



# A study of some species of the genus *Stictococcus* Cockerell (Hemiptera: Sternorrhyncha: Coccoidea: Stictococcidae), and a discussion on *Stictococcus vayssierei* Richard, a species injurious to cassava in Equatorial Africa with a description of a new species from Nigeria

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## Abstract

The adult female of the scale insect *Stictococcus vayssierei* Richard is described and illustrated. The species feeds on the root system of cassava (*Manihot esculenta*) (Euphorbiaceae) in Equatorial Africa, affecting tuber formation of the plant. Although damage has been reported only recently, the species has probably remained unnoticed because of its subterranean habit. The distribution and host plants of this species are listed and the segmentation of the adult female of *Stictococcus* is discussed to help describe the characters in detail when specimens are prepared on microscope slides. Six other species of *Stictococcus* are described or discussed: *S. formicarius* Newstead, *S. intermedius* Newstead, *S. pujoli* Richard, *S. sjostedti* Cockerell & Cockerell, *S. subterreus* Williams, Matile-Ferrero & Miller sp. n., and *S. formicarius* var. *tuberculata* Laing which is here raised to specific rank as *S. tuberculatus* Laing.

**Key words:** Scale insects, *Stictococcus*, *Manihot esculenta*, damage to roots, new species, description of adult females, key to genera, key to species

## Introduction

The purpose of this paper is to discuss the genus *Stictococcus* Cockerell and, in particular, the adult female of *Stictococcus vayssierei*, a species described by Richard (1971) on the basis of first-instar nymphs and the adult male only. We redescribe in detail the adult females of *S. formicarius* Newstead, *S. intermedius* Newstead, *S. sjostedti* Cockerell & Cockerell, and *S. vayssierei* Richard, and we discuss further, *S. pujoli* Richard and raise *S. formicarius* var. *tuberculata* Laing to specific rank as *S. tuberculatus* Laing. We also describe a new species on cassava roots as *S. subterreus* sp. n., and provide a key to genera of the family Stictococcidae and a key to separate the species of *Stictococcus*.

*Stictococcus vayssierei* was recorded originally from Cameroon and the Central African Republic on the roots of cassava (*Manihot esculenta*) (Euphorbiaceae) by Richard (1971). Further reports indicate that *S. vayssierei* causes extensive damage to cassava. Root feeding is unusual in the genus *Stictococcus*, and is found only in *S. vayssierei* and in *S. subterreus* sp. n., both of which have been found on cassava. All species of *Stictococcus* are apparently attended by ants and, in southern Cameroon, Dejean & Matile-Ferrero (1996) reported that the ant *Anoplolepis tenella* Santschi was the principal agent for the dispersal of *S. vayssierei*. This ant is a forest-dwelling species found everywhere in the area where the ground is out of direct sunlight. Lutete *et al.* (1997) indicated that heavy infestations of the scale insect totally disturbed the tuber formation of the plant in Bas Zaire (now the Democratic Republic of the Congo), but that the aerial parts of the plant were not affected. Ngeve (1995), however, reported that young plants affected by the insects in Cameroon showed stunted growth, extensive leaf-fall, wilting and tip-dieback. According to Ambe *et al.* (1999), farmers in Cameroon reported that the storage roots of cassava were smaller and deformed, and Tchuanjo *et al.* (2000) stated that more than 200 insects were observed on a single plant in the southern part of Cameroon, a semi-humid zone. In an interesting report on *S. vayssierei* on cassava in Cameroon, Ngeve (2003) indicated that pest frequency was only 12.5% in 1990 but increased to 87.5% by 1994. Furthermore, the insect attacks were more severe when cassava was planted on the flat rather than on ridges. There were more severe infestations when cassava was intercropped with other plants such as maize and groundnuts than when planted alone. Tubers were covered with the scale insect making them unattractive at market.

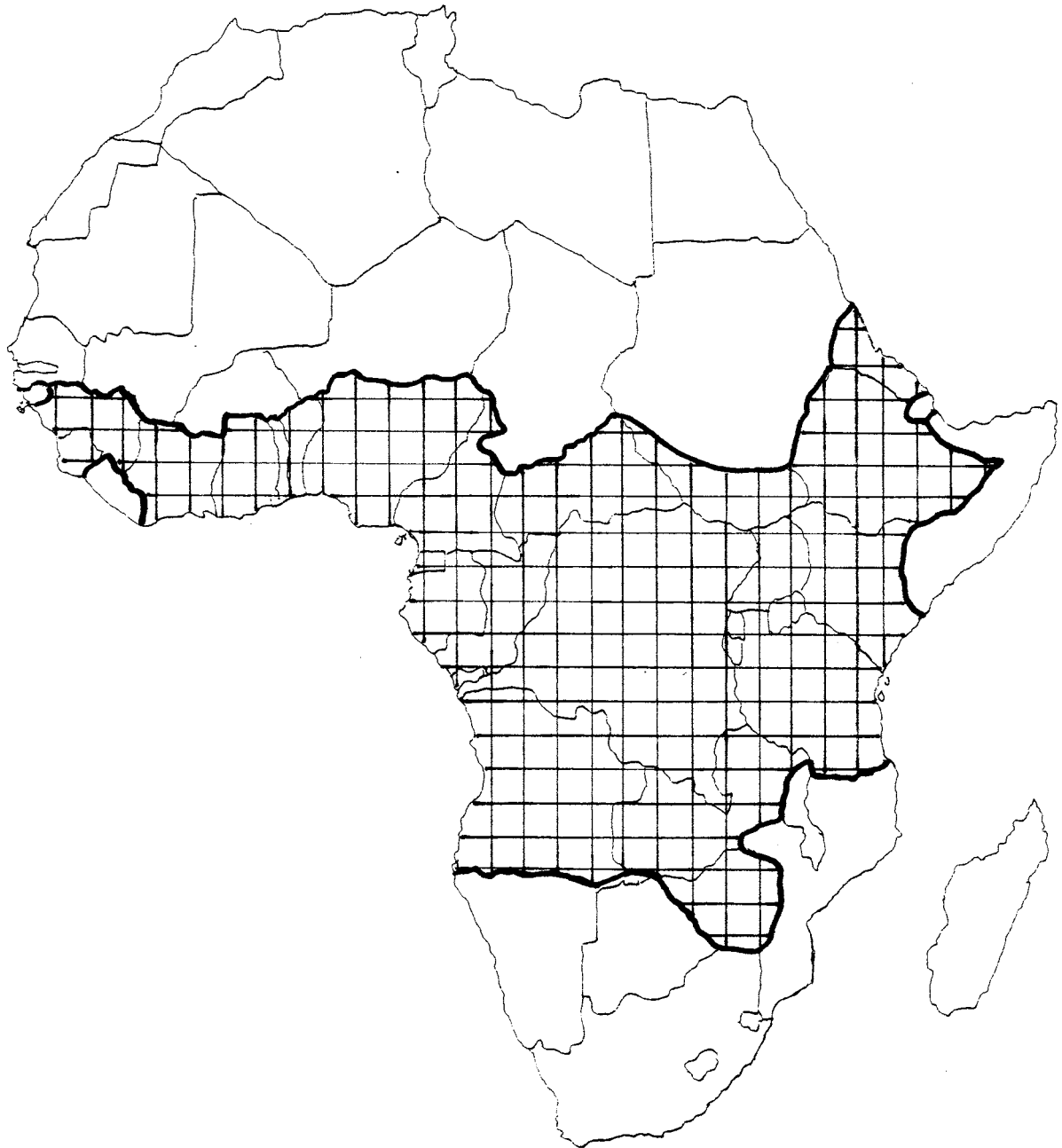
It is unclear why *S. vayssierei* has become a notable pest of cassava in recent years. Despite extensive surveys on cassava in Africa for the cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero, which first appeared in Africa in 1973 (Herren & Neuenschwander, 1991; Neuenschwander & Herren, 1998), there were no reports of a species of *Stictococcus*. Probably, *S. vayssierei* remained unnoticed because of its subterranean habit. It is interesting, however, that when Richard (1971) was studying the genus *Stictococcus*, she identified specimens of *S. vayssierei* collected in the Congo Republic (Brazzaville) in 1907 on an unidentified plant but never recorded the material. Cassava was first taken to São Tomé and the Congo from Brazil in the 16th century (Purseglove, 1982) and cannot be an original host plant because *Stictococcus* is restricted to Africa. Lutete *et al.* (1997) reported *S. vayssierei* on the roots of *Dioscorea* sp. (Dioscoreaceae) and *Xanthosoma* sp. (Araceae), plant genera that are of Asian origin. Specimens of *S. vayssierei* are also at hand collected on *Colocasia esculenta* (Araceae), a plant that possibly reached Africa in classical times (Purseglove, 1981).

Dejean & Matile-Ferrero (1996) recorded *Haumania danckelmania* (Marantaceae) (of African origin) and *Balanophora abbreviata* (Balanophoraceae) (not of African origin) as host plants. There are also unconfirmed reports of *S. vayssierei* on groundnuts, *Arachis hypogaea* (Fabaceae) (Ambe *et al.* 1999) (not of African origin). These authors also report that farmers in Cameroon claim it occurs on cocoa (Sterculiaceae) without causing pest problems. Cocoa, an introduced crop, and *Cola*, a plant genus endemic to Africa, also in the family Sterculiaceae, are hosts to other species of Stictococcidae, and may be confirmed as hosts of *S. vayssierei* in time, but this scale insect might be found eventually on the roots of a wide range of plant species. In addition to attacks on cassava, Bani *et al.* (2003) confirm attacks by *S. vayssierei* on groundnuts (*Arachis hypogaea*) and on *Chromolaena odorata* (Asteraceae) in Congo-Brazzaville.

The family Stictococcidae comprises 15 species in the genera *Stictococcus* Cockerell, *Parastictococcus* Richard and *Hockiana* Richard. At present, the family is confined to the tropical areas of Africa and differs from most other scale insect families in possessing a large anus situated almost on the mid-dorsum in adult females. Based on molecular data, Cook *et al.* (2002) and Cook & Gullan (2004), place the family near the Beesoniidae in a clade near *Cylindrococcus spiniferus* Maskell and *Eriococcus buxi* (Boyer de Fonscolombe), species at present included in the family Eriococcidae. Work on adult males by Hodgson (2001) also shows that the Stictococcidae is closely related to the Beesoniidae. When describing *S. formicarius* Newstead from *Barleria fistulosa* (Acanthaceae), Newstead (1910) discussed its habits and stated "It is very rarely that Coccids locate themselves in the hollow stems of their food-plants. Each female also forms a marked depression or pit which is distinctly traceable on the outer surface of the branch as a slightly raised and irregular prominence, more especially so on those branches in which the woody tissues are relatively thin." This observation might add support to a suggestion by Hodgson (in Takagi & Hodgson, 2005) that the stictococcids could once have been gall inducers like present-day beesoniids. Hodgson reasoned that the mid-dorsal position of the anus in stictococcids could have evolved from a gall-inducing habit as in the forward migration of the anus in the gall inducing beesoniid *Danumococcus parashoreae* Takagi & Hodgson. Many Coccoidea inducing galls are, however, parenchyma feeders, at least in their early instars (Gullan *et al.* 2005). Stictococcids, however, produce honeydew sought after by ants. This indicates that the insects are phloem feeders, so if stictococcids were once parenchyma feeders, it would have meant a switch to feeding on phloem.

According to Richard (1971), there are 3 instars in the female in the Stictococcidae and the male develops into a pupal instar after the second instar before emerging as an adult. This is contrary to the development of males in all related families and Richard may have overlooked either the prepupal or pupal instar in the male, making a total of 5 instars. Newstead (1917), when discussing *S. multispinosus* Newstead (now *Parastictococcus multispinosus* (Newstead)), mentioned a propupal (=prepupal) instar. As first shown by Newstead (1910), first instars of *S. dimorphus* Newstead (= *Parastictococcus multispinosus* (Newstead)) are dimorphic. Newstead (1913) also described the first-instar female of *S. gowdeyi* Newstead (now *Parastictococcus gowdeyi* (Newstead)) as possessing an anus on the mid-dorsum and that in the first-instar male as on the apex of the abdomen. Newstead (1913) noted also that the buccal organs were obsolete in first-instar males but present in first-instar females. These differences were discussed further by Vayssière (1936) and Richard (1971). In most families of scale insects, the first and second instars of both sexes are feeding instars but, in the Stictococcidae, the entire development of the male proceeds without feeding after emerging from the egg. Tindo *et al.* (2006) recently discussed and illustrated all female instars of *S. vayssierei*.

Based on literature records and specimens in The Natural History Museum, London, The National Museum of Natural History, Beltsville, Maryland, and the Muséum national d'Histoire naturelle, Paris, the family Stictococcidae is distributed over a wide area of Africa (Fig. 1). There are no records yet for Liberia, Zambia, Rwanda, Burundi or Somaliland, but these countries are included within the outline of distribution. Southern Sudan is included based on specimens of a species near *S. formicarius* Newstead in the collections of The Natural History Museum, London. The present distribution of the family corresponds almost to the boundaries of the so-called cassava belt of Africa and, if ecological conditions are right, then *S. vayssierei* could be a possible invasive species to other cassava areas of Africa and elsewhere. Specimens of Stictococcidae are often intercepted at quarantine inspection of plants, especially in the U.S.A., and there is always the possibility of outbreaks occurring outside Africa as a result of accidental introductions.



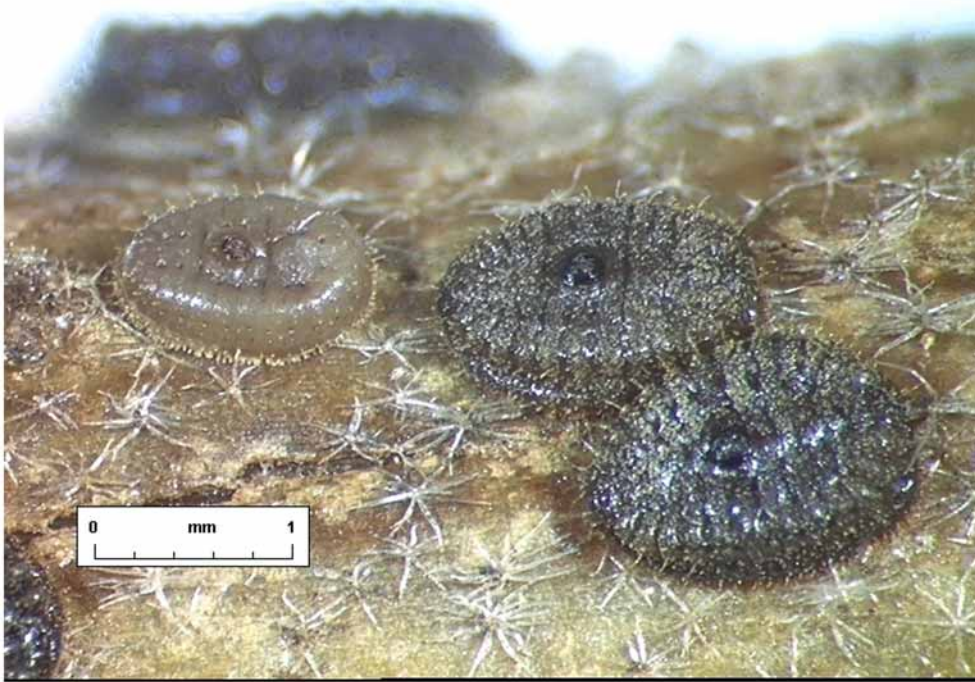
**FIGURE 1.** Outline Map of Africa showing distribution of the family Stictococcidae.

### **Material and methods**

Most of the specimens examined for the present work have been prepared on microscope slides using the method described by Williams & Granara de Willink (1992). The terminology used in the present descriptions of adult females follows that in Richard (1971, 1976) and Williams (2004). All the illustrations of the body of the adult female are drawn from slide-mounted specimens and depict the dorsum on the left and venter on the right. Enlargements of important characters are shown around the edges of the main illustration.

Abbreviations of the depositories of specimens mentioned in the text are: BMNH, The Natural History Museum, London, UK; MNHN, Muséum national d'Histoire naturelle, Paris, France; and USNM, United States Department of Agriculture, Beltsville, Maryland, U.S.A. (slide collections of the Smithsonian's National Museum of Natural History).

**Fig. 2**



**Fig. 3**



**FIGURE 2.** *Stictococcus formicarius* Newstead in life. Cameroon, Yaoundé, on stem of *Solanum melongena* showing young adult female on left and two mature adult females on right with rims on margins.

**FIGURE 3.** *Stictococcus vayssierei* Richard. Cameroon, Yaoundé, Kala, on roots of *Manihot esculenta*, adult females and first- and second-instar nymphs.

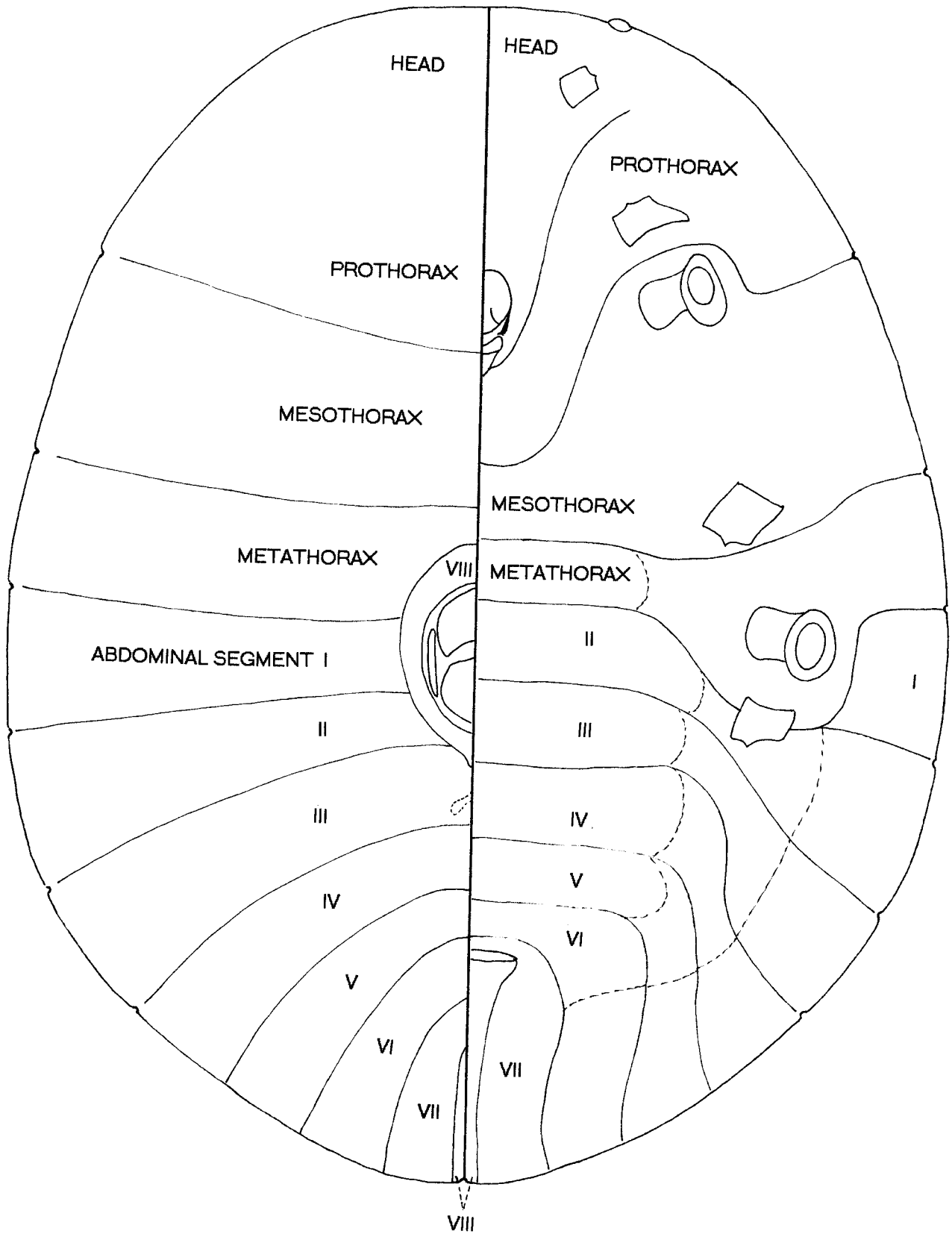


FIGURE 4. Body segmentation of adult female of *Stictococcus*.

## Results

### *Body*

When the adult female develops to maturity in most Coccoidea, the dorsum often becomes enlarged and overlaps on to the ventral surface. In *Stictococcus*, and possibly all stictococcids, the dorsum at maturity becomes sclerotized and slightly convex while the lateral areas of the venter form a narrow rim (Fig. 2), thus pushing the dorsum upwards as in many whitefly (Aleyrodoidea). When flattened on microscope slides, parts of the venter, therefore, overlap to the dorsum. Although there are white wax areas in some species (see Strickland, 1951a), often the dorsal surface is completely naked and becomes smooth and appears to be highly polished. The dorsal surface, however, contains numerous secretory pores and, at times, it is difficult to understand their function unless they secrete a type of varnish-like wax. Because these scale insects live in close association with ants, which feed on honeydew, any excess of honeydew not taken by the ants would run off the body easily and prevent contamination. Some species possess white marginal wax and clumps of dorsal wax (Strickland, 1951a; Tindo *et al.* 2006).

### *Segmentation*

So far there has been no discussion on the body segmentation in adult female stictococcids. The migration of the anus to the mid-dorsum has made segmentation difficult to follow. Also the segmentation on the venter, although fairly easy to define medially, is complicated by the latero-posterior migration of the hind legs and posterior spiracles (Fig. 4). In many mealybugs of the family Pseudococcidae, particularly those in the family *Paraputo* Laing, the anal ring on the dorsum is situated well forward from the apex of the abdomen. The obanal and cisanal setae, that are normally situated posterior to the vulva on the venter, are displaced to the dorsal surface. In the Stictococcidae, if it is assumed that the anus lies posterior to abdominal segment VII as in the Eriococcidae and Pseudococcidae, then the anus has migrated anteriorly, taking with it most of the remains of abdominal segment VIII. On the venter, if the vulva is situated between abdominal segments VII and VIII, then segment VIII is represented by the area covered by quinquelocular pores immediately posterior to the vulva. Parts of this segment are also displaced to the dorsum as shown by the dorsal line of quinquelocular pores that extends forwards from the apex of the abdomen in the adult female, similar to the displacement of the part of the venter to the dorsum in some species of the mealybug genus *Paraputo*. The vulva of *S. vayssierei* and other species of Stictococcidae, is situated well forward on the venter, but it is possible to trace rows of ventral setae representing abdominal segments VI and VII that curve latero-posteriorly. The area immediately anterior to the vulva, representing abdominal segments VI and VII, is compressed as in some species of the mealybug genus *Antonina* Signoret. It is possible to interpret the segmentation forwards by the rows of setae and quinquelocular pores. Assuming that abdominal segment I on the venter is represented by lateral areas only, and that medially, abdominal segment II lies immediately posterior to the metathorax, as in the Eriococcidae and Pseudococcidae, then the lateral margins of each segment on the venter must correspond to the lateral margins of each segment on the dorsum. Possible dorsal segmentation, therefore, of the adult female, as shown in teneral specimens by the rows of setae, is shown in Fig. 4.

### *Labium*

The labium is always shorter than the clypeolabral shield and is 2-segmented, lacking a minute basal segment present in some other families. On each side of the proximal segment there is always a sclerotized ridge-like structure which appears to join the labium to the clypeolabral shield. According to Koteja (1974), these structures do not represent modified forms of the small basal segment but probably originated as secondary modifications of the ventral cuticle.

### *Vulva*

We have studied teneral females of all species of *Stictococcus* except for *S. tuberculatus* Laing, and the segmentation adopted in Fig. 4 is used in the descriptions of the adult females that follow. The vulva is noticeably wide, and there is a wide genital chamber or possible wide oviduct internally that possesses lateral

rows of minute quinquelocular pores that are not illustrated in Figs 5–10. According to Richard (1976), all Stictococcidae are viviparous. Embryos are large and can be observed inside the body when specimens are prepared on microscope slides. The wide vulva and oviduct are necessary, therefore, for the large crawlers to pass through. Vayssière (1936) discussed the presence of a marsupium, but no such structure was observed by Richard (1976) or in the present study.

#### *Anus*

The anus in *Stictococcus* is composed of 4 sclerotized parts, an anterior and posterior rectangular sclerotized plate, and 2 lateral, elongate sclerotized areas. Each of the rectangular plates contains slender flagellate setae. According to Richard (1976), the lateral areas are absent from species in the genera *Parastictococcus* and *Hockiana*. The anus is surrounded by a wide sclerotized oval ring which extends posteriorly to form a lip. An internal, sclerotized winged structure, opening on to the dorsal cuticle, is present either attached to the lip or a short distance posteriorly.

#### *Antennae*

The antennae are either 5- or 6-segmented, tapering gradually and show little variation. All segments possess flagellate setae, and the terminal segment has fleshy setae also.

#### *Legs*

In all species of *Stictococcus*, the legs are fairly short for the size of the body but are well developed with few setae. The tibia is either slightly longer than the tarsus or about the same length, whereas in *Parastictococcus* and *Hockiana* the tibia is shorter than the tarsus. The claw is wide at the base but then becomes abruptly narrow and curves to a blunt tip. The paired digitules are remarkable, with one widely expanded distally and the other longer, slender and narrowly expanded at the tip. The tarsal digitules are equally disparate, with the outer digitule elongate and narrow and the other situated about midway on the distal edge and widely expanded distally.

#### *Spiracles*

These are fairly large with wide sclerotized apodemes and with the sclerotized atrium covered in minute papilla-like structures.

#### *Marginal clefts*

There are usually minute marginal clefts opposite each spiracle, opposite each mid coxa, one opposite each hind coxa, one a short distance posteriorly to the cleft opposite the hind coxa, one opposite each lateral edge of the vulva and a single cleft situated at the apex of the abdomen. Most clefts possess a minute sclerotized plate, but this is sometimes absent from the clefts opposite each mid coxa.

#### *Setae*

The dorsal setae vary considerably in shape and number and are among the most bizarre in any scale insect family. Dorsal setae are slender or thick, mostly barbed throughout their length with minute projections pointing forwards. Often the setae are thick near the base, then tapering gradually towards a widely expanded distal end, which is often fan-shaped with short finger-like projections. In *S. formicarius* Newstead, many dorsal setae are short and flower-shaped distally. Other dorsal setae are short and stout, smooth, and pointed and usually angled. Long, slender flagellate setae are often present around the margins and sometimes elsewhere on the dorsum.

The ventral marginal setae are thick and easily countable, usually equispaced and either almost cylindrical, bullet-shaped and bluntly pointed or widely expanded distally, bilobed or many lobed. Most ventral setae are short and bluntly or sharply pointed and spine-like. Those near the margin are usually longer than elsewhere on the venter. Flagellate setae are often present around the ventral margins, between the antennae and near the spiracles and midline. The vulva is surrounded by numerous short spine-like setae and longer stiff pointed setae on the anterior margin.



### *Pores and ducts*

One of the strange characteristics of the genus *Stictococcus* is the dense covering of dorsal pores. These are often in whorls or wide segmental bands. Trilocular pores are often of two sizes, and bilocular pores are sometimes of three main sizes. Minute quinquelocular pores are present from the apex of the abdomen and extend forwards to a position almost opposite the vulva. Other minute quinquelocular pores are often present in small numbers extending a short distance medially from the marginal clefts. Large size quinquelocular pores are associated with the dorsal depressions (see below). Sometimes a shallow-cupped type of pore with a central projection mingles with the other pores. Occasionally a few quadrilocular pores are present.

Ventral pores include minute quinquelocular pores, similar to the small quinquelocular pores on the dorsum, and are present in a definite arrangement (see later). Bilocular and trilocular pores, each with wide rims and different from the dorsal bi- and trilocular pores, are present in a submarginal zone. Minute tubular ducts are usually present across the thoracic and abdominal segments and become scattered on the head and towards the margins.

### *Dorsal depressions*

Each dorsal depression possesses a row of large quinquelocular pores around the external margin and either quinquelocular or discoidal pores at the base. In *S. sjostedti*, they reach their fullest development when each depression is internally spherical with the external rim surrounded by the quinquelocular pores. Other large quinquelocular pores form a band around the equator. A small number of discoidal or quinquelocular pores is usually present at the base of each depression often within a tessellated area. In other species, the depressions are cylindrical or only shallow pits. In *S. vayssierei*, they show little development. These dorsal depressions seem to be unique to the family Stictococcidae and occur in various numbers around the submargins, sometimes submedially and usually around the anus. They become fully developed in mature specimens when they are easily observed. Their function is unknown.

### *Pore and setal patterns*

There is little difference in the dorsal pore patterns in the different species except that the marginal pores are noticeably larger than elsewhere on the dorsum in all species except in *S. sjostedti*.

On the venter, the minute quinquelocular pores are present in a line from the cleft at the apex of the abdomen and then surround the vulva, then continue from the lateral edges of the vulva forwards to the posterior spiracles and often to the anterior spiracles, then anteriorly to near the eyes. They also extend in lines from the spiracles to the marginal stigmatic clefts and extend in lines to each of the other marginal clefts except sometimes they are few or absent from lines extending from the mid coxae. Other minute quinquelocular pores are present around the margin but sometimes are sparse on the abdominal margin. The areas around the margins enclosing the minute quinquelocular pores are occupied by wide-rimmed bi- and trilocular pores, minute tubular ducts and spine-like setae.

## ***Stictococcus* Cockerell**

*Stictococcus* Cockerell, 1903: 64; Morrison & Morrison, 1966: 188; Richard, 1971: 571, 1976: 656; Miller *et al.* 2005: 540.

Type species: *Stictococcus sjostedti* Cockerell & Cockerell, by monotypy.

### Description of features of adult females of *Stictococcus*

Adult female in life broadly oval, becoming convex or fairly flat, thickened and heavily sclerotized at maturity, usually dark to reddish brown; often shiny with marginal white wax and clumps or dots of white wax on dorsum. Dorsum often raised around margins by lateral edges of venter which form a narrow rim.

Slide-mounted teneral specimens membranous, mature specimens heavily sclerotized; broadly oval, sometimes almost rotund, often with 6 pairs of minute marginal clefts and a single cleft at apex of abdomen; each cleft usually associated with a minute sclerotized plate. Anus displaced to almost centre of dorsum,

comprising a wide, oval sclerotized ring enclosing an anterior and posterior sclerotized rectangular plate, each with a few flagellate setae; posterior plate often with reticulated surface; a pair of elongate sclerotized areas also present lateral to rectangular plates; posterior end of ring often extended, forming a small lip; an internal winged sclerotized process opening on to cuticle also present either attached to lip or situated a short distance posteriorly. Antennae 5- or 6-segmented, tapering gradually, with flagellate setae; terminal segment with fleshy setae also. Legs well developed but short for size of body, with few setae; tibia either same length as tarsus or shorter; claw wide at base then narrowing abruptly to curved blunt tip; digitules disparate, one elongate, slender and longer than claw with small expanded tip, other widely expanded distally, fan-shaped with small finger-like projections. Tarsal digitules also disparate, outer digitule on margin, elongate, slender, with small expanded tip; other situated about midway along distal margin, widely expanded and similar to widely expanded claw digitule. Spiracles large, each with heavily sclerotized apodeme and sclerotized atrium containing minute papilla-like structures. Eyes conical and sclerotized. Vulva wide, surrounded by short spine-like setae and with longer stiff-pointed setae at least on anterior margin. Labium 2 segmented, with sclerotized bar-like structure extending from each side of basal segment to lateral edge of clypeolabral shield.

Dorsal surface with variable number of long or short barbed setae, sometimes tapering to a point or widely expanded distally, with finger-like or lobed projections, sometimes short and flower-shaped; other setae present, short, pointed, smooth and curved; sometimes long flagellate setae present around margins and elsewhere on dorsum. Pores usually abundant, often in whorls or circles, either trilocular or bilocular, of at least two sizes and sometimes of three sizes (rarely a few quadrilocular pores present). Sometimes minute shallow cup-shaped pores present, each with minute central projection. Quinquelocular pores present, either minute and extending forwards from apical abdominal cleft to a position almost opposite vulva, and in small numbers next to other clefts; or larger, present associated with dorsal depressions, these depressions sometimes shallow or spherical.

Ventral surface with marginal setae broad and heavily sclerotized, cylindrical or tapering gradually or widely expanded distally with varying numbers of small lobes, sometimes slender but stiff, tapering, and always noticeably separated and easily countable; short spine-like setae, either bluntly or sometimes sharply pointed, also present usually in mid regions and submargins; flagellate setae present in mid regions, and often long flagellate setae present around margins. Quinquelocular pores, same as minute type on dorsum, present in definite pattern (see section on patterns above). Bilocular and trilocular pores, each with wide rims, present submarginally. Minute tubular ducts present across segments and scattered around submargins.

#### Comments

Strickland (1951b) remarked that some species are difficult to separate in the field except for *S. sjostedti*, which, apparently, is characteristic in its appearance. Slide-mounted specimens often show variation in the numbers and shapes of the dorsal setae and in the ventral marginal setae. The descriptions of the species that follow are based mainly on the original material and on a few other specimens. Often the marginal ventral setae are variable. Sometimes specimens with widely-expanded setae also possess cylindrical setae near the clefts and sometimes there are a few types of marginal setae present but the species discussed are defined by the marginal ventral setae predominantly of one type. There are probably more species than those discussed here, but they can only be described from teneral specimens which are not always available. There is a great need of molecular studies of these species. Care should be taken when new species are described, therefore, to take into consideration the wide variation in some of the characters in any one species.

There are hundreds of slide-mounted specimens that were examined by Claude Richard in the collection of the Muséum national d'Histoire naturelle, Paris, and the identifications are indicated with a question mark. We have not had the opportunity to study them in detail. For example, there are specimens from The Central African Republic collected in 1973 on *Manihot esculenta*, and these possess a complete row of ventral marginal setae that are all widely expanded and many lobed distally but agree in other characters with *S. vayssierrei*.

The following descriptions and illustrations are based either on original material or on specimens that compare well with the type material.

## Key to genera of the family Stictococcidae (adult females)

- 1 Most ventral setae normally short and spine-like, only a few flagellate setae present. Quinquelocular pores usually numerous on dorsum..... 2
- Ventral setae not spine-like, only flagellate setae present. Quinquelocular pores either rare on dorsum or absent.....  
..... *Hockiana* Richard
- 2 Ventral marginal setae abundant, not enlarged but elongate, barbed and tapering. Dorsal bi-, tri- and quadrilocular pores absent. Dorsal depressions, when present, not bordered by quinquelocular pores. Anus composed of 2 sclerotized parts. Tibia longer than tarsus ..... *Parastictococcus* Richard
- Ventral marginal setae few, enlarged, cylindrical or apically expanded and multilobed distally. Dorsal pores bi- tri- and quadrilocular. Dorsal depressions bordered by quinquelocular pores. Anus composed of 4 sclerotized parts. Tibia either shorter than tarsus or same length ..... *Stictococcus* Cockerell

## Key to adult females of *Stictococcus* species (except *S. tuberculatus*)

- 1 Marginal dorsal pores about twice size of other dorsal pores..... 2
- All dorsal pores about same size..... *sjostedti* Cockerell & Cockerell
- 2 Dorsum without flower-shaped setae ..... 3
- Dorsum with flower-shaped setae..... *formicarius* Newstead
- 3 If stout barbed setae present on dorsum, they are distributed in longitudinal rows ..... 4
- Dorsum with numerous stout barbed setae evenly distributed over surface..... *pujoli* Richard
- 4 Stout, dorsal barbed setae present in submarginal and submedial series..... 5
- Stout, dorsal barbed setae absent; barbed setae restricted to margin..... *vayssierei* Richard
- 5 Ventral marginal setae mostly elongate and slender, tapering only gradually, about 45–50 µm long. Dorsal marginal flagellate setae absent..... *subterreus* sp. n. Williams, Matile-Ferrero & Miller
- Ventral marginal setae mostly stout and each multilobed distally, each seta about 35 µm long. Dorsal marginal flagellate setae present ..... *intermedius* Newstead

## Description of species (adult females)

### *Stictococcus formicarius* Newstead

(Figs. 2, 5)

*Stictococcus formicarius* Newstead, 1910: 19; Richard, 1976: 667; Miller *et al.*, 2005: 541; Miller *et al.*, 2007 (compact disk).

**Description.** Body of adult female on microscope slide, broadly oval to rotund, 1.5–3.0 mm long, 1.1–2.5 mm wide, membranous at first, mature specimens heavily sclerotized. Antennae 176–207 µm long, 5-segmented, first segment widest, others tapering. Legs well developed, hind trochanter + femur 165–204 µm long, hind tibia + tarsus 157–204 µm long. Ratio of lengths of hind tibia + tarsus to trochanter + femur 1.00–1.08. Ratio of lengths of hind tibia to tarsus 0.80–0.99. Claw 24–27 µm long, stout at base then curving sharply to blunt tip, with one slender clubbed digitule longer than claw and one widely expanded digitule. Tarsus with one long clubbed digitule conspicuously longer than claw digitule, and one widely expanded digitule situated near middle of tarsus. Labium 2-segmented, 126–133 µm long, 91–100 µm wide, shorter than clypeolabral shield; a sclerotized ridge-like structure present on each side of basal segment joining labium to clypeolabral shield. Mesothoracic spiracles 90–114 µm long, 66–81 µm wide. Metathoracic spiracles 90–111 µm long, 70–73 µm wide; oval area surrounding each opening with numerous papilla-like structures. Vulva conspicuous, about 290 µm wide. Anus situated near mid-dorsum; anterior plate bearing 6 slender anterior flagellate setae; posterior plate usually with 4 setae near posterior margin; both plates plus 2 narrow lateral sclerotized areas surrounded by heavily-sclerotized oval rim, 200–224 µm long, 151–195 µm wide, with small posterior extension. A pair of saddle-shaped apodemes opening posterior to rim. Eyes oval, each about 42–45 µm long.

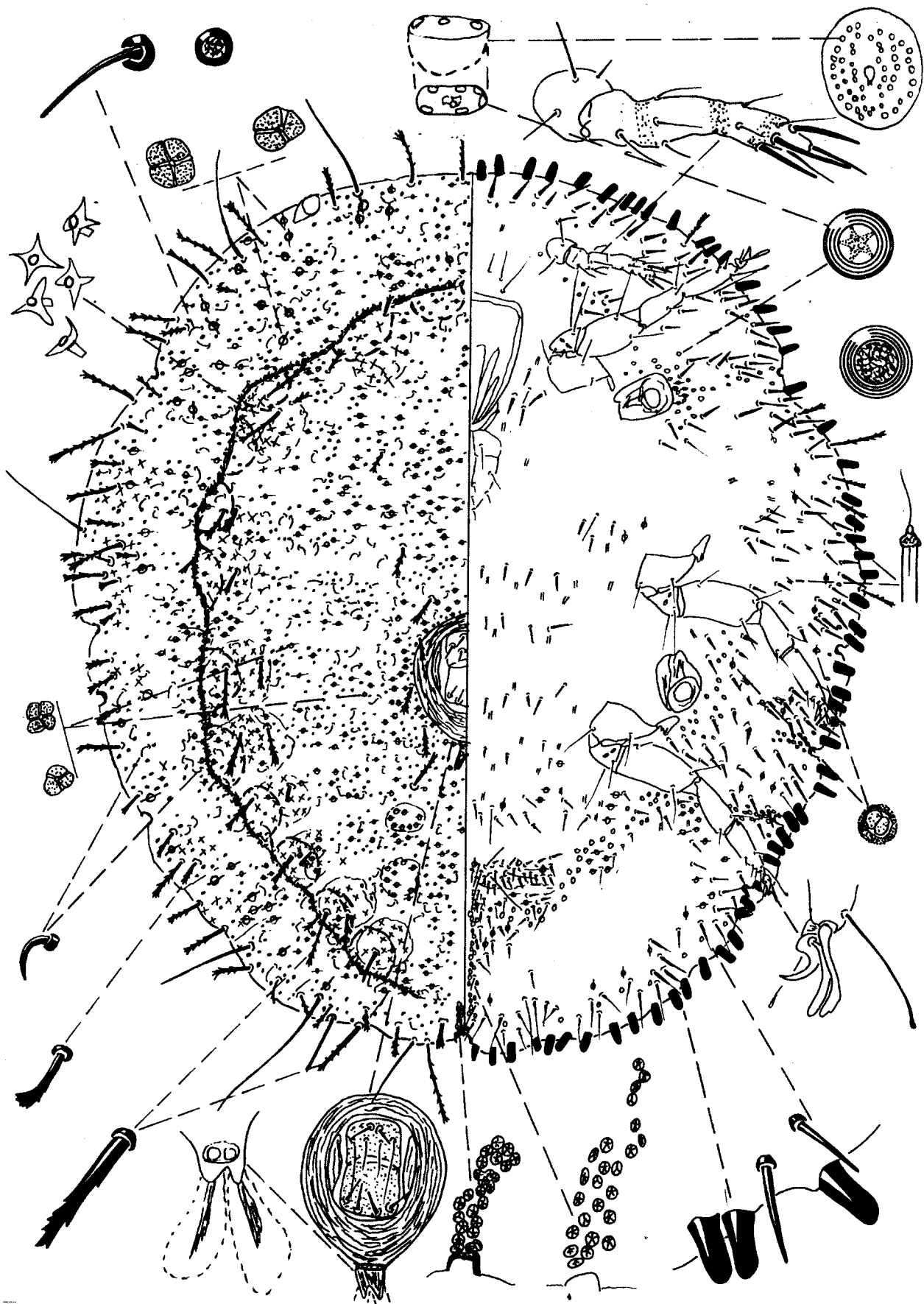


FIGURE 5. *Stictococcus formicarius* Newstead, adult female.

Dorsal surface of body with a series of marginal barbed setae about 135  $\mu\text{m}$  long, usually with several prongs on apex, longest posterior marginal setae on apparent anal lobe area about 124  $\mu\text{m}$  long, other posterior setae about 100  $\mu\text{m}$  long. Submarginal setae shorter, barbed, spatulate distally, each about 38  $\mu\text{m}$  long. Submedial setae 22–60  $\mu\text{m}$  long, medial setae about 70  $\mu\text{m}$  long, flattened distally. Long smooth to slightly barbed setae along margin about 204  $\mu\text{m}$  long, other flagellate setae absent except minute flagellate setae, 20–30  $\mu\text{m}$  long. Flower-shaped setae expanding distally, with 3 to 4 points, about 20  $\mu\text{m}$  wide, in marginal and submarginal areas. A series of usually 24 submarginal depressions present, 12–15 submedial depressions, and 12 medial depressions; teneral specimens with fewer noticeable depressions, all moderately sclerotized, depression opening varying from 60–120  $\mu\text{m}$  wide, each with distinct outer margin opening into a globe-like structure bearing marginal and inner rows of quinquelocular pores, each about 8–11  $\mu\text{m}$  in diameter; inner polar area with a small number of discoidal pores associated with a minute tessellated area 35–50  $\mu\text{m}$  long. Other pores abundant, variously shaped, often in fairly well-defined circles around setal collars and more or less segmentally arranged on thorax and abdomen, more scattered on head, comprising large bilocular oval pores, each about 9  $\mu\text{m}$  long, 7  $\mu\text{m}$  wide, trilocular pores about 9–12  $\mu\text{m}$  wide, sometimes with quadrilocular pores. Small bilocular pores, each about 7  $\mu\text{m}$  long, 6  $\mu\text{m}$  wide, and discoidal pores, each about 5–6  $\mu\text{m}$  in diameter, dome-shaped with outer sclerotized rim, also present. A double to triple row of small quinquelocular pores, each about 5  $\mu\text{m}$  in diameter, extending from apex of abdomen to area almost opposite vulva. A few similar pores also present on margin next to 5 or 6 minute sclerotized clefts.

Ventral surface with small quinquelocular pores about 5  $\mu\text{m}$  in diameter, almost encircling vulva then curving posteriorly to midline in a double to triple row extending to apex of abdomen; other pores lateral of vulva present also in a wide submedial row forwards to metathoracic spiracles then almost reaching mesothoracic spiracles before extending to eyes. Others in rows extending to 5 or 6 small sclerotized marginal clefts to join with a single marginal row from head almost to apparent anal lobes. Thick-rimmed oval bilocular pores, each about 7  $\mu\text{m}$  long, 6  $\mu\text{m}$  wide, or sometimes replaced by round trilocular pores, 6  $\mu\text{m}$  in diameter, sparsely distributed within areas demarked by quinquelocular pores, often more conspicuous on each side of rows of quinquelocular pores extending to marginal clefts. Minute tubular ducts, each at most 13  $\mu\text{m}$  long, 3  $\mu\text{m}$  wide at cup end and tapering slightly to opening, present across middle of segments and within area demarked by rows of quinquelocular pores. Marginal enlarged setae bullet shaped, 31–42  $\mu\text{m}$  long, 12–15  $\mu\text{m}$  wide at setal base, not expanding distally and not lobulate. Other ventral setae short, almost spine-like, 18–27  $\mu\text{m}$  long, present in more or less single rows across abdominal segments and then mainly following margins of areas demarked by quinquelocular pores; most marginal setae similar but longer, each about 30–48  $\mu\text{m}$  long. Apparently without long flagellate setae. Flagellate setae also situated around vulva, most on anterior edge 72–77  $\mu\text{m}$  long, and others on posterior edge about 18–22  $\mu\text{m}$  long.

**Type data.** “Trouvés dans les branches creuses de *Barleria fistulosa* Mast., [Acanthaceae], cultivés par les fourmis *Sina spininoda*, Andre. Trouvés à Romée près de Stanleyville [Kisimbani], Haut Congo [Democratic Republic of the Congo].” “No. 6” Coll. P. Hermann Kohl.

**Material examined.** Type material. Lectotype adult female here designated, on a microscope slide, left specimen of 2. Left label Romée nr. Stanleyville, Congo. Right label *Stictococcus formicarius* Newst. Parasitized ♀ (Co-types), BM 1945, 121 (BMNH).

Paralectotypes, same data as lectotype, adult female on same slide as lectotype. Romée, Stanleyville Haut Congo, Ex Coll. Kohl, 1909, No. 6, Types, BM1945, 121, *Stictococcus formicarius* Newst. ♀. In hollow stems of *Barleria fistulosa*. Associated with *Sina*, adult female in 6 pieces on 1 slide with 1 first-instar female nymph. Same data, 1 first-instar female nymph on 1 slide (BMNH).

**Other material.** Democratic Republic of the Congo, Sasagao, on *Theobroma cacao* (Sterculiaceae), 18.viii.1913, coll. J. Bequaert (MNHN).

Central African Republic, Boukoko, reserve forestière de La Maboké, on *Croton* sp. (Euphorbiaceae), 28.viii.1970, D. Matile; Boukoko, on *Croton mubongo*, 28.iii.1966, coll. R. Pujol, on *Croton mayumberensis*, 1966, R. Pujol, on same host, 5.ix.1968, M. Boulard, on *Porterandia cladantha* (Rubiaceae), 30.iii.1966, R. Pujol, on *Urera cameronensis* (Malvaceae), 5.ix.1968, M. Boulard (all MNHN).

Congo (Brazzaville), Dimonika, on *Acalypha* sp. (Euphorbiaceae), 13.xi.1975, D. Matile (MNHN).

Gabon, Ikoy, Bandja, on *Mimusops afrocana* (Sapotaceae), vii.1962, F. Brunck; Plantation de Libonga, on blossom of *Coffea* sp. (Rubiaceae), v.1938 (all MNHN).

“West Africa”, intercepted at U.S.A., St Louis, on unknown fruit, 20.vi.1989 (USNM) (illustrated).

**Comments.** The important distinguishing characters of this species are the combination of mainly bullet-shaped setae around the ventral margins and flower-shaped dorsal setae.

### ***Stictococcus intermedius* Newstead**

(Fig. 6)

*Stictococcus intermedius* Newstead, 1917: 13; Richard, 1976: 668; Miller *et al.*, 2005: 543.

**Description.** Body of adult female on microscope slide, broadly oval to rotund, 2.08–2.60 mm long, 1.80–2.40 mm wide, membranous at first, mature specimens heavily sclerotized. Antennae 159–206  $\mu\text{m}$  long, 5-segmented, first segment widest, others tapering. Legs well developed, hind trochanter + femur 165–195  $\mu\text{m}$  long, hind tibia + tarsus 162–193  $\mu\text{m}$  long. Ratio of lengths of hind tibia + tarsus to trochanter + femur 0.96–1.05. Ratio of lengths of hind tibia to tarsus 0.76–1.00. Claw 24–30  $\mu\text{m}$  long, stout at base then curving sharply to blunt tip, with one slender clubbed digitule longer than claw and one widely expanded digitule. Tarsus with one long clubbed digitule conspicuously longer than claw digitule, and one widely expanded digitule situated near middle of tarsus. Labium 2-segmented, about 133  $\mu\text{m}$  long, 137  $\mu\text{m}$  wide, shorter than clypeolabral shield; a sclerotized ridge-like structure present on each side of basal segment joining labium to clypeolabral shield. Mesothoracic spiracles 108–129  $\mu\text{m}$  long, 75–86  $\mu\text{m}$  wide. Metathoracic spiracles 96–150  $\mu\text{m}$  long, 72–105  $\mu\text{m}$  wide; oval area surrounding each opening with numerous papilla-like structures. Vulva conspicuous, 270–540  $\mu\text{m}$  wide. Anus situated near mid-dorsum; anterior plate bearing 5 slender anterior flagellate setae; posterior plate usually with 4 setae near posterior margin; both plates plus 2 lateral elongate sclerotized areas surrounded by heavily-sclerotized oval rim, 210–225  $\mu\text{m}$  long, 180–220  $\mu\text{m}$  wide, with small posterior extension. A pair of saddle-shaped apodemes opening posterior to rim. Eyes round, each about 46  $\mu\text{m}$  in diameter.

Dorsal surface of body with a series of marginal barbed setae 75–160  $\mu\text{m}$  long, pointed or bifurcate or trifurcate, longest posterior marginal setae on apparent anal lobe area about 256  $\mu\text{m}$  long, other posterior setae about 160  $\mu\text{m}$  long. Submarginal setae shorter, barbed, spatulate distally, each 37–51  $\mu\text{m}$  long. Submedial and medial setae apparently absent. Long submedial flagellate setae present, some on head about 432  $\mu\text{m}$  long, others 270–360  $\mu\text{m}$  long. Medial flagellate setae surrounding anus, each about 378  $\mu\text{m}$  long. Apparently without thick dorsal setae. Minute slender flagellate setae usually curved and fairly numerous, 15–22  $\mu\text{m}$  long. A series of usually 24 submarginal depressions, 24 submedial depressions, and 17 medial depressions present, all moderately sclerotized, each with distinct outer margin, opening into a globe-like structure, each varying in size from 43–92  $\mu\text{m}$  wide and bearing marginal and inner rows of quinquelocular pores, each 4.5–7.5  $\mu\text{m}$  in diameter; inner polar area with a small number of apparent similar pores associated with a minute tessellated area. Dermal pores abundant, variously shaped, numerous next to depressions and often in fairly well-defined circles around setal collars and more or less segmentally arranged on thorax and abdomen, becoming more scattered on head, comprising large bilocular oval pores, each about 8  $\mu\text{m}$  long, 5  $\mu\text{m}$  wide and trilocular pores about 9  $\mu\text{m}$  wide. Small bilocular pores, each about 5  $\mu\text{m}$  long, 3  $\mu\text{m}$  wide, small trilocular pores, each about 6  $\mu\text{m}$  long, and discoidal pores, each about 5–7  $\mu\text{m}$  in diameter, dome-shaped with outer sclerotized rim, also present. A double to triple row of small quinquelocular pores, each about 4  $\mu\text{m}$  in diameter, extending from apex of abdomen to area almost opposite vulva. A few similar pores also present on margin next to 5 or 6 minute sclerotized clefts.

Ventral surface with small quinquelocular pores, each about 4  $\mu\text{m}$  in diameter, almost encircling vulva then curving posteriorly to midline in a double to triple row extending to apex of abdomen; other pores lateral of vulva present also in a wide submedial row forward to metathoracic spiracles then almost reaching mesothoracic spiracles before extending to eyes. Others in rows extending to 5 or 6 small sclerotized marginal clefts to join with a single marginal row from head to almost to apparent anal lobes. Thick-rimmed oval

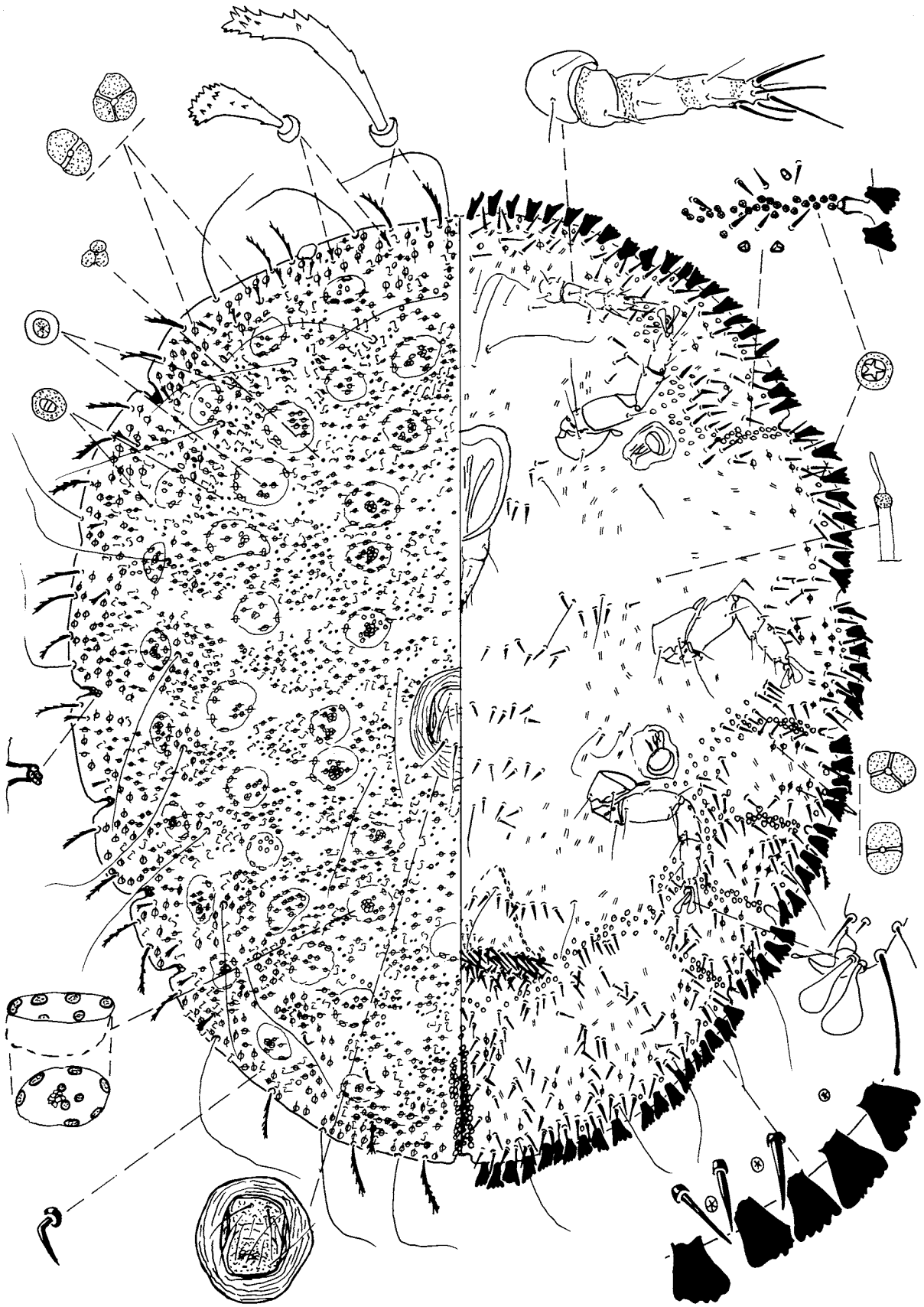


FIGURE 6. *Stictococcus intermedius* Newstead, adult female.

bilocular pores, each about 7 µm long, 5 µm wide, or sometimes replaced by round trilocular pores, 7 µm in diameter, sparsely distributed within areas demarked by quinquelocular pores, often more conspicuous on each side of rows of quinquelocular pores extending to marginal clefts. Minute tubular ducts, each at most 10 µm long, 2 µm wide at cup end and tapering slightly to opening, present across middle of segments and within area demarked by rows of quinquelocular pores. Marginal flat setae, 30–36 µm long, each expanding distally to a lobulate apex mostly about 30–39 µm wide, with 3–7 distal lobules; lobules subequal in size. Other ventral setae, short, almost spine-like, 15–27 µm long, present in more or less single rows across abdominal segments and then mainly following margins of areas demarked by quinquelocular pores; most marginal setae similar but longer, each 36–48 µm long. Long flagellate setae, each about 205 µm long, present around margins, and others occurring medially and submedially. Flagellate setae also situated around vulva, most on anterior edge 55–138 µm long, and others on posterior edge 24–45 µm long.

**Type data.** Gold Coast [Ghana], Aburi, on cacao [*Theobroma cacao*] [Sterculiaceae], ?1913, (W.H. Patterson).

**Material examined.** *Type material.*—Lectotype adult female, here designated. Left label, ? H. Patterson Aburi [Ghana]. Cocoa. Aburi [Ghana]. Newstead No. 26/88. 753. BM 1945, 121. Right label *Stictococcus intermedius* Newst. Cotype ♀♀ & larvae (BMNH). Clearly marked and mapped on a separate label with paralectotypes.

Paralectotypes, same data as Lectotype and on same slide, 6 adult females (1 with first-instar male embryo), 4 second-instar female nymphs (1 enclosing pharate adult female), 2 first-instar female nymphs, 1 first-instar male nymph (BMNH).

Cameroon, Mangomue, on *Didymopanax* sp. (Araliaceae), 23.x.1973, F. Brunck, 2 adult females (BMNH).

Ghana, Legon, on pod of *Theobroma cacao*, vi.1987, Mrs Lyall.

Ivory Coast, on *Theobroma cacao*, P. Vayssière, 1 adult female (BMNH).

Nigeria, Awi Plantation, on *Tectona grandis* (Verbenaceae), 3 adult females; Cross River State, on *Tectona grandis*, 12.ix.1963, 2 adult females; Iddo, xii.1913, D. Cator, 5 first-instar males, 5 first-instar females; Ibadan, on forest tree, attended by weaver ants, 21.x.1987, J Noyes (all BMNH); intercepted at U.S.A., Dallas, on fruit of *Cola acuminata*, 18.x.1981 (illustrated) (USNM).

Sierra Leone, Njala, on *Cola tonensis* (Sterculiaceae), 12.ii.1920, 15.ii.1920, 24.xii.1928, E. Hargreaves.

**Comments.** The distally-lobed marginal ventral setae are characters *S. intermedius* shares with *S. sjostetti* and *S. pujoli*, but the dorsal marginal pores on *S. intermedius* and *S. pujoli* are always larger than the other dorsal pores. On *S. sjostetti*, the dorsal marginal pores are the same size as the pores elsewhere on the dorsum. *S. intermedius* differs from *S. pujoli* in lacking the dense covering of dorsal barbed setae.

### ***Stictococcus pujoli* Richard**

(Fig. 7)

*Stictococcus pujoli* Richard, 1976: 657; Miller *et. al.*, 2005: 544.

**Comments.** Richard gave a brief description of this species as being near to *S. intermedius* in possessing multilobed ventral marginal setae. One of the important distinguishing characters of *S. pujoli* is the presence of numerous barbed stout setae covering the dorsal surface. The anal complex was described as the smallest of any species of *Stictococcus*, measuring only 190 µm long and 160 µm wide. Specimens examined since show that the dorsal marginal pores are larger than those elsewhere on the dorsum.

The species has not been collected since it was first described but it should be easily identifiable.

**Type data.** Guinée [Guinea], Sérédou, on *Cola gabonensis* [Sterculiaceae], 28.ii.1958 (R. Pujol) (MNHN).

**Type material.** Holotype adult female (labelled in ink directly on slide), left side ♀ adulte, MNHN-Paris 6271/1. Right side *Stictococcus Pujoli* Rich., s/*Cola guineensis*, Guinée, Sérédou, 28.II.1958, R. Pujol rec. Paratypes, 1 slide same data as holotype, 1 slide adult female, 6271/2, 1 slide second-instar nymph, 6271/3.



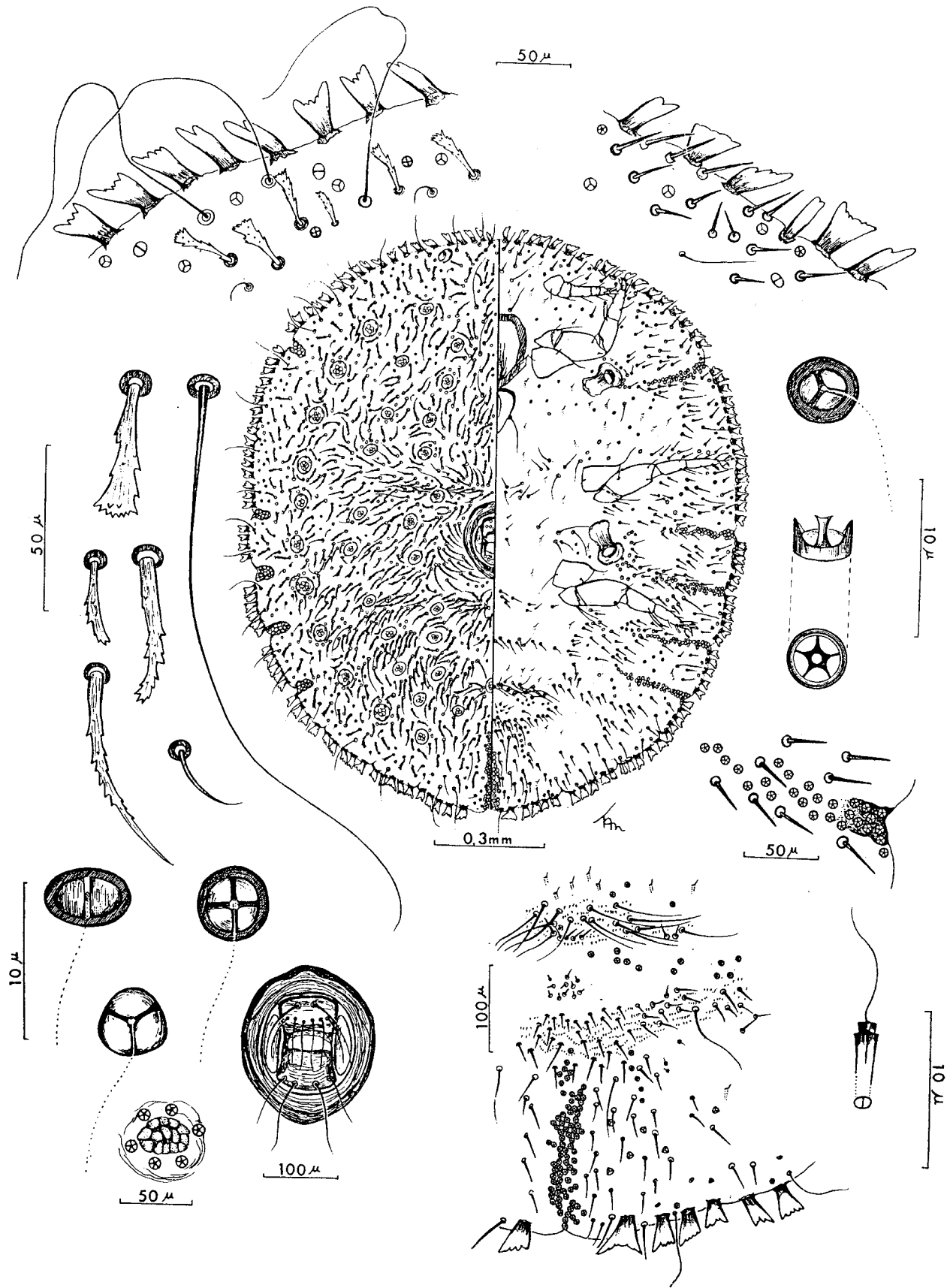


FIGURE 7. *Stictococcus pujoli* Richard, adult female.

## *Stictococcus sjostedti* Cockerell & Cockerell

(Fig. 8)

*Stictococcus sjostedti* Cockerell [T.D.A.] & Cockerell [W.P.] in Cockerell, 1903: 64.

*Stictococcus sjostedti* Cockerell, Richard, 1971: 591, 1976: 667; Miller *et al.*, 2005: 544.

**Description.** Body of adult female on microscope slide, broadly oval to rotund, 1.65–3.30 mm long, 1.45–3.00 mm wide, membranous at first, mature specimens heavily sclerotized. Antennae 180–200 µm long, 5-segmented, first segment widest, others tapering. Legs well developed, hind trochanter + femur 175–215 µm long, hind tibia + tarsus 180–195 µm long. Ratio of lengths of hind tibia + tarsus to trochanter + femur 0.92–1.03. Ratio of lengths of hind tibia to tarsus 0.85–1.00. Claw 30–35 µm long, stout at base then curving sharply to blunt tip, with one slender clubbed digitule longer than claw plus one widely expanded digitule. Outer tarsal digitules long and clubbed, distal inner digitules widely expanded distally, situated near middle of tarsus. Labium 2-segmented, 120–125 µm long, about 140 µm wide, shorter than clypeolabral shield; a sclerotized ridge-like structure present on each side of basal segment joining labium to clypeolabral shield. Mesothoracic spiracles 115–140 µm long, 90–125 µm wide. Metathoracic spiracles 110–140 µm long, 90–110 µm wide; oval area surrounding each opening with numerous papilla-like structures. Vulva conspicuous, about 700 µm wide. Anus situated near mid-dorsum; anterior plate bearing 4 slender anterior flagellate setae; posterior plate usually with 4 setae near posterior margin; both plates plus 2 lateral elongate sclerotized areas surrounded by heavily-sclerotized oval rim, about 250 µm long, 215 µm wide, with small posterior extension. A pair of saddle-shaped apodemes opening posterior to rim. Eyes oval, each about 50 µm long.

Dorsal surface of body with a series of marginal barbed setae 95–115 µm long, all pointed, longest posterior marginal setae on apparent anal lobe area about 260 µm long, other posterior setae about 175 µm long. Submarginal setae shorter, barbed, spatulate distally, each about 60 µm long. Submedial and medial setae similar to submarginal setae, flattened distally, mostly about 120 µm long. Long submedial flagellate setae present, some on head about 440 µm long, others about 290 µm long. Medial flagellate setae surrounding anus, each about 290 µm long. Some thick dorsal setae present, each about 40–50 µm long. Minute slender flagellate setae also present, usually curved and fairly numerous, 20–25 µm long. A series of usually 24 submarginal depressions and usually 21 medial depressions present, all moderately sclerotized, each with distinct outer margin opening into a globe-like structure bearing marginal and inner rows of quinquelocular pores, each about 7.5 µm in diameter; inner polar area with a small number of discoidal pores associated with a minute tessellated area 35–50 µm long, 25–30 µm wide; sometimes structure of all pores difficult to discern. Globe-like structures in teneral specimens about 50 µm wide at anterior and posterior ends of submedial and medial series, others as large as 120 µm wide. Other dermal pores abundant, variously shaped, often in fairly well-defined circles around setal collars and more or less segmentally arranged on thorax and abdomen, becoming more scattered on head, comprising large bilocular oval pores, each about 7.5 µm long, 5 µm wide and trilocular pores about 7.5 µm wide. Small bilocular pores, each about 6 µm long, 3.8 µm wide, and discoidal pores, each about 7.5 µm in diameter, dome-shaped with outer sclerotized rim present. A double to triple row of small quinquelocular pores, each about 5 µm in diameter, extending from apex of abdomen to area almost opposite vulva. A few similar pores also present on margin next to 6 minute sclerotized clefts.

Ventral surface with small quinquelocular pores about 5 µm in diameter, almost encircling vulva then curving posteriorly to midline in a double to triple row extending to apex of abdomen; other pores lateral of vulva present also in a wide submedial row forwards to metathoracic spiracles then almost reaching mesothoracic spiracles before extending to eyes. Others quinquelocular pores in rows extending to 6 small sclerotized marginal clefts to join with a single marginal row from head to almost to apparent anal lobes. Thick-rimmed, oval bilocular pores, each about 7.5 µm long, 5 µm wide, or sometimes replaced by round trilocular pores, 7.5 µm in diameter, sparsely distributed within areas demarked by quinquelocular pores, often more conspicuous on each side of rows of quinquelocular pores extending to marginal clefts. Minute tubular ducts, each at most 15 µm long, 2 µm wide at cup end, and tapering slightly to opening, present across middle of segments and within area demarked by rows of quinquelocular pores. Marginal flat setae, each

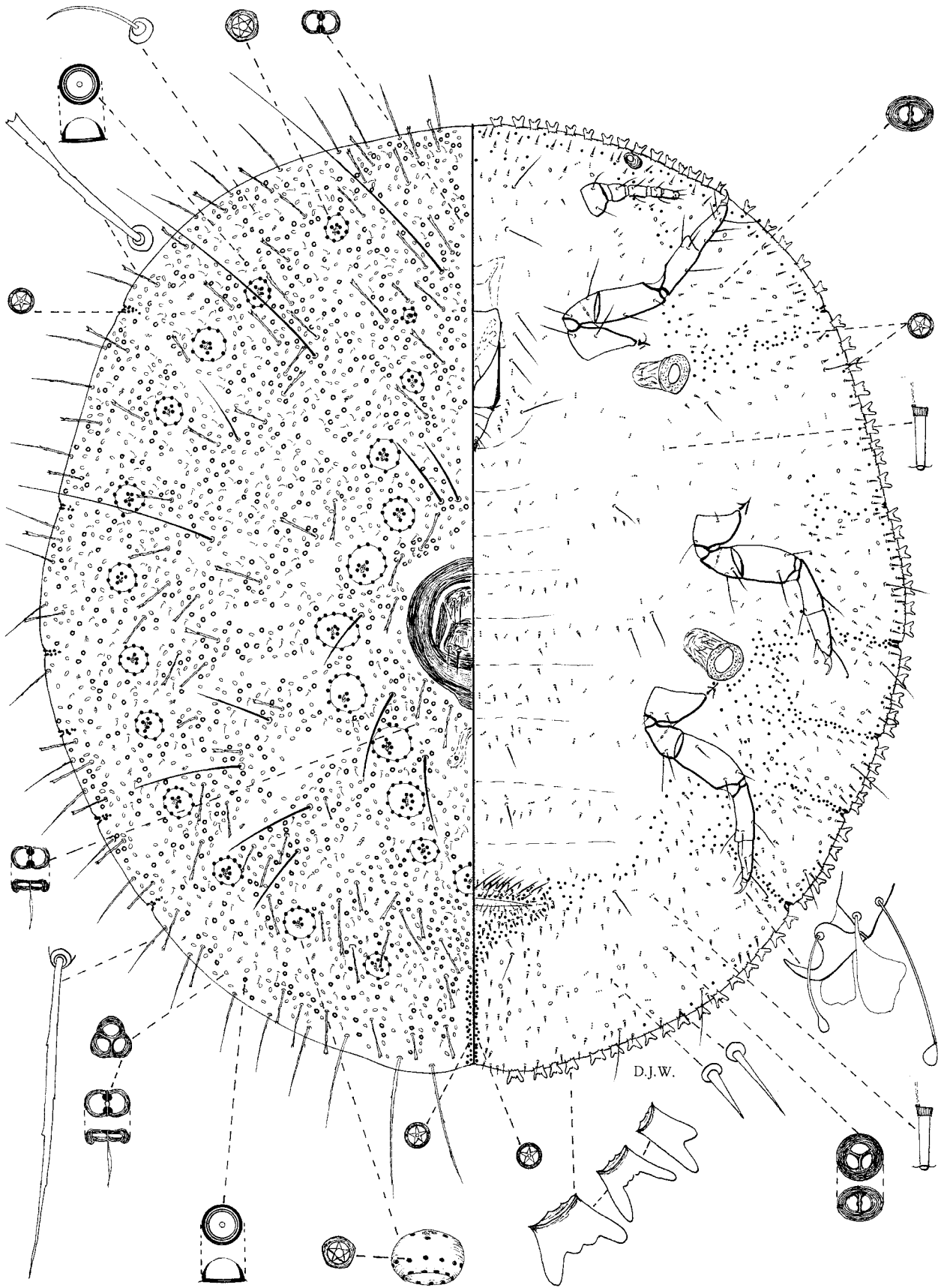


FIGURE 8. *Stictococcus sjostedti* Cockerell & Cockerell, adult female.

expanding distally to a lobulate apex, mostly about 40 µm wide, with 2–4 distal lobules, outer lobules longest. Sometimes, 1 or 2 setae next to marginal clefts replaced by blunt elongate setae. Other ventral setae, short, almost spine-like, 15–20 µm long, present in more or less single rows across abdominal segments and then mainly following margins of areas demarked by quinquelocular pores; most marginal setae similar but longer, each about 30 µm long. Long flagellate setae, each about 115 µm long, present around margins, and other occurring medially and submedially. Flagellate setae also situated around vulva, most on anterior edge 65–140 µm long, and others on posterior edge about 25 µm long.

**Type data.** Cameroons, W. Africa, Itoki, Feb., 1891; “Eskandi” and “Bonze”, Dr. Yngve Sjöstedt.

**Material examined.** *Type material.*—Lectotype adult female here designated, on a microscope slide, left specimen of 2 adult females, left label, *Stictococcus sjostedti* CKII. Co-Type Cameroons, W. Africa Sjöstedt Coll. From T.D.A. Cockerell Jan. 21 1903 (USNM).

Paralectotypes, same data as holotype, 1 adult female on same slide as holotype (USNM); one slide, right label [Cockerell’s handwriting], *Stictococcus sjostedti*. Cameroons W. Africa Dr Inga Sjöstedt, 4 adult females (USNM); one slide, same data, 7 first-instar males; one slide, same data, 5 first-instar females, 1 second-instar female; one slide same data, 5 first-instar males; one slide, 5 first-instar females; one slide (E.E. Green’s handwriting), similar data but also labelled ex coll. T.D.A. Cockerell (all USNM); one slide, similar data (E.E. Green’s handwriting), 2 adult females; one slide (R. Newstead’s handwriting: from E.E. Green), one adult female; one slide, similar data, 5 first-instar female nymphs, 6 first-instar male nymphs (all BMNH).

Cameroon, Victoria, on *Theobroma cacao*, 1904 (BMNH): N’iana, on *Elaeis* sp. (Arecaceae), 19.vii.1941, F.D. Golding (BMNH).

Ghana, Kumasi, on *Theobroma cacao*, B.M. Gerard; no locality, on *Musa paradisiaca* (Musaceae), x. 1941, G.S. Cotterell: on *Theobroma cacao*, G.S. Cotterell (all BMNH).

Nigeria, Agege, on pod of *Theobroma cacao*, 19.iv.1914, Lamborn (BMNH); Cross River State, Bacoco, on *Hypselodephys violacea* (Marantaceae), 3.xi.1984 J.C. Reid (BMNH); Ife-Ife, on *Artocarpus altilis* (Moraceae), v.1969, J.T. Medler (BMNH); intercepted at U.S.A., New York, on fruit of *Cola* sp., 23.iv.1986, Spall (USNM).

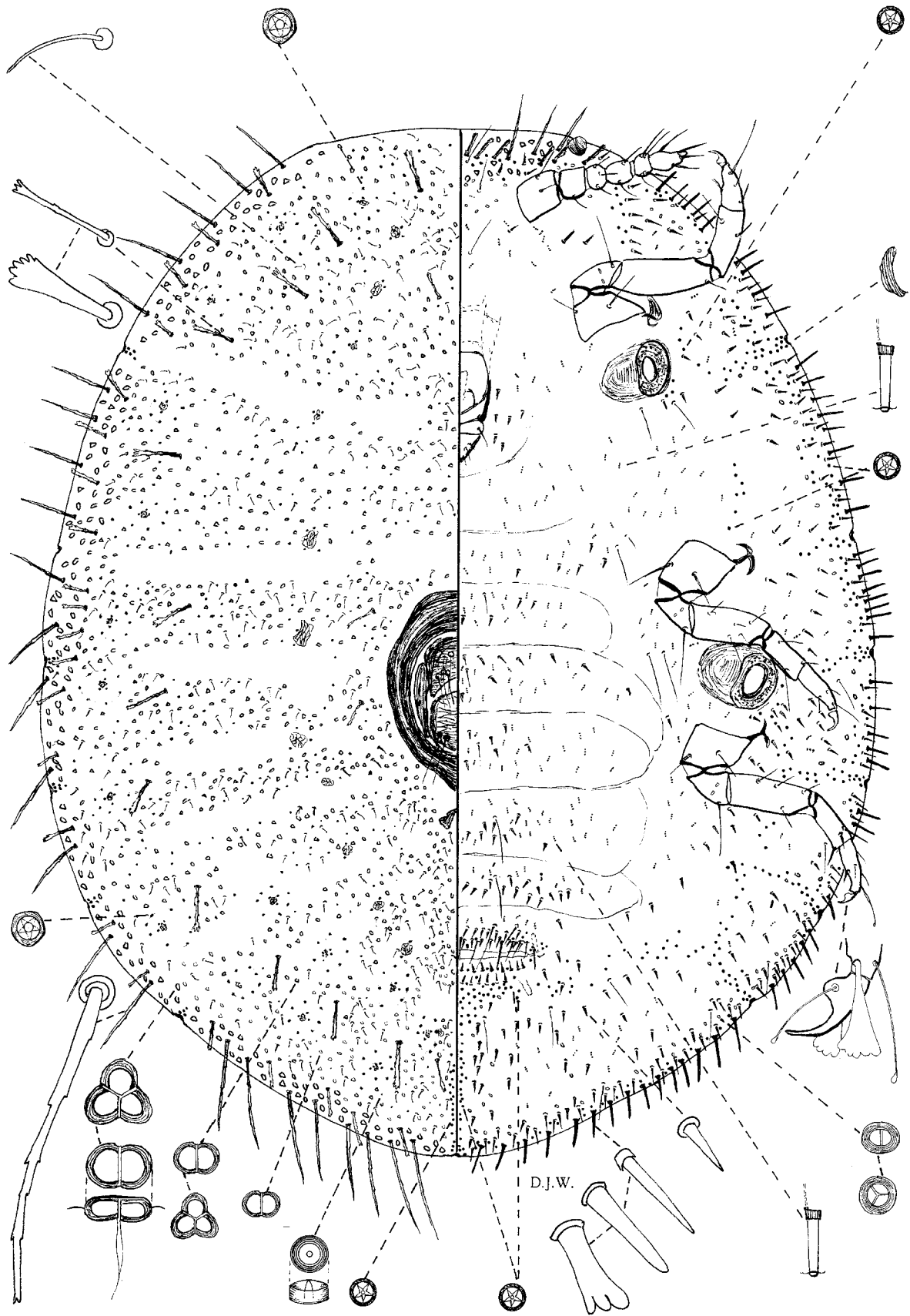
Sierra Leone, intercepted at U.S.A., New York, on *Cola acuminata*, 31.viii.1972, J. Peterson (USNM).

**Comments.** This species is easily distinguishable from all other species of *Stictococcus* in possessing dorsal pores all about the same size. In other known species, the marginal pores are noticeably larger than the other dorsal pores.

### ***Stictococcus subterreus* Williams, Matile-Ferrero & Miller sp. n.**

(Fig. 9)

**Description.** Body of adult female on microscope slide, broadly oval to almost rotund, 1.70–3.90 mm long, 1.35–3.30 mm wide, membranous at first then becoming sclerotized at maturity. Antennae 180–200 µm long, gently tapering, 6-segmented. Legs well developed, hind trochanter + femur 170–190 µm long, hind tibia + tarsus 160–180 µm long. Ratio of lengths of hind tibia + tarsus to trochanter + femur about 0.94. Ratio of lengths of hind tibia to tarsus 0.78–1.00. Claw curved, stout at base, tapering abruptly to tip, about 35 µm long, with one slender clubbed digitule longer than claw and one widely expanded digitule. Tarsal digitules knobbed, long and slender; distal inner digitule of each tarsus widely expanded distally, about as long as claw. Labium about 150 µm long, 2-segmented, shorter than clypeolasbral shield; a sclerotized ridge-like structure present on each side of basal segment, apparently joining labium to clypeolabral shield. Spiracles large and heavily sclerotized, each with sclerotized oval opening containing numerous minute papilla-like structures. Vulva wide and slit-like, at least 250 µm wide; lateral walls of oviduct with a series of minute pores. Anus situated near mid-dorsum, with a sclerotized anterior and posterior plate; anterior plate bean-shaped bearing 4 slender anterior flagellate setae and 6–8 slender posterior setae; posterior plate larger, almost quadrate, with 6 setae situated near posterior margin. A pair of long slender plates situated laterally, all 4 plates surrounded by a heavily-sclerotized oval rim, prolonged slightly posteriorly, each 230–240 µm long, 195–220 µm wide. A pair of sclerotized apodemes present, opening to derm immediately posterior to rim. Eyes present, heavily sclerotized, protruding, each measuring 30 µm at longest axis.



**FIGURE 9.** *Stictococcus subterreus* Williams, Matile-Ferrero & Miller sp. n., adult female.

Dorsal surface of body with a series of long serrated or barbed setae, each 90–135  $\mu\text{m}$  long, and almost pointed distally, longest setae usually situated at posterior end of body. A submarginal row of shorter setae, mostly about 35  $\mu\text{m}$  long, also present, each either slender and expanding only slightly at apex, or wider and expanding widely to denticulate apex. A submarginal row of setae present, these represented singly on each segment. Each seta barbed, ranging in shape from slender and expanding slightly at apex, each about 70  $\mu\text{m}$  long, to shorter and stouter setae, each about 55  $\mu\text{m}$  long and widely expanding to denticulate apex. Some slender barbed setae, each about 35  $\mu\text{m}$  long, present medially around anus and on head. Other setae present, short, usually curved and pointed, each about 20  $\mu\text{m}$  long, fairly numerous, evenly distributed but absent from intersegmental areas. Pores present, diverse in shape, abundant. A series of circular depressions, each with peripheral quinquelocular pores about 7.5  $\mu\text{m}$  in diameter, present around submargins of body and submedially on abdomen; a row also present medially next to anus. Bilocular pores, each 10.0–12.5  $\mu\text{m}$  long and 7.5  $\mu\text{m}$  wide, sometimes replaced by trilocular pores, present in a marginal zone. Similar smaller pores, each about 8.75  $\mu\text{m}$  long or in diameter, and others about 6.25  $\mu\text{m}$  long, associated with small circular pores, each about 6.25  $\mu\text{m}$  in diameter with pointed peg-like centre, often mixed and distributed in whorls or in circles over body surface. Quinquelocular pores, similar in shape to those in circular depressions but smaller, each about 5  $\mu\text{m}$  in diameter, present in a more or less single to double row from apex of abdomen to near base of abdominal segment VII. A series of small reticulated areas present singly on intersegmental lines submarginally.

Ventral surface of body with a marginal series of stout setae, sometimes each seta bluntly pointed, 45–50  $\mu\text{m}$  long, sometimes thicker and bluntly pointed, each 35–45  $\mu\text{m}$  long, or thick and expanding to a flat denticulate or lobulate apex with 2–4 lobules. Some specimens with a mixture of all 3 major types of marginal setae present. Ventral setae mostly short and stout, each almost narrowly conical and bluntly pointed, 20–25  $\mu\text{m}$  long, distributed across segments; conspicuous rows present anterior and posterior to vulva; row immediately anterior to vulva also accompanied by long, thick flagellate setae, each about 65  $\mu\text{m}$  long. Other long flagellate setae present submedially on thorax and between antennae; a few short flagellate setae also present medially on thorax next to short thick setae. Tubular ducts present, each about 15  $\mu\text{m}$  long and very slender, fairly evenly distributed over surface. Quinquelocular pores, each about 5  $\mu\text{m}$  in diameter, present in a marginal series, continuous from a compact group immediately posterior to vulva to apex of abdomen, then in more or less single rows extending medially between segments; rows on thorax extending to spiracular openings and all rows connected submarginally except on prothorax and head where each row connects near anterior spiracle to join marginal row near eye. Each marginal row of quinquelocular pores extending from between prothorax and mesothorax, mesothorax and metathorax, metathorax and abdominal segment I, and between each of abdominal segments I–IV and at apex of abdomen, each indicated by a small crescentic sclerotized plate. Sometimes a few quinquelocular pores present in these rows extending onto dorsal surface. Bilocular pores, occasionally trilocular, present around body margin slightly medial to marginal quinquelocular pores, each with thick rim 7.5  $\mu\text{m}$  long.

**Material examined.** Holotype adult female, Left label, attended by *Anoplolepis tenella*. Right label, Nigeria, Bakoko Village, 13 km N of Calabar, on cassava, *Colocasia* sp. [Araceae] and *Xanthosoma* sp. [Araceae], 9.ix.1978, J.C. Reid (BMNH). Paratypes, Nigeria, same data as holotype, 5 adult females on 3 slides (BMNH); same data 1 adult female (USNM); same data but 10.viii.1979, 2 adult females (BMNH); Cross River State, Ikot Oken., 13 km N of Calabar, base of cassava [*Manihot esculenta*], 1.xii.1981, J.C. Reid, 8 adult females, 2 second-instar female nymphs, 2 first-instar female nymphs on 6 slides (BMNH), 3 adult females (MNHN), 1 adult female (USNM); same data but 1.xii.1981, on subterranean parts of cassava, 2 adult females (BMNH); same data but 6.vii.1981, 5 adult females (BMNH); Ominame, 13 km N. of Calabar, on *Costus afer* (Zingiberaceae), underground, ant attended, 1.xii.1981, J.C. Reid, 3 adult females (BMNH).

**Comments.** There is some variation in the shapes of the ventral marginal setae in all the material examined, but this new species differs from other species in having slender and tapering marginal ventral setae. All specimens lack the long marginal flagellate setae, but sometimes there are a few marginal setae that are longer than the others but are quite thick.

### ***Stictococcus tuberculatus* Laing**

*Stictococcus formicarius* var. *tuberculata* Laing, 1932: 61; Miller *et al.*, 2005: 542.

**Comments.** Laing (1932) first described this species as a variety of *Stictococcus formicarius* stating that specimens differ from those of *S. formicarius* in the darker colour, being brownish black instead of light castaneous. Furthermore, the dorsum differs from that of *S. formicarius* in being convex and the crenulations on the rim are not so pronounced. Laing also stressed the importance of the presence of two tubercles at the posterior end.

We have examined original slide-mounted specimens and find that they are too poor to illustrate or describe in detail. The dorsal marginal pores are larger than other dorsal pores and the ventral marginal setae are mostly bullet-shaped, as in *S. formicarius* and *S. vayssierei*. There do not appear to be any flower-shaped setae on the dorsum, a major character of *S. formicarius*, and, on at least one specimen, there is an enlarged seta widely fringed at the distal end situated near the anus. Such setae are not present in *S. vayssierei*. Besides, Laing described *Stictococcus formicarius* var. *tuberculata* as living on twigs but *S. vayssierei* is always subterranean. The tubercles mentioned by Laing could be equivalent to dermal depressions but are, apparently, everted and convex instead of concave. There are many similar structures on the dorsum. We now give this so-called variety full specific rank.

**Type data.** Belgian Congo [Democratic Republic of the Congo], Stanleyville [Kisangani], on twigs of *Sterculia tragacantha* [Sterculiaceae], 1925.

**Type material.**—Lectotype of *Stictococcus formicarius* var. *tuberculata* here designated: adult female, left label, “*Stictococcus formicarius* Newst., var. *tuberculatus* Laing. TYPE”. Right label, “Name. *Stictococcus formi.*, var. *tuberculatus* nov. Host. *Sterculia tragacantha* [Sterculiaceae], Loc. Congo Belge: Stanleyville. Date 1925. Coll. J. Guesquière. No. 833.” (BMNH).

Paralectotypes of *Stictococcus formicarius* var. *tuberculata*: 3 adult females on 3 slides (same data as holotype) (BMNH).

This species has not been collected since it was first discovered. Guesquière (1932) reported that specimens were deposited in the Musée du Congo, but their fate is unknown.

### ***Stictococcus vayssierei* Richard**

(Figs 3, 10)

*Stictococcus vayssierei* Richard, 1971: 592; 1976: 668.

**Description.** Body of adult female on microscope slide broadly oval, 1.20–3.50 mm long, 1.00–3.10 mm wide, membranous at first, becoming sclerotized at maturity. Antennae 160–200 µm long, tapering to terminal segment, 6-segmented. Legs well developed, hind coxa 65–75 µm long, hind trochanter + femur 190–230 µm long, hind tibia + tarsus 175–200 µm long, claw stout at base then curving to narrow tip, 35–40 µm long, with one slender clubbed digitule longer than claw and one widely expanded digitule. Tarsal digitules clubbed, distal inner tarsal digitules widely expanded. Ratio of lengths of hind tibia + femur to hind trochanter + femur 0.78–0.97. Ratio of lengths of hind tibia to tarsus 0.77–1.00. Labium 125–165 µm long, 100–125 µm wide, shorter than clypeolabral shield, with a ridge-like structure present on each side of basal segment extending to clypeolabral shield. Mesothoracic spiracles 100–125 µm long, 90–100 µm wide. Metathoracic spiracles 125–175 µm long, 100–125 µm wide. Oval area of each spiracular opening with many papilla-like structures. Vulva 550–900 µm wide. Anus oval, 200–250 µm long, 190–200 µm wide, situated near mid-dorsum. A pair of saddle-shaped apodemes opening posteriorly. Eyes oval, 30–40 µm long, 25–35 µm wide. Minute marginal clefts, each with a sclerotized plate, usually totalling 11, present opposite each spiracle, opposite each hind coxa, 2 pairs on abdomen and one at apex of abdomen. A minute cleft, without any sclerotized plate, sometimes discernible opposite each mesothoracic coxa.

Dorsal surface of body with marginal, curved barbed setae, mostly about 75 µm long, except some about 85 µm long on apparent anal lobes, and some about 110 µm long on head margin. A few long marginal flagellate setae present, each 135–175 µm long, a few on head margin about 375 µm long and some on apparent anal lobes about 350 µm long. Normal dorsal setae mostly curved and flagellate, about 30 µm long, present in more or less segmental rows. Longer flagellate setae 45–50 µm long, angled near base, present around margins and submargins and area lateral to anal ring, associated with shallow depressions, each depression also with a few discoidal pores in centre in inner polar region, each pore about 6.25 µm in diameter. Large bilocular pores, each 10.0–12.5 µm long, 7.5 µm wide, or trilocular pores about 12.5 µm wide, present in a marginal zone. Similar pores but smaller, most 10.0–12.5 µm long, but with others about 6.25 µm long, present in whorls or circles, accompanied by small circular pores with a peg-like centre, distributed over surface, some associated with shallow depressions. Minute quinquelocular pores, each about 5 µm in diameter, present in a short medial row extending forwards from apex of abdomen.

Ventral surface with a marginal series of club-shaped setae, mostly 30 µm long, about 10.0 µm wide, sometimes replaced by a few expanded setae about 25 µm long, 20 µm wide at apex and base about 15 µm wide, present near sclerotized clefts. Occasionally, these expanded setae more numerous than club-shaped setae. Minute quinquelocular pores, about 5 µm in diameter, present around vulva, then curving medially to form a row between vulva and minute sclerotized cleft at apex of abdomen. Others present lateral to vulva and extending forwards submedially to metathoracic spiracles, sparsely to mesothoracic spiracles and then anteriorly to eyes; distinct rows also present between each spiracle and margin and on abdomen to each minute marginal cleft; others sparsely distributed around margins. Thick-rimmed pores, either bilocular and 10.0 µm long, 5.0 µm wide, or trilocular pores, about 10.0 µm in diameter, present within marginal areas demarked by minute quinquelocular pores. Minute tubular ducts, each about 15 µm long, 5 µm wide at cup end, present across abdominal segments, in medial areas of head and thorax and with a few present in marginal areas. Spine-like setae, each about 20 µm long, present across abdominal segments and within marginal areas demarked by minute quinquelocular pores; others sparsely distributed in medial areas of head and thorax. Some similar longer setae, about 30 µm long, present near margins. Slender flagellate setae 75–100 µm long, present between antennae, and others 50–75 µm long, distributed across abdominal segments and near spiracles. Thicker flagellate setae, 75–125 µm long, present on anterior edge of vulva.

**Type data.** Cameroun (Yaoundé, 13.xii.1969) sur *Manihot esculenta* (racines) déposée au Muséum national de Paris.

**Material examined.** *Type material:* labelled in ink directly on slide, left side, “Holotype, 7611/2, MNHN–Paris.” Right side, “1<sup>er</sup> st larv. ♀ *Stictococcus vayssierei* Richard 1<sup>er</sup> stade larvaire ♀ s/*Manihot esculenta*, CAMEROUN, 13 XII. 1969 (*N’Jensi*)” [MNHN].

Paratypes, same data as holotype, 3 adult males on 3 separate slides, Yaoundé, 6 1st-instar ♀, on 6 separate slides, Yaoundé. [MNHN].

Allotype, same data as holotype, 1 adult male [MNHN].

**Other material.** Cameroon, 2 km South of Ngoila, nr Adjela, on roots of *Manihot esculenta*, 1.ii.2004, R. Hanna; on roots of *Colocasia esculenta* (cocoyam, Araceae), 28.i.2004, R. Hanna; Aroston, on roots of *Manihot esculenta* (ant attended), 1.ii.2004, R. Hanna; Mboalmayo, on tubers of *Manihot esculenta*, 1992, W. Hammond (all BMNH); Yaoundé, Kala, on roots of *Manihot esculenta*, 27.iv.1993, A. Dejean (MNHN).

Congo (Brazzaville), Brazzaville, on unidentified plant, 1907, E. Roubaud & A. Weiss [MNHN].

Democratic Republic of the Congo (N.W. Bass Zaire), on roots of *Manihot esculenta* (BMNH).

Equatorial Guinea, Bioko, Belebou, on roots of *Xanthosoma* sp. (Araceae), 5.ii.2005, R. Hanna (BMNH). Uganda, Ruwenzori area, Field 3, on roots of *Manihot esculenta* (second instars), 20.vii.2004, G. Goergen (BMNH).

**Comments.** The accompanying illustration of the adult female of *S. vayssierei* is based on preparations of the adult female with identical data to those of the holotype. These specimens were mounted by Richard during her studies of the first instars and adult males but, although they were seen by Richard, they were not included in her description. The adult females, therefore, must be regarded as part of the original material only. The ventral marginal setae of this species are bullet-shaped as in *S. formicarius* but the latter species



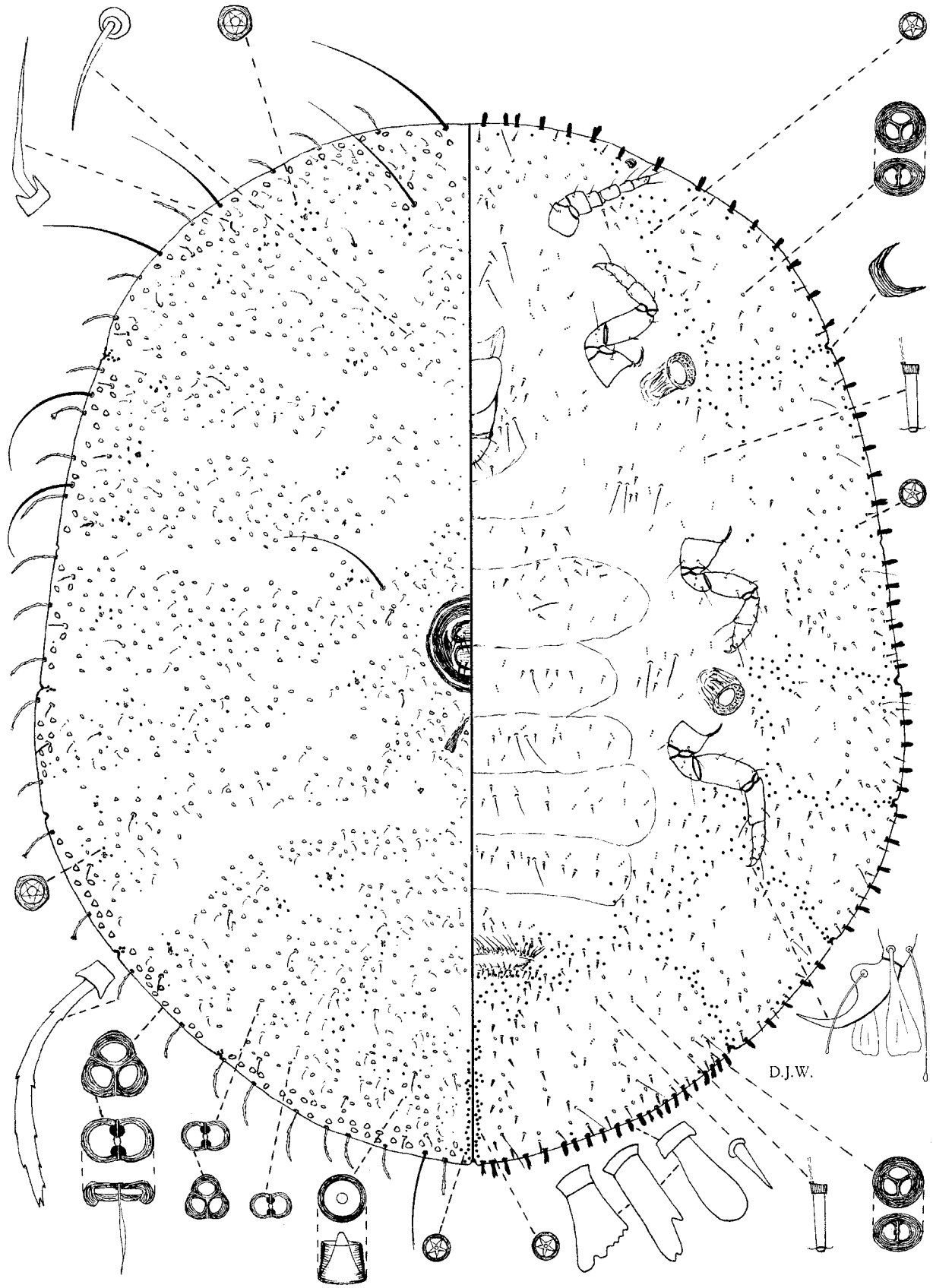


FIGURE 10. *Stictococcus vayssierei* Richard, adult female.

possesses flower-shaped dorsal setae and these are absent from *S. vayssierei*. Furthermore, the dorsal depressions are very shallow and sometimes difficult to locate in *S. vayssierei* whereas in all the other species the dorsal depressions are much more conspicuous.

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