

The adult and immature stages of a new species in the genus *Paurocephala* (Homoptera: Psyllidae) from South Africa

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SYNOPSIS

The adult and immature stages of a new species of *Paurocephala* (Psyllidae) from South Africa, which is found on Cape chestnut trees (*Calodendrum capense*), are described, and the relationships of the species are discussed.

INTRODUCTION

THE Psyllid described here is an apparently monophagous species very numerous on the leaves of the Cape chestnut (*Calodendrum capense* (Rutaceae)), which is widely distributed in the eastern forested areas of South Africa extending as far north as Tanzania. This Psyllid is of interest, as the immature stages are parasitised by a wasp of the genus *Tetrastichus* that is morphologically very similar to *T. radiatus* Waterston, the encyrtid parasite of the South African Citrus Psylla *Trioza erythrae* (Del Guercio). With this relationship in mind, a study of the biology of both these psyllid species has been undertaken, and this paper is a preliminary to a detailed account of the biology of the Cape chestnut Psyllid.

Paurocephala calodendri sp. n.

Adult

Size (in mm.).—*Newly emerged females*: body length (excluding wing tips and antennae), 1.81–2.13, mean 1.99, standard error ± 0.04 ; body width (across thorax at level of fore wings), 0.63–0.75, mean 0.65 ± 0.02 ; based on 7 measurements. *Newly emerged males*: body length, 1.75–1.88, mean 1.77 ± 0.03 ; body width, 0.53–0.75, mean 0.60 ± 0.02 ; based on 8 measurements. *Mature females*: body length, 1.83–2.18, mean 2.00 ± 0.02 ; body width, 0.59–0.66, mean 0.62 ± 0.006 ; based on 20 measurements. *Mature males*: body length, 1.40–1.76, mean 1.63 ± 0.02 ; body width, 0.51–0.62, mean 0.56 ± 0.007 ; based on 25 measurements.

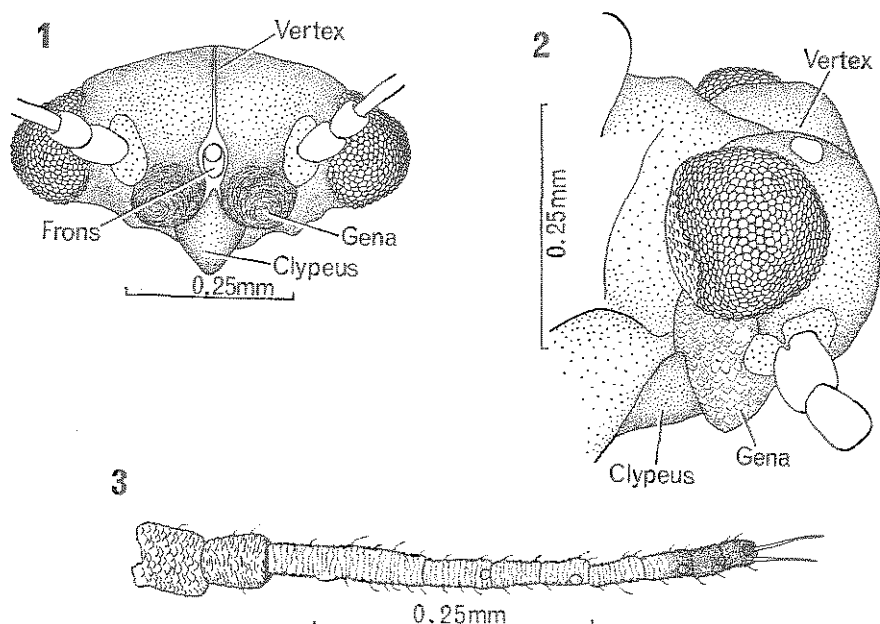
Coloration.—In this account the names and numbers of colours are taken from the Wilson Colour Chart (Wilson, 1939, 1942), and these colour choices are based on the assessment of 3 independent observers. The colours are included as an aid to identification, as in other geographical areas the colour of this species may differ. Coloration similar in males and females, but in both sexes varies considerably with age, newly emerged insects with a background colour predominantly green maturing to dull orange-buff. In mature specimens head overall orange-buff (No. 507/1) except for posterior regions of vertex, eyes and most of genae, which vary from Cyprus green (No. 59/3) to viridian green (No. 55/2). Compound eye facets black. Antennae usually with distal end of eighth segment and last 2 segments dark brown to black. Thoracic terga: pronotum orange-buff, semi-circular area on anterior part of meso-prescutum also orange-buff, remainder varying from Cyprus green to light pea green (No. 61/3); mesoscutum characterised by 2 conspicuous dark brown or black patches laterally abutting on suture between meso-prescutum and mesoscutum and by 2 similar dark brown patches posteriorly on the mesoscutum; these 4 dark brown patches on thorax very conspicuous in mature adults but pale at emergence. Rest of mesoscutum orange-buff except for lateral margins near axillary sclerites and for broad band on mid-line of mesoscutum which is Cyprus green to light pea green. Mesoscutellum viridian green to chrysocolla green (No. 56/2). Metascutum chrysocolla green to orange-buff. Metascutellum generally straw yellow (No. 604), meta-postnotum dark brown in mid-line, otherwise orange-buff. Legs very pale, varying from off white to extremely pale green or orange. Abdominal tergites Cyprus green to light pea green except for posterior margins which are straw yellow. First 2 abdominal terga sometimes dominated by dark brown or black. Abdominal sterna viridian green to Cyprus green.

Head (figs. 1, 2).—Head almost as wide as thorax and strongly deflexed. Vertex rounded forward and downward, lateral ocelli close to compound eyes. Vertex divided by clear epicranial suture. Frons distinct, located above genae at anterior end of epicranial suture and bearing median ocellus dorsally. Genae swollen and rounded but not produced into cones and not visible in dorsal view.

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Clypeus small, triangular and convexly rounded. Antennae (fig. 3) 10-segmented, length 0.605 mm.; all segments bearing short irregularly arranged setae, distal segment bearing 2 large apical setae. Sensoria or rhinaria present on antennal segments 4, 6, 8 and 9 with that on segment 4 indistinct.

Thorax.—Meso-præscutum and mesoscutum well developed and arched dorsally. Metascutellum not noticeably produced into a median horn-like epiphysis. Fore wings (fig. 4) transparent but with veins well defined and darkened distally. Base of *M+Cu* (cubital petiole) almost equal in length to base of *R*; *Rs* slightly convex and unbranched; nodal line (nodal cross vein) absent; bases of *R*₁, *Rs*, *M* and *Cu*₁ with ring-like thickenings, anal vein (*A*) thickened and bearing a row of square protuberances of doubtful function. Wing veins covered with small setae. Entire surface of wing covered with



FIGS. 1-3.—Head and antenna of *Paurocephala calodendri*: (1) anterior-ventral view of head; (2) lateral view of head; (3) antenna.

minute tubercles (spinules; Ossiannilsson, 1963*a, b*) which are larger and most evident in the pterostigmatic area. Hind wings (fig. 5) with only a few veins proximally; distal half of wing transparent. Costal vein with 9 wing-coupling hooklets. Wing surface completely covered with minute tubercles only easily visible using phase contrast illumination. Pro- and mesothoracic limbs very similar but fore leg (1.39 mm.) slightly longer than middle leg (1.35 mm.). Hind leg (fig. 6) longer (1.56 mm.) with enlarged coxa. Meraacanthus on metathoracic coxa not developed. Distal end of trochanter in all legs bears a row of 6 circular colourless areas of unknown function.

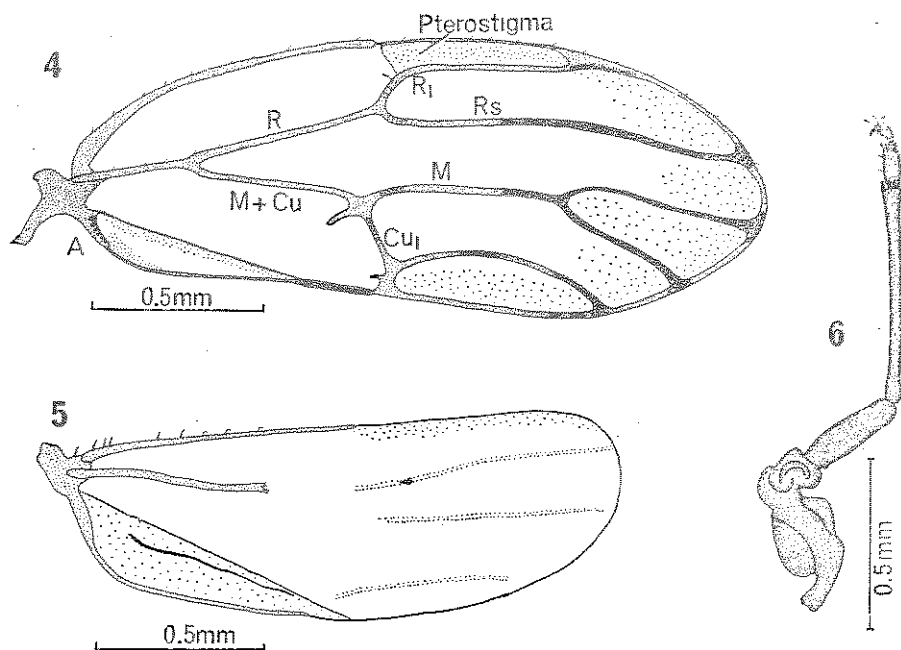
Abdomen.—Abdomen without special diagnostic features except for terminalia. **Female genitalia** (fig. 7) with proctiger and subgenital plate bearing long conspicuous setae; palps (dorsal valvulae; Muir, 1930) scored with lines radiating posteriorly from median anterior region; circumanal ring (fig. 8) on anterior half of proctiger, roughly oval in shape comprising an inner ring of rectangular pores bounded by minute circular pores; cuticle within circumanal ring thin and folded, bearing anus anteriorly. **Male genitalia** (fig. 9) with proctiger held vertically, anus at apex and bearing numerous setae, parameres (forceps and claspers) held parallel to proctiger bearing setae and a heavily sclerotised hook distally; aedeagus (fig. 10) normally geniculate, 2-segmented, largely folded within hypandrium, bearing papilla at distal end through which ejaculatory duct opens.

Immature stages

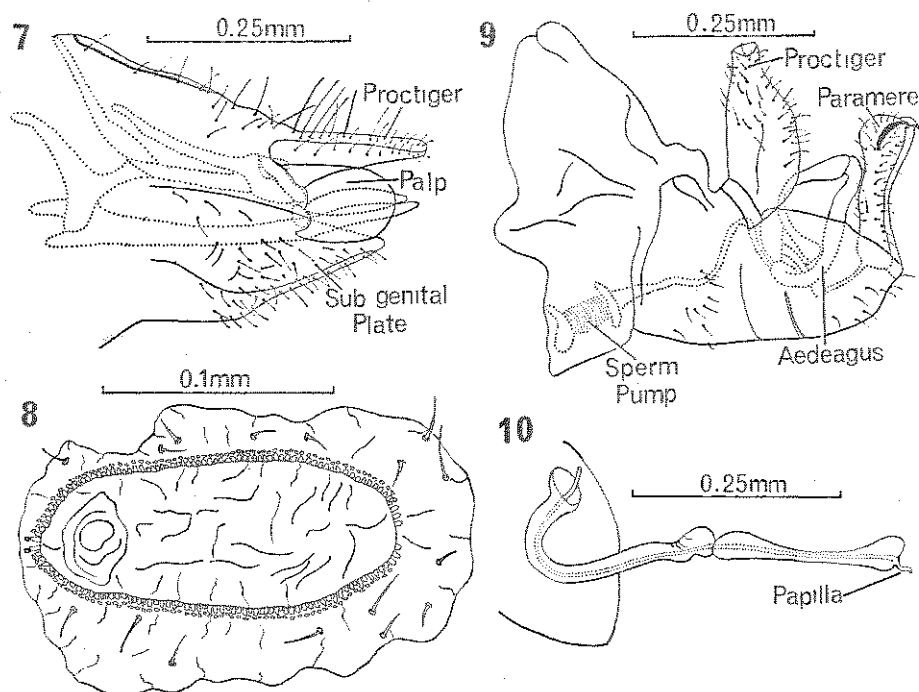
Egg (fig. 11).—Chorion smooth and almost transparent, revealing certain features of developing nymph, particularly eyes and area of mycetome. Conspicuous filament of variable length anteriorly, egg attached to host plant by posterior stalk or pedicel. Colour of egg variable depending on maturity, newly laid egg off-white to pale canary yellow (No. 2/3) ranging to dark lemon yellow (No. 4/2) on maturing. Length excluding anterior filament, 0.25 mm; width, 0.13 mm.

Nymphs

Descriptions except for comments on coloration based on specimens mounted in lactophenol



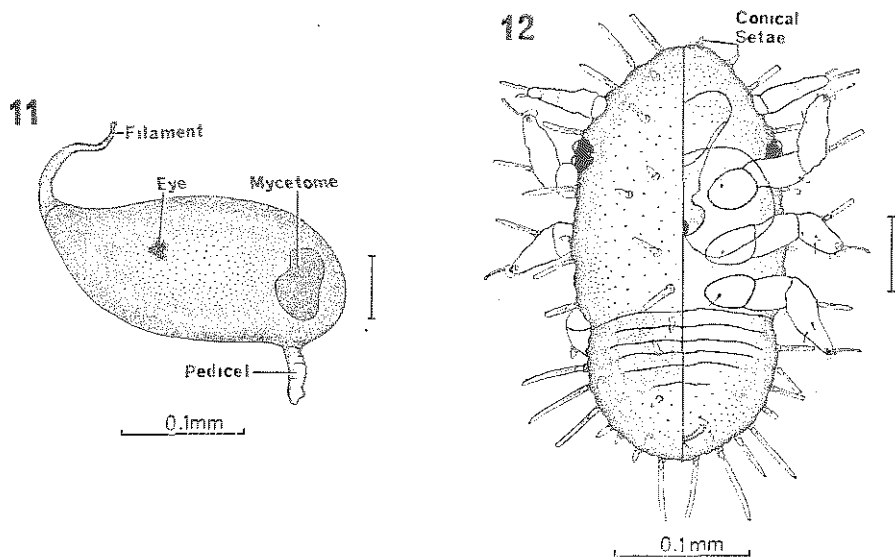
FIGS. 4-6.—Thoracic appendages of *Paurocephala calodendri*: (4) right fore wing; (5) right hind wing; (6) metathoracic leg.



FIGS. 7-10.—Genitalia and associated structures of *Paurocephala calodendri*: (7) lateral view of female terminalia; (8) dorsal view of circumanal ring in female; (9) lateral view of male terminalia; (10) extended aedeagus.

(Ossiannilsson, 1966). All instars extremely flattened dorsoventrally. Measurements in mm.

First instar nymph (fig. 12).—Length on emergence from egg (excluding setae), $0.25-0.33$, mean 0.29 ± 0.001 ; width at widest point, $0.13-0.19$, mean 0.16 ± 0.001 ; based on 93 measurements. Length at conclusion of instar, $0.28-0.34$, mean 0.32 ± 0.002 ; width, $0.16-0.21$, mean 0.18 ± 0.002 ; based on 57 measurements. Colour very pale straw yellow (No. 604/3), wing buds not developed, head and thorax not clearly demarcated. Body fringed with filaments arising from thick conspicuous conical setae, filaments often becoming detached. (Ossiannilsson (1965) has categorised the different spines in some psyllid nymphs, but the spines of *P. calodendri* do not readily fit this scheme.) Fourteen to sixteen conical setae spaced around periphery of abdomen. Number and arrangement of large conical setae on dorsum very variable, sometimes completely absent. Slender setae on ventral surface always in constant positions around circumanal ring and on coxae (fig. 12), but variable in other positions. Antennal segments not clearly defined. Legs with apical spines, pulvillus and 2 claws. Position of mycetome clearly visible through abdominal integument. Circumanal ring with 42 pores in outer ring.



FIGS. 11-12.—*Paurocephala calodendri*: (11) lateral view of egg; (12) first instar nymph, left half in dorsal view and right half in ventral view. Size comparisons of each stage are facilitated by the comparative scales (each $100 \times$ life size) drawn vertically and to the right of each figure.

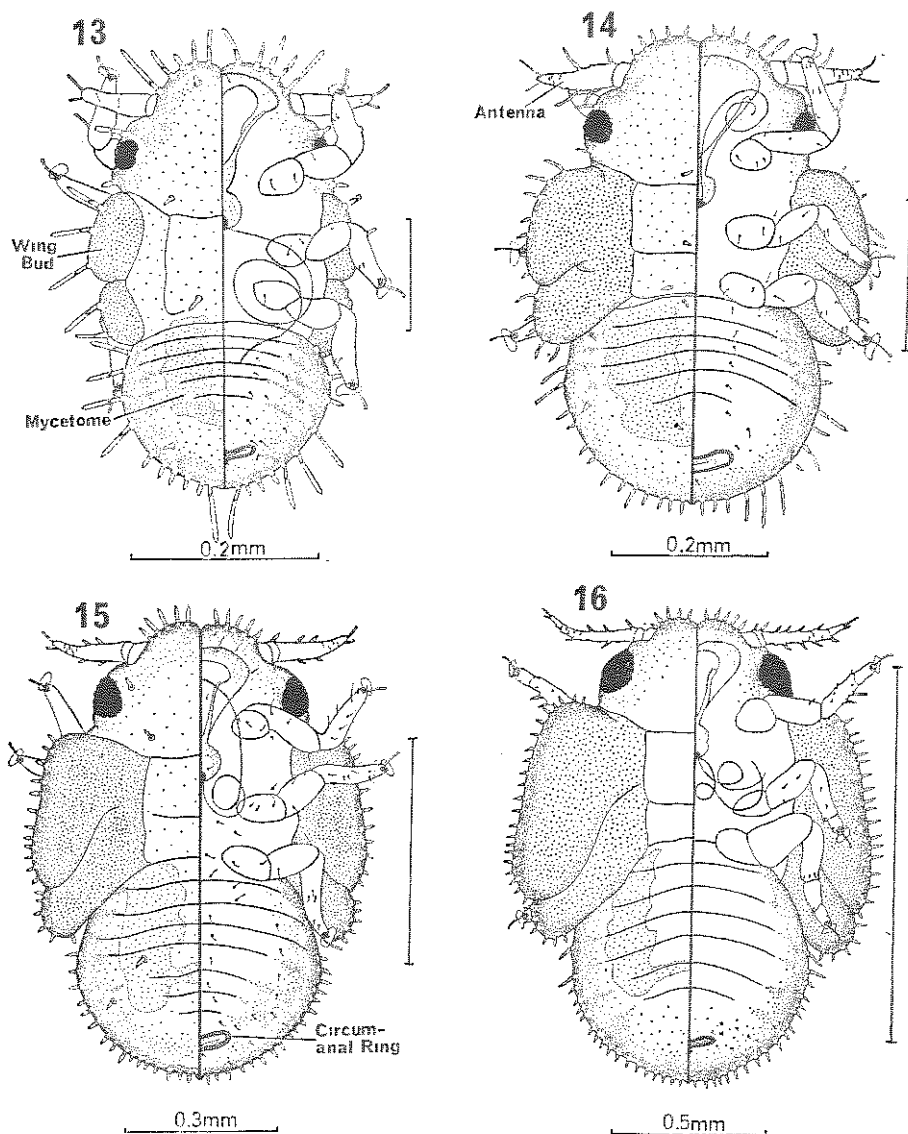
Second instar nymph (fig. 13).—Length at start of instar, $0.38-0.46$, mean 0.43 ± 0.002 ; width, $0.25-0.31$, mean 0.29 ± 0.002 ; based on 54 measurements. Length at conclusion of instar, $0.44-0.51$, mean 0.45 ± 0.002 ; width, $0.28-0.33$, mean 0.30 ± 0.002 ; based on 47 measurements. Colour variable, usually pale straw yellow (No. 604/3), mycetome approaching Naples yellow (No. 403/3), wing buds colourless with minute tubercles visible on surface. In living insect dark sclerotised areas visible dorsally on body. Twenty to twenty-two conical setae arranged around periphery of abdomen. Arrangement and number of conical setae on dorsum subject to individual variation. Ventral setae typically in positions indicated in figure 13. Circumanal ring with 56 pores in outer ring.

Third instar nymph (fig. 14).—Length at start of instar, $0.53-0.63$, mean 0.58 ± 0.004 ; width, $0.34-0.46$, mean 0.42 ± 0.004 ; based on 47 measurements. Length at end of instar, $0.56-0.69$, mean 0.63 ± 0.004 ; width, $0.38-0.51$, mean 0.44 ± 0.004 ; based on 37 measurements. Colour variable depending on age, from pale straw yellow (No. 604/3) to darker straw yellow (No. 604), yellow overlaid with dark sclerotised areas. Similar in appearance to second instar nymph except for slightly larger wing buds. Twenty-four to twenty-eight conical setae around periphery of abdomen. Conical setae on dorsum variable in number and arrangement, ventral setae usually in positions indicated in figure 14 but showing individual variation. Circumanal ring with 76-78 pores in outer ring, with inner ring of minute circular pores.

Fourth instar nymph (fig. 15).—Length at start of instar, $0.78-0.97$, mean 0.85 ± 0.007 ; width, $0.54-0.71$, mean 0.62 ± 0.007 ; based on 36 measurements. Length at conclusion of instar, $0.88-1.08$, mean 0.96 ± 0.01 ; width, $0.58-0.72$, mean 0.66 ± 0.006 ; based on 32 measurements. Colour variable, approaching dark straw yellow (No. 604) overlaid with dark sclerotised areas. Thirty-two to thirty-six conical setae spaced around periphery of abdomen, conical setae on dorsum variable in number and arrangement. Ventral slender setae less variable than in earlier instars and usually arranged as in

figure 15. Circumanal ring with 96-98 pores in outer ring, with clear inner ring of minute circular pores.

Fifth instar nymph (fig. 16).—Length at start of instar, 1.19-1.50, mean 1.32 ± 0.01 ; width, 0.91-1.13, mean 0.99 ± 0.01 ; based on 31 measurements. Length at end of instar just prior to adult emergence, 1.44-1.88, mean 1.63 ± 0.02 ; width, 1.00-1.19, mean 1.10 ± 0.01 ; based on 30 measurements. Female nymphs slightly larger than male nymphs. Colour variable, overall dorsal surface straw yellow (No. 604/2) to Naples yellow (No. 403/1) but much darker on wing buds and head. Overlaid by dark sclerotised areas of dark grey or lavender green (No. 000761/2). Ventrally, surface of abdomen very pale but approaching chartreuse green (No. 663/3), mycetome visible through integument, colour Naples yellow (No. 403/3). Eyes as in other instars dark red (Indian lake, No. 826). Thirty-eight to forty conical setae arranged around periphery of abdomen, conical setae normally absent on dorsum. Ventral setae sparse and variable in number and position, although those in immediate vicinity of circumanal ring always present and in constant position as in figure 16. Circumanal ring with



FIGS. 13-16.—*Paurocephala calodendri*: (13) second instar nymph; (14) third instar nymph; (15) fourth instar nymph; (16) fifth instar nymph. In each figure, left half in dorsal view and right half in ventral view. Size comparisons of the insects in each stage are facilitated by the comparative scales (each 100 × life size) drawn vertically and to the right of each figure.

138-140 pores in outer ring, with clear inner ring of minute circular pores. Adult structures visible through nymphal cuticle at conclusion of instar.

Holotype ♀, SOUTH AFRICA: Eastern Cape, Grahamstown, on *Calodendrum capense*, 24.i.1967 (V. C. Moran), deposited in Albany Museum, Grahamstown, South Africa. Slide preparation.

Paratypes, same data as holotype: 10 slide preparations plus 10 ♀, 10 ♂ in alcohol, in Albany Museum, Grahamstown, South Africa; 10 ♀, 10 ♂ paratypes to be deposited in British Museum (Nat. Hist.) and National Collection of Insects, Plant Protection Research Institute, Pretoria, South Africa. Specimens of nymphal material of all five instars to be deposited at the three institutions mentioned above.

DISCUSSION

The assignment of *P. calodendri* to the genus *Paurocephala* Crawford, 1913, is problematical, as this species has some features that seem alien to *Paurocephala* and others that would indicate a close affinity to *Camarotoscena* Haupt, 1935. The situation with regard to these two genera is confused, as Dobreanu & Manolache (1962) and Klimaszewski (1963) regard *Camarotoscena* as a subgenus of *Paurocephala*, whereas Heslop-Harrison (1952) and Vondráček (1963) regard it as a valid genus. Further, most authors consider the genus *Agonoscena* Enderlein, 1914, to be synonymous with *Paurocephala*, but Heslop-Harrison (1952) regards *Agonoscena* as a distinct genus, which he suggests is "not wholly distinct" from *Camarotoscena*. The distinctions between these closely related genera are not clear, and *Paurocephala* itself is not a clearly demarcated genus; this makes it necessary to discuss certain features of *P. calodendri* and indicate the relationship of this species to these genera.

The head of *P. calodendri* has most of the features of the genus *Paurocephala*. Crawford (1913), in his original description of *Paurocephala*, does not mention the genae specifically although he does say "lobes or cones wanting", which presumably refers to the genae. In a later paper (Crawford, 1914), the genae are used as diagnostic characters in keying out *Paurocephala*, and are mentioned as forming, together with frons and vertex, "a relatively smooth surface" on the head; in the same paper, however, the genae are described as "not conical, though often swollen". The genae in *P. calodendri* seem to fit the latter description, in that they are rounded and swollen, and it must be concluded, therefore, that this character allows inclusion of this species in the genus *Paurocephala*.

With regard to the thorax, Heslop-Harrison (1952) has emphasised the importance of the "horn-like metascutellar epiphysis" as a diagnostic character in "true representatives of the genus *Paurocephala*". This feature is also mentioned by Crawford (1913) in his original description of the genus. In *P. calodendri* the metascutellum is well developed but is only slightly swollen dorsally. In *P. gossypii* Russell, 1943 and *P. urenae* Russell, 1946, however, the metascutellar tubercle is apparently similar to that in *P. calodendri*, being small and rounded, and it would seem therefore that this is a variable character for the genus in its present sense. The legs are not useful in placing *P. calodendri*, although there are no subapical mesotibial combs of hairs, the absence of which, according to Eastop (1961), would indicate an affinity to *Paurocephala*. The fore wings in *P. calodendri* have a venation and texture typical of *Paurocephala*, and in this genus R_1 is divided with a distinct cell formed by R_{1a} and R_{1b} (Heslop-Harrison, 1952), which is true of *P. calodendri*. Haupt (1935) distinguishes between *Camarotoscena* and *Agonoscena* (synonymous with *Paurocephala*, according to most later authors), in that the former have the fore wings broadened apically and almost all the veins running parallel to the margin of the wing, whereas in the latter genus the fore wings are not broadened apically and the veins are not parallel to the margin. In *P. calodendri* the fore wings are broadened apically, but the wing veins are not as straight or parallel as in *Camarotoscena speciosa* (Flor), the wings of which are figured by

Dobreanu & Manolache (1962) and Haupt (1935). The venation of the fore wings in *P. calodendri* and *Camarotoscena* sp. Vondráček, 1963 appears very similar except for *Rs*, which is more convex in *P. calodendri*. This might indicate that the venation in *P. calodendri* is intermediate between that in *Camarotoscena* and *Paurocephala*. This similarity in wing venation, however, should probably be regarded as taxonomically superficial, as there are several other clear differences between *P. calodendri* and *Camarotoscena* sp. Heslop-Harrison (1952) regards the nodal line in the fore wings as of doubtful generic significance but points out that this line is best developed in *Camarotoscena*, less so in *Agonoscena* and only present in certain species of *Paurocephala* (listed by Heslop-Harrison, 1951). The nodal line is absent in *P. calodendri*, and this may be regarded as another point of similarity with *Paurocephala*.

The abdomen of *P. calodendri* provides few clues as to the systematic position of this species. The genitalia and aedeagus of the male and the genitalia and circumanal ring of the female show a superficial similarity to the structures in *Camarotoscena speciosa* as figured by Dobreanu & Manolache (1962), but the significance of this is uncertain.

P. calodendri has numerous features in common with *Paurocephala*, which allow its inclusion in this genus, although it retains strong affinities to the genus *Camarotoscena*. There is little doubt, however, that the genus *Paurocephala* and its closely related genera are in need of revision.

I am very grateful to Professor L. D. Tuthill (University of Hawaii, Honolulu, Hawaii) and to Miss L. M. Russell (Entomological Research Division, United States Department of Agriculture, Washington, D.C.) for their comments on specimens of *P. calodendri* which they have examined. Their conclusions about this species were communicated to me through Mr. A. L. Capener (Plant Protection Research Institute, Pretoria, South Africa), and both are agreed that the specimens of *P. calodendri* in their possession show affinities to *Paurocephala* and to *Camarotoscena*.

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