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MORPHOLOGICAL AND TAXONOMIC STUDIES ON THE MALES OF THREE SPECIES OF THE GENUS *PSEUDOCOCCUS* (HEMIPTERA: COCCOIDEA) *

by

J. H. GILIOMEE, M.Sc. (Agric.)

REDAKSIE

PROFF. P. S. DU TOIT (HOOFREDAKTEUR), M. DE VILLIERS, C. J. B. SMIT,
H. B. THOM, B. I. C. VAN EEDEN, H. W. WEBER

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J. H. GILIOMEE, M.Sc. (Agric.)

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ABSTRACT

A general description of the morphology of the pseudococcid male is given and three species i.e. *Pseudococcus fragilis*, *P. adonidum* and *P. maritimus* are described in detail. The presence of metasternal apophyses, vestigial metapleural apophyses and what is considered to be a trochantin, is revealed. In the male the circulus is situated between the 3rd and 4th abdominal segments and the ostioles in the 6th abdominal segment. It was found that the Pseudococcidae are fairly closely related to the Margarodidae and distinctly more primitive than the Lecaniidae. A large number of characters which seem to be of taxonomic significance, as well as a key to the species studied, are presented.

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I. INTRODUCTION

Until quite recently the study of male Coccoidea has been largely neglected and almost all attention has been focussed on the females. This is mainly due to the difficulties experienced in obtaining male specimens (Ghuri, 1959; Beardsley, 1960) and also because it was always thought that the males seem to be of but little value in distinguishing between species (Balachowsky, 1937; Ferris, 1957). Consequently our knowledge of this group of insects was very inadequate, especially with regard to its classification and affinities. The neotenic females (Reh, 1901; Börner, 1910) offer comparatively few characteristics which can be utilized in arriving at a sound natural classification. This fact is well appreciated by Ferris (1942, 1950) who states that "we shall not achieve a satisfactory system of classification until the males have been considered."

This seems to be particularly true for the Pseudococcidae. In this family the number of characters, even for generic differentiation, is much reduced (Ferris, 1950) and no proper attempt can yet be made to arrange the genera into tribes or even subfamilies (Ferris, 1953). This is not possible because of "the present state of our knowledge, which is deficient not only concerning the females, but infinitely more so concerning the males." (Ferris, 1953). It may be noted that, in 1956, Ezzat & McConnel established the tribe Planococcini, to which eight genera were assigned.

That the taxonomic characters of the male may be just as important on the specific level as those of the females was suggested by Theron (1958) and later proved by Ghauri (1959) for the family Diaspididae. The findings of Beardsley (1960) indicated that this might also be the case for the Pseudococcidae.

The present investigation was therefore undertaken: (i) to study the morphology of three species of the genus *Pseudococcus* in detail; (ii) to establish what characters are taxonomically significant; (iii) to describe the three species in detail and (iv) to determine the possible relationships of the Pseudococcidae with other subdivisions of the Coccoidea.

An adequate review of the literature up to 1959 pertaining to male coccids is given by Ghauri (1959) and need not be repeated here. Recently Beardsley (1960) briefly described the males of thirty species of the Hawaiian Pseudococcidae and provided a key to the species, based on male characters. The morphological aspects of the family were only discussed in broad outline.

II. MATERIAL AND TECHNIQUE

The males of the following species were studied:

1. *Pseudococcus fragilis* Brain. Females collected on seedpotatoes (*Solanum tuberosum* L.) at Stellenbosch.
2. *Pseudococcus adonidum* (L.) Females collected on an unidentified fern at Stellenbosch.
3. *Pseudococcus maritimus* (Ehrhorn). Females collected on *Vitis vinifera* L. at Stellenbosch.

The males of the above-mentioned three species were obtained by breeding the insects on sprouting potatoe tubers kept in muslin-covered glass vials. The latter were put in battery jars containing

about two inches of water, in order to avoid mixing of the colonies. Whenever males appeared they were removed and preserved in 70% alcohol.

Specimens were prepared for microscopic examination according to the method described by Theron (1958). Thus they were cleared in 10% KOH for 6 hours at 60°C, then washed in distilled water and slowly dehydrated by passing them through a graded series of alcohols. From absolute ethyl alcohol they were transferred to a saturated solution of Chlorazol Black E in absolute methyl alcohol and stained for about 6 hours, whereafter the excess stain was removed by leaving them in absolute ethyl alcohol for a few hours. (According to Ghauri (1959) the results are quicker and better if a few drops of pyridine are added to the absolute ethyl alcohol). Finally the alcohol was gradually replaced by terpeneol by means of the flotation method described by Gray (1952). Chlorazol Black E is not washed out by terpeneol and the specimens can be stored indefinitely in this medium. Terpeneol is an excellent medium in which to study the general morphology under the stereoscopic microscope and it can also be used in cavity slides for making temporary wholemounts.

Staining with basic fuchsin proved to be more satisfactory for differentiating the structural details of setae and sensilla. The specimens were cleared in 10% KOH as before, washed in distilled water, dehydrated in a series of alcohols up to 70% alcohol and further cleared in chloralphenol (1 part chloralhydrate + 2 parts phenol) for 12–24 hours. They were then stained in basic fuchsin (1.5 gm. in 100 cc. absolute alcohol) for 10 minutes and afterwards transferred to the alcohol-terpeneol mixture used in the flotation method. They were left in this medium until the excess stain was removed and afterwards transferred to pure terpeneol. They were then mounted temporarily in terpeneol or permanently in Canada-balsam. Basic fuchsin is slowly washed out by terpeneol.

All illustrations were made to scale on graph paper by using a squared eyepiece micrometer. Heavily sclerotized ridges are drawn in thick lines, sclerotized areas stippled and membrane left blank. When the margins of sclerotized areas are ill-defined they are indicated by dots, otherwise by a narrow line. Reticulations and folds in the membrane are also indicated by thin lines. Structures below the surface are drawn in broken lines. Except where otherwise indicated, only those setae are drawn whose points of insertion could be seen on the surface. The drawings were all made from specimens which were cleared in KOH and are presumably slightly distended when compared with living specimens.

In taking measurements of various structures and in studying dermal structures, ten specimens of each species were examined. In measuring the length of the scutellum and basisternum the broad ridges which delimit these sclerites were not taken into account. The lengths of the leg segments were measured as indicated in Fig. 11. The length of the style was measured from the middle one of the three dorsoventrally arranged setae to the apex of the style.

III. GENERAL MORPHOLOGY

A. THE HEAD

The structure of the head of the male Pseudococcidae is described by Berlese (1893), Vaney & Conte (1908), Uichanco &

Villanueva (1932), Cottier (1936), Betrem (1937), Mäkel (1942), Sulc (1943), Jancke (1955), Theron (1958) and Beardsley (1960). Mäkel's paper contains many details of the cephalic sclerites and musculature. The homologies of various structures are established by Theron while Beardsley briefly describes the head of *P. adonidum*. The other papers contain little morphologically and taxonomically significant information.

On examining the pseudococcid head, the following striking features are apparent:

- (i) The pronounced sclerite degeneration;
- (ii) The opistognathy;
- (iii) The absence of functional mouthparts;
- (iv) The invaginated apophysis on the ventral surface.

Theron (1958) has indicated that of the three distinct regions of the homopteran head, i.e. the epicranium, the "Vorderkopf", and the labium (Weber 1928, 1935), the first mentioned comprises almost the entire head capsule, while the second is reduced to a small area round the vestigial mouth opening, and the third is absent.

1. Head Capsule:

The dorsomedial part of the epicranium (dme) is slightly raised and only very weakly sclerotized. No demarcated triangular sclerite like that of *Planococcus citri* (Theron, 1958) is formed. The area is bounded posteriorly by a distinct U-shaped ridge (Figs. 1, 4, 7) which may be regarded as a remnant of the postoccipital ridge (por). According to Mäkel (1942) the anterior extensions of the U-shaped ridge are continuous with the preocular ridges, but this is shown to be incorrect by Theron (1958), although such a condition is almost reached in *P. fragilis*. In *P. maritimus* on the contrary, the anterior extremities of the postoccipital ridge are far removed from the preocular ridge and still further so in *P. adonidum*. The postoccipital ridge is medially closely approximated by a median ridge which terminates anteriorly between the antennae and which is regarded by Theron (1958) as a detached dorsal portion of the midcranial ridge (mcr). The ventral part of the midcranial ridge is Y-shaped, with its lateral branches (lmcr) running to the base of the scape, without, however, articulating with the latter. The ventral stem continues posteriorly towards the ventral eyes and disappears in front of them. The dorsal and ventral parts of the midcranial ridge are completely separated from one another in the three species studied and according to Theron (1958) also in *P. citri*. This is contrary to Mäkel's (1942) observations. No significant interspecific variations of the ridge were observed in the species examined.

The ocular sclerites (ocs) comprise most of the ventral surface and part of the lateral surface of the cranium. Posteriorly the ocular sclerites are bounded on each side by a ridge named the postocular ridge (pocr). This ridge originates behind the dorsal eye (Fig. 10) and runs ventrally posterior to the ocellus in a posteromedian direction, finally terminating in two sclerotic areas near the anterior tip of the proepisternum + cervical sclerite (pepcv) (Figs. 3, 6, 9). Antero-dorsally the ocular sclerite is bounded on each side by the preocular ridge (procr) which carries a small anterior process for articulation with the scape. It traverses the ocular sclerite anterior to the lateral ocellus and fuses with the postocular ridge (pocr) below the ocellus. Dorsal to the ocellus the two ridges are joined together by a transverse

ocellar ridge (ocr), which is absent in *P. citri* (Theron, 1958), but is described by Mäkel (1942) as part of the "sclerotized ring" which surrounds the lateral ocellus. She describes the postocular ridge as being the dorsal and ventral arms of a ridge which bifurcates below the ocellus, while she considers the preocular ridge to be part of the postoccipital ridge. Berlese (1893) describes these ridges incorrectly and does not name them. Anteroventrally the ocular sclerites are not bounded by ridges and are indistinguishably fused with each other ventromedially. Posteroventrally the ocular sclerites are bounded by the preoral ridges.

A large dorsal simple eye (dse) is borne on each ocular sclerite between the ocular ridges, while a pair of similar eyes (vse) is situated ventrally on two conical prominences. In addition a large lateral ocellus (o) occurs as a membranous transparent tubercle where the pre- and postocular ridges coalesce. The dorsal eyes are always widely separated from one another; in the species examined the distance varies between 92 and 119 μ . The ventral eyes are usually approximated, the distance between them varying from 17—31 μ . Relatively large individual variation in this distance was observed in *P. adonidum*. The dorsal and ventral eyes each have a well developed cornea of which the diameter is slightly larger in the ventral than in the dorsal eyes (dorsal eyes diameter 23—31 μ , ventral eyes diameter 26—37 μ). The eyes (dorsal and ventral) of *P. maritimus* are on the average smaller than those of *P. fragilis* and *P. adonidum*. Around the dorsal and ventral eyes the ocular sclerite is distinctly reticulated, exhibiting an irregular polygonal pattern. Dorsally the reticulated area extends back between the ocular ridge to the border of the ocular sclerite. In view of Pflugfelder's (1936, 1937) work on *Lecanium* it can be assumed that the dorsal and ventral eyes of *Pseudococcus* represent modified compound eyes and that the ocelli represent persisting larval ocelli.

A large membranous area, corresponding topographically to the genae (g), extends laterally from each postocular ridge to the cervical groove.

On the median line the ventral wall of the epicranium is invaginated to form a narrow slit-like ventral cavity (vc) whose external opening is situated behind the ventral eyes. From the ventral cavity a short dorsoventrally flattened apophysis stretches internally and, according to Mäkel (1942), serves for the attachment of four antennal muscles. Berlese (1893) refers to this apophysis as the occipital apophysis, but Theron (1958) more correctly calls it the cranial apophysis.

Immediately behind the ventral cavity two slightly sclerotized ridges, called the preoral ridges (pror), form an inverted V-shaped structure. Medially they fuse with one another and laterally they are connected with the postocular ridges by means of intermediate sclerotized plates (Figs. 3, 6, 9). A similar connection between the preoral and postocular ridges is described by Ghauri (1959) for most Aspidiotina (Diaspididae), but is not mentioned by Theron (1958) for *P. citri* or by Beardsley (1960) in his description of *P. adonidum*. The small mouth opening (mo), which is presumably non-functional, is situated in the membrane behind the preoral ridges.

The anterior tentorial arms originate in the ventral cavity posterior to the cranial apophysis. They are fused with one another

for a short distance and then extend posteriorly as two separate thread-like structures which fuse with the stouter posterior tentorial arms. The latter originate from two small tentorial pits (ptp) which are situated in the membrane surrounding the mouth opening. The posterior tentorial arms are connected by means of an arcuate tentorial bridge. Mäkel (1942) overlooked the anterior tentorial arms and consequently her interpretations of the ventral cranial wall are partly erroneous, as is shown by Theron (1958). No mention of the tentorium is made by Beardsley (1960).

Dermal structures: The chaetotaxy of the male Pseudococcidae has been studied to some extent only by Sulc (1943) and Beardsley (1960). Two distinct types of setae are found:

- (i) a thick-set, "fleshy" type (Fig. 17, fs) which tapers only slightly and has a rather blunt apex, and
- (ii) a slender "hair-like" type (Fig. 16, hs) which tapers quite notably and has an acute apex.

The fleshy setae of *P. fragilis* (Fig. 16, fse) are much more slender than those of *P. maritimus* and *P. adonidum* and it is sometimes difficult to separate them from the hair-like setae. In *P. maritimus* and *P. adonidum* the fleshy setae have a much stouter, peg-like appearance and the distinction is therefore easily made. Generally the hair-like setae on the dorsal surface are shorter than those on the ventral surface. The setae can be arranged in the following groups:

- (i) Dorsal head setae (dhs): They occur on both sides of the dorsal part of the midcranial ridge between the postoccipital ridge and the lateral midcranial branches (Figs. 1, 4, 7). There is little variation in the number of dorsal head setae in the species concerned, as is evident from the individual descriptions given later on. In the species studied the number of fleshy setae in this region varies from 4 to 14 and the hair-like setae from 7 to 13. The fleshy setae are generally longer than the hair-like setae, the former being about twice as long as the latter in *P. fragilis*.
- (ii) Ventral head setae (vhs): They are found on the ocular sclerite in between, as well as anterior to and lateral to the ventral eyes (Figs. 3, 6, 9). They extend anteriorly to the lateral branches of the midcranial ridge. Laterally some of the setae are inserted on the preocular ridge with one or two occurring beyond the ridge. Both fleshy and hair-like setae are present, the numbers varying between 29 and 93 for the fleshy, and between 13 and 39 for the hair-like setae. Striking differences are found in the nature of the setae posterior to the level of the anterior margins of the ventral eyes. In the case of *P. maritimus* no fleshy setae and 5—9 (av. 6.5) hair-like setae occur in this area, while in *P. adonidum* 3—7 (av. 4.5) fleshy setae and 1—3 (av. 2.2) hair-like setae are found here. In *P. fragilis* the corresponding numbers are 5—9 (av. 7.3) and 2—4 (av. 2.8) respectively. The fleshy setae of *P. fragilis* in this area are much longer than those in *P. adonidum* and, as noted previously, they are more slender.
- (iii) Genal setae (gs): They are situated on the genae. Occasionally one or two of these are found beyond the postocular

ridge on the dorsal part of the ocular sclerite posteromedial to the dorsal eyes. The number of fleshy setae in this region varies from 11—26, and the number of hair-like setae from 1—4. The hair-like setae are inserted fairly close to one another.

One to three circular quadrilocular disc pores (Fig. 28) are situated laterally near the base of each antenna. Minute sclerotized rings, which presumably represent pores, are scattered over the derm.

2. Antennae:

In almost all the descriptions of male Pseudococcidae only brief reference is made to the antennae. Uichanco & Villanueva (1932) give, in addition to the relative lengths of the segments, a description of the shape of every segment.

The antennae are situated at the anterolateral margin of the head, the diverging lateral branches of the midcranial ridge lying between them. The antennae are normally 10-segmented, but occasionally one of the segments between segments IV—IX, of one or both antennae, are reduced and its vestiges are incorporated in an adjacent segment, with the result that the antennae are apparently 9-segmented. Similar conditions are found in the Diaspididae (Ghauri, 1959). The general appearance of the antennae is filiform (Figs. 2, 5, 8). The scape and pedicel are short and broad while the segments of the flagellum are elongate. The length of the antennae varies from 524—988 μ ; the ratio of antennal length to body length varies from 1 : 1.69—2.44.

The nature of the setae on the antennae is somewhat problematic. The two basic types which occur on the head, i.e. fleshy and hair-like setae are present, and, as described previously, the fleshy setae of *P. fragilis* are longer and more slender than those of *P. adonidum* and *P. maritimus*. On the distal segments of *P. maritimus* and *P. adonidum*, however, a few setae are found which do not correspond to the fleshy or hair-like setae of these two species, but resemble the fleshy setae of *P. fragilis*. A further complication is the fact that in *P. fragilis* 1—2 stout setae, which resemble the fleshy setae of the other two species, occur ventrally on the proximal half of the terminal segment. From this condition it could possibly be deduced that three basic types of setae are present, i.e. (i) a stout type with a blunt apex; (ii) a slender type with a blunt apex, and (iii) a slender type with an acute apex. The 1st type occurs on segments II—X of *P. maritimus* and *P. adonidum* and on segment X of *P. fragilis*. The second type occurs on segments II—X of *P. fragilis* and on the distal segments of *P. fragilis* and *P. adonidum* while the 3rd type occurs on all the segments of all three species. More members of the family have to be studied before the position can be clarified. In the case of *P. maritimus* and *P. adonidum* no distinction was made between the 2nd and 3rd types in the illustrations and descriptions.

A single sensillum placodeum is present on the 2nd antennal segment, and sensilla basiconica are found on segments III and X.

The scape (scp) is the shortest and widest segment of the antenna, subrectangular in shape and sclerotized, except distally and laterally. A well sclerotized basal ridge articulates laterally with a projection of the preocular ridge. Distally the ventral sclerotization is produced into a distinct process, which articulates with the basal ridge of the pedicel. From 6—9 hair-like setae are present on the

scape, but no fleshy setae. A short hair-like seta with its basal disc surrounded by a strong basal ring, is always present dorsally on the posterior half of the segment.

The pedicel (pdc) is club-shaped and well sclerotized; at its greatest diameter it is almost as broad as the scape, but it is only half as broad at its base. The distal part is distinctly and prominently reticulated. The basal ridge is well developed ventrally, but not dorsally, and articulates with the ventral process of the scape. Apically a socket is formed for reception of the constricted basal part of segment III. Both fleshy and hair-like setae are present. Distally a circular sensillum placodeum (spl) is present on the dorsolateral surface of the segment.

The flagellum (F_{III-X}) is composed of the 3rd to the 10th segments. Its elongated segments are cylindrical and slightly constricted apically and basally where they articulate with adjacent segments. The segments are all well sclerotized, except for the constricted apical part which is membranous. The relative lengths of the segments vary considerably. The 1st segment of the flagellum is always the longest and, with the exception of the last segment, there is a general tendency for the segments to decrease in length distally. The terminal segment is usually somewhat longer than the preceding ones. The diameter of the flagellar segments remain fairly constant, but they bulge somewhat where the setae are inserted.

Relatively numerous fleshy setae and few hair-like setae are carried on each of the 4th to the 9th segments. The length of the fleshy setae varies in the species studied. In the case of *P. maritimus* the length is approximately equal to the diameter of the segments while it is 1—1½ times longer in *P. adonidum* and 1¼—2½ times longer in *P. fragilis*. A large fleshy seta occurs ventrally on the distal half of segments VIII and IX. These two setae resemble the fleshy setae of *P. maritimus* and *P. adonidum* but are more than twice their size, with large basal discs. They are termed "specialized sensory hairs" by Beardsley (1960). A sensillum basiconicum is situated ventrally on the distal part of segment III.

The terminal segment (Xth) is somewhat tubularly constricted at the apex in *P. adonidum* and *P. maritimus* and pointed in *P. fragilis*. Its length varies from 58—88 μ in the species studied. Both types of the setae are present on this segment. The fleshy setae are relatively few in *P. adonidum* and *P. maritimus* (9—12 and 10—13 respectively) but numerous in *P. fragilis* (19—25), while the hair-like setae are few in *P. fragilis* (1—3), but numerous in *P. adonidum* (4—7) and *P. maritimus* (6—10). Three of the large fleshy setae found on the 8th and 9th segments also occur near the apex of the 10th segment, one dorsally and two laterally. Two long, apically knobbed, sensory setae [seta semi-claviformes (set. scl.) of Sulc, 1943], with its basal disc surrounded by a strong basal ring are situated ventrally near the apex. A straight rigid seta, which is not knobbed apically, is situated at the apex. Two peg-like sensilla basiconica (bs) occur on the distal part of the 10th segment, one at the apex and the other ventrolaterally, a short distance behind.

B. THE THORAX

The thorax is described in some detail by Berlese (1893), Mäkel (1942) and Beardsley (1960) and is figured by Ezzat (1956).

The papers of Vaney & Conte (1908), Uichanco & Villanueva (1932), Cottier (1936), Betrem (1937), Sulc (1943) and Jancke (1955) contain little information. Theron (1958) made a comprehensive study of the thorax and established the homologies of the various structures.

The thorax is characterized by a marked sclerite degeneration of the pro- and metathorax. In the latter this is probably due to the replacement of the hind wings by halteres. The mesothorax, on the other hand, is well developed and exhibits relatively primitive features.

1. *Prothorax*:

The prothorax is distinctly separated from the head by a deep cervical groove and is largely membranous. Immediately behind the neck region two narrow transverse ridge-like sclerites are found (Figs. 1, 4, 7). They are separate dorsally and extend ventrally to articulate with the proepisternum + cervical sclerite. They are regarded as the first cervical sclerites by Mäkel (1942) and are named the prothoracic sutures by Ezzat (1956), but Theron (1958) points out that they probably represent part of the pronotum and calls them pronotal ridges (prnr). Dorsolaterally a less sclerotized area (prn), the "Cervicalast" of Mäkel (1942), is associated with the ridges on each side. These two sclerites are probably homologous with the lateral pronotal sclerites described by Ghauri (1959) in the Diaspididae. Further back a pair of sclerotized plates is found dorsolaterally. Following Weber (1928), Theron (1958) calls them posttergites (pt) and points out that this is merely a topographical term. They are not described by Mäkel (1942).

The cervical and pleural sclerites are reduced to two strong lateral ridge-like structures which articulate anteriorly with the postocular ridges (Fig. 10). Each of them fuses posteriorly with the pleural ridge and forms a small pleural apophysis (pla₁) internally. The weakening near the anterior end of the ridge induced Mäkel (1942) to regard the anterior part as a definite detached cervical sclerite. As this weakening does not occur in the more primitive Coccoidea (Theron, 1958), it is probably of secondary nature. The pleural ridge (plr₁) is reduced to a short process which extends downwards from the pleural apophysis and articulates with the basal process of the coxa. Although the pleural ridge and the pleural apophysis forms the hind margin of the pleural sclerite in the three Pseudococcidae studied, as well as in the Coccoidea studied by Theron, an epimeron is described by Ghauri (1959) in some Diaspididae. It is therefore more appropriate to call the anterior part of the ridge, representing the cervical and pleural sclerites, the proepisternum + cervical sclerite (pepcv) and not propleuron + cervical sclerite, as is proposed by Theron (1958). Ezzat (1956) refers to this ridge as the pleural sclerite of the prothorax.

A small triangular sternum (stn₁), which is bounded posteriorly by a strong transverse ridge, is found ventrally (Figs. 3, 6, 9). The prosternum is incorrectly figured by Mäkel (1942), who names it the ventral sclerite. Ezzat (1956) refers to it as the basisternum. Beardsley (1960) refers to it as a remnant of the prothoracic poststernum, erroneously stating that it was thus named by Theron (1958).

The prothoracic structures described thus far show no significant variation in the three species studied.

Dermal structures: Both hair-like and fleshy setae, similar to those found on the head, are present on the prothorax. Disc pores, which

are usually quadrilocular (Fig. 28), but sometimes trilocular (Fig. 29) or quinelocular (Fig. 27), are associated with the setae. As in the case of the head, *P. fragilis* possesses the largest number of prothoracic setae and *P. maritimus* the least.

Two groups of setae occur dorsally on each side of the median line. They can be termed medial pronotal setae (mpns). In the species studied the number of fleshy setae on each side varies from 0—9 and the number of hair-like setae from 0—5. A number of disc pores (1—5) are associated with these setae.

Setae are also found in the area ventral to the medial pronotal setae and dorsal to the proepisternum + cervical sclerite. Although it is sometimes difficult to separate these setae from the medial setae, they can be termed the lateral pronotal setae (lps). In the case of *P. maritimus* and *P. adonidum* no fleshy setae were observed in this region while a single fleshy seta was found in one specimen of *P. fragilis*. A single hair-like seta was found in this region in one specimen of *P. maritimus* while 0—5 hair-like setae are present in *P. fragilis* and *P. adonidum*. The number of disc pores in this region varies between 1 and 14.

A number of setae, the posttergital setae (pts), are associated with the posttergite. They occur on, or immediately behind, this sclerite and also extend downwards. In the species studied the number of fleshy posttergital setae varies from 3—13 and the hair-like setae from 0—4. No disc pores are found in this region.

In the area dorsal to an imaginary line drawn between the pleural apophysis and the spiracular opening a few setae, the antespircular dorsal setae (asds), occur. They are absent in *P. maritimus*, but a small number are found in both *P. fragilis* and *P. adonidum*. A few disc pores are usually also present in this region. Antespircular ventral setae (asvs) are found ventral to the imaginary line drawn between the pleural apophysis and the spiracular opening. The number of fleshy setae in this region varies from 0—4. A single hair-like seta was always present in all the species studied except for one individual of *P. maritimus* in which it was absent on one side. No disc pores occur in this region.

In *P. fragilis* it is sometimes difficult to distinguish between the antespircular ventral setae and the next group of setae, namely the prosternal setae (stn₁s). The latter are found between the coxae, anterior to the transverse ridge of the prosternum. In this group the fleshy setae vary from 4—24 and the hair-like setae from 2—8. A few disc pores usually occur in this region. Immediately ventral to the anterior part of the proepisternum + cervical sclerite 1 or 2 fleshy setae sometimes occur in *P. fragilis*.

2. *Mesothorax*:

As the mesothorax is the carrier of the principal organs of flight, it is well developed and reinforced by strong ridges. It shows various comparatively primitive features. Little variation in the sclerotized areas is noticeable.

(a) *Mesotergum*: It is well sclerotized and subdivided into the distinct alinotum which is composed of a prescutum, scutum and scutellum and the postnotum. The anterior margin of the mesonotum is curved inwards to form the mesoprephragma whose ventral margin is always slightly emarginated medially.

The prescutum (prsc) is strongly arched and is bounded laterally by strong prescutal ridges (pscr) which fuse anteriorly with the mesoprephragma. The posterior margin of the prescutum is formed by a groove-like depression, representing the prescutal suture (pscs) and lacking an internal ridge. Berlese (1893) refers to the prescutum as the oval anterior part of the mesonotum, but Mäkel (1942) correctly identifies the prescutum. She, however, considers the prealare to be part of the prescutum, but in the Pseudococcidae it has actually become part of the scutum. She refers to the prescutal ridges as parapsides. Jancke (1955) incorrectly applies the name proscutum to the prescutum and the structure identified as the prescutum by Ezzat (1956) is in reality the mesoprephragma.

The scutum (set) is a large transverse sclerite with anterior and posterior extensions laterad of the prescutum and scutellum respectively (Figs. 1, 4, 7). Each anterior extension is produced ventrally to form the prealare (pra), which is separated from the scutum by a strong secondary ridge. Anteriorly this ridge forms a finger-like apodeme (a). The distal part of the prealare is differentiated into a well sclerotized triangular plate (tp), the posterior margin of which curves sharply inwards and articulates with the episternum. Mäkel (1942) refers to the prealare as the "Tergalarm"; Ezzat (1956) calls the anterior extensions of the scutum the "anterior phragma", and the triangular plate the "prealar wing process". Medially the scutum bears a longitudinal suture-like depression. The lateral margin of the scutum is produced into a well developed anterior notal wing process (anp) which curves upwards. Immediately behind the anterior notal wing process a small notch is formed. From this notch a line of deflection extends towards the anterior margin of the scutellum. Posterior to this line the posterior extensions of the scutum are inflected downwards, for a short distance, and then upwards to form the posterior notal wing process (pnp) laterally. A small but distinct lateral emargination precedes the posterior notal wing process. The posterior extensions of the scutum are regarded as part of the scutellum by Berlese (1893), Mäkel (1942) and Jancke (1955), but Theron (1958) has shown that they belong to the scutum.

The scutellum (scl) appears in dorsal view as a subrectangular sclerite, which is separated from the scutum by the scutoscutellar suture (sets). The anterior and posterior edges of the scutellum curve inwards, thus forming a semicylindrical structure. Its posterior margin is bounded by a ridge, which probably corresponds to the posterior marginal fold of the alinotum (rd) (Theron, 1958). Medially a longitudinal, slightly less sclerotized area, called the membranous area by Ezzat (1956), is present on the scutellum.

The posterior part of the postnotum is separated from the scutellum by a large subtriangular membranous area which is called the "postscutellum or scutellum of the metanotum" by Berlese (1893) and the postscutellum by Jancke (1955). The posterior part of the sclerite stretches posteriorly for a considerable distance, curving inwards and extending within the metathoracic cavity. It is overlapped by the deeply involuted metanotum. The latter sclerite is not described by Beardsley (1960) and his illustration of *P. adonidum* wrongly gives the impression that the posterior part of the postnotum is situated externally. Internally a slightly emarginated mesopostphragma is formed where the mesopostnotum and metanotum meet. Anterolaterally

the postnotum is produced into a postalare (pa) which invades the pleural region and finds support in front of the mesopleural ridge. (Fig. 10). The anterior margin of the postalare is strengthened by a ridge, which might be termed the anterior postalare ridge (apar). Posteriorly it is reinforced by a posterior postalare ridge (ppar). Mäkel (1942) describes both these ridges without naming them. She incorrectly considers them, however, to be anteriorly fused with the mesopleural ridge. She also assumes that the posterior postalare ridge extends to the metathoracic pleural wing process. Ezzat's (1956) illustration of the pleural region of *Pseudococcus vitis* similarly gives the impression that the anterior postalare ridge is fused with the mesopleural ridge. Dorsally the postalare is connected to the scutum by means of a sclerotized band.

Anterolaterally the postnotal sclerite bears a pair of well developed finger-like postnotal apophyses (pna), to which Berlese (1893) refers as the corniculate apophyses of the metanotum, and Mäkel (1942) as the wedge-shaped apophyses. The postalare was first correctly identified as such by Theron (1958).

(b) *Mesopleuron*: Although modified because of sclerite degeneration and the development of secondary ridges, the principal structures of the mesopleuron are quite distinct. The pleural ridge (plr₂) stretches obliquely upwards across the pleuron (Fig. 10), articulating ventrally with the coxa and terminating dorsally in the pleural wing process (pwp₂). It fades out for a short distance above the coxa. Where the pleural ridge is overlapped by the postalare, a pleural apophysis (pla₂) is invaginated from the ridge. From the pleural apophysis a large triangular membranous area extends anteriorly to the subepisternal ridge (ser) and consequently divides the mesepisternum (eps₂) into dorsal and ventral parts. The posterodorsal edge of the episternum (called the tendon plate by Mäkel, 1942) is bent inwards underneath the basalare. Below this structure it forms a convex bulge. The anterodorsal part of the episternum is partly overlapped by the triangular plate of the prealare. A well developed basalare (bas) connects the episternum with the large rounded pleural wing process (pwp₂). This process is connected with the costal complex of wing veins by means of a narrow sclerite, which originates on the dorsal edge of the pleural wing process. Dorsally behind the pleural wing process a distinct subalare (sa) is found. Mäkel (1942) found both these epipleurites, but did not name them (although the word "basalare" is included in her list of abbreviations). The episternum is bounded anteriorly by a well developed secondary ridge, called the subepisternal ridge (ser) by Theron (1958). It extends from the marginal ridge of the basisternum to the triangular plate, but is not fused with either. Mäkel (1942) refers to it as a forked ridge and Ezzat (1956) as the pleural bridge. Behind the pleural ridge, above the coxal articulation, a small sclerotized area represents a vestige of the epimeron (epm₂). Anterior to the subepisternal ridge, immediately above the marginal ridge, a narrow sclerotized area stretches anteriorly. This is termed the lateropleurite (lpl) by Theron (1958) in other Coccoidea, but is not described by him in Pseudococcidae. Anterior to the coxal articulation a narrow sclerite extends downwards without, however, articulating with the coxa. This probably represents the trochantin (tn). It was not observed in any of the species studied by Theron (1958)

(although it is present in *Planococcus citri*), but is described by Weber (1928) and Roberti (1946) for *Aphis*, and by Kramer (1950) for five auchenorrhynchan Homoptera. Mäkel (1942) found this sclerite, but does not identify it as the trochantin. The mesothoracic spiracle (sp_2), with a well developed supporting peritreme (ptr_1), is situated in the membrane anterior to the subepisternal ridge.

Mäkel's (1942) descriptions and Ezzat's (1956) figures of the pleural region are generally incomplete and also incorrect in some respects. Beardsley's (1960) description lacks detail, and what he illustrates as a portion of the mesopleural ridge is in reality parts of the postalare and mesepimeron.

(c) *Mesosternum*: The mesosternum is represented by a large, well sclerotized, convex plate (Figs. 3, 6, 9) which is obviously the basisternum (stn_2) since it is situated anterior to the mesofurcal pits (fp). The basisternum was correctly identified as such by Mäkel (1942), but it is incorrectly called the furcasternum by Ezzat (1956). No true sternellum is present in the species studied, but Mäkel's description of the base of the furca as a furcasternite is probably correct. It is, however, definitely not part of the metathorax as is suggested by Larsén (1945). The furca (f) is well developed and consists of a broad basal stalk and two furcal arms extending antero-laterally. In front of the coxa the basisternum fuses laterally with the episternum, thus forming a distinct precoxal bridge. A postcoxal bridge is absent. A strong ridge, called the marginal ridge (mr) by Theron (1958), separates the basisternum from the pleuron. It fuses posteriorly with the pleural ridge at the point where the latter fades out above the coxal articulation. Anteriorly this ridge runs medially to meet its opposite number and these two together form the anterior margin of the basisternum. The posterior margin of the latter is bounded likewise by a ridge which fuses with the marginal ridge anterior to the coxa. This ridge is called the precoxal ridge (pcr_2) by Theron. Mäkel (1942) describes a weakly sclerotized "praesternite" anterior to the basisternite. No such sclerite could, however, be found in the specimens examined.

(d) *Articulation of the wings*: According to Theron (1958) the articulation of the wings in *Margarodes* is fairly typical of the articulation of the forewings of other Homoptera. Similarly, the articulation of the wings of the pseudococcid species studied, agrees fairly closely with that of *Margarodes*.

The alary sclerites taking part in the wing articulation are the following: the tegula, the first, second and third axillary sclerites, and the additional sclerite. The other thoracic elements taking part are the anterior notal wing process, the pleural wing process, the basalare and subalare. A humeral plate is described by Ghauri (1959) in the Diaspididae, but its presence in the Pseudococcidae is doubtful.

The tegula (teg) is situated far anterior to the base of the wing. It is a small meniscate structure, situated on the anterior portion of a membranous bulge. The tegular muscle is attached to the pleural wing process by means of a thin tendon-like apodeme (t). The first axillary sclerite (ax_1) is more or less triangular. Medially it articulates with the lateral margin of the scutum near the small notch which is formed behind the anterior notal wing process. Its anterior tip is supported by the anterior notal wing process and articulates with the costal

complex of wing veins. Its posterolateral apex is elongate and forms a distal arm which lies over the second axillary sclerite and articulates with the latter. This arm is not described by Theron (1958) in *Planococcus*, although he found it in some Margarodidae. Ghauri (1959) also found this structure in the Diaspididae. The second axillary (ax_2) is subrectangular in shape and its anterior apex, which is acute, is directed towards the costal complex of veins. The posterior part of the sclerite is expanded ventrally and its apex is bent upwards to support the third axillary sclerite. The third axillary sclerite (ax_3) is situated immediately behind the second axillary and is the largest of the three sclerites. Its anterior portion which articulates with the second axillary is triangular in shape and only slightly sclerotized. It may perhaps represent the first median plate as defined by Snodgrass (1935). The posterior part, however, is heavily sclerotized and functions as the axillary cord. It merges distally into the hind margin of the wing and is basally divided into a posterior dorsal process and an anterior ventral process. The latter is connected to the postalare by means of a tiny sclerotized band. Theron (1958) incorrectly states that this cord is attached to the posterior dorsal process. The additional sclerite (asc) is a weakly sclerotized plate and is situated immediately distal to the second and third axillary sclerites. This sclerite resembles the "Zusätzstück", which Weber (1929) describes in *Psylla*. It might possibly be the second median plate as defined by Snodgrass (1935).

Apart from Theron (1958), only Mäkel (1942) studied the wing articulation in some detail, but her descriptions are rather inaccurate. While she correctly identifies the anterior notal wing process she overlooks the true posterior notal wing process (pnp) and describes undefined parts of the scutum as such. She mistakes the costal complex of wing veins for the second axillary sclerite and regards the true second axillary as being part of the third. It is also most doubtful whether the circular sclerite, which she describes, is in fact a true sclerite, although it can be distinguished anterior to the distal part of the costal complex. Theron (1958) misinterpreted Mäkel's description of this "circular sclerite" and assumes that she is referring to the distal upturned part of the anterior notal wing process.

(e) *Dermal structures*: Both types of setae, i.e. hair-like and fleshy setae, as well as disc pores are present. The setae are found on the prescutum, scutum, scutellum, the tegular bulge, the basisternum, and on the membrane anterior to the basisternum and subepisternal ridges. They can be arranged in the following groups:

- (i) Prescutal setae (pscse): A number of hair-like setae occur on each side of the median line on the prescutum. In the species studied the number varies from 3—8, fleshy setae and disc pores being absent.
- (ii) Scutal setae (sctse): They are found on each side of the median line and a few are situated near the anterior notal wing process. Only hair-like setae are present and their number varies from 5—16 in the species studied. A few quadrilocular pores sometimes occur on the scutum of *P. fragilis*.
- (iii) Scutellar setae (scls): Small numbers of hair-like setae are present on both sides of the scutellum. The number on each side varies from 1—9.
On the scutum and scutellum minute membranous spots, some-

what reminiscent of vacant hair sockets, can be observed. They presumably represent some kind of pore.

- (iv) Tegular setae (tegs): They are carried on the anterior part of the tegular bulge and consist of hair-like setae only. The number varies from 4—7.
- (v) Postmesostigmatal setae (pms): These setae, consisting of both hair-like and fleshy setae, occur on the membrane posterior to the mesostigmata. When the full complement is present, the setae of opposite sides meet in front of the basisternum. An interesting phenomenon occurs in *P. maritimus*. It was found that the specimens could be divided into two distinct groups (for the sake of convenience called types A and B) according to the distribution patterns of the postmesostigmatal setae. In type A the full complement is present, with the setae occurring in front of the median transverse part of the marginal ridge. The number of hair-like setae here varies from 5—8, and the fleshy setae from 15—22, with no disc pores present. In type B only a small number of setae are present on each side posterior to the stigma. The number of hair-like setae on each side varies from 0—4 and the fleshy setae from 0—3, with 0—2 disc pores present on each side. A noteworthy phenomenon is that the relative abundance of setae in this region in type A can be correlated with an abundance of setae on the metathorax and the abdominal segments, as is described later on. Of the 24 specimens studied 8 were of the A type, thus constituting a ratio of 2 : 1. It is probable that this variation is due to genetic polymorphism. It is also worthy of note that Ferris (1950) found considerable variation among the females of this species. According to him some experimental tests carried out by other investigators seem to indicate that more than one species is involved. Ferris, however, could not find a morphological basis for the recognition of more species.
- (vi) Basisternal setae (stn_s): These setae occur mostly on the anterior region of the basisternum, although a few setae may also occur near the posterior part of the precoxal ridge. In the species studied the number of hair-like setae varies from 5—39. Fleshy setae occur only on the basisternum of *P. fragilis*, the number varying between 16 and 45.

3. Metathorax:

As a result of the replacement of the hind wings by halteres the metathorax is considerably reduced. Originating at the mesopost-phragma, the metanotum overlaps the invaginated mesopostnotum, being closely adjacent to the latter. The metanotum is not visible externally as it is in turn overlapped by a membranous area anterior to the metapostnotum. Two small sclerites, the suspensorial sclerites (ss), represent the metanotum externally and each of them is connected to a haltere (h) by means of a sclerotized band. They were not observed by Mäkel (1942), Ezzat (1956), and Beardsley (1960). Posteriorly the metanotum is represented by an irregular transverse sclerite (pn₃) (Figs. 1, 4, 7) which Mäkel and Ezzat also overlooked.

In the pleural region only the pleural ridge (plr₃) is well developed (Fig. 10). Ventrally from the coxal articulation it extends

anterodorsally across the pleuron. Terminally it expands slightly, forming the metapleural wing process (pwp₃), with which the haltere articulates. Near its middle the metapleural ridge fades out for a short distance and is slightly produced inwards, forming a reduced metapleural apophysis (pla₃). The latter is not described by Mäkel (1942), Theron (1958) or by Beardsley (1960). A sclerotized area anterior to the ventral part of the metapleural ridge represents the episternum (eps₃). From the ventral part of the latter a short vestigial precoxal ridge (pcr₃) extends medially. Between the precoxal ridge and the coxal articulation the episternum bears a slight ventral extension, which is somewhat reminiscent of the mesothoracic trochantin. The epimeron (epm₃) is represented by an irregular sclerotized area behind the pleural ridge. The metathoracic spiracle (sp₃), supported by a well developed peritreme (ptr₃), is situated in the membrane anterior to the episternum.

Ventrally two distinct metasternal apophyses (sta) are found posteromedially to the ventral extremities of the precoxal ridge (Figs. 3, 6, 9). They are figured (incorrectly), but not described, by Mäkel (1942) and overlooked by Theron (1958) in *Planococcus citri* and by Beardsley in *Pseudococcus adonidum*. Metasternal plates are absent.

Dermal structures: Both fleshy and hair-like setae as well as disc pores are present. In addition to the setae and pores, minute dermal denticulations occur in rows on the metasternum. Similar denticulations are also found on the abdomen and are similar in appearance to those of certain Aphididae. In *P. maritimus* more setae, especially of the fleshy type, are found in type A than in type B. The following groups of setae can be distinguished:

- (i) Metatergal setae (mts): They form a meniscoidal group extending between the two suspensorial sclerites (ss). In the species studied the number of fleshy setae varies from 1—17, and the number of hair-like setae from 4—21. In *P. fragilis* the disc pores vary from 0—20, being absent in the other two species.
- (ii) Metapleural setae (mps): They are associated with the metaspiracle, occurring mostly posterior to it. The number of fleshy setae in this group varies from 0—11 and the hair-like setae from 0—9. A few quadrilocular pores are found in *P. maritimus* and *P. fragilis*.
- (iii) Anterior metasternal setae (amss): They are situated on the membrane between the mesosternum and metasternum. The number of fleshy setae occurring here varies from 1—35, the number of hair-like setae from 0—12, and the number of disc pores from 0—8.
- (iv) Posterior metasternal setae (pmss): When these are numerous they are arranged in a meniscoidal band posterior to the precoxal ridges. The number of fleshy setae here varies from 0—24, hair-like setae from 0—5, no disc pores being present.

4. Wings and halteres:

One pair of large, membranous wings are attached to the mesothorax. The length of the wing varies from 979—1604 μ and the width from 450—687 μ . It is narrow at the base (Fig. 14) with the posterior

margin and wing tip rounded; the anterior margin is more or less straight and forms a rectangle with the body when outstretched. No notch occurs in the anterior margin of the wing, as is indicated by Beardsley (1960). Near the base a small pouch is formed by the dilation of the posterior margin of the wing. The distal upturned part of the apical seta of the haltere hooks into the deep ventral invagination of the pouch. When at rest, the wings are folded in a horizontal position over the abdomen and overlap each other. The entire alar area is covered by minute hairs (microtrichia) with those on the margins somewhat longer than elsewhere.

The venation is very much reduced, only two distinct veins being present which, according to Patch (1909), represent the radius (rad) and media (med). The former runs parallel to the anterior margin of the wing, the latter deflects towards the hind margin. The media and radius are not visibly connected. Anterior to the radius a short independent line extends for about $\frac{1}{4}$ of the length of the common stem of the radius and media. This is called the subcosta by Patch (1909), but it is doubtful whether it represents a true vein or is only a fold. The anterior wing margin basally contains an elongate sclerite forming the costal complex of wing veins (ccx). Basally the sclerite is divided into a pointed upper part and a broad lower part which articulates with the pleural wing process (pwp₂). The costal complex of veins tapers distally and curves posteriorly. The whole structure is called "Pterale 2" by Mäkel (1942).

Fairly long hair-like setae, which can be named alar setae (as), are found basally on the dorsal surface of the wing, immediately anterior to the common stem of the radius and media. Their number varies between 2 and 9. A short row of 2—5 circular sensilla is situated dorsally along the anterior margin of the radius, immediately distad to the point where the two veins meet.

The metathoracic wings are reduced to short membranous halteres (h), of which the basal halves are broad and the distal halves tapering. At its apex each haltere carries a long hooked seta which hooks onto the alar lobe of the forewing. The basal part of the haltere is slightly sclerotized and articulates with the metapleural wing process. It also carries a short process basally which is connected to the suspensorial sclerite (ss) by means of a sclerotized band. The length of the haltere varies from 68—109 μ and the width from 13—22 μ .

5. Legs:

One pair of well developed legs is attached to each of the three thoracic segments. In general appearance the legs are long, slender and well suited for locomotion. The front legs are the shortest and the hind legs the longest, the total length varying from 586—700 μ for the fore, 609—758 μ for the middle, and 689—853 μ for the hind legs. The legs (Fig. 11) are composed of a stout coxa, subtriangular trochanter, comparatively long femur, long and slender tibia, and a two-segmented tarsus which carries a single claw. The general tendency for all the segments is to increase from anterior to posterior.

The setae consist mainly of the two basic types which occur on the body and antennae, i.e. fleshy and hair-like setae. Both these

types are found in varying numbers on all the segments, the fleshy type being more numerous. Some of the hair-like setae are converted into thick-set, sharp-pointed, spine-like setae, which occur distally on the tibia and ventrally on the tarsus. A pair of digitules, i.e. long, apically knobbed setae, each with a strong basal ring, is present near the apex of each tarsus, while two very much reduced digitules occur on each claw.

The *coxa* (cx) is broadly conical in shape. Its broad base is strengthened by a well sclerotized basal ridge which articulates with the pleural ridge by means of a short basal process. Its apical margin is also strongly sclerotized and dorsally forms a U-shaped ridge which stretches back for more than half the length of the coxa. It bears a posterior and an anterior process which articulate with corresponding processes on the trochanter.

Both hair-like and fleshy setae are more or less evenly distributed over the coxal surface. Of the hair-like setae 2 to 4 are always situated on or near the basal ridge and one ventrally at the apex. A constant feature for all three species studied is the occurrence of a hair-like seta on the basal process of the front coxa only.

The *trochanter* (tr) is short; when viewed from behind it appears narrow basally and broad distally, the two parts being separated by a narrow ridge. It is separated from the femur distally by a narrow membrane. Basally there is a well-sclerotized ridge with an anterior and a posterior process which articulate with the corresponding processes of the coxa.

Both hair-like and fleshy setae are present. A short seta of the hair-like type is found on each of the anterior and posterior dilations of the basal ridge. A medium sized, rigid, hair-like seta is situated near the dorsal apex of the trochanter. Three circular sensilla are arranged in a triangle on each of the anterior and posterior faces. Beardsley (1960) located only five of these sensilla.

The *femur* (fm) is comparatively long and broad, being at its broadest more or less one third from the apex. It tapers slightly towards its extremities, and is connected to the trochanter by means of a narrow articular membrane. Its distal ridge is well developed, bearing an anterior and a posterior process, each of which articulates with corresponding processes on the tibia. With the exception of the large distal articular membrane, the femur is well sclerotized.

The setae, which are mostly of the fleshy type, are more or less evenly distributed over the entire surface. In *P. maritimus*, where they are less numerous, they are divided into a dorsal and a ventral group. One pair of hair-like setae occurs dorsally near the apex of the femur on all three legs.

The *tibia* (tib) is the longest segment of the leg and is comparatively slender when viewed from behind. It is well sclerotized except for the basal articular membrane. Its basal ridge is well developed and possesses an anterior and a posterior process which articulate with corresponding processes on the femur. Dorsally at the apex a short ridge is present which articulates with the tarsus. The latter is separated from the tibia by a narrow articular membrane.

The setae are mostly of the fleshy type, and more or less evenly distributed over the entire surface of the tibia. A few short hair-like

setae occur on the dorsal surface, whereas longer hair-like setae are situated ventrally and laterally near the apex. Strong spurs of various sizes are found distally on the lateroventral surface. Two of these are distinctly larger than the others.

The *tarsus* (tar) is composed of two tarsomeres. The first consists of a sclerotized ring, with the ventral part enlarged. Articular membranes join it to both the tibia and the 2nd tarsal segment. The latter is well sclerotized and elongate. A curious incised area occurs ventrally near its apex and a short ridge is formed dorsally where the 2nd tarsal segment articulates with the claw. Lobdell (1937) records two-segmented tarsi for a number of Pseudococcidae (including *P. adonidum*) while Mäkel (1942) overlooked the first segment in the species she examined.

Both fleshy and hair-like setae are present, the latter being more numerous on the ventral surface. The hair-like setae occurring on the ventral surface are more thick-set and spine-like in appearance. Two long sub-equal and apically knobbed tarsal digitules (tdgt) are present dorsally near the apex of the second tarsal segment. One pair of long sharp-pointed spines is situated on each side of the second segment immediately anterior to the incised area. A constant feature is a circular campaniform sensillum (cam.s) on the dorsal proximal surface of the second tarsal segment.

The *claw* (cl) is well developed, curved, pointed and articulates dorsally with the apical ridge of the tarsus. A minute sharp-pointed unguis (udgt) is present on each of the anterior and posterior surfaces. They are described by Cottier (1936), but were not found by Mäkel (1942) in adult males.

C. THE ABDOMEN

As a result of sclerite degeneration the abdomen has become almost completely membranous and is not distinctly separated from the metathorax. The segmental boundaries are not very distinct, but the segmentation is indicated by the segmental arrangement of the setae and the denticulations as well as by shallow intersegmental grooves. As it is largely membranous, the abdomen is easily distorted when mounted. It is therefore difficult to describe and figure its outline correctly.

(1) *The pregenital segments*: There are evidently eight pregenital segments, as described by Berlese (1893), Mäkel (1942) and Theron (1958) and not 7, as is suggested by Beardsley (1960). The first segment is not developed ventrally, but dorsally two small sclerites represent vestiges of the 1st abdominal tergite (at_1). Two small tergites (at_2) also appear on the 2nd segment and may sometimes be recognized on the 3rd (at_3) and 4th (at_4) segments. The 8th tergite is represented by a fairly large tergal plate (at_8). Ventral sclerotizations are absent, except for two small irregular sternites (ast_8) on the 8th abdominal segment (Figs. 3, 6, 9). A minute apophysis, which probably serves for the attachment of muscles, is present pleurally on the 8th abdominal segment. The 1st to the 3rd segments are broad, and the width of the segments then gradually decreases towards the 7th segment and narrows abruptly at the 8th segment. In *P. fragilis*, and sometimes to a lesser extent in the other species, the ventral intersegmental boundary

between the 3rd and 4th segments is slightly invaginated in two small oblong areas (ia), which apparently correspond to the lateral extremities of the circulus which is present in the larvae and adult females. According to Mäkel (1942) some abdominal muscles are deflected medially in the larvae in connection with the circulus and this condition is retained in the adult males, although they lack this structure. The invaginated areas were not observed in any of the species studied by Beardsley (1960).

At the posterolateral margin of the 6th abdominal tergum a pair of slit-like openings (ost) occur, the derm about them being slightly elevated. They are apparently homologous with the posterior dorsal ostioles of the adult female.

The segmental position of the circulus and ostioles is of much interest as it furnishes additional information on the abdominal segmentation of the adult female which is still a subject of controversy. According to Balachowsky's (1937) and Borkhsenius' (1949) interpretation of the abdominal segmentation of the adult female, the circulus is situated between the 3rd and 4th segments and the ostioles in the 6th segment, but according to the manner in which Ferris (1950) and Ezzat & McConnel (1956) count the segments, the circulus is situated between the 4th and 5th segments and the ostioles in the 7th segment. The position of these structures in the larva and adult male, however, definitely suggests that the former interpretation may be the correct one.

Beardsley (1960), following Ferris' interpretation of the abdominal segmentation of the female, contends that the ostioles of the male belong to segment VII, and that the 1st abdominal segment is therefore completely absent. As this assumption is based solely on the disputable segmental position of the ostioles in the neotenic females, it is doubtful whether the latter criterium can be regarded as being more reliable than the evidence supplied by the comparative anatomy of the Sternorrhyncha (see Weber, 1928; 1935).

Dermal structures: Both fleshy and hair-like setae are present. They are segmentally arranged in distinct groups on the dorsal (ads), pleural (aps) and ventral (avs) surfaces. When the setae are numerous, as in *P. fragilis*, it is sometimes difficult to distinguish between the dorsal and pleural setae of the first abdominal segment. Dorsally and ventrally the hair-like setae are more or less arranged in a transverse row with the fleshy setae scattered amongst them.

A small number of disc pores are usually present on the abdominal pleura and may, in rare instances, occur on some of the dorsal and ventral areas. They are usually quite numerous on the 1st abdominal pleuron and are mostly of the quadrilocular type (Fig. 28), but may also be trilocular (Fig. 29) or quinquelocular (Fig. 27). The 8th abdominal segment bears on its posterior margin, lateral to the genital segment, two clusters of pores, called the glandular plates (glp) (Pflugfelder, 1939). On each cluster two long setae (length about $\frac{1}{3}$ to $\frac{1}{4}$ of the length of the body) arise from a slight central depression. In addition, two to four shorter setae, but still longer than the body setae, occur in this region. The long setae serve as supporting cores around which wax is secreted by the pores, which are actually wax glands (Pflugfelder, 1939). The setae situated among these pores are called setae of the glandular plate (glps).

Ventrally, and to a lesser extent also dorsally and pleurally, the derm is characterized by minute denticulations which occur in rows among the setae. They are similar to those found in the metasternal region. Minute circular structures, resembling empty hair sockets (although about twice as small), are sometimes associated with the abdominal setae, especially the pleural setae. Also scattered over the derm are minute sclerotized rings. Both are presumably pores.

(2) *The genital segment and external genitalia:* The genital segment consists of a membranous upper part and a sclerotized lower part (Fig. 10), the latter forming the penial sheath (ps). A small, slightly sclerotized area (at₉₊₁₀) is situated posteriorly on the dorsal membranous part. This probably represents the fused 9th tergite and 10th segment (Theron, 1958) and is only visible in well stained specimens. The anus (an) is situated behind this sclerite and from here the membrane slopes steeply downwards to the penial sheath. Internally the posterior part of the rectum is broadly sclerotized. The penial sheath is well developed and, as Theron points out, it represents the lateral parts of the 9th abdominal sternum which have become fused posteriorly and which were called pygofers by Singh-Pruthi (1925) and Kershaw & Muir (1922). Ossiannilsson *et al.*, in Tuxen (1956) state that the penial sheath is an apical process of the 9th segment, but give no evidence to support this supposition. The sheath terminates distally in a short projection or style (st) which is curved slightly upwards, and in dorsal view appears pointed (*P. fragilis*), broadly rounded (*P. maritimus*) or truncate (*P. adonidum*). Anteriorly the ventral and lateral margins of the sheath are provided with a strong, basal ridge (brps) which is partly overlapped by the membrane of the 8th segment, forming ventrally an internal projection on each side. This projection of the basal ridge (pr) is very well developed in *P. adonidum*. On the ventral surface of the distal half of the sheath, there is formed a longitudinal slit through which the aedeagus protrudes. The edges of the slit may each bear a short heavily sclerotized process (pro) which is called the apophyses of the genital valve by Berlese (1893), paramere-like projections by Mäkel (1942), lobular extensions by Theron (1958), and median lobes by Beardsley (1960). They may represent the sub-genital plates described by Singh-Pruthi (1925) for most of the auchenorrhynchan Homoptera studied by him. They are well developed in *P. adonidum*, vestigial in *P. fragilis* and absent in *P. maritimus*. The dorsal part of the aedeagus (aed) is shaped like a curved, semi-cylindrical tube which is almost entirely concealed in the cavity of the 9th segment when at rest. Its tip, which protrudes through the ventral slit, may end broadly (*P. fragilis* and *P. maritimus*) or may be sharp-pointed (*P. adonidum*). Anteriorly the ductus ejaculatorius (dej) enters the aedeagus through what is called the basal foramen (Singh-Pruthi, 1925) or internal genital aperture (iga) (Theron, 1958) and runs posteriorly towards the gonopore at the apex of the penis. A strong basal rod (bra) connects the internal genital aperture with the ventral wall of the penial sheath anterior to the ventral slit. According to Theron (1958) this rod may represent the fused "basal plates prolongation" or "lateral process of the basal plates," described by Singh-Pruthi (1925) and Marks (1951) respectively in Homoptera, and it may incorporate the basal plates. Parameres are absent.

The male genitalia of Pseudococcidae are fairly accurately described by Berlese (1893) and Mäkel (1942).

Dermal structures: A small number of hair-like setae (gts) are found on the lateral and ventral surfaces. Posterolaterally, near the dorsal margin of the penial sheath, a group of 3 setae (rarely 2 in *P. maritimus*) is arranged in a dorsoventral row. At the apex of the processes of the penial sheath or, when they are absent, on the ventral margin of the penial sheath in the area normally occupied by them, a number of tiny setae (pros) are found. They are probably sensilla, the function of which is possibly connected with the act of copulation. Small weakly sclerotized spots on the style are possibly also sensilla.

The transverse rows of denticulations of the abdomen are continued on the dorsal surface of the genital segment. In the lateral and ventral regions these denticulations occur only in small numbers.

IV. DESCRIPTION OF SPECIES

For convenience the individual descriptions of male Pseudococcidae, which are given below, conform to the same general plan as that followed by Ghauri (1959) in his descriptions of male Diaspididae. As the taxonomic significance of the various characters has, as yet, not been properly evaluated, these descriptions are perhaps more detailed than is actually necessary.

1. *Pseudococcus fragilis* Brain (= gahani Green) Figs. 1, 3, 10.

Only winged forms known. Total body length 1454—1738 (av. 1598) μ including genital segment which is 150—163 (av. 155) μ long. Width at mesothorax 340—387 (av. 359) μ . Wing expanse 2504—3444 (av. 3082) μ .

Head: Roughly inversely conical, roundly constricted posteriorly. Length from apex to postoccipital ridge 116—156 (av. 142) μ ; width across genae 221—244 (av. 236) μ . Midcranial ridge (mcr) with ventral median part, lateral branches (lmcr) as well as detached dorsal part well developed, the latter meeting postoccipital ridge dorsomedially. Dorsomedial part of epicranium (dmep) slightly raised, only very weakly sclerotized. Postoccipital ridge (por) relatively well developed, continuous medially, anterior extremities almost meeting preocular ridge anteriorly. Dorsal head setae (dhs): 4—11 (av. 7.4) fleshy and 8—12 (av. 10.5) hair-like setae on each side of midcranial ridge, with 1—3 (av. 2.2) quadrilocular pores on each side near base of antenna. Genae (g) large, rounded, with 17—26 (av. 20.4) fleshy and 1—4 (av. 3.1) hair-like genal setae (gs) on each gena. Dorsal eyes (dse) widely separated, 100—119 (av. 113) μ apart, with round corneae, 28—31 (av. 29) μ in diameter. Ventral eyes (vse) approximated, 22—26 (av. 23) μ apart, corneae rounded, slightly larger than dorsal eyes, diameter 33—37 (av. 35) μ . Dorsal and ventral eyes surrounded by distinct, polygonal reticulations. Lateral ocellus (o) small. Preocular ridge (procr) strongly developed, produced dorsally beyond anterior articular process, demarcating reticulated area. Postocular ridge (pocr) strongly sclerotized, ventrally considerably extended towards and joined by a sclerotized area with weakly developed preoral ridge (pror). Ocellar ridge (ocr) well developed. Ocular sclerite (ocs) weakly sclero-

tized. Cranial apophysis short, flattened dorsoventrally, not bifurcate. Mouth opening (mo) and tentorial pits (ptp) small, situated in membrane posterior to preoral ridge. Anterior tentorial arms and posterior tentorial arms present. Ventral head setae (vhs): fleshy setae 45—93 (av. 74.5), hair-like setae 12—39 (av. 19.0); of these 5—9 (av. 7.3) fleshy and 2—4 (av. 2.8) hair-like setae situated posterior to level of anterior margin of ventral eyes.

Antenna (Fig. 2): 10-segmented, occasionally less owing to incorporation of vestiges of one segment in an adjacent segment; length 782—988 (av. 854) μ ; filiform, distal segments of flagellum not becoming wider than proximal segments. Length of segments in microns:

	SEGMENT									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Length	45-54	65-73	125-156	84-116	73-116	80-112	73-95	73-92	62-78	78-88
Average	50	68	136	92	84	86	78	80	69	83

Width of scape (across center) 35—44 (av. 39) μ , pedicel 36—44 (av. 39) μ and flagellar segments 18—24 (av. 21) μ . Ratio antennal length to body length 1 : 1.69 — 1.99 (av. 1.88). Ratio width of prescutum to antennal length 1 : 5.22 — 6.13 (av. 5.61). Scape (scp) sclerotized, except distally and laterally, with basal ridge and distal process well developed; setae: fleshy setae absent, 6—9 (av. 8.1) hair-like setae. Pedicel (pdc) distinctly reticulated distally, with a dorsolateral sensillum placodeum (spl) distally. Flagellar segments III—IX (F_{111-IX}) with parallel sides, slightly constricted apically and basally; fleshy setae relatively long and slender, length $1\frac{3}{4}$ — $2\frac{1}{2}$ times width of 3rd segment. Segment III with sensillum basiconicum (bs) ventrodistally; 24—33 (av. 29.1) fleshy and 3—6 (av. 4.5) hair-like setae. Segment IV: 21—24 (av. 21.9) fleshy and 1—3 (av. 2.5) hair-like setae; V: 17—24 (av. 20.3) fleshy and 1—2 (av. 1.4) hair-like setae; VI: 16—20 (av. 19.9) fleshy and 1—3 (av. 1.8) hair-like setae; VII: 18—22 (av. 19.3) fleshy and 1—3 (av. 2.0) hair-like setae; VIII: 18—22 (av. 19.7) fleshy setae, including 1 large seta situated ventrally on distal half, and 2—3 (av. 2.3) hair-like setae; IX: 17—20 (av. 18.3) fleshy setae including one large seta situated ventrally on distal half, and 1—3 (av. 2.0) hair-like setae. Terminal segment (Xth) (Fig. 16) not tubularly constricted apically, but pointed, with 19—25 (av. 22.0) fleshy setae including 3 large setae on distal half, one dorsally and two laterally, including also two stout setae occurring ventrally on the proximal half; hair-like setae 1—3 (av. 1.5); one apical seta, length 32—37 (av. 35) μ , not knobbed apically; two long, subapical, apically knobbed setae (set. scla) with well developed basal ring, both situated on ventral surface; two peg-like sensilla basiconica (bs), one near apex with other one more posterior, ventrally.

Thorax: Total length from postoccipital ridge to mesopostphragma 632—695 (av. 659) μ .

Prothorax separated from head by a deep cervical groove. Pronotal ridge (prnr) narrow, collarlike. Lateral pronotal sclerites (prn) small. Median pronotal setae (mpns) on each side of median line: 2—9 (av. 5.2) fleshy and 2—6 (av. 3.8) hair-like, with 1—5 (av. 2.3) disc pores. Posttergite (pt) well sclerotized, posttergital setae (pts) on each side: fleshy 5—12 (av. 9.1), hair-like 1—4 (av. 1.8). Lateral pronotal setae (lps) on each side: fleshy 0—1 (av. 0.1), hair-like 0—5 (av. 1.1), with 0—14 (av. 4.7) disc pores. Antespircular dorsal setae (asds) on each side: fleshy 0—4 (av. 1.6), hair-like 1—3 (av. 2.2), with 1—10 (av. 3.0) disc pores. Proepisternum + cervical sclerite (pepcv) strong, ridge-like, with weakening near anterior end. Propleural ridge (plr₁) short, with small pleural apophysis (pla₁). Propimeron absent. Antespircular ventral setae (asvs) on each side: fleshy 2—4 (av. 2.6) hair-like 1. Prosternum (stn₁) triangularly shaped, bounded posteriorly by a strong transverse ridge. Prosternal setae (stn_{1s}): fleshy 6—24 (av. 16.4), hair-like 2—8 (av. 3.7), with 0—2 (av. 0.3) disc pores. Immediately ventral to anterior part of proepisternum + cervical sclerite 0—2 (av. 0.2) fleshy setae occur.

Mesothorax: Mesoprephragma well developed, with ventral margin slightly emarginated medially. Prescutum (prsc) strongly arched, uniformly well sclerotized, bounded laterally by strong prescutal ridges (pscr) and posteriorly by a groove-like prescutal suture (pscs); length of prescutum (approx.) 93—116 (av. 103) μ , width (maximum) 136—160 (av. 152) μ . Prescutal setae (pscs) on each side: 5—8 (av. 6.5) hair-like, fleshy setae absent. Scutum (sct) well sclerotized, with shallow, longitudinal depression medially; prealare (pra) separated by a strong ridge from anterior arm of scutum, differentiated distally into a well sclerotized triangular plate (tp); anterior notal wing process (anp) strong, upturned; distinct posterior notal wing process (pnp) present, preceded by a lateral emargination; scutal setae (sctse) on each side: hair-like 8—16 (av. 11.4), disc pores 0—7 (av. 0.7), fleshy setae absent. Scutellum (scl) subrectangular, slightly less sclerotized medially; length 55—67 (av. 64) μ , width 110—132 (av. 122) μ ; scutellar setae (scls) on each side: hair-like 3—9 (av. 5.5), fleshy setae absent. Postnotum well developed, separated from scutellum by a large, subtriangular membranous area; postalare (pa) and postnotal apophysis (pna) well developed. Mesopostphragma slightly emarginated medially. Mesopleuron: Pleural ridge (plr₂) strong fading out for a short distance above coxal articulation, invaginated medially to form pleural apophysis (pla₂) and supporting large rounded pleural wing process (pwp₂) dorsally. Mesepisternum (eps₂) well developed, dorsal and ventral parts separated by a triangular membranous area; bounded anteriorly by strong subepisternal ridge (ser); epimeron small. Lateropleurite (lpl) small. Basalare (bas) and subalare (sa) well developed, the former connecting episternum with pleural wing process. Mesosternum: Basisternum (stn₂) large, convex, length 146—190 (av. 173) μ , with marginal (mr) and precoxal (pcr₂) ridges forming strong anterior and posterior margins respectively; basisternal setae (stn_{2s}): fleshy 16—45 (av. 28.8), hair-like 5—23 (av. 9.1). Furca (f) well developed. Postmesostigmatal setae (pms): fleshy 6—52 (av. 31.8), hair-like 4—18 (av. 9.6), with 0—15 (av. 3.1) disc pores. Mesothoracic spiracle (sp₂) with well developed peritreme (ptr₂). Tegula (teg) small, well defined, borne anteriorly on large membranous bulge,

which carries 5—7 (av. 6.2) hair-like setae anteriorly. Pteralia: 1st axillary sclerite (ax₁) triangular, 2nd axillary (ax₂) subrectangular, 3rd axillary (ax₃) with two basal processes, additional sclerite (asc) ill-defined.

Metathorax: Motanotum externally represented by two small suspensorial sclerites (ss), each being connected by a sclerotized band to base of haltere (h); transverse median metapostnotal sclerite (pn₃) present posteriorly. Metatergal setae (mts): fleshy 1—16 (av. 9.7), hair-like 11—21 (av. 15.3) with 0—20 (av. 2.7) disc pores. Pleural ridge (plr₃) well developed, with small pleural wing process (pwp₃) supporting haltere pleural apophysis vestigial. Episternum (eps₃) and epimeron (epm₃) distinct with irregular margins. Metathoracic spiracle (sp₃) similar to mesothoracic one. Metapleural setae (mps) on each side: fleshy 2—11 (av. 7.5), hair-like 0—5 (av. 2.4) with 0—6 (av. 0.8) disc pores. Metasternum represented by 2 distinct metasternal apophyses (sta); anterior metasternal setae (amss): fleshy 13—35 (av. 23.8), hair-like 0—12 (av. 7.3) with 2—8 (av. 5.0) disc pores; posterior metasternal setae (pmss): fleshy 12—24 (av. 17.0), hair-like 0—4 (av. 2.3), with disc pores absent.

Wings: membranous, with well developed alar lobe; oblong, length (1106—1604, av. 1395 μ) more than twice width (474—687, av. 599 μ); radius (rad) and media (med) well developed, not visibly connected; independent line anterior to common stem of radius plus media gives the impression of a small vein being present; costal complex (ccx) well sclerotized, elongated; alar setae (as): 6—9 (av. 6.5) hair-like setae; sensilla: 3—5 (av. 3.8). Halteres (h) membranous, tapering distally; well developed, 88—109 (av. 92) μ long, 15—22 (av. 17.0) μ wide; carrying one long apically hooked seta distally.

Legs: well developed, slender; fore leg smallest, hind leg largest. Length of segments of leg in microns (averages in brackets):

Coxae (cx): broadly conical with basal and apical ridges and articulating processes well developed; setae: 18—23 (av. 21.2) fleshy and 9—14 (av. 11.6) hair-like setae on fore, 20—26 (av. 22.2) fleshy and 10—14 (av. 12.0) hair-like setae on middle and 21—28 (av. 23.5) fleshy and 10—14 (av. 11.3) hair-like setae on hind coxa; one hair-like seta always present on basal process of front coxa. Trochanters (tr) subtriangular, basal ridge and articulating processes well developed; setae: 4—6 (av. 5.0) fleshy and 7—8 (av. 7.8) hair-like setae on fore,

Legs	Coxa	Trochanter	Femur	Tibia	Tarsus	Claw	Av. Total
I	50—65 (58)	61—73 (65)	164—238 (204)	179—277 (231)	74—87 (77)	28—36 (33)	668
II	61—73 (67)	65—76 (69)	203—268 (227)	240—346 (275)	73—90 (80)	37—42 (40)	758
III	65—76 (70)	65—71 (68)	231—251 (242)	322—361 (340)	90—95 (92)	38—42 (41)	853

6—9 (av. 7.7) fleshy and 7—9 (av. 8.3) hair-like setae on middle, 7—9 (av. 7.8) fleshy and 6—9 (av. 7.9) hair-like setae on hind trochanter; six circular sensilla always present on basal half. Femora (fm) long and broad, distal ridge well developed; setae: 30—47 (av. 40.2) fleshy and 11—20 (av. 16.0) hair-like setae on fore, 34—45 (av. 40.6) fleshy and 10—25 (av. 15.4) hair-like setae on middle, 41—49 (av. 45.6) and 8—16 (av. 11.7) hair-like setae on the hind femur. Tibiae (tib) long, slender; length in relation to width (center) of fore tibia 1 : 9.2 — 11.2 (av. 10.1), basal ridge well developed; setae: 43—56 (av. 50.2) fleshy and 6—9 (av. 7.4) hair-like setae on fore, 53—63 (av. 59.0) fleshy and 7—9 (av. 8.3) hair-like setae on the middle, 62—70 (av. 64.6) fleshy and 5—9 (av. 6.7) hair-like setae on the hind tibia; length of fleshy setae 1½—2 times longer than width of segment; strong spurs of various sizes (two usually distinctly bigger than others) situated on ventral apex of fore (5—7, av. 6.1), middle (4—6, av. 5.3) and hind (3—7, av. 5.5) tibia. Tarsi (tar) well developed, two-segmented. Second segment with membranous incised area near ventral apex; 18—24 (av. 20.6) fleshy and 10—13 (av. 12.0) hair-like setae on fore, 18—24 (av. 20.8) fleshy and 10—14 (av. 12.0) hair-like setae on the middle, 19—25 (av. 22.3) fleshy and 10—14 (av. 12.3) hair-like setae on the hind tarsus; ventral setae thick-set, spur-like; two pairs of long sharp-pointed spines always present on tarsus anterior to membranous incised area; tarsal digitules (tdgt) one pair, about as long as claw, subequal and apically knobbed; campaniform sensillum (cam. s) always present on dorsal proximal surface. Claws (Figs. 21—23, cl) well developed, subequal, slightly curved; unguis digitules (udgt) subequal, sharp-pointed, length less than half the distance from base of digitule to tip of claw.

Abdomen: length from mesopostphragma to basal ridge of penial sheath 632—727 (av. 672) μ , width at 3rd segment 252—348 (av. 319) μ ; 1st (at₁), 2nd (at₂) (sometimes 3rd (at₃)) and 8th (at₈) tergites and 8th sternite (ast₈) present; ventral invaginated areas (ia) between 3rd and 4th segments always present; ostioles (ost) prominent. Number of abdominal dorsal setae (ads), abdominal pleural setae (aps), abdominal ventral setae (avs) and disc pores (mostly quadrilocular, sometimes quinquelocular or trilocular), are as follows (averages in brackets): (See Table on next page.)

Setae of glandular plate (glps): 5—6 (av. 5.3) of which 2 are long, about ¼ length of body, others shorter. Genital segment: total length 150—163 (av. 155) μ ; tergite (at₉₊₁₀) weakly sclerotized, with anus (an) immediately behind; dorsal denticulations distinct, in transverse rows. Style (st) comparatively long, length 44—50 (av. 45) μ , apex curving upwards, pointed in dorsal view. Basal ridge of penial sheath (brps) developed ventrally and laterally, internal projection (pr) short. Process of penial sheath (pro) vestigial. Aedeagus (aed) well developed, broadened distally in lateral view, apex broad in dorsal view; basal rod (bra) well developed. Setae on genital segment (gts): 3—6 (av. 4.6) hair-like setae on each side anteriorly and 3 hair-like setae on each side posteriorly, the latter arranged in a dorsoventral row. Setal sensilla (pros) 3—6 (av. 4.2) on each side.

2. *Pseudococcus adonidum* (Linnaeus) Figs. 4, 6.

Only winged forms known. Total body length 1240—1446 (av. 1349) μ including genital segment which is 153—187 (av. 173) μ long.

Region	Description	SEGMENT							
		I	II	III	IV	V	VI	VII	VIII
Dorsal (ads)	fleshy setae	2-8 (5.3)	4-16 (12.2)	9-18 (13.2)	10-17 (13.3)	8-17 (13.2)	10-16 (12.9)	5-13 (10.1)	2-5 (3.5)
	hair-like setae	6-11 (8.0)	7-15 (8.6)	7-11 (8.6)	7-11 (7.8)	6-10 (7.3)	5-6 (5.4)	4-7 (5.3)	5-9 (6.7)
	disc pores	0-7 (0.7)	0-7 (0.8)	0-2 (0.2)	0-1 (0.1)	0-1 (0.1)	0	0	0
Pleural (aps)	fleshy setae	2-8 (4.8)	0-9 (4.4)	1-9 (5.4)	1-10 (5.5)	1-10 (5.7)	3-11 (6.8)	3-10 (6.6)	3-5 (3.4)
	hair-like setae	1-7 (4.4)	3-8 (4.8)	4-9 (5.3)	5-8 (5.5)	4-9 (5.4)	4-8 (5.2)	3-7 (5.3)	0-3 (0.7)
	disc pores	4-13 (7.7)	0-5 (0.8)	0-5 (0.8)	1-6 (1.5)	0-5 (1.7)	1-5 (2.1)	2-5 (3.2)	0
Ventral (avs)	fleshy setae		7-25 (14.6)	14-26 (19.8)	16-26 (19.1)	14-25 (20.3)	15-26 (20.1)	12-22 (17.0)	9-13 (11.3)
	hair-like setae		1-13 (5.1)	4-14 (8.0)	4-13 (5.5)	4-8 (4.4)	4-6 (4.3)	4-5 (4.1)	0
	disc pores		0	0	0	0	0	0	0

Width at mesothorax 255—306 (av. 285) μ . Wing expanse 2188—2599 (av. 2408) μ .

Head: Roughly inversely conical, roundly constricted posteriorly. Length from apex to postoccipital ridge 122—146 (av. 135) μ ; width across genae 184—214 (av. 201) μ . Midcranial ridge (mcr) with ventral median part, lateral branches (lmcr) as well as detached dorsal part well developed, the latter meeting postoccipital ridge dorsomedially. Dorsomedial part of epicranium (dmep) slightly raised, only very weakly sclerotized. Postoccipital ridge (por) relatively well developed, continuous medially, anterior extremities not reaching preocular ridges. Dorsal head setae (dhs): 4—11 (av. 7.9) fleshy and 7—13 (av. 11.1) hair-like setae on each side of midcranial ridge, with 1—2 (av. 1.9) quadrilocular pores on each side near base of antenna. Genae (g) large, rounded, with 14—25 (av. 19.7) fleshy and 3—4 (av. 3.2) hair-like genal setae (gs) on each gena. Dorsal eyes (dse) widely separated, 92—110 (av. 101) μ apart, with round cornea, 24—31 (av. 28) μ in diameter. Ventral eyes (vse) approximated, 17—31 (av. 21) μ apart, cornea rounded, slightly larger than dorsal eyes, diameter 29—36 (av. 33) μ . Dorsal and ventral eyes surrounded by distinct, polygonal reticulations. Lateral ocellus (o) small. Preocular ridge (procr) strongly developed, produced dorsally beyond anterior articular process, demarcating reticulated area. Postocular ridge (pocr) strongly sclerotized, ventrally considerably extended towards and joined by a sclerotized area with weakly developed preoral ridge (pror). Ocellar ridge (ocr) well developed. Ocular sclerite (ocs) weakly sclerotized. Cranial apophysis short, flattened dorsoventrally, not bifurcate. Mouth opening (mo) and tentorial pits (ptp) small, situated in membrane posterior to preoral ridge. Anterior tentorial arms and posterior tentorial arms present. Ventral head setae (vhs): fleshy setae 41—62 (av. 53.9), hair-like setae 14—21 (av. 18.1); of these 3—7 (av. 4.5) fleshy and 1—3 (av. 2.3) hair-like setae situated posterior to level of anterior margin of ventral eyes.

Antenna (Fig. 5): 10-segmented, occasionally less owing to incorporation of vestiges of one segment in an adjacent segment; length 639—738 (av. 683) μ ; filiform, distal segments of flagellum not becoming wider than proximal segments. Lengths of segments in microns:

	SEGMENT									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Length	41-56	59-69	92-109	59-90	56-77	67-77	58-76	56-69	54-67	58-64
Average	48	63	101	73	67	72	66	65	58	60

Width of scape (across center) 31—37 (av. 33) μ , pedicel 31—37 (av. 33) μ , flagellar segments III—IX, 18—21 (av. 20) μ and terminal segment 23—26 (av. 24) μ . Ratio antennal length to body length 1 : 1.89—2.09 (av. 1.98). Ratio width of prescutum to antennal length 1 : 4.80—5.82 (av. 5.18). Scape (scp) sclerotized, except distally and laterally, with basal ridge and distal process well developed; setae: fleshy setae absent, 7—9 (av. 7.9) hair-like setae. Pedicel (pdc) dis-

tinently reticulated distally, with 16—22 (av. 19.0) fleshy and 12—19 (av. 16.0) hair-like setae, and with a dorsolateral sensillum placodeum (spl) distally. Flagellar segments III—IX (F_{111-1x}) with parallel sides, slightly constricted apically and basally; fleshy setae relatively thick-set, length about $1\frac{1}{2}$ times diameter of 3rd segment. Segment III with sensillum basiconicum ventro-distally; 18—25 (av. 21.1) fleshy and 3—8 (av. 5.8) hair-like setae. Segment IV: 15—29 (av. 22.3) fleshy and 2—5 (av. 3.3) hair-like setae; V: 16—31 (av. 20.6) fleshy and 1—4 (av. 2.4) hair-like setae; VI: 18—24 (av. 20.3) fleshy and 3—4 (av. 3.8) hair-like setae; VII: 15—23 (av. 18.1) fleshy and 4—6 (av. 4.8) hair-like setae; VIII: 13—22 (av. 18.3) fleshy setae, including 1 large seta situated ventrally on distal half, and 4—6 (av. 5.4) hair-like setae; IX: 13—19 (av. 14.3) fleshy setae, including 1 large seta situated ventrally on distal half, and 6—8 (av. 7.1) hair-like setae. Terminal segment (Xth) (Fig. 17) tubularly constricted apically, with 9—12 (av. 11.0) fleshy setae including 3 large setae on distal half, one dorsally and two laterally; hair-like setae 4—7 (av. 5.9); one apical seta, length 35—38 (av. 37) μ , not knobbed apically; two long, sub-apical, apically knobbed setae (set. scl) with well developed basal ring, both situated on ventral surface; two peg-like sensilla basiconica (bs), one near apex, with other one more posterior ventrally.

Thorax: Total length from postoccipital ridge to mesopost-phragma 493—578 (av. 532) μ .

Prothorax separated from head by a deep cervical groove. Pronotal ridge (prnr) narrow, collarlike. Lateral pronotal sclerites (prn) small. Median pronotal setae (mpns) on each side of median line: 2—7 (av. 4.1) fleshy and 1—4 (av. 2.7) hair-like, with 1—2 (av. 1.1) disc pores. Posttergite (pt) well sclerotized posttergital setae (pts) on each side: fleshy 7—13 (av. 10.9), hair-like 2—3 (av. 2.1). Lateral pronotal setae (lps) on each side: fleshy setae absent, hair-like 0—5 (av. 2.9), with 1—4 (av. 1—8) disc pores. Antespircular dorsal setae (asds) on each side: fleshy setae absent, hair-like 1—4 (av. 2.2), with 0—2 (av. 1.0) disc pores. Proepisternum + cervical sclerite (pepcv) strong ridge-like, with weakening near anterior end. Propleural ridge (plr₁) short, with small pleural apophysis (pla₁). Proepimeron absent. Antespircular ventral setae (asvs) on each side: fleshy 0—2 (av. 0.9), hair-like 1. Prosternum (stn₁) triangularly shaped, bounded posteriorly by a strong transverse ridge. Prosternal setae (stn_{1s}): fleshy 5—16 (av. 10.9), hair-like 2—3 (av. 2.2), with 0—2 (av. 0.9) disc pores.

Mesothorax: Mesoprephragma well developed, with ventral margin slightly emarginated medially. Prescutum (prsc) strongly arched, uniformly well sclerotized, bounded laterally by strong prescutal ridges (pscr) and posteriorly by a groove-like prescutal suture (pscs); length of prescutum (approx.) 73—93 (av. 83) μ , width (maximum) 117—143 (av. 131) μ . Prescutal setae (pscse) on each side: hair-like 3—8 (av. 5.5), fleshy setae absent. Scutum (set) well sclerotized, with shallow, longitudinal depression medially; prelare (pra) separated by a strong ridge from anterior arm of scutum, differentiated distally into a well-sclerotized triangular plate (tp); anterior notal wing process (anp) strong, upturned; distinct posterior notal wing process (pnp) present, preceded by a lateral emargination; scutal setae (sctse) on each side: hair-like 5—9 (av. 7.3), fleshy setae and disc pores absent. Scutellum

(scl) subrectangular, slightly less sclerotized medially; length 48—61 (av. 55) μ , width 80—100 (av. 90) μ ; scutellar setae (scls) on each side: hair-like 2—3 (av. 2.4), fleshy setae absent. Postnotum well developed, separated from scutellum by a large, subtriangular membranous area; postalar (pa) and postnotal apophysis (pna) well developed. Mesopostphragma slightly emarginated medially. Mesopleuron: Pleural ridge (plr₂) strong, fading out for a short distance above coxal articulation, invaginated medially to form pleural apophysis (pla₂) and supporting large rounded pleural wing process (pwp₂) dorsally. Mesepisternum (eps₂) well developed, dorsal and ventral parts separated by a triangular membranous area; bounded anteriorly by a strong subepisternal ridge (ser); epimeron small. Lateropleurite (lpl) small. Basalare (bas) and subalare (sa) well developed, the former connecting episternum with pleural wing process. Mesosternum: Basisternum (stn₂) large, convex, length 132—162 (av. 146) μ , with marginal (mr) and precoxal (pcr₂) ridges forming strong anterior and posterior margins respectively; basisternal setae (stn_{2s}); hair-like 24—39 (av. 31.0), fleshy setae absent. Postmesostigmatal setae (pms): fleshy 26—39 (av. 33.8), hair-like 6—8 (av. 7.2), with disc pores absent. Mesothoracic spiracle (sp₂) with well developed peritreme (ptr₂). Tegula (teg) small, well defined, borne anteriorly on large membranous bulge, which carries 5—7 (av. 5.6) hair-like setae anteriorly. Pteralia: 1st axillary sclerite (ax₁) triangular, 2nd axillary (ax₂) subrectangular, 3rd axillary (ax₃) with two basal processes, additional sclerite (asc) ill-defined.

Metathorax: Metanotum externally represented by two small suspensorial sclerites (ss), each being connected by a sclerotized band to base of haltere (h); transverse median metapostnotal sclerite (pn₃) present posteriorly. Metatergal setae (mts): fleshy 7—17 (av. 11.9), hair-like 4—13 (av. 8.5) with no disc pores present. Pleural ridge (plr₃) well developed, with small pleural wing process (pwp₃) supporting haltere; pleural apophysis vestigial. Episternum (eps₃) and epimeron (epm₃) distinct, with irregular margins. Metathoracic spiracle (sp₃) similar to mesothoracic one. Metapleural setae (mps) on each side: fleshy 4—10 (av. 7.7), hair-like 0—4 (av. 1.4), with disc pores absent. Metasternum represented by 2 distinct metasternal apophyses (sta); anterior metasternal setae (amss): fleshy 18—31 (av. 24.3), hair-like 2—5 (av. 3.6), with disc pores absent; posterior metasternal setae (pmss): fleshy 1—5 (av. 3.2), hair-like 1—5 (av. 3.7), with disc pores absent.

Wings: membranous, with well developed alar lobe; oblong, length (979—1201, av. 1097) μ more than twice width (450—553, av. 505) μ ; radius (rad) and media (med) well developed, not visibly connected; independent line anterior to common stem of radius plus media gives the impression of a small vein being present; costal complex (ccx) well sclerotized, elongated; alar setae (as): 3—6 (av. 3.8) hair-like setae; sensilla: 3—4 (av. 3.6). Halteres (h) membranous, tapering distally; well developed, 72—87 (av. 80) μ long, 13—21 (av. 16) μ wide; carrying one long apically hooked seta distally.

Legs: well developed, slender; fore leg smallest, hind leg largest. Length of segments of leg in microns (averages in brackets):

Legs	Coxa	Trochanter	Femur	Tibia	Tarsus	Claw	Av. Total
I	43-56 (50)	65-78 (69)	186-244 (212)	220-294 (258)	75-86 (79)	31-33 (32)	700
II	50-60 (55)	61-78 (68)	181-244 (210)	231-294 (261)	71-86 (79)	33-38 (36)	709
III	58-73 (66)	65-78 (72)	199-255 (227)	281-372 (327)	82-100 (91)	36-41 (38)	821

Coxae (cx): broadly conical with basal and apical ridges and articulating processes well developed; setae: 16-21 (av. 19.0) fleshy and 9-12 (av. 10.2) hair-like setae on the fore, 15-22 (av. 17.5) fleshy and 10-12 (av. 11.0) hair-like setae on the middle and 23-30 (av. 26.3) fleshy and 10-12 (av. 11.4) hair-like setae on the hind coxa; one hair-like seta always present on basal process of front coxa. Trochanters (tr) subtriangular, basal ridge and articulating processes well developed; setae: 6-9 (av. 7.4) fleshy and 7-8 (av. 7.5) hair-like setae on the fore, 6-8 (av. 7.0) fleshy and 7-8 (av. 7.8) hair-like setae on the middle, 8-9 (av. 8.5) fleshy and 7-9 (av. 8.0) hair-like setae on the hind trochanter; six circular sensilla always present on basal half. Femora (fm) long and broad, distal ridge well developed; setae 42-56 (av. 48.5) fleshy and 10-12 (av. 11.3) hair-like setae on the fore, 40-60 (av. 48.0) fleshy and 9-11 (av. 9.3) hair-like setae on the middle, 52-65 (av. 57.1) fleshy and 8-10 (av. 9.0) hair-like setae on the hind femur. Tibia (tib) long and slender, length in relation to width (center) of fore tibia 1 : 11.5-13.5 (av. 12.1), basal ridge well developed; setae 50-68 (av. 56.1) fleshy and 10-14 (av. 11.1) hair-like setae on the fore, 48-64 (av. 54.9) fleshy and 5-9 (av. 7.0) hair-like setae on the middle, 63-81 (av. 69.7) fleshy and 7-11 (av. 8.7) hair-like setae on the hind tibia; length of fleshy setae about 1½ times longer than width of segment; strong spurs of various sizes (two usually distinctly bigger than others) situated on ventral apex of fore (6-8, av. 7.3), middle (6-11, av. 9.4) and hind (8-12, av. 10.7) tibia. Tarsi (tar) well developed, two-segmented. Second segment with membranous incised area near ventral apex; 17-21 (av. 18.3) fleshy and 14-16 (av. 15.0) hair-like setae on the fore, 17-21 (av. 19.0) fleshy and 14-18 (av. 15.5) hair-like setae on the middle, 18-24 (av. 21.6) fleshy and 15-17 (av. 16.1) hair-like setae on the hind tarsus; ventral setae thick-set, spur-like; two pairs of long sharp-pointed spines always present on the tarsus anterior to membranous incised area; tarsal digitules (tdgt) one pair, about as long as claw, subequal and apically knobbed; campaniform sensillum (cam.s) always present on dorsal proximal surface. Claws (Figs. 24-26, cl) well developed, subequal, slightly curved; unguis digitules (udgt) subequal, sharp-pointed, length slightly less than half the distance from base of digitule to tip of claw.

Abdomen: length from mesopostphragma to basal ridge of penial sheath 458-553 (av. 502)μ, width at 3rd segment 214-272 (av. 245)μ; 1st (at₁) (sometimes 2nd (at₂)) and 8th (at₈) tergites and 8th sternite

(ast₈) present; ventral invaginated areas (ia) between 3rd and 4th segments only rarely present; ostioles (ost) prominent. Number of abdominal dorsal setae (ads), abdominal pleural setae (aps), abdominal ventral setae (avs) and disc pores (mostly quadrilocular, sometimes quinquelocular or trilocular), are as follows (averages in brackets):

Region	Description	I	II	III	IV	V	VI	VII	VIII
Dorsal (ads)	fleshy setae	8-13 (10.3)	10-15 (12.9)	11-15 (13.1)	11-15 (12.8)	9-15 (12.1)	8-15 (11.8)	5-10 (6.9)	4-7 (4.9)
	hair-like setae	6-8 (7.1)	7-8 (7.1)	7 (7.0)	7-8 (7.1)	6-7 (6.9)	5 (5.0)	2-4 (3.0)	5-7 (6.2)
	disc pores	0	0	0	0	0	0	0	0
Pleural (aps)	fleshy setae	3-9 (5.1)	0-5 (2.6)	1-3 (1.9)	1-5 (2.9)	2-6 (3.4)	2-6 (4.1)	3-9 (6.1)	2-6 (4.3)
	hair-like setae	3-6 (4.3)	3-5 (4.0)	4-6 (5.0)	4-5 (4.9)	4-6 (5.0)	4-6 (4.9)	5-6 (5.4)	2-4 (2.6)
	disc pores	1-4 (2.7)	0-1 (0.9)	1-2 (1.1)	1 (1.0)	1-2 (1.1)	1-2 (1.2)	1-2 (1.7)	0
Ventral (avs)	fleshy setae		6-13 (10.6)	10-17 (14.2)	10-17 (13.9)	9-15 (12.3)	10-18 (13.9)	9-13 (11.3)	4-14 (7.8)
	hair-like setae		2 (2.0)	5-7 (6.6)	4-6 (4.8)	4-5 (4.1)	4 (4.0)	4 (4.0)	1-3 (1.6)
	disc pores		0	0	0	0	0	0	0

Setae of glandular plate (glps): 4 setae of which 2 are long, about 2/7th length of body, others shorter. Genital segment (Fig. 12): total length 153-187 (av. 173)μ; tergite (at₉₊₁₀) weakly sclerotized, with anus (an) immediately behind; dorsal denticulations distinct, in transverse rows. Style (st) comparatively short: length 26-31 (av. 28)μ, apex curving upwards, truncate in dorsal view. Basal ridge of penial sheath (brps) developed ventrally and laterally, internal projection (pr) very well developed, pointing into cavity of preceding segment. Process of penial sheath (pro) relatively well developed, pointing backwards. Aedeagus (aed) well developed, apex sharp in dorsal and lateral view; distal part of aedeagus slightly elevated; basal rod (bra) well developed. Setae of genital segment (gts): 5-10 (av. 7.2) hair-like setae on each side anteriorly and 3 hair-like setae on each side posteriorly, the latter arranged in a dorsoventral row. Setal sensilla (pros) 4-6 (av. 5.0) on each side.

3. *Pseudococcus maritimus* (Ehrhorn) (= *capensis* Brain) Figs. 7, 9.

Only winged forms known. Total body length 1276-1446 (av. 1323)μ including genital segment which is 146-170 (av. 154)μ long. Width at mesothorax 252-296 (av. 274)μ. Wing expanse 2310-2520 (av. 2462)μ.

Head: Roughly inversely conical, roundly constricted posteriorly. Length from apex to postoccipital ridge 126-143 (av. 134)μ; width across genae 197-218 (av. 206)μ.

Midcranial ridge (mcr) with ventral median part, lateral branches (lmcr) as well as detached dorsal part well developed, the latter meeting postoccipital ridge dorsomedially. Dorsomedial part of epicranium (dmep) slightly raised, only very weakly sclerotized. Postoccipital ridge (por) relatively well developed, continuous medially, anterior extremities distinctly separated from preocular ridge. Dorsal head setae (dhs): 4—14 (av. 8.9) fleshy and 8—13 (av. 10.1) hair-like setae on each side of midcranial ridge, with 1—3 (av. 1.9) quadrilocular pores on each side near base of antenna. Genae (g) large, rounded, with 11—24 (av. 15.6) fleshy and 2—4 (av. 2.9) hair-like genal setae (gs) on each gena. Dorsal eyes (dse) widely separated, 100—113 (av. 105) μ apart, with rounded corneae, 23—27 (av. 25) μ in diameter. Ventral eyes (vse) approximated, 21—28 (av. 25) μ apart, corneae rounded, slightly larger than dorsal eyes, diameter 26—30 (av. 28) μ . Dorsal and ventral eyes surrounded by distinct, polygonal reticulations. Lateral ocellus (o) small. Preocular ridge (procr) strongly developed, produced dorsally beyond anterior articular process, demarcating reticulated area. Postocular ridge (pocr) strongly sclerotized, ventrally considerably extended towards and joined by a sclerotized area with weakly developed preoral ridge (pror). Ocellar ridge (ocr) well developed. Ocular sclerite (ocs) weakly sclerotized. Cranial apophysis short, flattened dorsoventrally, not bifurcate. Mouth opening (mo) and tentorial pits (ptp) small, situated in membrane posterior to preoral ridge. Anterior tentorial arms and posterior tentorial arms present. Ventral head setae (vhs): fleshy setae 29—44 (av. 35.4), hair-like setae 19—33 (av. 21.2); of these no fleshy setae and 5—9 (av. 6.5) hair-like setae situated posterior to level of anterior margin of ventral eyes.

Antenna (Fig. 8): 10-segmented, occasionally less owing to incorporation of vestiges of one segment in an adjacent segment; length 525—660 (av. 592) μ ; filiform, distal segments of flagellum not becoming wider than proximal segments. Length of segments in microns:

	SEGMENT									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Length	38-49	61-69	77-90	54-72	56-72	53-67	54-56	51-59	46-56	59-73
Average	43	65	85	59	63	61	55	54	52	65

Width of scape (across center) 32—36 (av. 34) μ , pedicel 31—36 (av. 33) μ and flagellar segments 18—22 (av. 19) μ . Ratio antennal length to body length 1 : 2.07—2.44 (av. 2.24). Ratio width of prescutum to antennal length 1 : 4.35—5.03 (av. 4.68). Scape (scp) sclerotized, except distally and laterally, with basal ridge and distal process well developed; setae: fleshy setae absent, 6—7 (av. 6.2) hair-like setae. Pedicel (pdc) distinctly reticulated distally, with 9—17 (av. 13.8) fleshy and 13—18 (av. 15.1) hair-like setae, and with a dorsolateral sensillum placodeum (spl) distally. Flagellar segments III—IX (F_{111-IX}) with parallel sides, slightly constricted apically and basally; fleshy setae relatively thick-set, length about equal to diameter of 3rd segment. Segment III with sensillum basiconicum ventrodistally; 8—15

(av. 12.0) fleshy and 2—7 (av. 5.3) hair-like setae. Segment IV: 9—11 (av. 11.2) fleshy and 3—6 (av. 4.5) hair-like setae; V: 12—17 (av. 14.7) fleshy and 2—6 (av. 3.7) hair-like setae; VI: 12—17 (av. 14.0) fleshy and 2—4 (av. 3.3) hair-like setae; VII: 12—19 (av. 14.8) fleshy and 2—4 (av. 3.2) hair-like setae; VIII: 9—15 (av. 12.3) fleshy setae including 1 large seta situated ventrally on distal half, and 3—5 (av. 4.3) hair-like setae; IX: 10—14 (av. 11.5) fleshy setae, including 1 large seta situated ventrally on distal half, and 3—8 (av. 5.8) hair-like setae. Terminal segment (Xth) (Fig. 15) tubularly constricted apically, with 10—13 (av. 11.3) fleshy setae, including 3 large setae on distal half, one dorsally and two laterally; hair-like setae 6—10 (av. 7.7); one apical seta, length 26—35 (av. 31), not knobbed apically; two long, subapical, apically knobbed setae (set. scl) with well developed basal ring, both situated on ventral surface; two peg-like sensilla basiconica (bs), one near apex, with other one more posterior, ventrally.

Thorax: Total length from postoccipital ridge to mesopostphragma 496—575 (av. 526) μ .

Prothorax separated from head by a deep cervical groove. Pronotal ridge (prnr) narrow, collar-like. Lateral pronotal sclerites (prn) small. Median pronotal setae (mpns) on each side of median line: 0—2 (av. 1.1) fleshy, 0—3 (av. 1.0) hair-like, with 1—5 (av. 3.3) disc pores. Posttergite (pt) well sclerotized, posttergital setae (pts) on each side: fleshy 3—6 (av. 5.0), hair-like setae absent. Lateral pronotal setae (lps) on each side: fleshy setae absent, hair-like setae 0—1 (av. 0.1), with 1—5 (av. 2.9) disc pores. Antespiracular dorsal region: setae absent, 1—3 (av. 1.8) disc pores. Proepisternum + cervical sclerite (pepcv) strong, ridge-like, with weakening near anterior end. Propleural ridge (plr₁) short, with small pleural apophysis (pla₁). Proepimeron absent. Antespiracular ventral setae (asvs) on each side: fleshy 0—1 (av. 0.1), hair-like 0—1 (av. 1.0). Prosternum (stn₁) triangularly shaped, bounded posteriorly by a strong transverse ridge. Prosternal setae (stn_{1s}): fleshy 4—8 (av. 6.3), hair-like 2—4 (av. 2.7), with 0—6 (av. 2.8) disc pores.

Mesothorax: Mesoprephragma well developed, with ventral margin slightly emarginated medially. Prescutum (prsc) strongly arched, uniformly well sclerotized, bounded laterally by strong prescutal ridges (pscr) and posteriorly by a groove-like prescutal suture (pscs); length of prescutum (approx.) 73—91 (av. 80) μ , width (maximum) 177—136 (av. 127) μ . Prescutal setae (pscse) on each side: hair-like 5—7 (av. 5.3), fleshy setae absent. Scutum (sct) well sclerotized, with shallow, longitudinal depression medially; prealare (pra) separated by a strong ridge from anterior arm of scutum, differentiating distally into a well sclerotized triangular plate (tp); anterior notal wing process (anp) strong, upturned; distinct posterior notal wing process (pnp) present, preceded by a large lateral emargination; scutal setae (sctse) on each side: hair-like 5—8 (av. 6.6), fleshy setae and disc pores absent. Scutellum (scl) subrectangular, slightly less sclerotized medially; length 48—56 (av. 51) μ , width 80—95 (av. 87) μ ; scutellar setae (scls) on each side: hair-like 1—3 (av. 1.9), fleshy setae absent. Postnotum well developed, separated from scutellum by a large, subtriangular membranous area; postalare and postnotal apophysis (pna) well developed. Mesopostphragma slightly emarginated medially. Mesopleuron: Pleural ridge (plr₂) strong, fading out for a short distance above coxal articulation, invaginated medially to form pleural apophysis (pla₂),

supporting large rounded pleural wing process (pwp₂) dorsally. Mesepisternum (eps₂) well developed, dorsal and ventral parts separated by a triangular membranous area; bounded anteriorly by a strong subepisternal ridge (ser); epimeron small. Lateropleurite (lpl) small. Basalare (bas) and subalare (sa) well developed, the former connecting episternum with pleural wing process. Mesosternum: Basisternum (stn₂) large, convex, length 134—156 (av. 143)μ, with marginal (mr) and precoxal (pcr₂) ridges forming strong anterior and posterior margins respectively; basisternal setae (stn₂s): hair-like 16—26 (av. 19.6), fleshy setae absent. Postmesostigmatal setae (pms): Type A: fleshy setae 15—22 (av. 17.7), hair-like 4—8 (av. 6.4), with disc pores absent; Type B on each side: fleshy setae 0—3 (av. 1.5), hair-like setae 0—4 (av. 2.0), with 0—2 (av. 0.7) disc pores. Mesothoracic spiracle (sp₂) with well developed peritreme (ptr₂). Tegula (teg) small, well defined, borne anteriorly on a large membranous bulge, which carries 4—6 (av. 4.8) hair-like setae. Pteralia: 1st axillary sclerite (ax₁) triangular, 2nd axillary (ax₂) subrectangular, 3rd axillary (ax₃) with two basal processes, additional sclerite (asc) ill-defined.

Metathorax: Metanotum externally represented by two small suspensorial sclerites (ss), each being connected by a sclerotized band to base of haltere (h); transverse median metapostnotal sclerite (pn₃) present posteriorly. Metatergal setae (mts): Type A: fleshy 1—8 (av. 5.9), hair-like 5—9 (av. 7.4); Type B: fleshy 2—9 (av. 4.1), hair-like 4—8 (av. 6.6); with no disc pores present. Pleural ridge (plr₃) well developed, with small pleural wing process (pwp₃) supporting haltere; pleural apophysis vestigial. Episternum (eps₃) and epimeron (epm₃) distinct, with irregular margins. Metathoracic spiracle (sp₃) similar to mesothoracic one. Metapleural setae (mps) on each side: Type A: fleshy 1—4 (av. 2.5), hair-like 0—1 (av. 0.5), with 0—1 (av. 0.3) disc pores; Type B: fleshy 0—2 (av. 0.8), hair-like 0—1 (av. 0.3), with 0—2 (av. 1.1) disc pores. Metasternum represented by 2 distinct metasternal apophyses (sta). Anterior metasternal setae (amss): Type A: fleshy 3—9 (av. 5.6), hair-like 3—6 (av. 4.4), with 0—6 (av. 2.8) disc pores; Type B: fleshy setae 1—7 (av. 4.2), hair-like setae 2—7 (av. 4.5) with 0—6 (av. 2.8) disc pores. Posterior metasternal setae (pmss): Type A: fleshy 0—3 (av. 0.5), hair-like 0—2 (av. 0.9); Type B: fleshy 0—1 (av. 0.3), with no disc pores present.

Wings (Fig. 14): membranous, with well developed alar lobe; oblong, length (1067—1122, av. 1093)μ more than twice width (490—537, av. 508)μ; radius (rad) and media (med) well developed, not visibly connected; independent line anterior to common stem of radius plus media gives the impression of a small vein being present; costal complex (ccx) well sclerotized, elongated; alar setae (as): 2—4 (av. 3.0) hair-like setae; sensilla: 2—3 (av. 2.2). Halteres (h) membranous, tapering distally; well developed, 68—79 (av. 73)μ long, 13—18 (av. 16.0)μ wide; carrying one long apically hooked seta distally.

Legs (Fig. 11): well developed, slender; fore leg smallest, hind leg largest. Length of segments of leg in microns (averages in brackets): (See Table on next page.)

Coxae (cx): broadly conical with basal and apical ridges and articulating processes well developed; setae 8—12 (av. 9.4) fleshy and 10—12 (av. 11.2) hair-like setae on the fore, 9—14 (av. 11.7) fleshy and 10—13 (av. 11.4) hair-like setae on the middle, 10—18 (av. 13.5) fleshy and 10—14 (av. 11.3) hair-like setae on the hind coxa; one

Legs	Coxa	Trochanter	Femur	Tibia	Tarsus	Claw	Av. Total
I	43-49 (45)	61-69 (65)	147-199 (177)	164-220 (198)	64-76 (72)	27-31 (29)	586
II	41-54 (49)	56-71 (66)	147-197 (180)	169-235 (210)	64-77 (72)	27-35 (32)	609
III	41-61 (51)	58-80 (70)	160-214 (192)	207-289 (259)	77-90 (84)	29-37 (33)	689

hair-like seta always present on basal process of fore coxa. Trochanters (tr): subtriangular basal ridge and articulating processes well developed; setae 2—3 (av. 2.3) fleshy and 8—9 (av. 8.4) hair-like setae on the fore, 2—4 (av. 2.6) fleshy and 8—9 (av. 8.3) hair-like setae on the middle, 3—5 (av. 4.0) fleshy and 8—9 (av. 8.1) hair-like setae on the hind trochanter; six circular sensilla always present on basal half. Femora (fm) long and broad, distal ridge well developed; setae 16—32 (av. 22.0) fleshy and 10—14 (av. 12.1) hair-like setae on the fore, 17—32 (av. 25.9) fleshy and 9—11 (av. 9.9) hair-like setae on the middle, 27—44 (av. 34.7) fleshy and 9—10 (av. 8.3) hair-like setae on the hind femur. Tibiae (tib) long and slender, length in relation to width (center) of fore tibia 1 : 8.0—10.6 (av. 9.4), basal ridge well developed; setae: 22—32 (av. 26.4) fleshy and 10—19 (av. 14.7) hair-like setae on the fore, 28—44 (av. 34.3) fleshy and 12—16 (av. 13.1) hair-like setae on the middle and 33—58 (av. 42.2) fleshy and 11—19 (av. 14.6) hair-like setae on the hind tibia; length of fleshy setae about equal to width of segment; strong spurs of various sizes (two usually distinctly bigger than others) situated on ventral apex of fore (5—7, av. 6.3), middle (5—8, av. 6.8) and hind (7—10, av. 8.2) tibia. Tarsi (tar) well developed, two-segmented. Second segment with membranous incised area near ventral apex; 7—11 (av. 8.6) fleshy and 13—18 (av. 15.4) hair-like setae on the fore, 5—9 (av. 7.6) fleshy and 17—21 (av. 18.9) hair-like setae on the middle, 7—12 (av. 8.6) fleshy and 16—22 (av. 18.3) hair-like setae on the hind tarsus; ventral setae thick-set, spur-like; two pairs of long sharp-pointed spines always present on the tarsus anterior to membranous incised area; tarsal digitules (tdgt) one pair, about as long as claw, subequal and apically knobbed; campaniform sensillum (cam. s) always present on dorsal proximal surface. Claws (Figs. 18—20, cl) well developed, subequal, slightly curved; unguis digitules (udgt) subequal, sharp-pointed, length slightly more than half the distance from base of digitule to tip of claw.

Abdomen: length from mesopostphragma to basal ridge of penial sheath 482—573 (av. 510)μ, width at third segment 211—269 (av. 240)μ; 1st (at₁), 2nd (at₂) (sometimes 3rd (at₃) and 4th (at₄)) and 8th (at₈) tergites and 8th sternite (ast₈) present; ventral invaginated areas (ia) between 3rd and 4th segments only rarely present; ostioles (ost) prominent. Number of abdominal dorsal setae (ads), abdominal pleural setae (aps), abdominal ventral setae (avs) and disc pores (mostly quadrilocular, sometimes quinquelocular or trilocular), are as follows (averages in brackets):

TYPE A

Region	Description	SEGMENT							
		I	II	III	IV	V	VI	VII	VIII
Dorsal (ads)	fleshy setae	1-4 (2.3)	6-13 (9.6)	8-13 (10.4)	7-12 (10.1)	7-12 (10.8)	7-12 (9.9)	4-13 (8.3)	0-4 (2.1)
	hair-like setae	4-6 (4.7)	6-8 (7.0)	6-8 (7.0)	6-7 (6.4)	5-7 (5.9)	5-6 (5.1)	3-6 (4.6)	3-8 (4.4)
	disc pores	0	0	0	0	0	0	0	0
Pleural (aps)	fleshy setae	0-3 (1.9)	0-1 (0.1)	0-1 (0.3)	0-2 (0.9)	0-3 (1.4)	0-3 (1.6)	1-3 (2.1)	1-4 (2.3)
	hair-like setae	1-4 (3.3)	3-5 (4.0)	3-6 (4.9)	5 (5.0)	3-6 (5.0)	4-7 (5.4)	4-6 (5.1)	2-5 (2.8)
	disc pores	7-12 (8.7)	0-2 (0.6)	0-2 (0.9)	0-2 (1.1)	0-3 (1.6)	1-3 (2.1)	3-5 (3.4)	0
Ventral (avs)	fleshy setae		3-8 (5.9)	3-8 (6.4)	3-8 (5.9)	2-7 (4.9)	3-8 (5.3)	1-6 (4.0)	0-3 (2.4)
	hair-like setae		2-5 (3.0)	7-9 (7.9)	4-6 (5.0)	4-6 (4.9)	3-6 (4.9)	4-6 (4.9)	0-2 (0.9)
	disc pores		0-1 (0.1)	0	0	0	0	0	0

TYPE B

Region	Description	SEGMENT							
		I	II	III	IV	V	VI	VII	VIII
Dorsal (ads)	fleshy setae	0-5 (2.3)	3-8 (4.7)	3-9 (5.7)	2-9 (4.9)	2-10 (4.4)	3-9 (4.5)	2-10 (4.7)	1-4 (2.2)
	hair-like setae	1-6 (3.4)	5-8 (6.5)	5-8 (6.5)	5-7 (5.9)	5-7 (6.0)	4-6 (5.3)	3-5 (4.2)	3-7 (4.4)
	disc pores	0	0	0	0	0	0	0	0
Pleural (aps)	fleshy setae	0	0	0	0	0-1 (0.1)	0-2 (0.4)	0-2 (0.5)	0-2 (0.4)
	hair-like setae	1-4 (2.4)	3-5 (4.0)	4-5 (4.9)	5-6 (5.1)	5-6 (5.2)	5-7 (5.4)	5-8 (5.2)	1-3 (2.2)
	disc pores	7-13 (9.6)	0-2 (0.8)	0-2 (1.0)	0-2 (1.3)	0-4 (1.3)	1-4 (2.0)	1-6 (3.6)	0
Ventral (avs)	fleshy setae		0-4 (1.3)	0-4 (0.7)	0-1 (0.6)	0-2 (0.3)	0-2 (0.3)	0-1 (0.1)	0-1 (0.1)
	hair-like setae		2-6 (3.5)	6-9 (7.5)	4-6 (4.6)	4-6 (5.1)	3-6 (4.4)	4-5 (4.2)	0-1 (0.1)
	disc pores		0-1 (0.1)	0-1 (0.2)	0	0	0	0	0

Setae of glandular plate (glps): 4 setae, of which 2 are long, about $\frac{1}{3}$ length of body, others shorter. Genital segment (Fig. 13): total length 146-170 (av. 154) μ ; tergite (at_{0+10}) weakly sclerotized, with anus (an) immediately behind; dorsal denticulations distinct, in transverse rows. Style (st) medium sized, length 32-38 (av. 36) μ , apex curving upwards, broadly rounded in dorsal view. Basal ridge of penial sheath (brps) developed ventrally and laterally, internal projection (pr) short. Process of penial sheath absent. Aedeagus (aed) well developed, tapering sharply distally, apex broad in dorsal view, sharp in lateral view; basal rod (bra) well developed. Setae of genital segment (gts): 3-7 (av. 4.8) hair-like setae on each side anteriorly and 3 hair-like setae on each side posteriorly, the latter arranged in a dorsoventral row. Setal sensilla (pros) 2-6 (av. 4.0) on each side.

V. DISCUSSION

The present study of male Pseudococcidae contributed various interesting facts concerning:

1. The presence of taxonomically significant characters in the male.
2. The relationships of the Pseudococcidae with other subdivisions of the Coccoidea.

1. Taxonomic characters:

The characters considered to be most important in separating the three species of *Pseudococcus* from one another, are listed in Tables I, II and III. From an examination of these tables it is obvious that distinction between the species can easily be made, as considerable variation is found in a number of characters in the different species.

The degree of development of the postoccipital ridge is of some significance although the ridge is not sharply demarcated. The invaginated areas, which occur on the ventral intersegmental boundary between the 3rd and 4th abdominal segments, are always present in *P. fragilis*, but only rarely in the other two species. The variations in the shape and development of the structures of the genital segment and external genitalia seem to afford some of the most important diagnostic characters. Thus the degree of development of the processes of the penial sheath and the internal projections of the basal ridge, the length and shape of the style and the shape of the aedeagus are all of taxonomic importance.

The setae also provide a number of very useful characters. This applies especially to the fleshy setae, whose shape, size and distribution vary considerably in the species studied. The distribution of the disc pores seem to have very limited taxonomic value as the intraspecific variation is considerable.

Variation in size is also notable among the three species concerned, *P. maritimus* being the smallest and *P. fragilis* the largest, with *P. adonidum* in an intermediate position. Consequently the length of a number of structures can be used in separating the species.

When utilizing the number of setae and the size of structures for diagnostic purposes it must, however, be kept in mind that only a limited number of specimens (ten) of each species were used in obtaining the degree of variation. Therefore only those characters showing considerable variation in the different species are listed in the tables.

2. Relationships of the Pseudococcidae with other subdivisions of the Coccoidea:

The interrelationships of the three types of males recognized by Balachowsky (1937, 1942) i.e. margaroid, lecanoid and diaspidoid are discussed in some detail by Theron (1958). Ghauri (1959) enlarged and improved on Theron's views regarding the relationships of the diaspidoid male with the other groups.

Although Theron studied only one species (*Planococcus citri*) of the Pseudococcidae, the present study generally confirms his observations and conclusions concerning the affinities of this group. To supplement and correct Theron's findings the following observations are recorded here:

- (i) In comparing the lecanoid type, which includes *Pseudococcus*, with the margaroid type the absence of metasternal apophyses is listed by Theron as one of the specialized characters of the lecanoid type. These apophyses are, however, undoubtedly present in the three species studied and also in *Planococcus citri*.
- (ii) Another specialization noted by Theron is the absence of a distinct postoccipital ridge in the lecanoid type. Although still very much reduced in comparison with the margaroid type (and the diaspidoid type) the postoccipital ridge was, however, found to be fairly distinct in the species studied by me.
- (iii) The presence of vestigial metapleural apophyses is an additional primitive characteristic of *Pseudococcus*. These apophyses were also found by Ghauri (1959) in the more specialized Diaspididae, but is not described by Theron in *Planococcus*.
- (iv) If the sclerotization observed anterior to the mesocoxa is indeed a trochantin and not only a secondary sclerotization, the Pseudococcidae possess a primitive feature not shared by any of the other Coccoidea studied so far.

The above observations suggest that the Pseudococcidae are perhaps closer related to the Margarodidae than is indicated by Theron. The presence of metasternal apophyses in the Pseudococcidae is also an indication that this family is more primitive than the Lecaniidae and is widely separated from the Diaspididae.

TABLE I: Characters separating *P. adonidum* and *P. fragilis*.

Characters	<i>P. adonidum</i>	<i>P. fragilis</i>
1. Nature of fleshy setae	stout	long and slender
Head:		
2. Anterior extensions of postoccipital ridge	not nearly reaching preocular ridge	almost meeting preocular ridge
3. Setae posterior to level of anterior margin of ventral eyes	3—7 (av. 4.5) fleshy	5—9 (av. 7.3) fleshy
Antenna:		
4. Length, total	693—738 (av. 683) μ	782—988 (av. 854) μ
5. Length, 3rd segment	92—109 (av. 101) μ	125—156 (av. 136) μ
6. Length, 10th segment	58—64 (av. 60) μ	75—88 (av. 83) μ
7. Length in relation to length of posterior leg	shorter	subequal
8. Length of fleshy setae on 3rd segment in relation to width 3rd segment	1½ times longer	1¾—2½ times longer
9. No. of fleshy setae on 10th segment	9—12 (av. 11.0)	19—25 (av. 22.0)

Characters	<i>P. adonidum</i>	<i>P. fragilis</i>
Thorax:		
10. Length	493—578 (av. 532) μ	632—695 (av. 659) μ
11. No. of basisternal setae	0 fleshy	16—45 (av. 28.8) fleshy
	34—39 (av. 31.0) hair-like	5—23 (av. 9.1) hair-like
12. No. of fleshy posterior metasternal setae	1—5 (av. 3.2)	12—24 (av. 17.0)
13. No. of alar setae	3—6 (av. 3.8)	6—9 (av. 6.5)
Legs:		
14. Fore tibia: length/width	11.5—13.5 (av. 12.1)	9.2—11.2 (av. 10.1)
15. Length of fleshy setae on tibia in relation to width of tibia	1½ times longer	1½—2 times longer
Abdomen:		
16. Length (excl. genital segment)	458—553 (av. 502) μ	632—727 (av. 672) μ
17. Ventral, invaginated areas between 3rd and 4th segments	rarely present	always present
18. No. of setae on glandular plate	4	5—6 (av. 5.3)
Genital segment:		
19. Length of style	26—31 (av. 28) μ	44—50 (av. 45) μ
20. Apex of style in dorsal view	truncate	pointed
21. Internal projection of basal ridge	well developed	short
22. Processes of penial sheath	well developed	vestigial
Aedeagus:		
23. Apex in dorsal view	sharp	broad
24. Distal part in lateral view	sharp	broad

TABLE II: Characters separating *P. maritimus* and *P. fragilis*

Characters	<i>P. maritimus</i>	<i>P. fragilis</i>
1. Nature of fleshy setae	stout	long and slender
Head:		
2. Anterior extensions of postoccipital ridge	distinctly separated from preocular ridge	almost meeting preocular ridge
3. Setae posterior to level of anterior margin of ventral eyes	0 fleshy	5—9 (av. 7.3) fleshy
Antenna:		
4. Length, total	524—660 (av. 592) μ	782—988 (av. 854) μ
5. Length, 3rd segment	77—90 (av. 85) μ	125—156 (av. 136) μ
6. Length in relation to length of posterior leg	shorter	subequal
7. Length of fleshy setae on 3rd segment in relation to width of 3rd segment	subequal	1¾—2½ times longer

Characters	<i>P. maritimus</i>	<i>P. fragilis</i>
8. No. of fleshy setae on 3rd segment	8—15 (av. 12.0)	24—33 (av. 29.1)
9. No. of setae on 10th segment (excl. apical and subapical setae)	10—13 (av. 11.3) fleshy 6—10 (av. 7.7) hair-like	19—25 (av. 22.0) fleshy 1—3 (av. 1.5) hair-like
Thorax:		
10. Length	496—575 (av. 526) μ	632—695 (av. 659) μ
11. No. of fleshy basisternal setae	0	16—45 (av. 28.8)
12. No. of fleshy anterior metasternal setae	1—9 (av. 4.9)	13—35 (av. 23.8)
13. No. of posterior metasternal fleshy setae	0—3 (av. 0.5)	12—24 (av. 17.0)
14. No. of alar setae	2—4 (av. 3.0)	6—9 (av. 6.5)
Legs:		
15. Length of fleshy setae on tibia in relation to width of tibia	subequal	1½—2 times longer
16. No. of setae on fore tibia	22—32 (av. 26.4) fleshy 10—19 (av. 14.7) hair-like	43—56 (av. 50.2) fleshy 6—9 (av. 7.4) hair-like
17. No. of setae on fore tarsus	7—11 (av. 8.6) fleshy 13—18 (av. 15.4) hair-like	18—24 (av. 20.6) fleshy 10—13 (av. 12.2) hair-like
18. Length of unguual digitules	slightly more than half the distance from base of digitule to tip of claw	slightly less than half the distance from base of digitule to tip of claw.
Abdomen:		
19. Length (excl. genital segment)	482—573 (av. 510) μ	632—727 (av. 672) μ
20. Ventral invaginated areas between 3rd and 4th segments	rarely present	always present
21. No. of fleshy setae ventrally on each of 3rd to 7th segments	not more than 8	not less than 12
22. No. setae ventrally on 8th segment	0—3 (av. 1.3) fleshy 0—2 (av. 0.5) hair-like	9—13 (av. 11.3) fleshy 0 hair-like
23. No. of setae on glandular plate	4	5—6 (av. 5.3)
24. Length of longest seta on glandular plate	approx. ⅓ length of body	approx. ¼ length of body
Genital segment:		
25. Length of style	32—38 (av. 36) μ	44—50 (av. 45) μ
26. Apex of style in dorsal view	broadly rounded	pointed
27. Distal part of aedeagus in lateral view	sharp	broadened

TABLE III: Characters separating *P. maritimus* and *P. adonidum*

Characters	<i>P. maritimus</i>	<i>P. adonidum</i>
Head:		
1. Setae posterior to level of anterior margin of ventral eyes	0 fleshy 5—9 (av. 6.5) hair-like	7—8 (av. 7.3) fleshy 2—4 (av. 2.8) hair-like
Antenna:		
2. Length fleshy setae on 3rd segment in relation to width 3rd segment	subequal	1½ times longer
3. No. of fleshy setae on 3rd segment	8—15 (av. 12.0)	18—25 (av. 21.1)
Thorax:		
4. No. of basisternal setae (all hair-like)	16—26 (av. 19.6)	34—39 (av. 31.0)
5. No. of anterior metasternal fleshy setae	1—9 (av. 4.9)	18—31 (av. 24.3)
Legs:		
6. Length of fleshy setae on tibia in relation to width of tibia	subequal	1½ times longer
7. Fore tibia: length/width	1 : 8.0—10.6 (av. 9.4)	1 : 11.5—13.5 (av. 12.1)
8. No. of fleshy setae on fore femur	16—32 (av. 22.0)	42—56 (av. 48.5)
9. No. of fleshy setae on fore tibia	22—32 (av. 26.4)	50—68 (av. 56.1)
10. No. of fleshy setae on fore tarsus	7—11 (av. 8.6)	17—21 (av. 18.3)
11. Length of unguual digitules	slightly more than half the distance from base of digitule to tip of claw	slightly less than half the distance from base of digitule to tip of claw
Abdomen:		
12. No. of fleshy setae ventrally on each of 3rd to 7th segments	not more than 8	not less than 9
Genital segment:		
13. Apex of style in dorsal view	broadly rounded	truncate
14. Internal projection of basal ridge	short	well developed
15. Process of penial sheath	absent	well developed
16. Apex of aedeagus in dorsal view	broad	sharp

VI. KEY TO THE SPECIES STUDIED

The following key has been compiled by selecting from Tables I, II and III characters which appear to be most significant and easily recognizable.

1. Apex of style pointed in dorsal view; distal part of aedeagus broadened in lateral view; fleshy setae long and slender, $1\frac{1}{4}$ to $2\frac{1}{2}$ times longer than width of 3rd antennal segment and $1\frac{1}{2}$ times longer than width of tibia; number of fleshy setae on basisternum 16—45 (av. 28.8); number of fleshy posterior metasternal setae, 12—24 (av. 17.0); length of antenna shorter than length of posterior leg *P. fragilis*.
Apex of style truncate or broadly rounded in dorsal view; distal part of aedeagus sharp; fleshy setae stout, not more than $1-1\frac{1}{2}$ times longer than width of 3rd antennal segment and width of tibia; fleshy setae on basisternum absent; number of fleshy posterior metasternal setae, 0—5 (av. 1.9); antennae and posterior legs subequal in length. 2.
2. Apex of style truncate in dorsal view, process of penial sheath well developed; internal projection of basal ridge well developed; setae posterior to level of anterior margin of ventral eyes: 7—8 (av. 7.3) fleshy and 2—4 (av. 2.8) hair-like; numbers of fleshy setae on fore femur, tibia and tarsus 42—56 (av. 48.5), 50—68 (av. 56.1) and 17—21 (av. 18.3) respectively; number of fleshy anterior metasternal setae 18—31 (av. 24.3); fleshy setae $1\frac{1}{2}$ times longer than width of 3rd antennal segment and width of tibia; number of fleshy setae ventrally on each of 3rd to 7th abdominal segments not less than 9 *P. adonidum*.
Apex of style broadly rounded in dorsal view; process of penial sheath absent; internal projection of basal ridge short; setae posterior to level of anterior margin of ventral eyes: 0 fleshy and 5—9 (av. 6.5) hair-like; numbers of fleshy setae on fore femur, tibia and tarsus 16—32 (av. 22.0), 22—32 (av. 26.4) and 7—11 (av. 8.6) respectively; number of fleshy anterior metasternal setae 1—9 (av. 4.9); length of fleshy setae subequal to width of 3rd antennal segment and width of tibia; number of fleshy setae ventrally on each of 3rd to 7th abdominal segments not more than 8 *P. maritimus*.

VII. SUMMARY

1. The general morphology of three species of the Pseudococcidae i.e. *Pseudococcus fragilis*, *P. adonidum* and *P. maritimus* is described in detail and the results are compared critically with those of other workers.
2. The presence of metasternal apophyses, vestigial metapleural apophyses and what is considered to be a trochantin is established.
3. Studies of the male indicate that the circulus is situated between the 3rd and 4th abdominal segments and the ostioles in the 6th abdominal segment.
4. Evidence is presented which supports the views that the Pseudococcidae are fairly closely related to the Margarodidae and distinctly more primitive than the Lecaniidae.
5. Taxonomic characters of the three species are described in detail.
6. A large number of characters seem to be of taxonomic significance, including: (i) the variations in the shape and development of the

- genital segment and external genitalia; (ii) the shape, size and distribution of the setae, and (iii) the size of some of the structures.
7. A key is given to the species studied.

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- Fig. 27: Quinquelocular disc pore.
- Fig. 28: Quadrilocular disc pore.
- Fig. 29: Trilocular disc pore.

XI LIST OF ABBREVIATIONS

a	finger-like apodeme
ads	abdominal dorsal setae
aed	aedeagus
amss	anterior metasternal setae
an	anus
anp	anterior notal wing process
apar	anterior postalar ridge
aps	abdominal pleural setae
as	alar setae
asc	additional sclerite
asds	antespiracular dorsal seta(e)
ast ₈	8th abdominal sternite
asvs	antespiracular ventral setae
at	abdominal tergite
avs	abdominal ventral setae
ax ₁	first axillary sclerite
ax ₂	second axillary sclerite
ax ₃	third axillary sclerite
bas	basalare
bra	basal rod of penis
brps	basal ridge of penial sheath
bs	sensilla basiconica
cam. s	campaniform sensillum
ccx	costal complex of wing veins
cl	claw
cx	coxa
dej	ductus ejaculatorius
dhs	dorsal head setae
dmep	dorsomedial part of epicranium
dse	dorsal simple eye
epm ₂	mesepimeron
epm ₃	metepimeron
eps ₂	mesepisternum
eps ₃	metepisternum
f	furca
F _{111-x}	segments of flagellum 3rd to 10th
fm	femur
fp	furcal pit
fs	fleshy seta (<i>P. adonidum</i> , <i>P. maritimus</i>)
fse	fleshy seta (<i>P. fragilis</i>)
g	gena

glp	glandular plate
glps	setae of the glandular plate
gs	genal setae
gts	setae on genital segment
h	haltere
hs	hair-like seta
ia	invaginated area
iga	internal genital aperture
lmcr	lateral branch of midcranial ridge
lpl	lateropleurite
lps	lateral pronotal seta(e)
mcr	midcranial ridge
med	media
mo	mouth opening
mpns	medial pronotal seta(e)
mps	metapleural setae
mr	marginal ridge
mts	metatergal setae
o	ocellus
ocr	ocellar ridge
ocs	ocular sclerite
ost	ostiole
pa	postalare
pcr ₂	precoxal ridge of mesothorax
pcr ₃	precoxal ridge of metathorax
pd	pedicel
pepcv	proepisternum + cervical sclerite
pla ₁	propleural apophysis
pla ₂	mesopleural apophysis
pla ₃	vestigial metapleural apophysis
plr ₁	propleural ridge
plr ₂	mesopleural ridge
plr ₃	metapleural ridge
pms	postmesostigmatal setae
pmss	posterior metasternal setae
pn ₃	vestigial metapostnotal sclerite
pna	postnotal apophysis
pnp	posterior notal wing process
pocr	postocular ridge
por	remnant of postoccipital ridge
ppar	posterior postalar ridge
pr	projection of basal ridge

pra	prealare
prn	pronotal sclerite
prnr	pronotal ridge
pro	process of penial sheath
procr	preocular ridge
pror	preoral ridge
pros	setal sensilla on process of penial sheath
prsc	prescutum
ps	penial sheath
pscr	prescutal ridge
pssc	prescutal suture
psscse	prescutal setae
pt	posttergite
ptp	posterior tentorial pit
ptr ₂	peritreme of mesothoracic spiracle
ptr ₃	peritreme of metathoracic spiracle
pts	posttergital setae
pwp ₂	mesopleural wing process
pwp ₃	vestigial metapleural wing process
rad	radius
rd	posterior marginal fold of notum
sa	subalare
scl	scutellum
scls	scutellar setae
scp	scape
set	scutum
sets	scutoscutellar suture
setse	scutal setae
ser	subepisternal ridge
set. scla	subapical sensory setae
sp ₂	mesothoracic spiracle
sp ₃	metathoracic spiracle
spl	sensillum placodeum
ss	suspensorial sclerite
st	style
sta	metasternal apophysis
stn ₁	prosternum
stn ₂	mesosternum
stns	prosternal setae
stn ₂ s	basisternal setae
t	tendon-like apodeme
tar	tarsus

tdgt	tarsal digitule
teg	tegula
tegs	tegular setae
tib	tibia
tn	trochantin
tp	triangular plate
tr	trochanter
udgt	ungual digitule
vc	ventral cavity
vhs	ventral head setae
vse	ventral simple eye





