Scale insects of the families Asterolecaniidae and Eriococcidae (Hemiptera: Coccoidea) in New Caledonia

D. J. WILLIAMS

Department of Entomology, The Natural History Museum, London, UK

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Abstract
The scale insect families Asterolecaniidae and Eriococcidae are discussed from New Caledonia. One new genus Oacoccus gen. nov., and a new species Oacoccus nothofagi sp. nov. on Nothofagus sp., are described in the Asterolecaniidae, and a new species Eriococcus millei sp. nov. is described in the Eriococcidae. A new genus Rhopalotococcus gen. nov., and two new species Rhopalotococcus dugdalei sp. nov. and Rhopalotococcus metrosideri sp. nov., are also described in the Eriococcidae. Both species induce leaf galls on Metrosideros sp. Keys are provided for all the New Caledonian genera and species in the families Asterolecaniidae and Eriococcidae.

Keywords: Asterolecaniidae, Eriococcidae, New Caledonia, new genera, new species, scale insects

Introduction
Scale insects discovered and recorded so far from New Caledonia and listed by Ben-Dov et al. (2006) total 84 species. Not included in this list are two species of the family Asterolecaniidae that were discussed by Williams and Watson (1990), and two species of Diaspididae in the genus Furcaspis Lindinger that have been described recently (Williams et al., 2006).

First lists of scale insects of New Caledonia compiled by Cohic (1956, 1958) and by Brun and Chazeau (1980) concentrated mainly on species of economic importance. Later, Williams and Watson (1988a, 1988b, 1990) described and illustrated all the species at the time known from New Caledonia within the wider context of the tropical South Pacific region. The majority of the scale insects already known belong to the family Diaspididae, numbering 40, but apart from six species that are not known elsewhere and are regarded as endemic, all the others are tropicopolitan in distribution. Only five of the 16 species of the mealybug family Pseudococcidae are endemic and all the 12 species of Coccidae are common tropicopolitan species. The five species of Ortheziidae include three possible endemic species and, of the two species of Eriococcidae, one is endemic. Endemicity is highest in the family Margarodidae with six of its nine species known only from New
Caledonia (Bhatti 1991). Most of the common tropicopolitan species have probably been introduced on plant material.

Considering how long New Caledonia has been isolated and noted for its old endemic flora and fauna, the endemic scale insect fauna known at present is still surprisingly small. New Caledonia is one of older land masses in Australasia and, because land existed during the middle of the Mesozoic era, it would have been in existence during dispersal of Gondwanaland from the beginning of the Cretaceous (Holloway 1979) (for maps see Smith and Briden 1977). In the late Cretaceous, any close association of the land mass comprising New Caledonia and New Zealand, with Australia and Antarctica, came to an end (Holloway 1979).

The purpose of this paper is to discuss the few scale insect species in the families Asterolecaniidae and Eriococcidae from New Caledonia and to describe a species on *Nothofagus codonandra* (Nothofagaceae) along with others that induce galls on the leaves of unidentified species of *Metrosideros* (Myrtaceae). Scale insects on these host plants were collected by John S. Dugdale during a visit in 1978, mainly on Mont Do and Monts des Koghis. In addition to general collecting to improve basic biogeographic information, other reasons for the visit were to see how the insect fauna of New Caledonia compared with that of New Zealand, and to compare associations of insects on crops with those in the eastern Pacific area (Dugdale et al. 1978).

According to Read and Hope (1996), of the 35 living species of *Nothofagus*, only four are known in New Caledonia and these belong to the *N. brassi* group. Species producing *N. brassi*-type pollen probably originated in the West Antarctica–southern South America region (Hill and Dettermann 1996). Most species of *Nothofagus* have poorly dispersed seed resulting in a slow migration rate and the New Caledonia species may be particularly vulnerable because of their localised distribution and because of possible climate change (Read and Hope 1996).

There are no previous records of Coccoidea on *Metrosideros* (Myrtaceae) in New Caledonia. *Metrosideros*, however, is well represented in New Caledonia and throughout the Pacific area. The seeds are small and easily dispersed and, according to Wright et al. (2001), have dispersed to as far north as Hawaii from New Zealand. Most species of Coccoidea on *Metrosideros* are recorded from New Zealand (Ben-Dov and Miller 2006) including many in the family Eriococcidae.

Of the 50 species of *Metrosideros* (Wright et al. 2003) about 17 are known from New Caledonia and two species of Eriococcidae occurring on *Metrosideros* are described herein. Numbers of Coccoidea so far found on *Nothofagus* and *Metrosideros* in New Caledonia are small and probably represent a small proportion of those awaiting discovery. The present paper, therefore, may stimulate an interest in further collecting in this island and the study of further species that may be languishing in international collections. The opportunity is taken to describe a species of *Eriococcus* (unfortunately without host data) kindly made available by Rosa Henderson.

There is little faunal similarity between the scale insects of New Caledonia and those of New Zealand. The new species of *Eriococcus* described herein is most similar to *E. pallidus* Maskell from New Zealand. Among the mealybugs, the recently described species, *Rastrococcus namartini* Williams and Henderson, comes closest to *R. matileae* Williams described from New Caledonia. These *Rastrococcus* species occur on the most eastern range of the genus. Otherwise, the dissimilarity of the faunas may reflect the more tropical position of New Caledonia, although the montane fauna of New Caledonia is long due for scale insect surveys and these may reveal species related to some in New Zealand.
Methods

The study is based on slide-mounted specimens using the methods discussed by Williams and Granara de Willink (1992). Measurements of the whole body are given in millimetres (mm) and measurements of all other structures are in microns (µm). Each figure shows the entire insect with the dorsum on the left and the venter on the right with enlargements of important characters around the edges. Terminology used to discuss the Asterolecaniidae follows that of Russell (1941) and Williams and Watson (1990), and that used for the Eriococcidae follows that of Miller and McKenzie (1967) and Williams and Watson (1990).

Abbreviations of the depositories mentioned in the text are: BMNH, The Natural History Museum, London, UK; IANC, Institut Agronomique néoCalédonien, Station de Recherches Fruitières de Pocquereux, La Foa, New Caledonia; NZAC, New Zealand Arthropod Collection, Auckland, New Zealand; USNM, United States National Collection of Natural History, Coccoidea collections housed at USDA, Beltsville, Maryland, USA.

ASTEROLECANIIIDAE Cockerell

Type genus. Asterolecanium Targioni Tozzetti.

Comments

There is no general definition of this family at present containing about 25 genera. It is usually based on the characters of the adult females of the type genus Asterolecanium and its relatives in possessing 8-shaped pores often in a continuous row around the ventral margin. The anal lobes are sometimes present although little developed, the antennae are often reduced to tubercles, legs are often absent and stigmatic furrows may be present, each containing only one row of quinquelocular pores. The anal ring is sometimes cellular with setae or is reduced to a simple opening without pores or setae. One of the important characters of some genera is the presence of elongate tubular ducts slightly bent at an angle at the inner end.

Despite these distinctive characters, some genera are assigned to the family tentatively, having few of these characters, and such is the case with the new genus described herein.

In a study of the Coccoidea based on the characters of the adult male, Hodgson (2002) showed the family as a sister group on the same clade that comprises the families Diaspididae and Conchaspididae. There is added support for this relationship because species in these three families do not produce honeydew, as do most of the other families, and maybe they are parenchyma feeders but certainly not phloem feeders. It is difficult to understand, however, why Asterolecanium variolosum Ratzeburg should possess a filter chamber as described by Parr (1940). Phylogenetic (studies) based on molecular work by Cook et al. (2002), however, showed the Asterolecaniidae falling among the eriococcid taxa in all the analyses they presented.

Only two species in two genera in the family have been recorded from New Caledonia and a new genus and species, tentatively assigned to the family, are included here. The three genera can be separated by the following key.
Key to New Caledonian genera of the family Asterolecanidae

1 Dorsum and ventral margins with 8-shaped pores. Stigmatic furrows with quinquelocular pores present. Antennae reduced to tubercles. Legs absent, occasionally reduced to sclerotized areas each with a single claw. Anal lobes sometimes poorly developed or apex of abdomen rounded, with apical setae but not forming a cleft; without a large, entire plate-like area on dorsum forming lobes with apical setae ......................................................... 2
   – Dorsum without above characters but with an anal cleft and a large, entire plate-like area on dorsum at base of cleft forming lobes at posterior edge. Antennae well developed, with eight segments. Legs well developed .................. Oacoccus gen. nov.

2 Dorsal tubes present near apex of abdomen .................................. Bambusaspis Cockerell
   – Dorsal tubes absent entirely .................................. Asterolecanium Targioni Tozzetti

Asterolecanium Targioni Tozzetti
Asterolecanium Targioni Tozzetti 1868, p 734. Type species Coccus aureus Boisduval 1868, p 301, by monotypy (=Lecanium epidendri Bouché 1844, p 300).

Asterolecanium pustulans Cockerell
Asterolecanium pustulans (Cockerell 1893, p 8); Russell 1941, p 165; Williams and Watson 1990, p 196.

Comments
In an extensive revision of the genus Asterolecanium, Russell (1941) recorded this tropicopolitan species from New Caledonia, Iles des Pins, on Nerium sp. (Apocynaceae) and Grevillea robusta (Proteaceae). Brun and Chazeau (1980, p 75) listed this scale insect as being of agricultural importance in New Caledonia, and Williams and Watson (1990) discussed the species from the tropical Pacific Region and recorded it from New Caledonia on Nerium oleander.

Bambusaspis Cockerell
Bambusapis Cockerell 1902, p 114. Type species Chermes miliaris Boisduval, by subsequent designation of Sanders 1906, p 3.

Bambusaspis bambusae (Boisduval)
Chermes bambusae Boisduval 1869, p 261.
Asterolecanium bambusae (Boisduval), Signoret 1870, p 280; Russell 1941, p 47.
Bambusaspis bambusae (Boisduval), Borchsenius 1960, p 135; Williams and Watson 1990, p 201.

Comments
Russell (1941), apparently, first recorded this species from New Caledonia on bamboo and later Cohic (1956, 1958) discussed it from the Iles des Pins on Bambusa sp. (Poaceae) where it sometimes causes damage. Brun and Chazeau (1980) listed it as of agricultural importance and Williams and Watson (1990) discussed it from the tropical Pacific Region including New Caledonia.
**Oacoccus** gen. nov.

_Type species._ Oacoccus nothofagi sp. nov.

**Description**

Body of adult female on microscope slide, membranous, with cleft at posterior end of abdomen forming two apparent anal lobes. Base of cleft on dorsum with oval sclerotized area or plate, entire, except divided posteriorly by narrow cleft with parallel sides, forming anal lobes, each with an apical seta; base of cleft with cellular anal ring divided into two lateral sclerotized areas, containing six setae. Dorsal margin of body with an uninterrupted series of sclerotized finger-like extensions directed medially, each expanded at base at body margin, space between each base with an elongate microduct opening at margin. Antennae six-segmented, only gently tapering. Legs well developed, mesothoracic and metathoracic legs displaced posteriorly. Spiracles normal, metathoracic spiracles displaced nearer posterior end of body. Ventral segmentation apparent on abdomen, with oblique rows of quinquelocular pores directed forwards to metathoracic spiracles.

**First-instar nymphs**

None available after parturition, described from embryos only. Body oval, membranous, with dorsal marginal finger-like extensions and microducts as in adult female. Anal lobes poorly developed, rounded, each with apical seta. Anal ring U-shaped. Dorsum with series of submarginal and submedial slender setae. Quinquelocular pores present on venter in oblique rows extending forwards to metathoracic spiracles. Antennae six-segmented. Legs normal, claws slender, apparently without denticles.

**Comments**

Normally, genera assigned to the family Asterolecaniidae, based on characters of the adult female, as in *Asterolecanium* Targioni Tozzetti (Russell, 1941), *Frenchia* Maskell (Lambdin and Kosztarab, 1981), and *Polea* Green (Lambdin, 1977), possess 8-shaped pores, quinquelocular pores somewhere on the body, and other characters discussed above. First-instar nymphs usually have 8-shaped pores, occasionally three narrow sclerotized areas in the anal areas and claws that lack denticles (Miller 1991). In the new genus, there are no 8-shaped pores in the adult female, the tubular ducts are very slender and straight, resembling long microducts, the antennae are six-segmented, there is an anal cleft with a large, entire dorsal anal plate or sclerotized area that is divided at the posterior end, and legs are present. First instar-nymphs of *Oacoccus* lack 8-shaped pores and the claws apparently lack denticles.

It could be argued that *Oacoccus* should be included in the family Eriococcidae. First-instar nymphs of Eriococcidae, however, usually possess enlarged setae, protruding anal lobes and denticles on the claws. Many adult females of Eriococcidae have protruding anal lobes but sometimes, as in *Erioichiton* Maskell (Hodgson and Henderson, 1996), *Neoeriochiton* (Hodgson, 1994), and *Chilechiton* (Hodgson and Miller, 2002), the lobes are displaced anteriorly forming a cleft at the posterior end of the body but the lobes always remain separate and never form a single plate-like area. There are genera presently included in the family Eriococcidae, such as the Australian genus *Floracoccus* Beardsley, 1974, with
few characters that allow easy assignment to any family. *Floracoccus* lacks anal lobes, enlarged setae and tubular ducts, the antennae and legs are reduced to tubercles, and quinquelocular pores are present. The genus, nevertheless, seems to be closely related to *Sphaerococcopsis* Cockerell, another Australian genus with clearer eriococcid features.

The anal ring of *Oacoccus* is similar to that of many species in the Asterolecaniidae with two plate-like areas joined anteriorly by a narrow rim. Furthermore, the claws in both the adult female and first-instar nymph lack denticles, and the labium, which appears to be two-segmented but with setae at the apex only, are asterolecaniid-like and it is for these reasons that the genus is tentatively assigned to the family Asterolecaniidae although reluctantly as a monotypic genus. There seems to be no other family at present that could contain it. The plate-like anal area of the adult female does not correspond to any discussed by Hodgson (1995) but the anal area of the first-instar nymph is more asterolecaniid-like.

When Ferris (1955) described the genus *Mycococcus* Ferris (type species *M. copernicae* Ferris) from Cuba, he included the Australian species *Sphaerococcus diaspidiformis* Green in it as *Mycococcus diaspidiformis* (Green) and assigned *Mycococcus* to the family Asterolecaniidae. *M. diaspidiformis* is not congeneric with the type species but, as discussed by Miller et al. (1998), it should probably remain in the family Asterolecaniidae. First-instar nymphs of *M. diaspidiformis* lack 8-shaped pores, the adult female possesses tubercle-like antennae, and a labium that is two-segmented. Although *M. diaspidiformis* cannot be included in *Oacoccus*, there are similarities.

The two Australian genera *Callococcus* Ferris and *Eremococcus* Ferris, formerly placed in the family Asterolecaniidae, have been transferred to the family Eriococcidae by Gullan et al. (2005). These genera bear no resemblance to *Oacoccus*.

**Etymology**

The name is formed from the Greek word “oa”, meaning a border in the form of a hem, alluding to the dorsal margin, combined with the generic name *Coccus*.

*Oacoccus nothofagi* sp. nov.

(Figure 1)

**Description**

External appearance covered in a thin greyish waxy scale with raised brownish centre, resembling scale cover of many Diaspididae but without exuviae; on twigs and woody petioles.

Adult female on microscope slide almost circular, 1.40–1.55 mm long, 1.30–1.45 mm wide, posterior end with a cleft, forming apparent anal lobes; base of cleft dorsally with an oval to semicircular sclerotized area, plate-like, 165–190 μm wide, 120–125 μm long, entire, except divided at posterior edge to almost half its length by a narrow parallel cleft about 55 μm long, forming a pair of true anal lobes each with a stiff apical seta 20–35 μm long, inner end of cleft rounded enclosing anal ring. Anal ring cellular, 15–17 μm in diameter composed of two outer semicircular plates joined at anterior edge by a narrow rim, with six setae, each 30–40 μm long, reaching nearly to anal lobes. Dorsal body margin with a continuous series of finger-like extensions, inwardly projected, 60–110 μm long, each swollen at base on margin and usually with a single microduct about 25–35 μm long, 1.0 μm wide, between each pair, opening on margin. Antennae normally six-segmented, 110–120 μm long, segments 2–6 all about same width, segment 3 longest; all segments with
Figure 1. *Oaococcus nothofagi* sp. nov., adult female.
a few short flagellate setae about 10 μm long, except on terminal segment where some about 20 μm long; also a single seta at apex about 40 μm long. Last two segments also with fleshy setae about 10 μm long. Legs well developed but small and slender; mesothoracic and metathoracic legs situated well posterior on lower half of body; hind coxa 25–30 μm long, hind trochanter + femur 80–87 μm long, hind tibia + tarsus 70–75 μm long. Claw about 10 μm long without a denticle but with two disparate knobbed digitules, one much more expanded apically than other. Distal trochanteral seta about 25 μm long; translucent pores absent from hind coxa; hind tarsus with two outer and two inner short setae each about 10 μm long. Ratio of hind tibia + tarsus to hind trochanter + femur 0.80–0.88. Ratio of lengths of hind tibia to hind tarsus 0.50–0.55. Mouthparts situated about one-quarter distance of body from anterior head margin. Labium 30–35 μm long, apparently two-segmented with four short setae at apex. Clypeolabral shield longer than labium; pharynx noticeably long and easily visible when stained. Spiracles each about 30 μm long, metathoracic spiracles situated on posterior half of body about one-quarter distance from apex of abdomen.

Dorsum without apparent segmentation, with minute setae, each scarcely 5.0 μm long, a few present on sclerotized area and on medial areas of dorsum, others sparse around submargins. Ventral surface with abdomen displaced towards posterior end of body, segmented in medial area with a few short setae each about 10 μm long. Other setae about 35–40 μm long, present between antennal bases. Remainder of body without setae and ducts but with minute quinquelocular pores, each about 2.0 μm in diameter, on abdominal segment VIII and extending in two oblique rows to areas around metathoracic spiracles.

First-instar nymph

Description. Described from embryos only. Body broadly oval with poorly developed anal lobes each with an apical seta about 20 μm long. Anal ring situated at base of anal lobes, cellular, about 12.5 μm in diameter, almost U-shaped, consisting of two outer sclerotized plate-like areas joined anteriorly by a narrow rim; with six setae each about 25 μm long surpassing anal lobes in length. Dorsal surface of body with a continuous series of finger-like processes extending inwards. A single microduct present between each pair of processes, opening on margin as in adult female. Dorsal surface with submarginal setae, each minute and stiff, and with a submedial series of similar setae. Ventral surface with minute quinquelocular pores extending anteriorly from near base of anal lobes in two oblique rows to metathoracic spiracles as in adult female. Antennae six-segmented. Legs normal; claw slender, apparently without a denticle.

Material examined

Holotype: adult ♀, New Caledonia, Mt Do, 1000 m, on twigs and woody petioles of Nothofagus codonandra, 22 October 1978 (coll. J. S. Dugdale), No. 23 (NZAC). Paratypes: New Caledonia, same data as holotype, one adult ♀ (NZAC), two adult ♂♂ (BMNH), one adult ♀ (USNM), one adult ♀ (IANC).

Etymology

The name is based on the name of the plant genus Nothofagus in the Latin genitive meaning of or from.
ERIOCOCCIDAE Cockerell

Type genus. Eriococcus Targioni Tozzetti

Description

Genera normally with enlarged setae that are robust, conical, bulbous or truncate, especially on dorsum, but sometimes dorsal setae flagellate. Anal lobes often well developed and protruding but sometimes displaced anteriorly forming an anal cleft, sometimes anal lobes not developed. Anal ring often cellular with a single row of cells and often six to eight setae but sometimes reduced to semicircular shape and sometimes without cells and with reduced number of setae. Enlarged tubular ducts usually present, each with inner end cupped. Microducts, quinquelocular pores and cruciform pores often present.

Comments

No full definition of the family is available and sometimes the family is defined as lacking characters of other families such as ostioles, cerarii, circuli, and stigmatic setae. Genera at present included in the family have been catalogued by Miller and Gimpel (2000). The first phylogenetic hypothesis based on molecular data of some genera (Cook et al. 2002) has shown that eriococcids are paraphyletic and even the genus Eriococcus may need to be subdivided. A better understanding of the family will be gained after the large eriococcid fauna of Australia is studied in detail. In the present work, the species discussed from New Caledonia are treated using the broad concepts of the family as catalogued by Miller and Gimpel (2000).

The Eriococcidae of New Caledonia discussed by Williams and Watson (1990) comprised only two species, Chazeauana gahniae Matile-Ferrero and Eriococcus araucariae Maskell. This number has now been increased to five species in three genera and the genera may be separated by the following key.

Key to genera of New Caledonian Eriococcidae

1 Anal lobes strongly developed and prominent. Marginal and dorsomedial enlarged setae present. Anal ring with cells and six to eight setae . . . . . . . . . . 2
   – Anal lobes lacking, posterior end of body rounded, or with poorly developed anal lobes. Marginal and dorsomedial enlarged setae absent, flagellate setae present only. Anal ring semicircular or transversely oval, without cells, with two to four setae . . . . . . . . . . . . . . . . . . . . . . Rhopalotococcus gen. nov.

2 Marginal enlarged setae each expanded at apex, abruptly pointed. Legs vestigial, minute. Antennae each with four segments . . . . Chazeauana Matile-Ferrero
   – Marginal enlarged setae tapering to blunt or pointed apex. Legs well developed. Antennae each with six or seven segments . . . . Eriococcus Targioni Tozzetti

Chazeauana Matile-Ferrero

Chazeauana Matile-Ferrero 1988, p 68; Williams and Watson 1990, p 49; Miller and Gimpel 2000, p 80. Type species Chazeauana gahniae Matile-Ferrero, by original designation and monotypy.
Comments

This monotypic genus, apparently, is endemic to New Caledonia. It is easily recognisable in having vestigial legs and enlarged marginal setae expanded at the apex before abruptly forming a point. This combination of characters is not found in other genera of the Eriococcidae.

Chazeauana gahniae Matile-Ferrero

Chazeauana gahniae Matile-Ferrero 1988, p 70; Williams and Watson 1990, p 49; Miller and Gimpel 2000, p 80.

Comments

This remarkable species is easily distinguished in possessing well-developed anal lobes, four-segmented antennae, and minute vestigial legs only. A cellular anal ring possesses six setae and the enlarged marginal setae on the posterior abdominal segments are expanded apically and then abruptly pointed. Enlarged tubular ducts are apparently absent but microducts are present. Quinquelocular and bilocular pores are present.

The species was described from material collected in New Caledonia, Yaté, on Gahnia novocaledonensis (Cyperaceae), the only record on this plant genus and family known in the family Eriococcidae.

Eriococcus Targioni Tozzetti

Eriococcus Targioni Tozzetti 1868, p 726; Miller and Gimpel 2000, p 105. Type species Coccus buxi Foncolombe by subsequent restriction of Signoret 1872, p 429 and by designation by Melville 1982, p 95. Opinion 1203 under the plenary powers of the International Commission on Zoological Nomenclature (Name Number 2153).

Description

Important characters of this genus are: legs present, well developed; anal lobes well developed, protruding; antennae normally with six segments; macrotubular ducts present on dorsum; enlarged setae often present on dorsal margin and in dorsomedial area.

Comments

Many genera are regarded as being identical to Eriococcus in Miller and Gimpel (2000). These authors list nearly 350 species of Eriococcus worldwide, many of which are in great need of revision. Only one species, E. araucariae Maskell, was previously known from the tropical Pacific region including New Caledonia (Williams and Watson 1990) and a second species is now described from New Caledonia. Species in New Zealand can now be identified after the work by Hoy (1962) but identification with certainty of many of the 55 species described from Australia is difficult and often impossible from the present literature.

The two species known from New Caledonia can be separated by the following key.

Key to adult female species of Eriococcus from New Caledonia

1 Marginal enlarged dorsal setae conspicuously longer than dorsomedial setae, at least three times as long. Dorsomedial setae short, truncate, with parallel sides.

........................... E. araucariae araucariae Maskell
Marginal enlarged dorsal setae, at most, only twice as long as dorsomedial setae. Dorsomedial setae pointed, same shape as marginal setae. . . . millei sp. nov.

**Eriococcus araucariae araucariae** Maskell

*Eriococcus araucariae* Maskell 1879, p 218; Ferris 1955, p 100; Williams and Watson 1990, p 51.
*Acanthococcus araucariae* (Maskell), Miller and Miller 1992, p 9.

*Eriococcus araucariae araucariae* Maskell; Miller and Gimpel 2000, p 125.

**Description**

Body of adult female broadly oval. Anal lobes heavily sclerotized, protruding, each with three enlarged dorsal setae. Hind coxae with translucent pores. Marginal dorsal setae enlarged, almost conical, bluntly tipped. Other enlarged setae on dorsum, small and truncate. Macrotubular ducts of two sizes. A large type present on dorsum and around margins of venter. A smaller type present on venter of abdominal segments. Microtubular ducts present on dorsum and ventral submargins. Anal ring cellular, with eight setae. Quinquelocular pores present on venter only. Cruciform pores present.

**Comments**

The combination of names to this species has been changed to subspecies level recently because, although the characters of the species are well defined, there are still two other subspecies, *E. araucariae minor* Maskell described from Australia on *Kunzea capitata* (Myrtaceae), and *E. araucariae nudus* Gómez-Menor Ortega, described from Spain on *Cycas* sp. (Cycadaceae) that are little known and whose characters await redescription. Only some of the main references are listed here; for full synonymy and literature citations, see Miller and Gimpel (2000).

There are adequate descriptions and illustrations of this species in Ferris (1958), Miller and Miller (1992, 1993), and Williams and Watson (1990) affording easy recognition.

Although I have not seen specimens of this species from New Caledonia, it has been well documented from there by Cohic (1956, 1958), Brun and Chazeau (1980), and Williams and Watson (1990) who report damage to *Araucaria columnaris* and *A. cunninghamii* mainly by heavy infestations causing sooty moulds to develop on honeydew excreted by the insects. The insects are kept under control by the coccinellid *Cryptolaemus montrouzieri* Mulsant. Laing (1933) also reported this felt scale from Dge, Uen [Ouen], on *Araucaria* sp.

**Eriococcus millei** sp. nov.

(Figure 2)

**Description**

External appearance, covered in white wax and with white, long and loosely woven ovisac extending from rear of insect.

Body of adult female on microscope slide either broadly oval or with sides subparallel, membranous, 1.15–1.75 mm long, 0.65–1.15 mm wide, widest at mesothorax or abdominal segment I, with faint minute nodules mainly on head and thorax. Posterior
Figure 2. *Eriococcus millei* sp. nov., adult female.
end rounded except for sclerotized anal lobes, each lobe conical, 60–80 μm long, 33–45 μm wide at base, inner edges crenate, with an apical flagellate seta 75–80 μm long and a dorsal enlarged sub-apical seta about 30 μm long, an inner dorsal, almost basal seta about 45 μm long, an inner subapical ventral seta about 25 μm long, and an outer sub-apical ventral seta about 25 μm long; all anal lobe enlarged setae noticeably narrower than dorsal enlarged body setae. Antennae 160–200 μm long, six-segmented, segment 3 longest. Legs well developed, hind coxa 50–60 μm long, hind trochanter + femur 130–160 μm long, hind tibia + tarsus 140–160 μm long. Claw fairly stout, 20–25 μm long, with a single denticle near apex and with two knobbed digitules 32 μm long, noticeably longer than claw, one digitule with large expanded distal end larger than other. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.00–1.07. Ratio of lengths of hind tibia to tarsus 1.00–1.28. Distal trochanteral setae each about 55 μm long. Hind coxa with about 20 translucent pores on posterior surface and a few near outer margin on anterior surface. Hind tibia with a pair of setae at distal end only. Labium much shorter than clypeolabral shield, 60–70 μm long, with three segments, basal segment very narrow with two pairs of minute setae. Anal ring 45–50 μm in diameter, with a single row of cells and six setae each 70–90 μm long. Suranal setae pointed, each about 40 μm long. Each eye about 20 μm in diameter.

Dorsal surface with conical enlarged marginal setae, acutely pointed, often slightly curved in profile, mostly 30–35 μm long, 7.5–10.0 μm wide at base, usually two present on margin of each abdominal segment except on abdominal segment VII where usually only one present about 38 μm long and about 10 μm wide at base. Other dorsal setae, same shape but smaller, 15–20 μm long, 5.0–7.5 μm wide at base, present in single rows across middle of segments except scattered on head and prothorax. Macrotubular ducts, each about 15 μm long, 4 μm wide at cup end, present across segments usually in single rows near anterior and posterior edges of abdominal segments and some across middle of abdominal segments near enlarged setae; others becoming scattered on head and thorax. Microtubular ducts elongate, each about 10.0 μm long and scarcely 1.0 μm wide at inner end, scattered over surface.

Ventral surface with a series of marginal to submarginal enlarged setae, similar to dorsal setae but most smaller, 15.0 μm long, 6.0 μm wide at base, present singly on abdominal segments, more frequent on thorax; enlarged setae on head margin larger, about 22 μm long. Other setae across segments, flagellate. Macrotubular ducts, same size as dorsal ducts, present in a marginal to submarginal zone. A smaller macrotubular duct, about 12.5 μm long and 2–3 μm wide at cup end, present across abdominal segments and submedially on head and thorax, sparse or absent in medial area of thorax. Microtubular ducts as on dorsum, present around margins and submargins, a few extending medially on thorax. Quinquelocular pores, each about 4.0 μm in diameter, most numerous in medial to submedial areas of abdomen, others present submedially on thorax, and three or four present next to spiracular openings; others scattered medially on head and prothorax. Cruciform pores, smaller than quinquelocular pores, sparsely distributed submedially on head and thorax.

Material examined

Holotype: adult ♀, New Caledonia, Belep, on leaves of unidentified plant, 6 April 2004 (coll. C. Mille), #04-089a (NZAC). Paratypes: New Caledonia, same data as holotype, one adult ♀, #044-089d (NZAC), one adult ♀, #044-089b (IANC), one adult ♀, #04-089c (BMNH).
Etymology

The species is named after the collector, Christian Mille, Institut Agronomique neo-Calédonien, La Foa, New Caledonia.

Comments

Eriococcus millei is most similar to E. pallidus Maskell described from New Zealand on Myoporum laetum and Elaeocarpus sp. by Maskell (1885) and known from subsequent collections on numerous host plants. Hoy (1962) listed these host plants and described and illustrated E. pallidus in detail. Specimens of E. pallidus are available (BMNH) sent by Maskell to R. Newstead dated 1890. Rosa Henderson, Landcare Research, Auckland, New Zealand, who kindly sent the material of E. millei for study, has also sent photographs of slide preparations of authentic material of E. pallidus and added valuable comments. E. millei differs from E. pallidus mainly in possessing marginal dorsal enlarged setae that are noticeably longer than the dorsomedial setae (almost twice the length) but in E. pallidus they are mostly about the same size. Furthermore, the enlarged setae in E. millei are acutely pointed whereas in E. pallidus they are bluntly tipped. The anal lobes of E. millei taper much more than those of E. pallidus. In E. pallidus, the anal lobes are more truncate and, whereas the apical setae in E. millei are terminal, in E. pallidus they are situated more to the outer edge. The ovisac of E. millei (as described by Rosa Henderson) is white, long and loosely woven, extending from the rear of the insect. In L. pallidus, it is closely felted covering the insect.

The locality Belep, actually a group of islands, lies about 50 km north of the main island of New Caledonia.

Rhopalotococcus gen. nov.

Type species. Rhopalotococcus dugdalei sp. nov.

Description

Adult female elongate-oval, abdomen gently tapering to narrow posterior segments, anal lobes poorly developed or apex of abdomen rounded, derm membranous but sometimes nodulose or stippled on posterior segments. Apical setae flagellate. Antennae each with six or seven segments, segments narrowing towards apical segment. Legs well developed, without translucent pores. Claw slender, with a minute denticle near tip and with knobbed digitules longer than claw. Anal ring ventral, situated a short distance from apex of abdomen, semi-circular to transversely oval, without cells, with two to four setae. Suranal setae, when present, short and pointed. Frontal lobes absent. Dorsal setae slender, flagellate. Dorsal macroducts absent. Ventral macroducts present on abdomen and in medial area of thorax. Quinquelocular pores present on venter only, either next to spiracles only or also sparse on abdomen. Microducts present or absent. Cruciform pores absent.

Etymology

The name is based on the Greek word “Rhopalotos” meaning club-shaped, alluding to the shape of the body, combined with the generic word Coccus, and is masculine.
Comments

In lacking well-developed anal lobes but possessing legs and antennae either with six or seven segments, with macroducts and an anal ring that is semicircular to transversely oval, this genus could qualify as a member of the ovaticin group as defined by Miller and McKenzie (1967). The name of the group, at present without tribal or familial status, is based on characters of the genus *Ovaticoccus* Kloet. Most species of *Ovaticoccus*, as defined by Ferris (1955), Boratyński (1958), and Miller and McKenzie (1967), possess enlarged setae but in *O. californicus* McKenzie, a species with slender setae only, there are macroducts and quinquelocular pores on the dorsum, and cruciform pores are present. *O. senarius* McKenzie also lacks enlarged setae but macrotubular ducts are present on the dorsum, and the anal ring is circular. Although *O. amplicoxae* Williams and Martin (2003) was doubtfully included in *Ovaticoccus*, the abdomen tapers, the anal ring is cellular, the setae are all slender and flagellate, quinquelocular and cruciform pores are present on the dorsum and venter, and the enlarged hind coxae possess translucent pores. These characters would exclude the species from *Rhopalotococcus*.

Geographically, the nearest genus to *Rhopalotococcus* is the Australian genus *Phacelococcus* Miller, as revised by Gullan and Strong (1997). There are no enlarged setae in *Phacelococcus*, the anal lobes are not developed to any extent, and the posterior edge of the abdomen is rounded. Macrotubular ducts may be present or absent on the dorsum and macrotubular ducts are present. Other distinguishing characters of *Phacelococcus* are quinquelocular pores present either in dense clusters or densely scattered. Furthermore, the anal ring is circular or U-shaped and is cellular.

Although *Pseudochermes* Nitsche is a Palearctic genus, it is similar to *Rhopalotococcus* in the shape of the anal ring but the ring in *Pseudochermes* is cellular as shown by Williams (1985). There are a few enlarged setae present, quinquelocular pores and macrotubular ducts are present on both the dorsum and venter, microducts are present but cruciform pores are absent.

There are two genera, possibly Gondwanan in origin in South America, that are similar to *Rhopalotococcus*. *Tectococcus* Hempel, as discussed by Ferris (1958) and in a key to South American genera of Eriococcidae by Hodgson et al. (2004), has a similar shape to that of *Rhopalotococcus* but there are enlarged setae on the dorsum, and macrotubular ducts and quinquelocular pores are also present on the dorsum. The galls induced by the type species, *T. ovatus* Hempel, apparently, are similar in shape to those induced by species of *Rhopalotococcus*. Another genus, *Melzeria* Green, discussed recently by Miller and Williams (1998), possesses dorsal macrotubular ducts with associated setae at each orifice, there are translucent pores on the hind coxae and the anal ring is circular without cells.

It would be difficult to include the two new species discussed here in any of these genera or to expand the definitions of these genera to include the species, and the only course open is to include the new species in a new genus.

Hoy (1958) described *Capulinia orbiculata* Hoy on *Metrosideros orbiculata* and *M. umbellata* from New Zealand but in this eriococcid species, the antennae and anterior and middle pairs of legs are reduced to tubercles, and the hind legs are in the form of elongate processes showing signs of normal segmentation. Clearly this species is not congeneric with the two new species.

The second-instar female of one of the new species of *Rhopalotococcus* is described but the single first-instar nymph available is incomplete and is not satisfactory to illustrate.
Key to adult females of *Rhopalotococcus*

1  Hind legs with tibia + tarsus conspicuously longer than those of first and second legs. Antennae seven-segmented. Microducts absent. Anal ring with two setae only, suranal setae absent .......................... *metrosideri* sp. nov.

2  Hind legs with tibia + tarsus about same size as those of first and second legs. Antennae six-segmented. Microducts present. Anal ring with four setae, suranal setae present .......................... *dugdalei* sp. nov.

*Rhopalotococcus dugdalei* sp. nov.  
(Figures 3, 4)

**Description**

Inducing leaf galls, dome-shaped on upper surface, elongate-conical and truncate on lower surface. Some galls split on under-surface where crawlers possibly escape.

Body of adult female (Figure 3) on microscope slide, elongate to broadly oval, 0.86–1.25 mm long, 0.35–1.0 mm wide, widest at about mesothorax, membranous, abdomen tapering to rounded posterior end. Position of each anal lobe with a stout, flagellate apical seta 65–75 μm long. Antennae short, 60–110 μm long, six-segmented, becoming narrower distally, situated close together on anterior margin of head, each segment with only a few short flagellate setae except on terminal segment where longest seta about 35 μm long; fleshy setae on last two segments about 20 μm long. Legs well developed, slender, hind coxa 30–50 μm long, hind trochanter + femur 95–130 μm long, hind tibia + tarsus 95–125 μm long. Claw slender, about 20 μm long, with a minute denticle and a pair of knobbed digitules conspicuously longer than claw. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 0.95–1.00. Ratio of lengths of hind tibia to tarsus 0.72–1.00. Distal trochanteral seta about 50 μm long; hind coxa without translucent pores. Labium 45–60 μm long, shorter than clypeolabral shield. Anal ring ventral, situated well anterior to apex of abdomen, semicircular, sclerotized, joined anteriorly by a very thin rim, ring about 25 μm wide, 15 μm long, non-cellular, with two pairs of short setae, each about 5.0 μm long, and a pair of lateral setae, each about 15.0 μm long. Eyes 25–30 μm in diameter.

Dorsal surface with short, slender flagellate setae, mostly about 10 μm long, situated mainly across middle of segments. Extremely slender elongate microducts, each about 7.0 μm long, scattered on posterior abdominal segments, elsewhere sparse across segments.

Ventral surface with similar setae to those on dorsum, not numerous. Macroducts present, each about 12 μm long, 1.5 μm wide, sparse, occurring in groups of one to three on submargins of abdominal segments IV–VI, and one or two present medially on each segment of thorax. Microducts, same as on dorsum, a few scattered on anal lobe segment and a few present anteriorly around margins. Quinquelocular pores, each about 5.0 μm in diameter, present on abdomen in almost single rows medially across abdominal segments V and VI and submedially on abdominal segments II, III, and VII, one or two also present medially on abdominal segment VIII; others present in groups of two to four next to each spiracular opening.

Second-instar female (Figure 4)

Body on microscope slide, elongate oval, membranous, 0.75–0.85 mm long, 0.28–0.32 mm wide, widest at about mesothorax; abdomen narrowing posteriorly to rounded posterior
Figure 3. *Rhopalotococcus dugdalei* sp. nov., adult female.
Figure 4. *Rhopalotoccus dugdalei* sp. nov., second-instar female.
end. Position of each anal lobe with a flagellate apical seta about 65 μm long. Antennae situated on anterior head margin, 50–90 μm long, seven-segmented. Legs well developed, slender, hind coxa 30–45 μm long, hind trochanter + femur 70–90 μm long, hind tibia + tarsus 95–100 μm long. Claw slender, about 15 μm long, with a minute denticle near apex and a pair of knobbed digitules longer than claw. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.11–1.35. Ratio of lengths of hind tibia to hind tarsus 0.72–1.11. Distal trochanteral seta about 50 μm long. Labium about 50 μm long, shorter than clypeolabral shield. Anal ring ventral, situated a short distance from apex of abdomen, semicircular and sclerotized, 25 μm wide, 15 μm long, joined at anterior end by an extremely narrow rim; sclerotized area with four minute setae, each about 5.0 μm long, and two lateral setae each about 15.0 μm long.

Dorsal surface with flagellate setae, mostly 30–35 μm long, noticeably longer than in adult female, distributed across middle of segments in more or less single rows. Macrotubular ducts present of two sizes. A larger type with shallow cup, about 18.0 μm long, cup about 3.0 μm wide, present in rows of four to six across middle of abdominal segments II–VI, usually two present on abdominal segment VII, more numerous in rows on head and thorax. A smaller type of duct with deeper cup, about 10 μm long, cup about 2.0 μm wide, interspersed with larger type but less frequent. Microtubular ducts about 7.0 μm long, same as in adult female, represented by one or two at posterior end of abdomen.

Ventral surface with similar flagellate setae to those on dorsum. Macrotubular ducts present of two sizes. A small type, same as small type on dorsum, present in submedial clusters of four to six on abdominal segments V–VII. An intermediate size duct, larger than small ducts but smaller than large dorsal ducts, about 12 μm long, with orifice surrounded by thick hyaline rim about 3.0 μm in diameter, occurring singly on submargins of thorax and abdominal segments II–VI, a few also present in medial area of thorax. Microtubular ducts, same as on dorsum, sparsely distributed around margins of most abdominal segments. Quinquelocular pores, minute, about 3.50 μm in diameter, present next to spiracular openings, usually two or three present next to each mesothoracic spiracle and singly or in pairs next to metathoracic spiracles.

Material examined

Holotype: adult ♀, New Caledonia, Mt Koghis, inducing galls on leaves of *Metrosideros* sp., 5 October 1978 (coll. J. S. Dugdale), No. 13 (NZAC). Paratypes: New Caledonia, same data as holotype, 15 adult ♀♀, three second-instar ♀♀, one first-instar nymph (NZAC), 12 adult ♀♀, one second-instar ♂ (BMNH), one adult ♀ (USNM), one adult ♀ (IANC).

Etymology

The species is named after John S. Dugdale, who collected the species and sent other species from New Caledonia for study.

Comments

This species can be separated easily by the characters discussed in the key. All legs of the adult female of *R. dugdalei* are about the same size, whereas in *R. metrosideri* the hind legs are noticeably longer. The galls are unlike any of the galls induced by scale insects on *Metrosideros* discussed and illustrated from New Zealand by Henderson and Martin (2006).
They appear to resemble the galls induced by *Tectococcus ovatus* Hempel, a South American species found on the leaves of *Psidium* spp., another genus of Myrtaceae. Galls induced by *T. ovatus* are reported to be convex on one side of the leaf and acuminate on the other side (Gullan et al. 2005).

**Rhopalotococcus metrosideri** sp. nov.

(Figure 5)

**Description**

Appearance of leaf gall induced by this species resemble galls described under *R. dugdalei*.

Adult female on microscope slide, membranous, elongate-pyriform, 1.00–1.45 mm long, 0.50–0.70 mm wide, widest at about mesothorax, abdomen gently tapering to poorly developed anal lobes set close together. Each anal lobe membranous, with a stout flagellate seta 95–100 μm long. Antennae 180–200 μm long, seven-segmented, segments becoming narrower towards distal end, each segment with a few setae 25–60 μm long except on terminal segment where longest seta about 70 μm long; fleshy setae on segments 6 and 7 about 30 μm long. Legs well developed, hind legs conspicuously longer than first and second legs; hind coxa 60–70 μm long, hind trochanter + femur 170–190 μm long, hind tibia + tarsus, stout, 280–320 μm long. Claw slender, about 25 μm long, with a small denticle near apex and with a pair of knobbed digitules noticeably longer than claw. Ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.68–1.88. Ratio of lengths of hind tibia to tarsus 0.82–1.00. Distal trochanteral seta about 30 μm long. Hind coxa without translucent pores but with diagonal lines on anterior surface. Labium 70–80 μm long, with three segments, shorter than clypeolabral shield. Eyes about 30 μm in diameter. Anal ring ventral, situated a short distance from apex of abdomen, transversely oval, 30–35 μm wide, 15–20 μm long, heavily sclerotized with a narrow anterior rim, non-cellular, with only a pair of short setae 15–25 μm long.

Dorsal surface with flagellate setae only, 7.5–25.0 μm long, in more or less single transverse rows mainly across middle of segments; longest setae present on head and thorax.

Ventral surface with flagellate setae similar to those on dorsum. Macrotubular ducts about 12.5 μm long, 2.5 μm wide, with a hyaline oval rim about 5.0 μm wide, present usually singly and submedially on abdominal segments VI and VII, a little more numerous across medial areas of anterior abdominal segments and metathorax and in small groups of two to four present medially on prothorax and mesothorax. Quinquelocular pores, each about 5.0 μm in diameter, present in small groups of four or five closely associated anteriorly to each mesothoracic spiracle and in groups of two to five next to each metathoracic spiracle.

**Material examined**

Holotype: adult ♀, New Caledonia, Mt Koghis, inducing galls on leaves of *Metrosideros* sp., 5 October 1978 (coll. J. S. Dugdale), No. 13 (NZAC). Paratypes: New Caledonia, same data as holotype, two adult ♀♀ (NZAC), two adult ♀♀ (BMNH).

**Etymology**

The name is based on the name of the plant genus *Metrosideros* in the Latinized genitive, meaning of or from.
Figure 5. *Rhopalotococcus metrosideri* sp. nov., adult female.
Comments

The adult female of this species is easily distinguishable from that of *R. dugdalei* in having hind legs conspicuously longer than the first and second pairs of legs.

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