec. (drawings found among the papers of the late Dr. P. van der Goot).

Fig. 39. Adult female, dorsal surface (*au*, eye).

Fig. 40. Adult female. Top of abdomen, dorsal surface (*a*, anus; *al*, anal lobe).

Fig. 41. Adult female. Distal part of tibia (*ti*), and tarsus (*ta*) with claw (*cl*), tarsal and ungual digitules.

Both species have in common the tuft of 5 large setae on the top of the anal lobes, and the same structure of the legs and antennae, so that they are probably congeneric. Van der Goot had written on his drawing the name *Formicoccus montana,* so that I propose to name this species provisionally **Hippeococcus montanus.** The original drawing is preserved in the Zoological Museum at Amsterdam. It remains uncertain in which part of Java this species was collected; there is no indication of the locality on the drawing. I had considered *H. montanus* the species found by van der Goot on the top of Mt. Salak, but Dr. Kalshoven informs me that the drawing was found among van der Goot's papers on aphids which date from his residence at Salatiga (about 1915), and that after his appointment at Buitenzorg van der Goot worked no longer on aphids. He has been employed at Pasuruan, Salatiga, and Buitenzorg, i.e., in East-, Central-, and West-Java.

As Dr. Kalshoven had still seen the "ant-riders" after 1945 in the Botanical Garden at Tjibodas, on *Diospyros*-trees near the house of the curator, I wrote to Dr. M. A. Lieftinck, director of the Zoological Museum at Bogor, about this occurrence, and requested him to collect material for me, if possible also from the ants' nests. The "Mountain Garden" at Tjibodas, on the slope of Mt. Gedeh, is a branch of the well-known Botanical Garden at Bogor (formerly named Buitenzorg), and can be easily reached from that town.

On 21.I. 53 Mr. A. M. R. Wegner, entomologist on the staff of the above-mentioned museum, visited Tjibodas. He discovered *Hippeococcus* immediately on some *Diospyros*-trees near the curator's house (alt. ca. 1400 m), and after some searching also a nest of the visiting ants, about 5-10 cm under the surface of the soil, near one of the *Diospyros*-trees. The ants were identified as *Dolichoderus* (*Hypoclinea*) *gibbifer* Emery by Mr. G. E. J. Nixon by the kind assistance of Dr. W. J. Hall, director of the Commonwealth Institute of Entomology in London.

The *Hippeococcus*-species found at Tjibodas proved to be different from *H. rappardi* and *H. montanus,* and is described below as *H. wegneri* nov. spec., after Mr. Wegner who collected abundant material of this new species and made several observations on it. The material collected on 21.I.'53 contained a large number of larvae, taken from young shoots of *Diospyros kaki* L. (Ebenaceae), further some hundreds of mature females (wholly filled with full-grown embryos) and a lot of ants taken from the above-mentioned *Dolichoderus*-nest.

Mr. Wegner examined 6 young *Diospyros*-trees, planted at a distance of about 5 m, so that their twigs were touching each other in some places. He

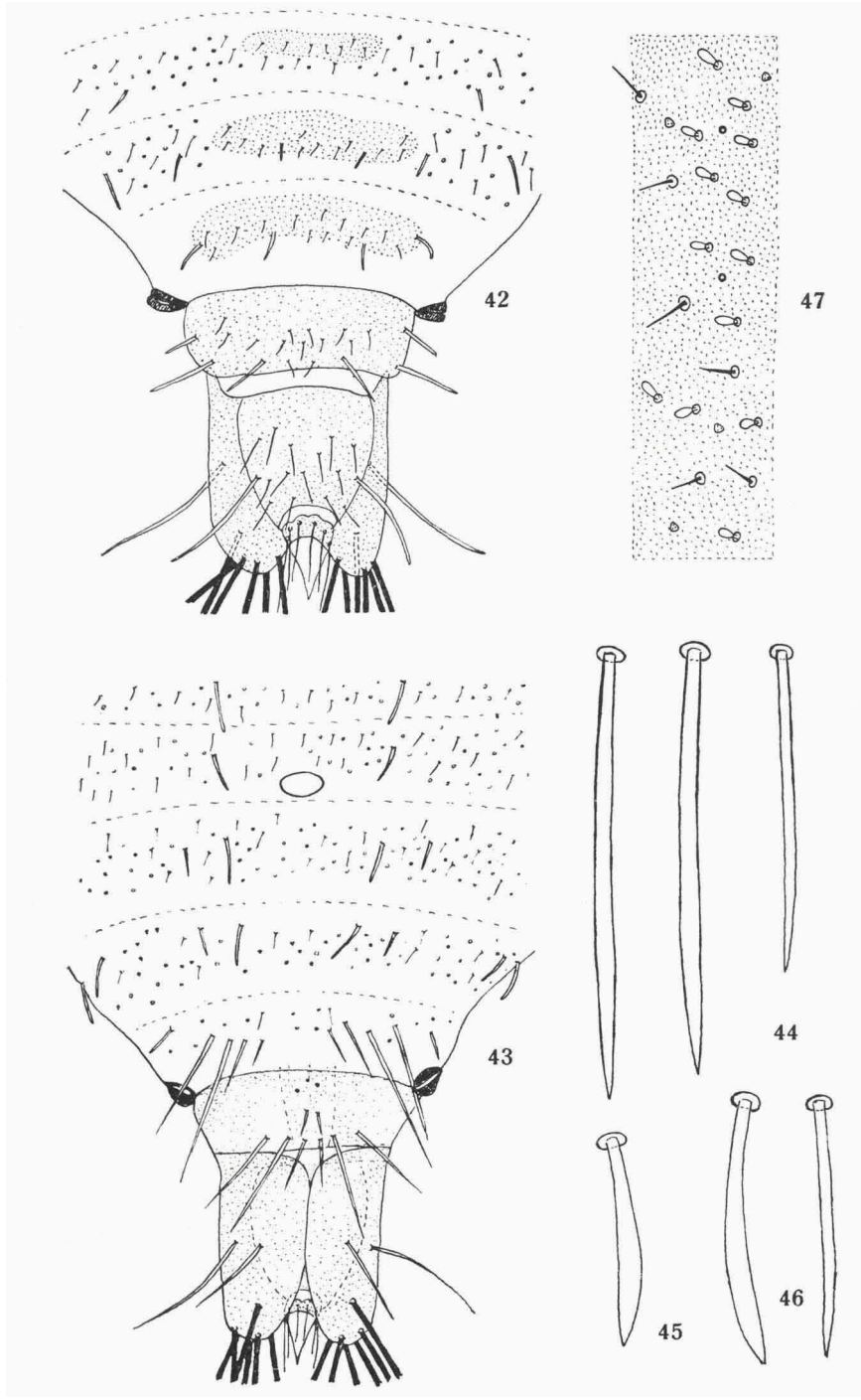
found the *Hippeococcus*-larvae on the young shoots and also on the young fruits, but did not observe adult specimens on these trees. On the visiting ants, which were walking up and down the stems, he saw usually one or two coccid larvae clinging to the thorax and other parts of the body.

In opening the *Dolichoderus*-nest, mentioned above, a large crowd of ants emerged who tried to save their larvae and pupae. Mr. Wegner saw immediately an ant dragging along a swollen adult *Hippeococcus* which clung to one of its legs; he observed also ants with *Hippeococcus*-larvae on their bodies. The whole ant-nest was put into a linen bag, and carefully examined in the laboratory which took Mr. Wegner several hours. Some hundreds of mature females of the coccid were collected from this nest, and also a number of larvae, but to my regret no adult males which possibly might throw some light on the position of the genus *Hippeococcus* among the Pseudococcidae. Among 19 second stage larvae of *H. rappardi* 4 male larvae were found (provided with multilocular and tubular glands), but among 46 second stage larvae of *H. wegneri* examined only one male specimen was present (dimensions 1.1 × 0.5 mm).

On the *Diospyros*-shoots preserved in alcohol I found several larvae, accumulated on the leaf stalks, in the leaf axils, and on the young fruits; they were less numerous on the underside of the leaves. The species seems to be ovoviviparous, as the mature females in the ant-nest were wholly filled with full-grown embryos; their swollen redbrown bodies reminded Mr. Wegner of engorged ticks.

On 22.IV.'53 Mr. Wegner visited Tjibodas again. He examined another group of 7 *Diospyros*-trees, but only on one of them a few *Hippeococcus*-larvae were present on 2 twigs. On the group of 6 trees, examined on 21.I.'53, young shoots were no longer present. The fruits, which were very small during his first visit, were now almost full-grown and turning yellow. The coccids were this time feeding at the base of the *Diospyros*-fruits on the fruit peduncles.

Larvae and many adult females were also found on the immature fruits of a climbing plant, *Cyclanthera explodens* Naud. (Cucurbitaceae), where they could be easily observed with a low power binocular (of the type used like spectacles). When Mr. Wegner approached the ants, they assumed at once an alarm position by erecting their bodies rigidly at an angle of about 45°. If a leaf or twig was shaken, the ants started immediately to evacuate the coccids. They tapped on the coccid larvae with their antennae, upon which the larvae quickly climbed on the ants. At first they clung to the ventral side of the ant's body but soon climbed upon their backs, so that some ants looked like buses overcrowded with passengers, as Mr. Wegner wrote. Lar-



Figs. 42-47. *Hippeococcus wegneri* nov. spec. For explanation see p. 253.

vae that were slow to respond to the alarm signal of their attendants were simply seized by the ants and put on their thorax, upon which they climbed to their definite seats. Only in a few cases the ants kept the larvae between their mandibles while running away. The youngest larvae and the mature females were slow to respond to the alarm signal. The ants had to put them on their bodies, but in case of panic (caused by a strong disturbance) they were left behind. Mr. Wegner got the impression that the ants were especially anxious to evacuate the larger larvae, and that they showed less affection to the smaller ones and the adult females. In some cases he saw that a mature female, which had already climbed upon an ant, was simply knocked from its seat; other ants running past took no notice of such victims. During a panic, as caused by a strong disturbance, it was also observed that the ants sometimes tried to pick away larvae which were already safely seated upon other ants, but they did not succeed as the larvae were firmly attached. The ants fled only a short distance. Some time after the disturbance, when everything seemed safe, they returned and unloaded their passengers.

Mr. Wegner supposed that the larger larvae were evacuated before the younger ones and mature adults because they produce more honeydew, but hitherto neither Mr. Rappard nor Mr. Wegner could observe that the ants are especially interested in the honeydew-secretion of *Hippeococcus*.

Prof. Dr. P. Buchner, who examined some mature females of *H. wegneri*, states that a mycetome is absent. Minute bacteria, which are observed in small cells distributed among the fat body, seem to represent symbionts, but they are scarcely recognizable as the coccids were fixed in 70 % alcohol. The embryos, however, point clearly to symbiosis, as a large spherical cell-mass is present which, like in many other Homoptera, is pushed forward by the growing germ band. This cell-mass is at first spherical, but during the

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Fig. 42. Adult female. Posterior end of abdomen, dorsal surface. Ordinary hairs are drawn full (black), "larval hairs" only in outline (white); circlets indicate spatulate hairs. Dotted parts are sclerotized. Of the apical hairs on the anal lobes only the basal part is figured.

Fig. 43. The same, ventral surface.

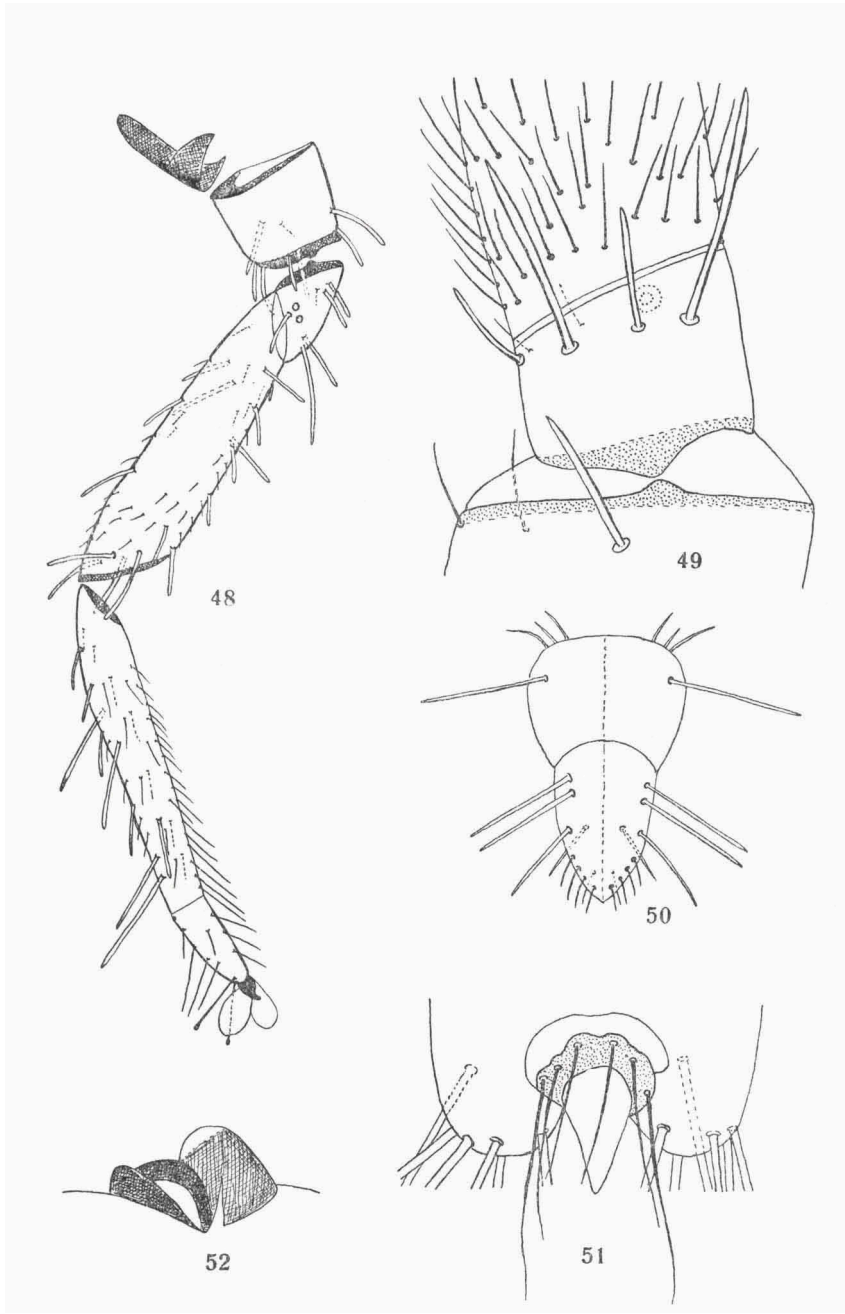
Fig. 44. Adult female. "Larval hairs" on tibia (left) and trochanter (middle) of hind leg, and on basal segment of labium (right).

Fig. 45. Adult female. "Larval hair" on ventral surface of third abdominal segment.

Fig. 46. "Larval hairs" on dorsal surface of second abdominal segment in the first stage larva, at left of *H. wegneri*, at right of *H. rappardi*.

Fig. 47. Adult female. Cuticle of the dorsal surface of the second abdominal segment, with two types of gland pores, ordinary hairs, and spatulate hairs; the dots indicate minute warts.

Figs. 42, 43, × 90; 44, 45, 47, × 430; 46, × 630.



Figs. 48-52. *Hippeococcus wegneri* nov. spec.

Fig. 48. Adult female. Hind leg.

Fig. 49. Adult female. Second antennal segment with 4 "larval hairs" and 2 ordinary ones; top of first segment with one "larval hair"; base of third segment densely clothed with fine hairs, like the following segments IV-VI.

Fig. 50. Adult female. Labium, ventral surface, with "larval hairs" (except those at the tip). See also right figure of fig. 44.

Fig. 51. Adult female. Anal ring with anal hairs, dorsal surface.

Fig. 52. Adult female. Eye with anterior ostiole.

Fig. 48, × 90; 49, × 430; 50, 51, 52, × 200.

formation of the appendages it is gradually flattened, and finally envelops the posterior end of the germ band. After the reversion of the embryo the cell-mass is found between the alimentary canal and the ventral side; afterwards it probably disintegrates by distribution of its components in the body cavity. The symbionts are difficult to recognize, even in the embryos (Prof. Buchner in litt., 29.V.'53).

Hippeococcus wegneri nov. spec.

This species differs from the generic type *H. rappardi,* as described above, in the following respects.

First stage larva. Body hairs of the same type as in *H. rappardi* but more or less widened in the upper half (fig. 46). Anal ring distinctly sclerotized. Anal hairs straight, not twisted. Colour yellow or yellowish. Largest specimens (on the point of moulting), as measured on the slide 1.4 × 0.6 mm, smallest specimens 0.9 × 0.3 mm; full-grown embryos 0.92-0.97 mm in length.

Second stage larva of the female. Anal lobes slightly pronounced, each with 6 long apical hairs (only 5 in larva I); one apical hair on the ventral side of the lobe is placed more forward than the others, this hair is absent in larva I. Anal ring distinctly sclerotized; anal hairs straight, not twisted. Body with many hairs of the type as found in larva I (on abdomen and thorax about 12-14 per segment). Such "larval hairs" are also present on the first and second antennal segments. Dimensions of larva II 1.3-1.6 × 0.6-0.8 mm (4 specimens moulting to adult female 1.5-1.6 × 0.7-0.8 mm).

Adult female. Anal lobes slightly pronounced, with 6 long apical hairs as in larva II (figs. 42, 43). Anal ring (fig. 51) distinctly sclerotized; anal hairs straight, not twisted. The length of the anterior anal hairs is ca. 100 μ, of the middle ones 125 μ, and of the posterior ones 150 μ. Some "larval hairs" present on the first and second antennal segments (fig. 49), and also on the labium (fig. 50). Several of these larval hairs are present on the ventral side of the abdomen, dorsally only on the fourth and following abdominal segments (figs. 42, 43, 45). Larval hairs are also numerous on the legs, excepting the tarsus (figs. 44, 48). On the whole these larval hairs are more numerous and more conspicuous than in *H. rappardi.* The cuticle is less sclerotized than in this species. Wax pores are more numerous than in *H. rappardi,* but of an obscure structure; in most cases 3 loculi seem to be present, but sometimes 4-5; diameter of the pores ca. 3 μ. Besides these obscure trilocular pores smaller unilocular pores with a thickened rim are present (diameter ca. 2 μ); this latter type of pores is

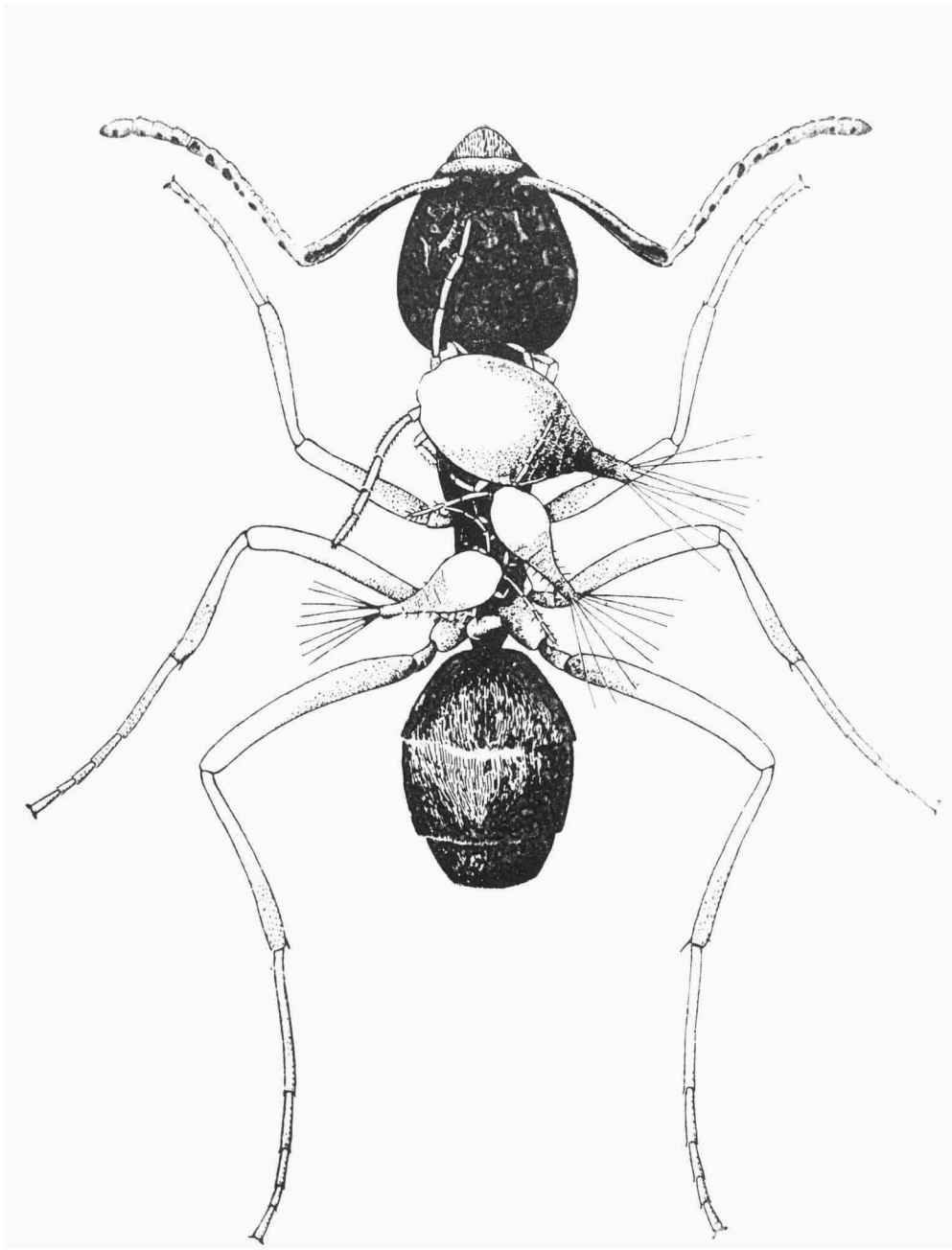


Fig. 53. *Dolichoderus gibbifer* Em. worker, running away with *Hippeococcus* on its back. Specimens from Getassan (Central Java). Drawn by the Javanese artist Kades under the direction of the late Dr. P. van der Goot in the laboratory of the Experimental Station at Salatiga. Drawing kindly supplied by Prof. Dr. W. Roepke at Wageningen.

According to the antennae two larvae of the first stage of a *Hippeococcus* have been figured, and one of the second stage (or a ♀ ad. juv.). It is not possible to identify the species of this figure. It is not *H. montanus* with its long anal lobes. It may be *H. wegneri,* but this species has 6 apical hairs on each anal lobe in the second larval stage, while the present figure shows only 4. Material from Central Java is not available for examination. The figure shows ant and coccids enlarged about 20 times.

also found in *H. rappardi* but very scantily. Several spatulate hairs and numerous small warts are present on the cuticle of *H. wegneri* as in *H. rappardi* (fig. 47). These spatulate hairs are in *H. wegneri* at least 5 times, and in *H. rappardi* 10 times as numerous as the trilocular pores. Apparently the wax pores are almost functionless in *Hippeococcus,* there is no visible secretion of wax; the function of the spatulate hairs, found in the adult females, is not known. Eye-cone and rim of ostioles sclerotized as in *H. rappardi* (fig. 52).

The colour of *H. wegneri* is variable from redbrown to purple. Dimensions of the mature females (on slide) 2.5-3.0 × 2.0-2.3 mm. The species is ovoviviparous. Collected by Mr. A. M. R. Wegner in the Botanical Garden at Tjibodas (W. Java) on *Diospyros kaki* L. and *Cyclanthera explodens* Naud. at an altitude of ca. 1400 m, in January and April 1953. Types in the Rijksmuseum van Natuurlijke Historie at Leiden.

The adult females of the 3 species of *Hippeococcus,* which are at present known from Java, can be easily distinguished from each other, even with a pocket lens.

1. Anal lobes very pronounced, more than twice as long as wide, with 5 long apical hairs . . . . . *H. montanus.*
2. Anal lobes slightly pronounced, with 6 long apical hairs . . . *H. wegneri.*
3. Anal lobes obsolete, with 5 long apical hairs . . . . . *H. rappardi.*

All figures were drawn with a camera lucida. Shaded and dotted portions indicate sclerotized areas. To the first stage larva of *H. rappardi* refer figs. 1, 3, 5, 8-14, 19, 32-25, to the second stage female larva figs. 2, 16-19, 30, 31, 34, to the male larva of the second stage fig. 38, and to the adult female figs. 4, 6, 7, 15, 19-28, 34, 36, and 37.

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