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Revision Of The Ant Genus Procryptocerus (hymenoptera: Formicidae: Myrmicinae: Cephalotini)

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REVISION OF THE ANT GENUS *PROCryptocerus* (HYMENOPTERA: FORMICIDAE:
MYRMICINAE: CEPHALOTINI)

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by

Francisco Javier Serna-Cardona

2009

Dedication

To my parents Marco Antonio and Martha Inés. An amazing couple.

REVISION OF THE ANT GENUS *PROCRYPTOCERUS* (HYMENOPTERA: FORMICIDAE:
MYRMICINAE: CEPHALOTINI)

by

FRANCISCO JAVIER SERNA-CARDONA, I.A., M.Sc.

DISSERTATION

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Chapter 1

A DESCRIPTIVE MORPHOLOGY OF THE ANT GENUS *PROCRIPTOCERUS* (HYMENOPTERA: FORMICIDAE).

Abstract.

Morphology is the most direct approach biologists have to recognize uniqueness of insect species as compared to close relatives. Ants of the genus *Procriptocerus* (Hymenoptera: Formicidae) possess important morphologic characters that have not been explored for use in a taxonomic revision. The genus is characterized by the protrusion of the clypeus forming a broad nasus and antennal scrobes over the eyes. The toruli are located directly posterior to the flanks of the nasus opposite to each other. The vertex is deflexed in most species. I present an in-group comparison of the external morphology focusing on the workers. I also present a general morphology for gynes and males. I analyze previously mentioned characters as well as new ones, and clarify their character states in different species. For the metasoma I propose a new system of ant metasomal somite nomenclature applicable to Aculeata in general. Finally, a glossary of morphological terms is offered for the genus. Most of the terminology can be used in other members of the Formicidae and Aculeata.

Key words: Hymenoptera, Aculeata, Formicidae, external anatomy, Taxonomy, Cephalotini, qualitative characters.

Introduction.

The genera *Procryptocerus* and *Cephalotes* comprise the tribe Cephalotini (de Andrade and Baroni-Urbani 1999. Emery (1922) demonstrated that the tribe possesses the synapomorphic anatomical trait of mushroomhead-shaped proventricular valves (Kempf 1951) (Fig. 1). This observation is supported by the studies of de Andrade and Baroni Urbani (1999). *Procryptocerus* was created by Emery (1887) to include species of Neotropical ants that were considered similar to those of the Paleotropical genus *Cataulacus* of the tribe Catalaucini (Kempf 1951). *Procryptocerus* is a lineage composed of about 80 species inhabiting rainforests from the Isthmus of Tehuantepec in Mexico to northern Argentina. Due to their cryptic habits, living inside twigs, these ants are rarely collected (Mackay and Vinson 1989). At present, most species are known from Central America, Colombia and Brazil.

Procryptocerus has been the object of two revisionary studies. Kempf (1951) revised the entire genus and Longino and Snelling (2002) the Central American species. Kempf (1951) recognized 23 species, 13 subspecies and 7 varieties, while for Central America Longino and Snelling (2002) recognized 14 species, described four new species, synonymized two species, and elevated two subspecies to species level. Currently, 56 nominal taxa are included in the genus (Bolton et al. 2006).

Procryptocerus ants possess notoriously variable morphology. Different characters, such as propodeal spine length, form of the clypeus, type of sculpture, and other such characters vary remarkably, sometimes even within the same species. We propose a diagnostic morphology of the genus to be used as a template for a revisionary study of the entire group following the recommendations suggested by Bolton (2007): "... [not] make an unwarranted assumption that previous authors have already investigated all the useful characters..."; "Initial dependence on previous publications has a strong tendency to restrict the scope of a new investigation..."; "... develop a personal insight into [the] morphology and variation that is not unduly influenced by what has previously been published." Knowledge of morphology and anatomy is incomplete for all species. New characters must be discovered, and old characters tested. Morphological descriptions are thus essential components of our understanding of species and their diversification (Wheeler 2008, Bert Hölldobler, pers. communication).

This approach is divided into two sections. In the first part, I present a diagnosis that expands previous morphological diagnoses of the genus provided by Kempf (1951) and Longino and Snelling (2002). Additional observations, current morphological terminology, and figures are part of this new diagnosis. I additionally propose unification of the terminology within ants with other Apocrita regarding the specialized system used to name the metasomal somites (abdominal (Abd) somites II to pygidium) (see Discussion).

In the second part, a selected glossary is offered containing terminology appropriate for *Procryptocerus*. The provided terminology might also be used for descriptions as well as

identification keys of other taxa of ants. Working on the study of morphology and the associated terminology is a constant necessity in order to unify criteria for the basic descriptive work in taxonomy and comparative biology.

Materials and Methods.

Worker, gyne and male specimens of *Procryptocerus scabriusculus* from CWEM (William and Emma Mackay Collection, El Paso, Texas, USA) were drawn at 60X power with a Wild Heerbrugg microscope using a grid and a micrometer. Some structures were cleared in potassium hydroxide (10%) for 36 hours. To analyze the metasomal sclerites, the method in Bolton (1994) was followed. To show differences in sculpturing, structures of different species were also drawn. A diagnosis of males is modified from Kempf (1951). Since few males are available for study, this morphological diagnosis emphasizes females and is concentrated in qualitative characters. Common positions of structures and orientations for specific views are shown in Fig. 2. Terminology used for positions and orientations is described in the Discussion section. For the study of exoskeletal morphology, the main literature resources were Snodgrass (1935), Bohart and Menke (1976), Gauld and Bolton (1988), Bolton (1994), and Ward and Downie (2005). Sculptural terminology is from Sparks (1941), Harris (1979), Nichols (1989), Brown (1979) and Hölldobler and Wilson (1990). Vestitural terminology is from Sparks (1941), Hölldobler and Wilson (1990), and Ward (2004). Although *Procryptocerus* ants are mostly black, variation in color is included to help distinguish some forms. Specific terminology is selected from different publications used for descriptions of ants and other Apocritans:

Snodgrass (1935), Gauld and Bolton (1988), Nichols (1989), Gordh and Headrick (2000), Hölldobler and Wilson (1990), Mackay (1991, 1993), Bolton (1990, 1994, 2003), Agosti et al. (2000), Longino and Snelling (2002), Mackay and Mackay (2003, 2006), Triplehorn and Johnson (2005), Wilson (2003) and Ward (1999, 2004).

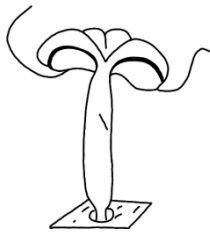


Figure 1. Mushroom-shaped proventricular valves found in the tribe Cephalotini (Redrawn from Emery 1922).

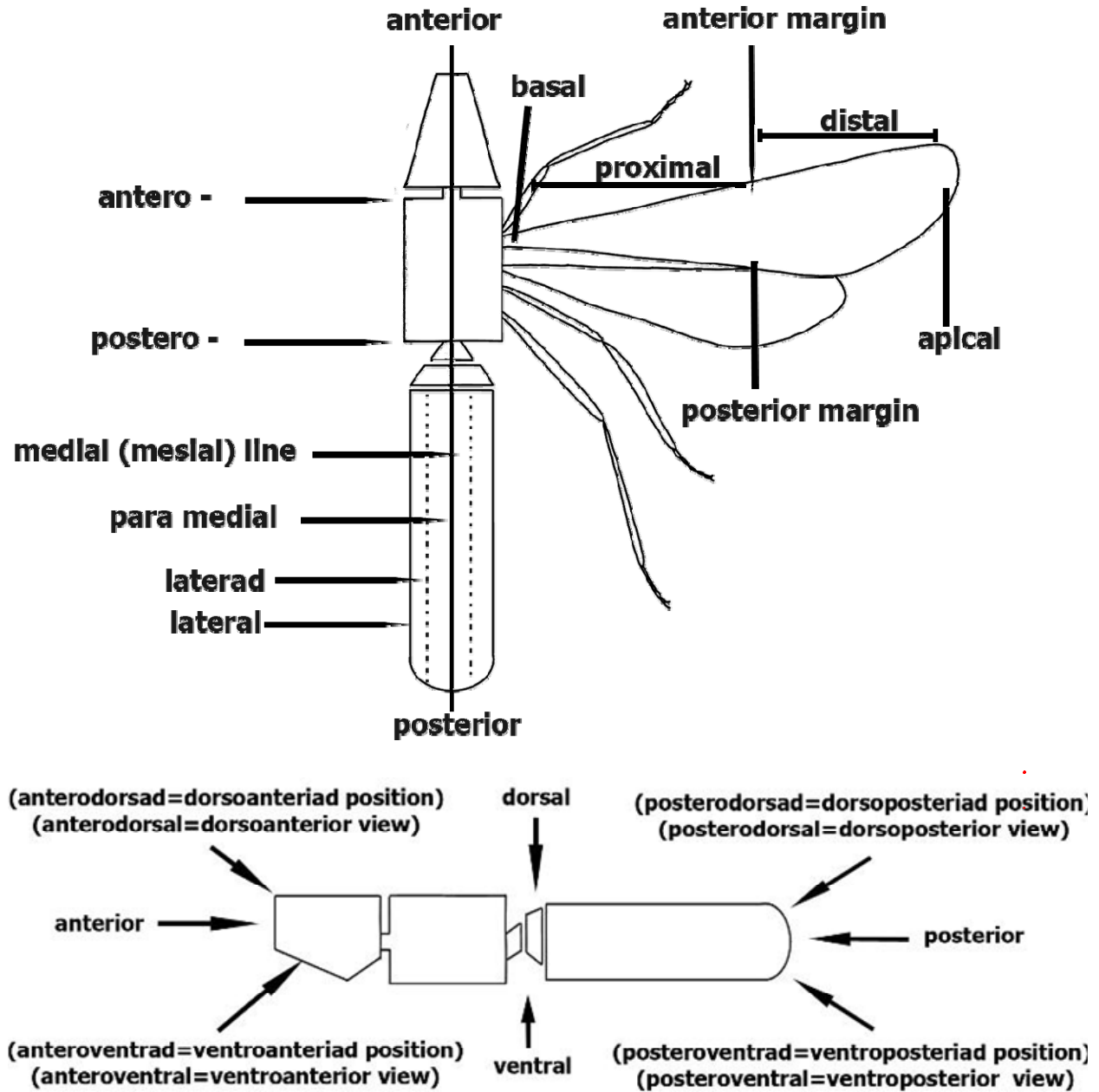


Figure 2. Dorsal (upper), and lateral (lower) representation of an hypothetical insect showing common positions and orientations used to describe bilateral organisms.

Terminology indicated within parentheses and quotation marks, e.g. (“girdling constriction”) has been avoided. Words within brackets and *italized*, e.g. [*mayri*] are examples of species

possessing the specific character state pointed out; accordingly, this bracket use does not indicate that the defined character state is restricted to the examples given. No examples are given when the character state explained is fairly common. Numbers within brackets following the capital letters FS_, [FS_01], [FS_02], [FS_03], etc., indicate species level taxa in the process of being described. When we use hyphenated sculptural states, i.e. “foveate-costate”, both forms of sculpture are present as intraspecific variation. In the discussion section sculptural terminology is organized as interpreting the form of sculpturing from the smallest to the largest.

Results.

Workers and gynes.

Diagnosis.

Frontal carinae posteriorly divergent; malar space not covered dorsally by frontal carinae; clypeus protruded developed into a broad nasus lying between toruli; antennal scrobes impressed laterally above eyes, limited by frontal carinae dorsally (Figs. 3, 4), extending from nasus to vertex; vertex deflexed (truncate) in most species; toruli located in lateral panels of nasus opposite to each other; Abd V postergite visible from above. Adult coloration mostly black, body variously sculptured; workers monomorphic, ranging from 3.5-8.5 mm (Kempf 1951), gynes from 3.7 mm [*schmitti*] to 9.5 [*mayri* part].

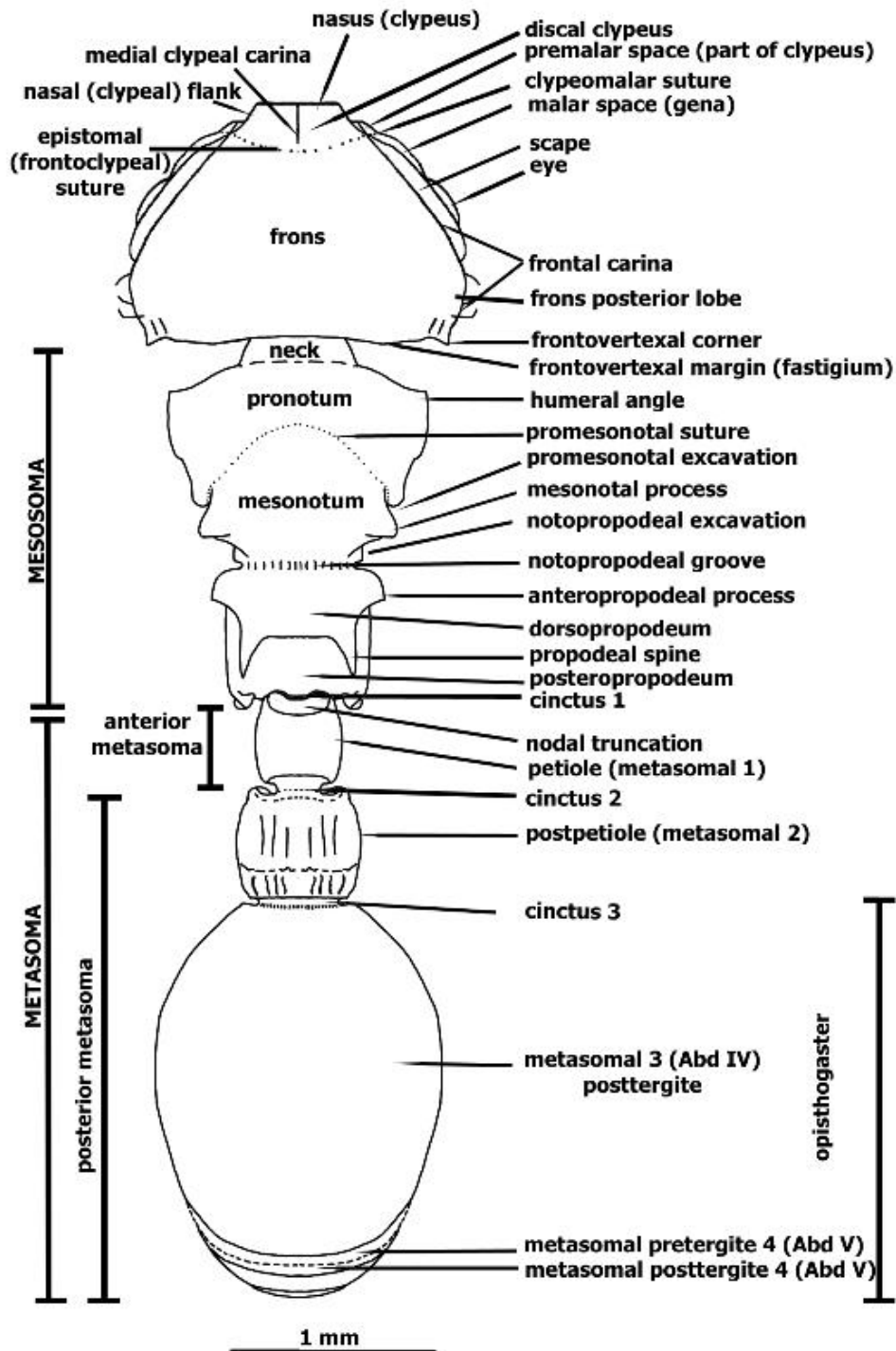


Fig. 3. *Procryptocerus scabriusculus*. Dorsal view.

Head (Figs. 3, 4, 5, 8, 9).

Prognathous, usually in anteroventrad position in preserved specimens (Fig. 9); prognathism formed by combination of hypostomal, genal and postgenal bridges. In full frons (“full face”) view, subtrapezoidal, broadened posteriorly (Fig. 4), circular [*nalini*] (Fig. 23), subcircular [*regularis*, *pictipes*] or subquadrate [*belti* (Fig. 20), FS_02]; in lateral view, more often elliptic; mandibles, anteclypeal carina and clypeus anteriorly positioned; frontoclypeus (“face”) anterodorsally extended, comprising epistoma (anteclypeus, plus clypeus) and frons; frons dorsal; vertex posterior, opposite to nasus, often orthogonal to frons (deflexed); in dorsal (full frons) view, frontoclypeal (epistomal) suture and frontovertexal margin located in nearly same plane; malar space (Gauld and Bolton 1988) extended dorsolaterally, laterad to antennal scrobe and anterior to eye (Figs. 3, 4, 9); hypostomal bridge and genal bridge ventral (Fig. 7), opposite to frons, occiput and occipital foramen posteroventrad, postgenal bridge ventroposteriad, posterior to genal bridge, with the two areas meeting in a curve or an angle behind eye; anteclypeal carina (Fig. 4) indistinct, emarginate, or bilobate; clypeus differentiated into discal (central) and truncate strikingly orthogonal lateral nasal flanks toward toruli (Figs. 3, 4, 9) [*eladio*, *pictipes*, *goeldii*, *marginatus*], or trapezoidal, not orthogonally flanked, being wider on lower lateral area toward malar space and forming invaginated antennal fovea (Fig. 24) [*batesi*]; frontoclypeal (epistomal) suture obsolete between toruli, turning down laterad between nasal flank (located anteriorly) and torulus (located posteriorly); epistomal suture lateral between clypeus and torulus, not grooved [*paleatus*], faintly grooved [*mayri*], or variably grooved and forming clypeo-torular sulcus [*carbonarius*, some *rudis*] (Figs. 9, 24), continuing downward to pleurostoma, anterior to malar space, sometimes indistinct and forming vanishing clypeomalar (clypeogenal) suture (Figs. 3, 4) separating narrow premalar space from malar space; anterior

tentorial pit located into clypeomalar suture, anterior to lateral fovea (Gordh and Headrick 2000); nasal flanks anterior to toruli; discal clypeus protruded into broad, nasus (Figs. 3, 4, 9) in approaching frons; nasus describing in profile short anterodorsal curve at toruli level; lateral fovea beneath torulus (not visible in dorsal view) and posterior to clypeomalar suture, marking antennal scrobe at most anterior point and receiving lamella of scape shaft base; facial fovea (malar depression), when present [*mayri*, *batesi*, *carbonarius*, *rudis*] (Fig. 24) encircling part of clypeogenal suture, and often part of antennal fovea (Nichols 1989); malar tumulus (Fig. 24) anteriad to eye and limiting facial fovea laterally [*batesi*, *rudis*]; frons anteriorly delimited by faint frontoclypeal (epistomal) suture or faint frontal triangle (Fig. 4), laterally by frontal carinae, posteriorly by frontovertexal margin; frontal carinae diverging from clypeus to vertex, straight, uni or bilobate [*mayri*, *batesi*] (dorsal view) into frontal lobe and frons posterior lobe, posterior lobe deflexed posteriad in some species forming an angulate scrobe [*rudis*] (Fig. 24); frontal lobe indistinct (not flanged) (Figs. 3, 4, 9, 17-19, 23, 29) [*scabriusculus*, *hylaeus*, brazilian species] or distinct [*rudis*, *mayri*, *batesi*] (Figs. 20-22, 24); antennal scrobe lateral, under frontal carina, not visible in full frons view, formed of long, deep, wide lateromesial invagination (groove), extended anteroposteriorly, starting at lateral fovea, passing over eye, and terminating in notch on vertex at frontovertexal corner level (Figs. 9, 24), dorsally delimited by frontal carina and ventrally by dorsal ocular suture or anteocular costula; eye lateral, infra antennal scrobe (head in profile), slightly posteriad, or intermediate between torulus and vertexal margin; eye globular [*convergens*, *rudis*], flat [FS_03], rounded not-protruded [*marginatus*], ellipsoid [*scabriusculus*, *kempfi*], dorsally depressed [*adlerzi*, *sampaioi*]; vertex deflexed, often delimited anteriorly from frons by transverse frontovertexal margin, posteriorly by occipital carina, and laterally by posterior notches of antennal scrobes [*batesi*, *rudis*, *mayri*, *virgatus*]; frontovertexal margin

distinct throughout forming fastigium (Figs. 3, 4, 9, 14, 15, 16-19, 25, 27, 29) [*impressus*, *paleatus*, *regularis*, *adlerzi*, *scabriusculus*], indistinct throughout [*coriarius*, *schmitti*] (Fig. 23), medially indistinct and laterally distinct [*mayri*, *clathratus*] (Figs. 20-22), or frontovertexal margin outline (frontal or posterior view) straight [*eladio*, *kempfi*, *subpilosus*], slightly medially notched [*scabriusculus* in part, *convergens*] (Figs. 4, 19), crenate [*clathratus*, *impressus*, *marginatus*, *spiniperdus*] (Fig. 18), crenulate [*paleatus*], convex [*coriarius*, *nalini*] (Fig. 23), slightly convex-crenulate [*paleatus*], biconvex [*adlerzi*] or flanged-biconvex [*adlerzi*] (Fig. 27); frontovertexal corner with (Figs. 3, 4, 9, 16, 17, 20, 22, 27) or without [*coriarius*, *nalini*] (Fig. 18) angulate processes; vertex concave [*clathratus*, *marginatus*, *paleatus*, *impressus*, *spiniperdus*], flat [*scabriusculus*, *lepidus*, *balzani*] or slightly convex [*coriarius*]; hypostomal tooth lobose. Mandible (Figs. 5-7) subrectangular, possessing scrobe ventrally and trulleum dorsally, massive, medially turned; inferior margin (lateral view, mandible closed) ventrad [generally species at low elevations], anteroventrad [most Andean species over 600 m]; apical (“dentical”) margin medially directed, possessing major distinct, infra, apicolateral (“apical”) tooth; preapicolateral tooth (tooth number 2) half size of apicolateral; tooth number 3 [obsolete in *pictipes*, *mayri*] half size of number 2 [FS_01]; tooth 4 obsolete or absent; supra, apicomesial (“basal”) angle acute. Maxillar-labial palp formulae 4-3 [FS_01, *carbonarius*] (Fig. 8), 6-3 (Kempf 1951); palpifer almost half size of first palpomere; first and second palpomeres same size, apical (fourth) longest. Antenna 11-segmented; scape comprises short, basal radicle and long, distad shaft; radicle divided into condylar bulb (Bolton 1994) (Figs. 4, 14) (inserted into torulus) and condylar constriction (“neck”), which functionally fits into posterior notch of torulus during anteroposterior movement of scape; condylar bulb anteriorly visible [*attenuatus*, *victoris*, *seabrai*, FS_03] or relatively concealed by torulus [*carbonarius*]; scape stalk truncate basally

[*attenuatus*], often proximally terete (narrow), wide [*attenuatus*, *nalini*], or slightly tapered [*scabriusculus*, *convergens*], basally uni or bilamellate (broad, thin, flanged carina) overlapping condylar constriction [*rudis*], or ecarinate [*schmitti*]; scape lateral axis (lateral stalk) not completely covered by frontal carina when accommodated into antennal scrobe; scape shorter than scrobe length, terminating between eye and vertex; funiculus 10-segmented, second funicular segment shorter than first or third, three distal segments compose club, apical segment subconical.

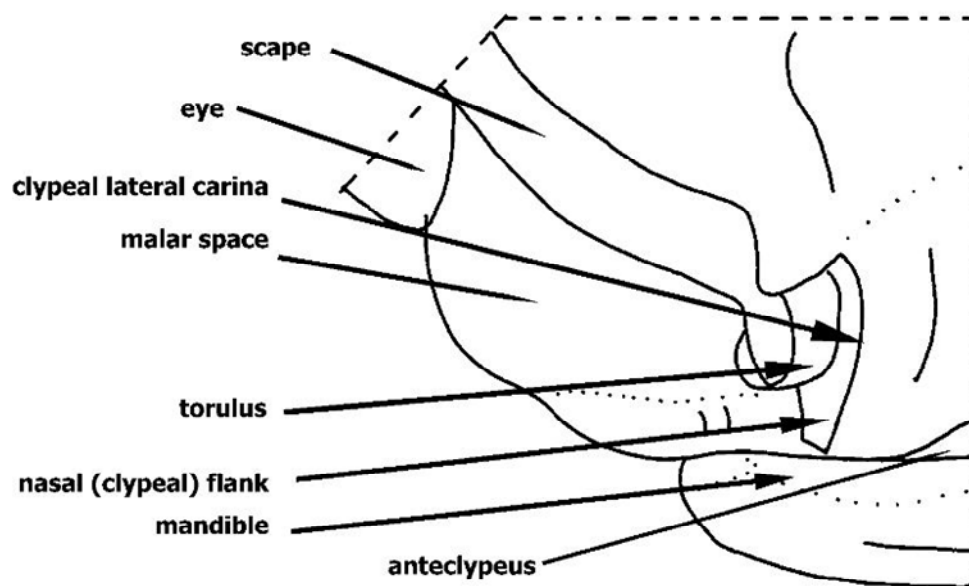
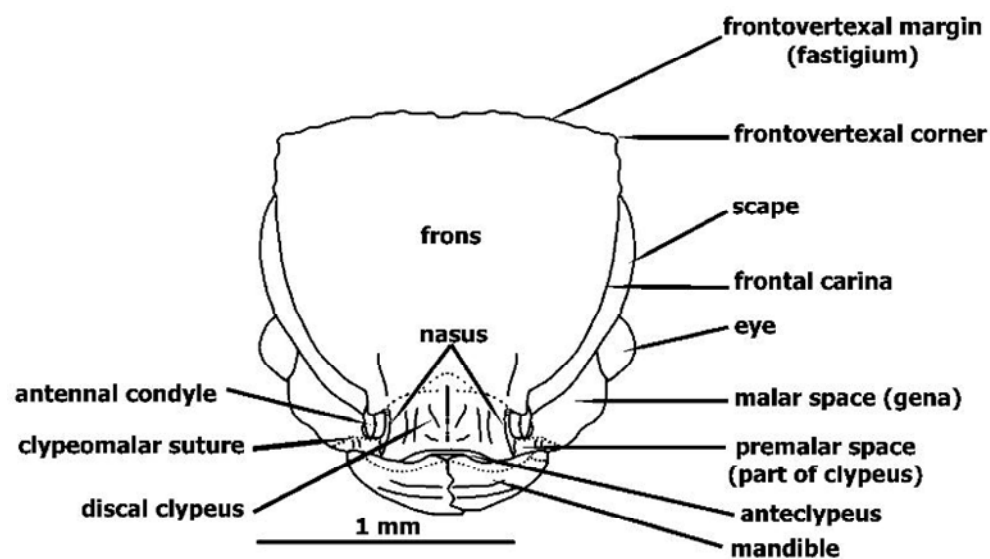


Fig. 4. *Procryptocerus scabriusculus*. Worker. Head, dorsoanterior (frontal) view. Above: face. Lower: half side of face zoomed (part) to show morphological details.

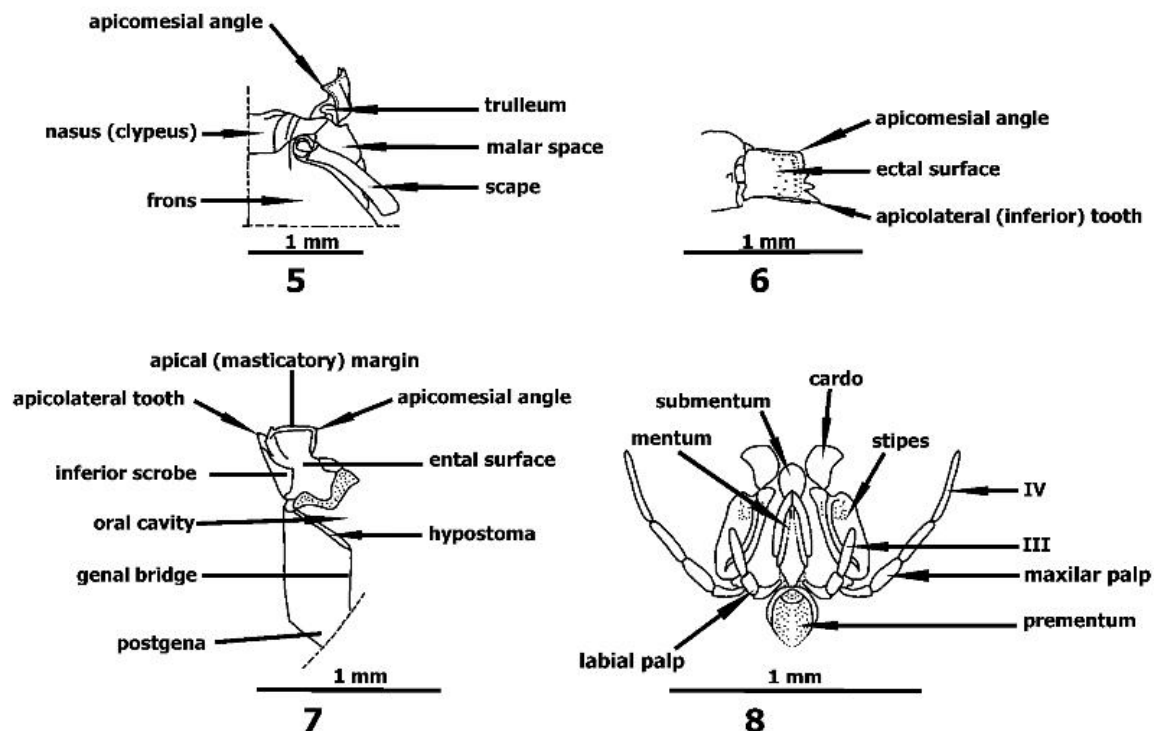


Fig. 5-8. *Procryptocerus scabriusculus*. Worker. Buccal pieces. **5-7** right mandible: **5**: dorsal, **6**: lateral, and **7**: mesial views; **8**: posterior view of maxilolabial complex.

Mesosoma (Figs. 3, 9-11, 26-30).

Subcubic, trunk-shaped, dorsally convex or flat. Tergal, pleural (meso and meta) and propodeal sclerites fused into notosternal-propodeal capsule. Pleura subparallel or mesially inflected between meso and metapleura. Pronotum hood-shaped, covering more than 1/3 of dorsal and lateral areas of mesosoma, forming dorsopronotum and lateropronotum (= pronotal side panel - Gauld and Bolton 1988) (Fig. 9); dorsal profile from markedly convex [*gibbosus*] to horizontal

(dorsally flat) [*paleatus*, *impressus*]; dorsopronotum and lateropronotum divided by pronotum dorsolateral margin (Fig. 9); lateropronotum subtriangular with vertex at level of procoxal base, sometimes forming inferior lamella (inferior pronotal process - Fig. 10) flanking procoxa basally [Andean species], both structures (inferior pronotal process and procoxa base) probably forming stridulum; lateropronotum overlapping propleuron in most species (Fig. 9) and forming pronotal lobe posteriorly (Fig. 9), lateropronotum mesially inflected conforming humeral angle anteriorly (Fig. 3) and humerus (elongate, narrow anterior area connecting with neck dorsally); humeral inflection forming lateral carina limiting humerus and lateropronotum (wide lateral panel); lateropronotum flat discally (Fig. 9) or slightly inflected (Figs. 29, 30) receiving disciform profemur [*impressus*], both structures probably forming stridulating organ; ventro-propleurites separated by ventro medial suture (Fig. 11), sometimes apparently fused; ventropropleurite and humerus forming protruded or flat area coupling postgenal bridge when head deflexed downwards; prosternum between procoxae, posteriad to ventropropleurites; mesonotum flat [*pictipes*] or convex [*sampaioi*], laterally fused to anepisternum (Figs. 9, 10), anteriorly delimited by vestigial promesonotal suture (Figs. 3, 9, 26, 27), extending posteriad until meeting notopropodeal fusion, usually possessing lobose or spiniform lateral process (mesonotal process) (Figs. 3, 9, 27); promesonotum possessing lateral excavations between pronotal lobe and mesonotal process; lateropronotum and mesopleuron separated by opened, narrow, nearly straight or sinuate lateropronotal-mesopleural suture continuing dorsally, forming promesonotal excavation between pronotal lobe and mesonotal process, connected to promesonotal suture (Fig. 3); anapleural sulcus (“anterior oblique sulcus”) (Fig. 19) down promesonotal excavation, dividing smaller anepisternum supra and larger katapisternum infra (Figs. 9, 10); katapisternum extended lateroventrally, ventrally forming epicnemium (Gauld and Bolton 1988) separating pro

and mesocoxae; epicnemial carina (“omalus” sensu Bohart and Menke 1976) (Figs. 10, 12) and epicnemium forming shallow-concave surface receiving procoxa posterior face; epicnemial carina projected anteriorly into distinct laminate, variable shaped, subcircular [most Andean species], truncate, square [*adlerzi*, *regularis*], or falcate [*victoris*] epicnemial process (Figs. 10, 12, 30) flanking procoxae externally, both structures probably forming stridulating organ; notopropodeal fusion often marked by groove and lateral excavations [*spiniperdus*, *eladio*, *adlerzi*] (Fig. 3) or lateral excavations only [*sampaioi*]; mesopleuron usually inflected (mesosoma constricted) receiving femora downward notopropodeal excavation; metapleural gland scrobe (Figs. 10, 12) superior to metacoxa, extending posteroanteriorly from metapleural gland bulla (Figs. 10, 12) to mesopleural-coxal excavation (mesopleural coxal process - Snodgrass 1935- inflected into excavation) (Fig. 10); metapleural gland scrobe canalicular, channel delimited superiorly and inferiorly by two longitudinal carinae, inferior carinula flanking metapleural gland slit ventrally; metapleural gland extending dorsoposteriorly, turning downward ventroanteriorly forming metapleural gland slit (Fig. 12); slit very narrow, bicarinulate, running ventrally posteroanteriorly from metapleural bulla to mesopleural-coxal excavation; propodeum (first abdominal (Abd I) tergite) divided into anteropropodeum and posteropropodeum, first subdivided into dorsal (dorsopropodeum) and lateral (lateropropodeum) areas (Figs. 9, 10); lateropropodeum including spiracle, posteropropodeum (declivitous face) (Figs. 9, 10) under propodeal spines terminating at posteropropodeal lobes (propodeal lobes) (Fig. 12); dorsopropodeum usually horizontal in profile [FS_01, *scabriusculus*] to convex [*hylaesus*, *sampaioi*], same plane as mesonotum [*pictipes*, *lenkoi*, *sampaioi*] or lower than mesonotum [*clathratus*], expanded anterolaterally into somewhat anteropropodeal process (Fig. 3); propodeal spines (Fig. 3) horizontal and parallel [*kempfi*], divergent and upturned [*rudis*],

parallel upturned [*clathratus*], parallel upturned-curved [*eladio*], parallel down-turned [*scabriusculus* part] (Fig. 9), or different sizes within same population [*scabriusculus* part]; propodeal spiracle tubulose, downward on lateropropodeum between anteropropodeal process and propodeal spine base, commonly directed posteriorly, often accommodated into lateropropodeal excavation, internal margin generally fused to excavation, lateral margin usually free; posteropropodeum sometimes forming continuously concave descending declivity until reaching posteropropodeal lobes, somewhat vertical or slightly diagonal supra, shorter infra (between posteropropodeal lobes), supra and infra areas rarely same length [*scabriusculus* part] (Fig. 9); posteropropodeal lobe posterior to bulla (Fig. 12); metacoxal cavity ental (Fig. 12); legs similar to male's (fig. 47), procoxa trunk-like augmented basally, twice size of meso or metacoxa; profemur tectiform (roof-like), securiform (triangular) in cross section (clear vertices on inferior side), equilateral, or ventral side narrower than anterior and posterior sides [*belti*, *eladio*], fusiform (spindle-shaped) [*mayri*, *batesi*], or compressed disciform (disc-shape) [*impressus*] with dorsal margin carinate (keeled) [*impressus*, *paleatus*] and concave anteromesially (entad) and proximally [*impressus*, *paleatus*], or convex; slightly convex posterolaterally; meso and metafemora commonly tectiform, ventral side weakly concave, separated from trochanter by small, dorsad, cuneiform prefemur (Kukalová-Peck 1991) ("trochantellus") (Figs. 9, 47), (male profemur elongate fusiform (fig. 47)); tibia subcylindric, possessing four poorly defined panels, anteriad and posteriad wider than ventromesiad (flexor) and dorsolaterad (extensor); foretibia possessing strigil (pectinate curved spur) ventrodistally forming antenna cleaner with curved and pectinate probasitarsus; meso and metabasitarsi cylindrical and longer; postarsus ("pretarsus") formed by bilobed padded arolium and bifurcate curved claw.

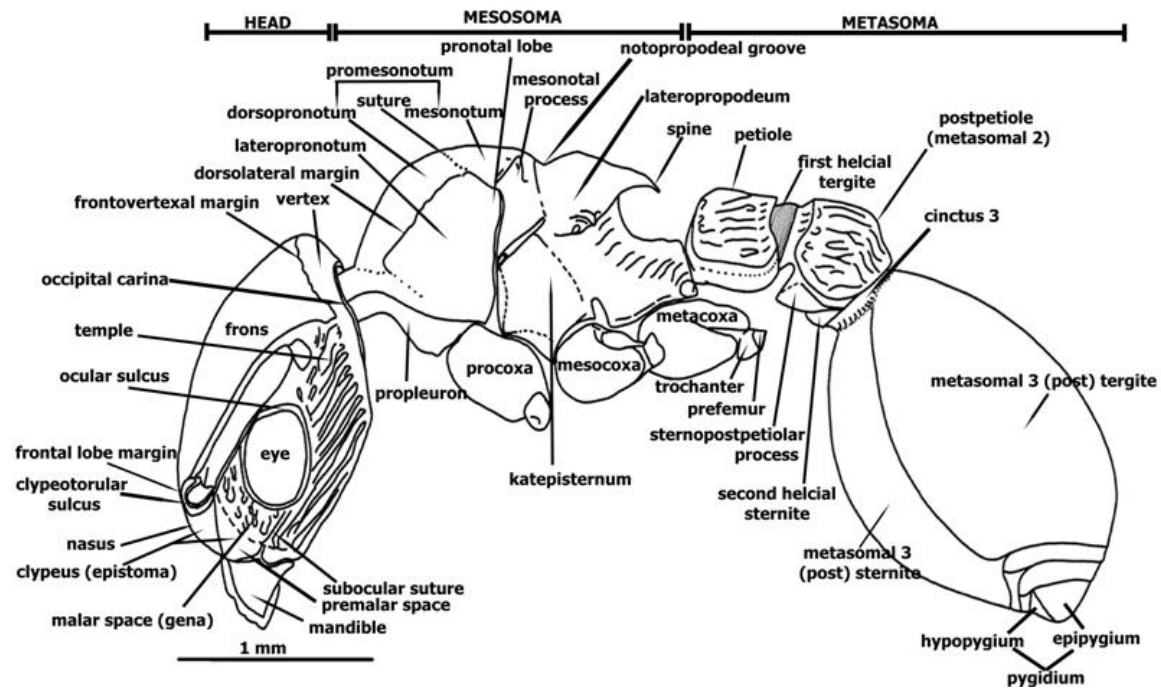


Fig. 9. *Procryptocerus scabriusculus* Worker. Lateral (profile) view.

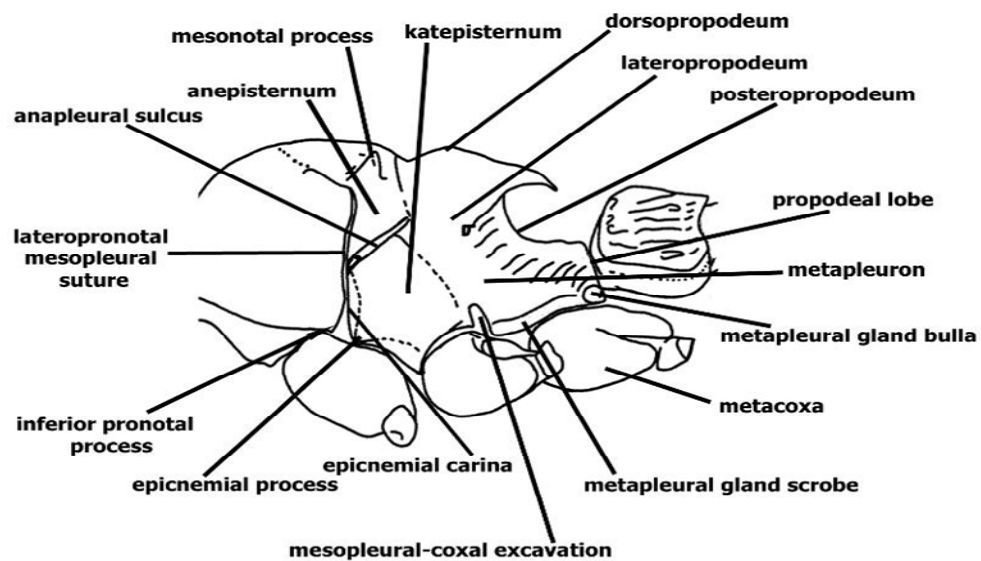


Figure 10. *Procryptocerus scabriusculus*. Worker. Mesosoma profile zoomed to show details.

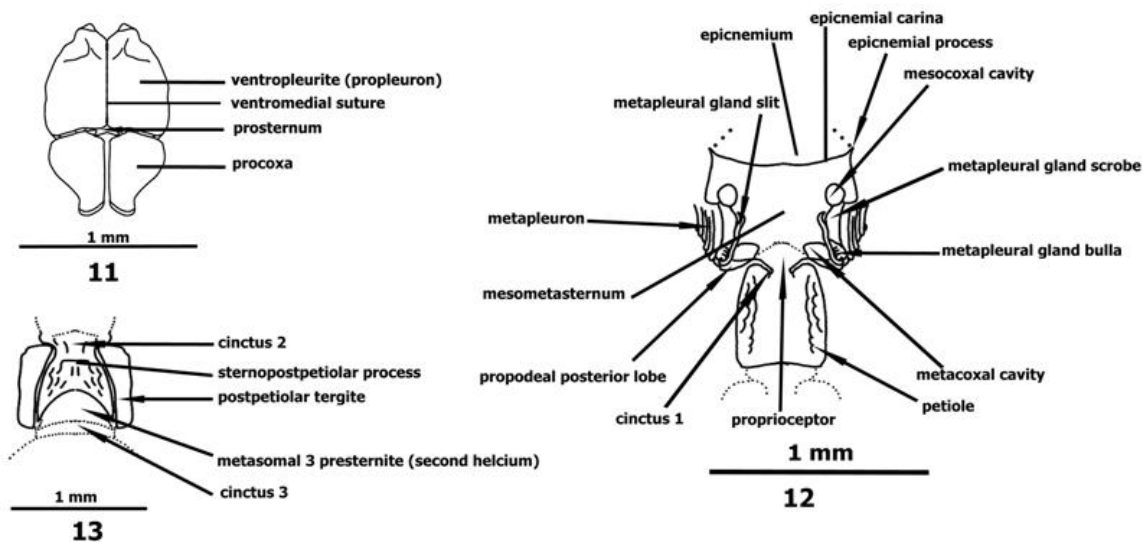


Figure 11-13. Worker. Mesosoma and waist region. Ventral view.

Metasoma. (Figs. 3, 9, 12, 13, 15, 16, 26-34, and table 1).

(Justification of terminology used here for third tagma in **Metasoma** under Discussion section).

Petiole (metasomal 1 = Abd II), first specialized metasomite articulated to propodeum by manubrium (Perrault 2004), composed of tergite and sternal presclerite (Fig. 12), forming syntergosternite (tergite and sternite fused), sessile, constricted anteriorly into cinctus 1 (cinctus: constriction between pre and postsclerites, see under Metasoma in the discussion section) (Fig. 12), nodiform, narrower than distance between propodeal spine bases, subcylindrical [*kempfi*], slightly wider anteriorly, or barrel-shape [*eladio*, *batesi*], usually without dorsal or lateral excrescences or projections; node anterior face reduced [*nalini*] or more commonly truncate forming nodal truncation (Figs. 3, 32) opposite to and functionally received by posteropropodeum, often delimited by nodal dorsolateral margin; nodal truncation convex, straight, curvate supraposteriorly [*adlerzi*], concave [*coriarus*, *sampaioi*], or absent [*nalini*], petiolar summit anteriorly (Figs. 3, 29, 31), midway [*hylaesus*] or posteriorly [*seabrai*]; sternopetiolar (“subpetiolar”) process between cinctus 1 and node (Figs. 29, 31), and usually laminar-lobose [*scabriusculus*, *rudis*, *mayri*] or obsolete, petiole posterior foramen margin (lateral view) sinuate (Figs. 9, 10) or vertically set off, spiracle anteroventrad. Postpetiole, second specialized metasomite (metasomal 2) (Abd III) (Fig. 3), wider than petiole, anterior foramen vertically set off, formed of first helcium (Bolton 1990), adjusted into posterior petiolar foramen, posttergite largest sclerite of postpetiole generally subfungiform (Figs. 3, 9, 32, 34), posteriorly augmented forming postnodus (Fig. 3), usually with anterolateral lobes [*belti*] posterolaterad to cinctus 2; postnodus usually composed of dorsal and posterodorsad faces [MA, *scabriusculus*, *clathratus*, *rudis*], continuously convex posteriorly (the two faces not differentiated

by postnodus) (Fig. 31) [*convergens*], or dorsally flat, narrowing into postnodus and somewhat vertically set off forming lamella posteriorly [*mayri*, *batesi*]; tergite and sternite separated by dorsosternal sutures, fused (Bolton 2003); poststernite crescentiform, emarginate posteriorly, leaving helcial metasomal 3 (Abd IV) presternite visible (Figs. 9, 13, 16), projected anteromedially into sternopostpetiolar (“subpostpetiolar”) process (Fig. 9); sternopostpetiolar process forming with cinctus 2 (Fig. 13) transversal (trans-sternal) cavity ventrally, where petiolar sternite posterior margin couples; ventropostpetiolar process somewhat conic, transversally truncate (Fig. 13), blunt [*spiniperdus*], unilobate [*mayri*] or bilobate apically; caudal postpetiolar foramen posteroventrad giving posteroventrad position (lateral view) to opisthogaster (metasomal 3 [Abd IV] to pygidium, see Metasoma under Discussion section) (Fig. 3); postpetiolar spiracle anteriad, slightly ventrad. Metasomal 3 (Abd IV) (Fig. 3), largest metasomite, first opisthogastral somite, third specialized (possessing second helcium and third cinctus) metasomite occupying nearly 2/3 of metasoma; elliptical or ovate; presclerites forming second helcium (Bolton 1990) (Fig. 3); stridulatory organ (Wheeler 1984) formed between metasomal 2 and second helcium; helcial sclerites and postsclerites separated by cinctus 3 (“girdling constriction”) (Figs. 3, 9); postergite and poststernite largest metasomal sclerites comprising approximately 3/4 of opisthogastral region; posttergite convex (Fig. 9) or slightly depressed [*rudis*]; spiracle anteriad, subdorsad. Metasomal 4 to pygidium somites non-specialized, pre- and posttergites differentiated by pronounced carina (Longino and Snelling 2002); pygidium (Abd VII) divided into epipygium (tergite) and hypopygium (sternite) (Figs. 3, 9).

Gyne (Figs. 14-16).

Although similar to worker, gyne larger and thoracic sclerites (Figs. 15-16) corresponding to alates in Apocritans. Ocelli posteriad within frons (Fig. 14).

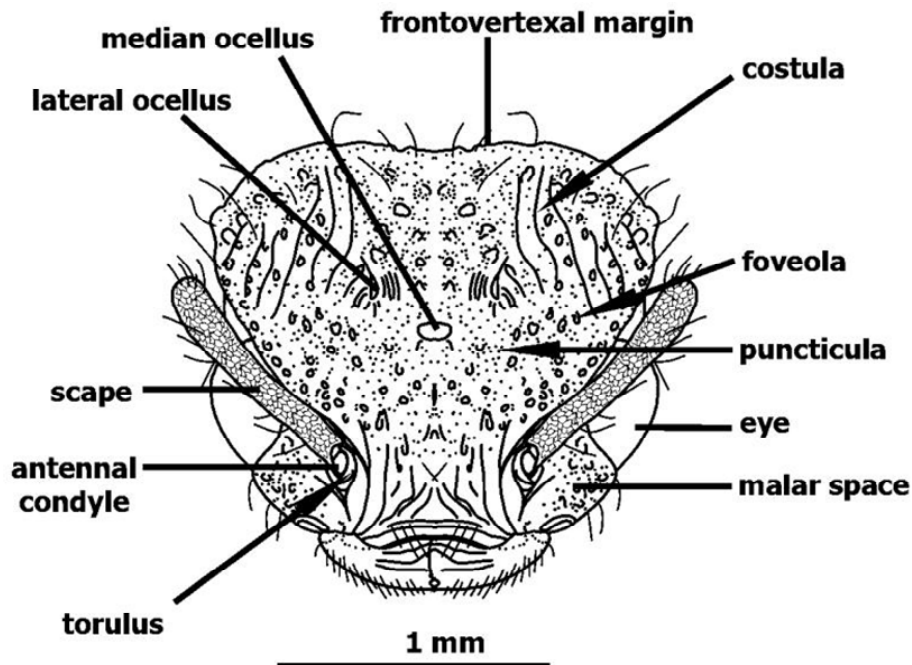


Figure 14. Gyne. *P. scabriusculus*. Head frontal view.

Gyne variations on mesosoma (Figs. 16, 17). Mesonotum divided into anterior scutum and posterior scutellum by curvate, scutoscutellar, or prescutellar groove; scutum divided by transcutal suture into greater anterior sclerite, and posterior prescutellar region, dorsomesial

between axillae; parapsidal lines extended posteroanteriorly from transcutal suture to discal scutum, slightly diverging anteriorly; axillae laterally longer and wider, forming prescutellum and embracing scutellum anteriorly; axillular scrobe (“fossa”), where wings rest, lateral, under axilla, formed of lateromedially impressed axillar groove, running from wing axillar sclerites to scutellum; mesoanepisternum and metanepisternum separated by lateral mesometathoracic (mesometapleural) suture; metanepisternum and metakatepisternum separated by short metanapleural sulcus. Wings similar to male’s.

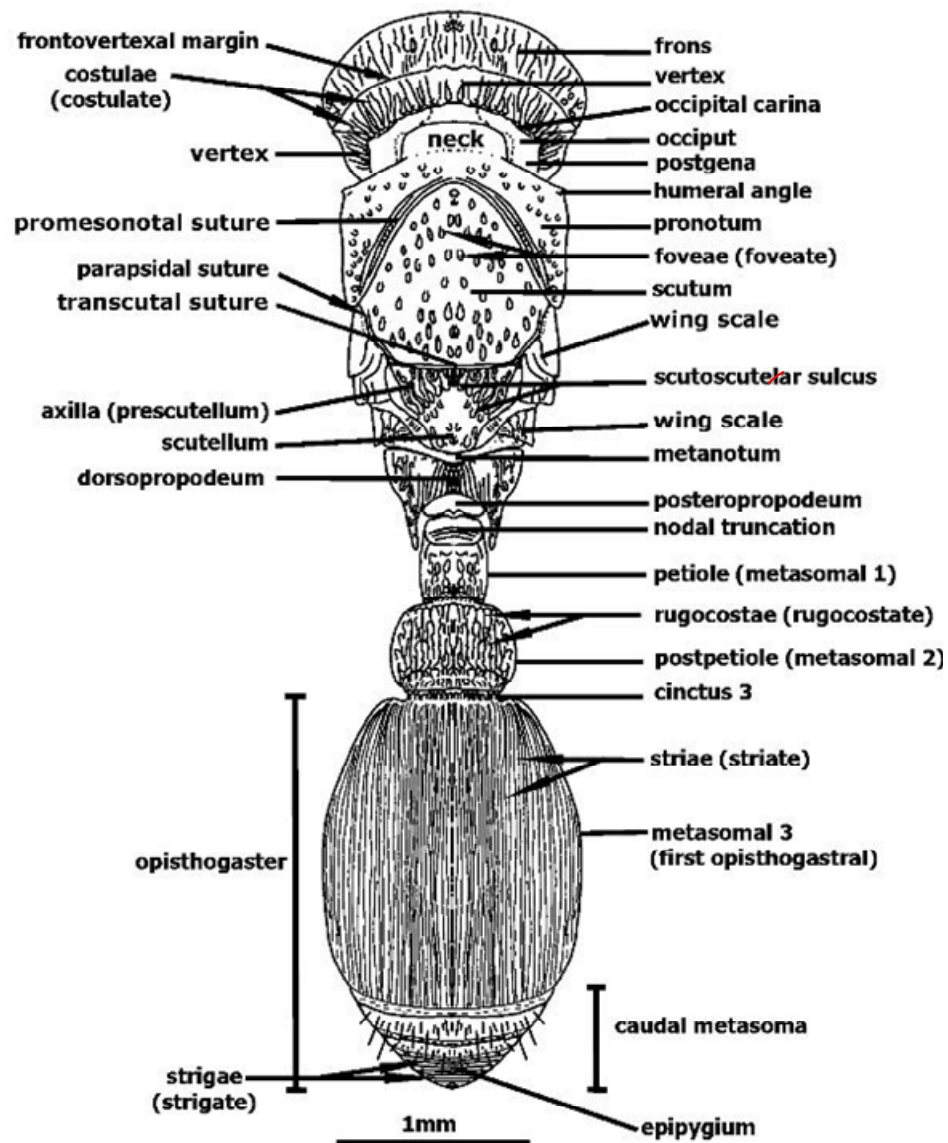


Figure 15. Gyne. *P. scabriusculus*. Dorsal view.

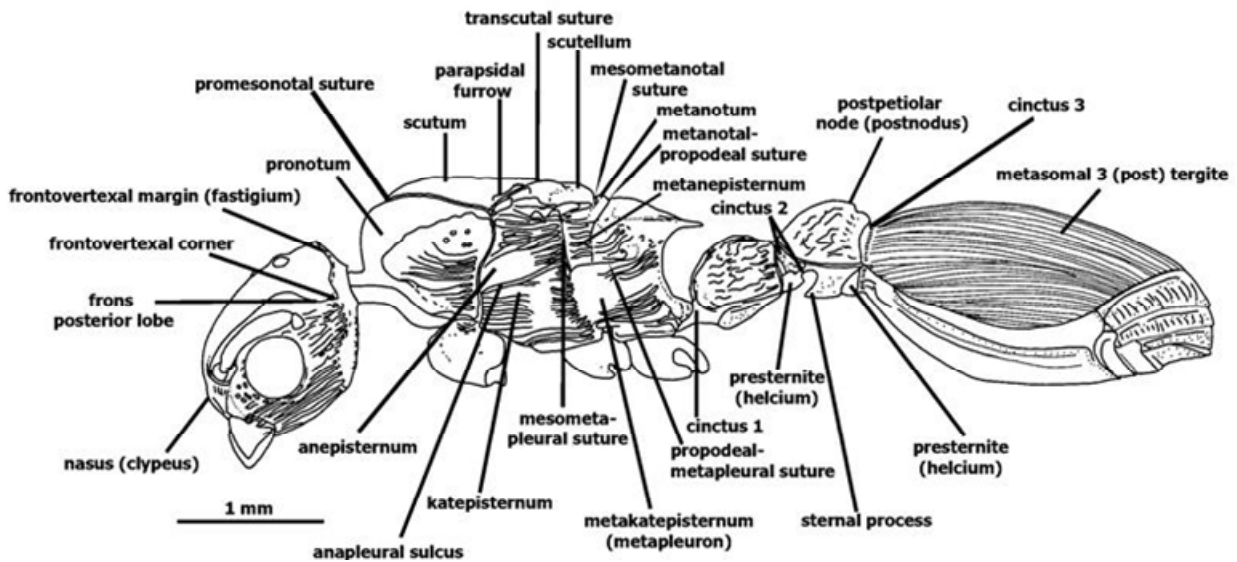


Figure 16. Gyne. *P. scabriusculus*. Lateral (profile) view (habitus).

Sculpture (Figs. 15, 17-34).

Sclerites usually exhibit combination of two or three sorts of sculpturing. Sculpture in *Procrystocerus* divided into microsculpture (background sculpture), and macrosulpture (regular [circular] or irregular depressions, or longitudinal and transverse elevations). Microsculpture:

micropunctate, microreticulate, microimbricate or microstrigulate. Macrosculpture: impressed holes without costae, ridges or carinae (foveate, foveolate, punctate), at level of surface (shallow) (striolate, imbricate, areolate, dotted, puncticulate), raised (costate, carinate, carinulate, vermiculate, striate, sulcate, strigate), or their combinations (scrobiculate, porcate, alveolate, rimose). Often, when integument smooth and polished (shiny = glossy), dorsum, especially on metasomal 3 sclerites, micropunctulate and bears combination of other micro sculpture.

Surfaces normally without sculpturing: torulus, hypostoma, funicular segments, and postocciput. Surfaces regularly micropunctate, and without macrosculpture, neck, prosternum, mesonotal lobes, ventral metepisternum, propodeal spines, posteropropodeum, sternal petiole and postpetiole, and metasomal 3 in Andean species over 600 m of elevation. Surfaces microreticulate or microimbricate, without macrosculpture: scape (almost always microimbricate), femora (microimbricate or microstriolate). Elevated ridges (costae and carinae) often microsculptured (micropunctate or microimbricate) on background. Striations and sulcations more common in Brazilian species. Circular impressed sculptures and combination with costae, striations and sulcations more common in Andean and Mesoamerican species.

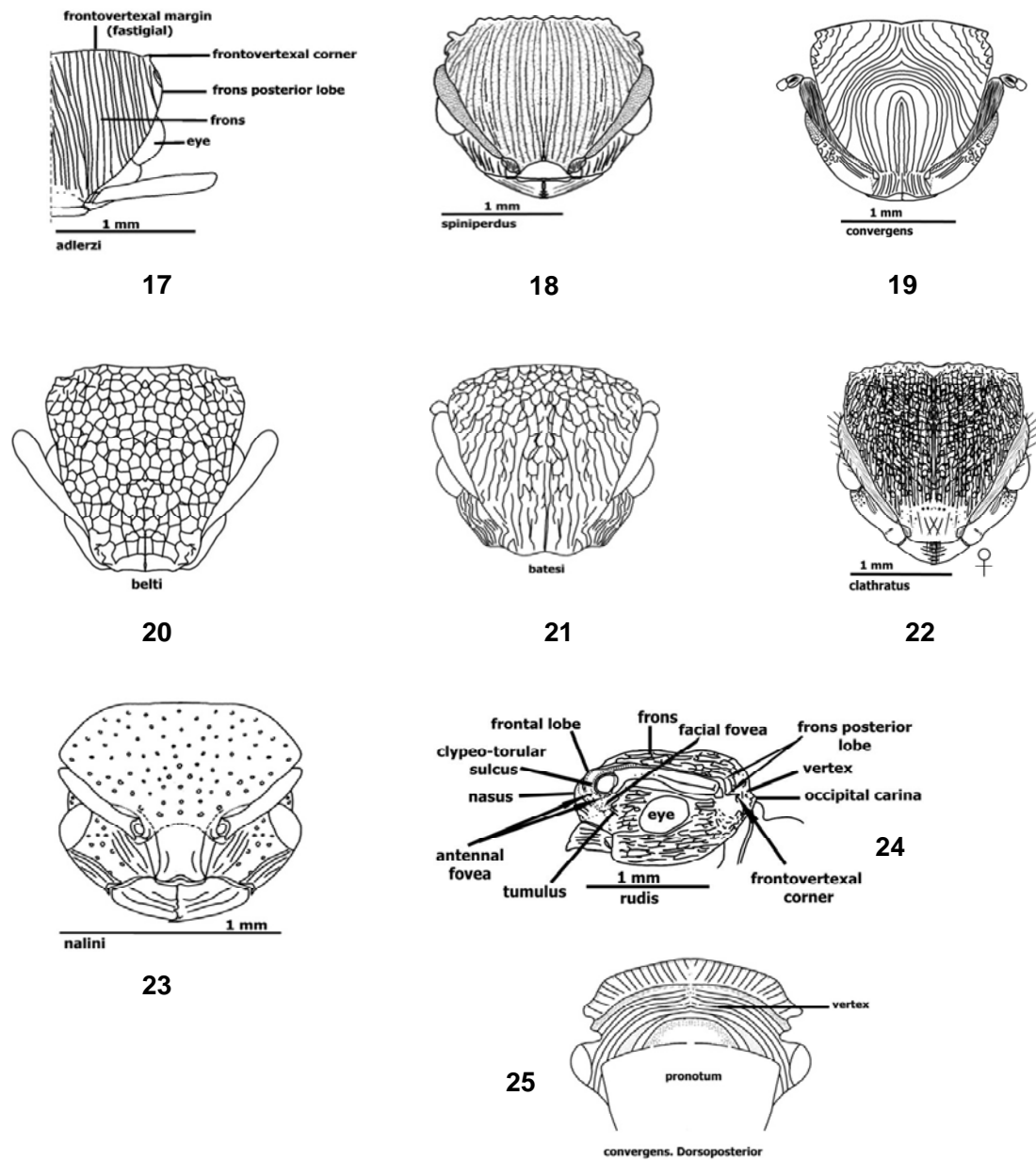
Frons clathrate in Andean species [*mayri*, *batesi*] and Brazilian *clathratus* (Figs. 21, 22) or foveolate (*schmitti*, *coriarius*, *nalini*); metasomal 3 punctate [*belti*, *impressus* (Fig. 33)], glossy [*eladio*, *belti*, *mayri*, *attenuatus*, *convexus*, *carbonarius*-*posteriad*], or finelly striate (Figs. 15, 32) [some Andean, Mesoamerican, and northern South American species] [*scabriusculus*, *tortuguero*, *marginatus*, *spiniperdus*, *ferreri*]. Alveolate sculpture of Andean and Mesoamerican

species on frons posteriad, pronotum anteriad, tergal petiole [*eladio*, FS_11] and postpetiole (Fig. 31); mesosoma, petiole and postpetiole porcate [*batesi*, *mayri*], tergal postpetiole rugocostate [Brazilian species] [*regularis*, *sampaioi*, *convergens*, *schmalzi*], femora costulate or costate in Central American [*paleatus*, *impressus*] and Brazilian [*schmalzi*] species.

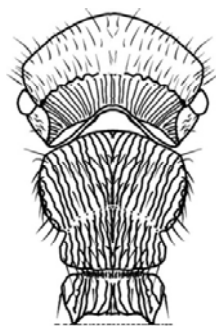
Clathrate sculpture on frons and promesonotum [*carbonarius*, *rudis*, *batesi*, *mayri*, *clathratus*] (Figs. 21, 22); costate or costulate sculpturing often on mandibles, clypeus (nasus), nasal flanks, frons (Figs. 14, 15, 18), malar space, temple, vertex (Fig. 15), gena, promesonotum, discal lateropronotum, mesopleuron, propodeum, coxae, femora, tibiae, and metasomal tergites 1, 2, 3; rimae (ondulate striae or costae) more common on frons [*sampaioi*, *victoris*, *convergens*] and mesonotum [*victoris*], when metasomal tergite 3 punctulate (densely punctate), some species have farinose texture [*impressus*, *belti*, *subpilosus*]; scrobiculae often bordering areas as vertex [*mayri*, *schmitti*, *clathratus*], temple [*eladio*], lateropronotum posteriad [*scabriusculus*], mesepisternum anteriad [*scabriusculus*], notopropodeal fusion when grooved [*schmitti*, *coriarius*], petiole and postpetiole posteriad, cincti 2 and 3 (Figs. 15, 32).

Mandible often longitudinally costulate (Fig. 4); anteclypeal region often strigate, discal clypeus ecarinate, variably longitudinally costate, or with medial carina or costa (Figs. 3, 4), nasal flank ecarinate or costulate; clypeal carina often extending back and continuing mesiad, parallel and very close to frontal carina; frontal carina describing more or less straight line [*eladio*], curvate [*scabriusculus*], *convergens*, *regularis*, *subpilosus*, *coriarius*] (Figs. 3, 4, 14), sinuate [*belti*] (Fig. 20) or sinuate-bilobate [*mayri*, *batesi*]; frons foveolate (or foveate) [*nalini*, *eladio*, *pictipes*-

anterior] (Fig. 23), foveate-costulate [*scabriusculus*] (Fig. 14), striate [*adleri*] (Fig. 17), costulate [*virgatus*], costate [*regularis*], reticulate or areolate [*belti*, *hirsutus*, *convexus*, *pictipes*] (Fig. 20), reticulate [*pictipes*-anterior], areolate [*pictipes*-posterior], clathrate and areolate [*batesi*] (Fig. 21), infra lateropronotum porcate or costate [most species] (Fig. 29); mesopleuron porcate or costulate (Fig. 29), and foveolate; propodeal spines microsculptured or ecarinate and glossy, posteropropodeum supra strigate [*hylaesus*, *mayri*], ecarinate and shiny [*mayri*], or striate (or longitudinally costate) [*montanus*, *striatus*]; meso and metapleura usually costulate (Fig. 29); nodal truncation ecarinate and glossy [*belti*] or strigate [*scabriusculus*]; tergal petiole and postpetiole areolate [MA, *coriarius*] (Fig. 31); sternal petiole and postpetiole ecarinate [most species]; metasomal 3 tergite striate-costate (Fig. 15), costulate, or costate [several species in the whole range of the geographical distribution] (Figs. 15, 16, 32); metasomals 4-6 pretergites smooth, posttergites strigulate or microtuberculate; epipygium punctulate; metasomal 3 sternite ecarinate [most species], striate (or costulate) [*ferreri*] (Fig. 34).

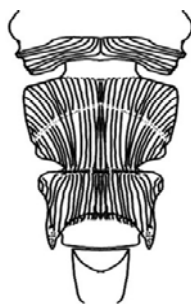


Figures 17-25. Sculpture on head. 17-23 frontal (dorsoanterior); 24 lateral (profile); 25 dorsoposterior. 17 costate, 18 costate, concentricus in middle, 19 diverging costate posteriad, concentricus anteriad, 20 reticulate, 21 clathrate posteriad and in middle, rugocostate anterolaterad, anastomosate anteromesiad, 22 clathrate, 23 foveate or foveolate, 24 parietal costate or rugocostate, frons clathrate, 25 vertex strigate.



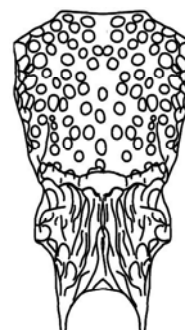
1 mm
clathratus

26



1 mm
adlerzi. Dorsal

27



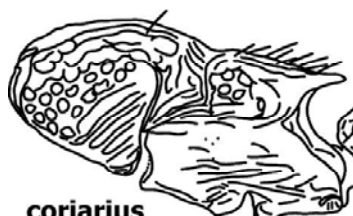
coriarius

28



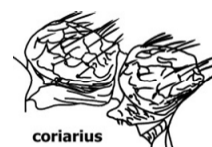
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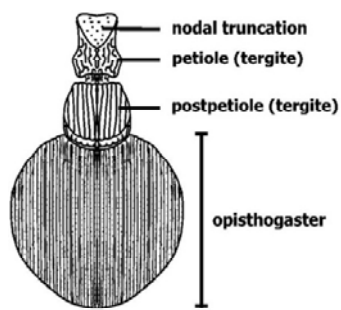
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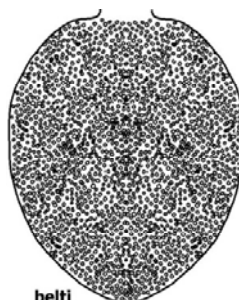
coriarius

31



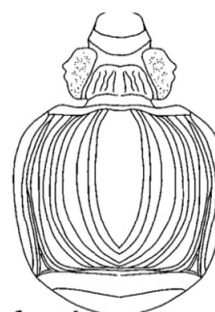
1 mm
adlerzi

32



belti

33



ferreri

34

Figures 26-34. Sculpture on pro, meso and metasoma. 26 vertex striate (or longitudinally costate), mesosoma costate-vermiculate (or rimosus), 27 vertex strigate (or transversally costate), mesosoma costate, 28 (based on Longino 2006): promesonotum foveate, dorsopropodeum costate-porcate, 29 costate-sulcate, 30 (based on Longino 2006): lateropropodeum supra foveate, infra costate, pleuron rugocostate, 31 (based on Longino 2006): rugocostate-alveolate, 32 petiole rugocostate, cinctus 2 scrobiculate, postpetiole costate (or porcate when interspaces are deep), metasomal 3 (Abd IV) striate-punctulate (densely punctate), 33 metasomal 3 (Abd IV) tergite punctate, 34 metasomal 3 (Abd IV) sternite costulate-concentric, glossy in middle.

Vestiture (Figs. 17, 21, 25, 26).

Two kinds of vestiture are present in *Procryptocerus*. Pilosity (Figs. 26, 30, 31) refers to long, erect, suberect, subdecumbent, decumbent (Fig. 35), or appressed (not drawn) hairs, and pubescence (not drawn) refers to exceptionally short, fine hairs forming second layer beneath pilosity (Hölldobler and Wilson 1990).

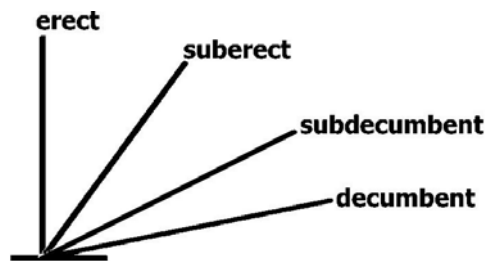


Figure 35. General orientation of hairs.

Procryptocerus bear both short and long, flexous (flagellate) pilosity (Fig. 26), or short and long, stiff or subspatulate pilosity (Figs. 22, 30, 31); longest pilosity on tergal petiole and postpetiole [*mayri*, *impressus*,]; often medial dorsal line of meso and metasoma denudate; lateral hairs of anteclypeus pecten (Fig. 22) commonly convergent; frons more common with stiff, scattered pilosity; frons posteriad and frontovertexal margin usually with two transverse lines of uniformly separated stiff hairs slightly directed anteriorly; eyes denudate; malar space often possessing few scattered hairs; shorter flexous pilosity or pubescence on postgenal bridge; mandible with erect short hairs, ventrally and distally with flexous pilosity; scape usually with

short, stiff, uniformly distributed, sparse hairs (Fig. 22) promesonotum and dorsopropodeum with long stiff or flexous hairs; propleuron denudate or pubescent; meso and metapleura usually denudate; coxae both pubescent and with flexous hairs on ventral, dorsal and posterior faces, usually medially pubescent combined with some flexous, sparse hairs; dorsum of femora and tibiae usually with decumbent and subdecumbent, stiff hairs; petiole and postpetiole dorsolaterally with subdecumbent or suberect stiff or flexous hairs, ventrally usually denudate; ventropostpetiolar process denudate or bearing few scattered, long, flexous hairs, rarely pubescent, metasomal 3 (Abd IV) tergite denudate or bearing either erect or suberect, long or short, flexous pilosity, or combination of both; exception of pubescent metasomal 3 tergite is Andean species from Panama and Venezuela; ventral metasomal 3 denudate, pubescent, or with combination of pubescent and short, scattered, flexous hairs; metasomals 4 to pygidial posttergites with few erect or suberect flexous or stiff hairs, often arranged in transverse lines with shorter hairs [species at low elevations]; hypopygium pubescent or not, and often possessing short, subdecumbent, flexous hairs. Brazilian species usually with stiff pilosity shorter than flexous hairs of some Andean and Mesoamerican species, short stiff hairs in Andean *convexus*, *hirsutus*, *belti*. Some Andean species may bear flexous or stiff, long or short pilosity; other species may possess abundant flexous pilosity [*batesi*]. Some species almost denudate dorsally and pubescent ventrally, especially on opisthogastral sternites [*eladio*]. Few Brazilian species with some very scarce long flexous hairs on caudal metasoma posttergites.

Color.

Color usually varies from dark-orange or red-brown appendages, and black meson in some Andean species usually over 600 m of elevation, to completely black in most species found at low elevations. Minor color variations are as follows. Scape and pedicel yellow, orange, red, or brown; eye brown; palps yellow; mandible brown laterodistad; flagellum, tibiae and telotarsi orange-brown; remaining body black.

Male (Figs. 36-45).

Male longer, slender than gyne (Fig. 37), ranging from 4.8 mm [COL] to 9.9 mm [*scabriusculus*]. Following traits separate *Procryptocerus* males from others in the Tribe Cephalotini: scape long, subequal to or longer than second funicular segment; postpetiole longer than height; mandibles strongly mesially curvate; head subglobular; posterolateral spines or teeth on dorsopropodeum (Kempf 1951).

Head (Figs. 36-38).

Subglobular, never transverse. Interocular distance shorter than, or subequal to, median head length; mandibles curvate mesially; anteclypeal carina medially weakly notched; clypeus protruded into nasus; frontoclypeal sutures modified in transverse groove between toruli; frontal carina short, divergent caudad; vestigial to obsolete behind eyes; antennal scrobe above eyes; vertex not distinctly deflexed; frons posterior corners distinct to obsolete. Eyes lateral, strikingly protruding, slightly extending dorsad and ventrad, comprising most of head; ocelli protruding in

most species dorsally, posteriad to eyes, anteriad to vertexal margin, sometimes assemblaged on ocellar triangle; antenna filiform, 13-segmented; scape subequal to or longer than second funicular segment.

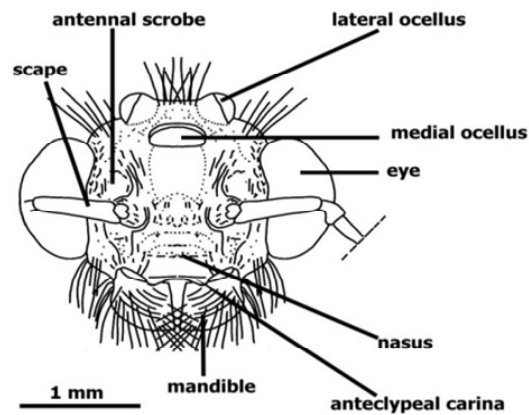


Figure 36. *Procryptocerus scabriusculus*. Male. Head. Frontal (anterodorsal) view.

Mesosoma (Figs. 37, 38).

Trunk-shaped, humped; scutum with deeply impressed notauli; anterior branches longer than the posterior medial stem; episternum superior to mesocoxa, usually ecarinate; dorsopropodeum with small, spiniform process posterolaterally; femora moderately concave mesially and

incrassate in middle; all segments of legs comparatively long and slender; middle and hind tibiae usually without apical spur.

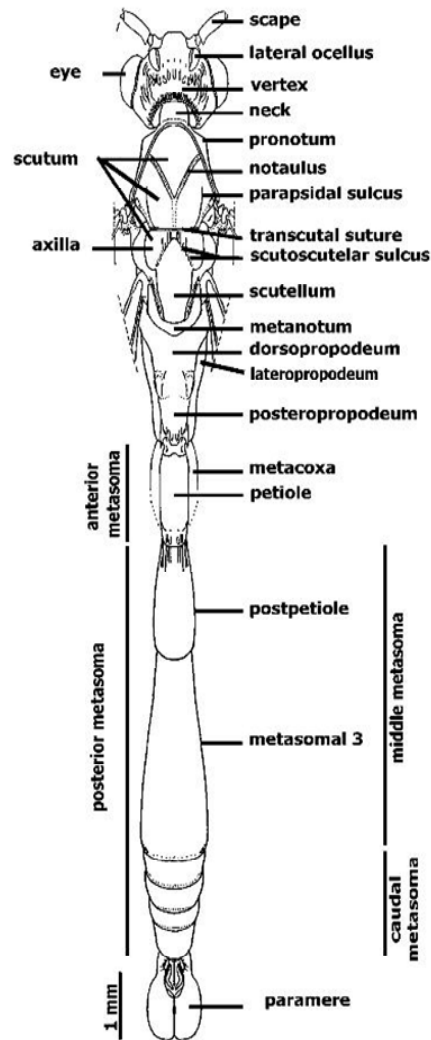


Figure 37. *Procryptocerus scabriusculus*. Male. Dorsal view.

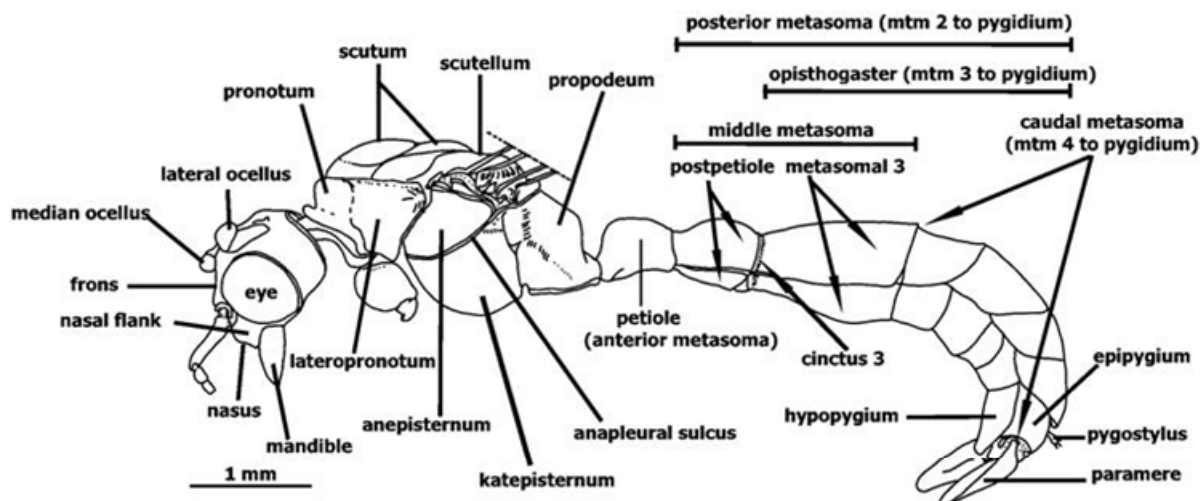


Figure 38. *Procryptocerus scabriusculus*. Male. Lateral view; mtm: metasomal.

Metasoma (Figs. 37, 38).

Metasomal 1 (Abd II = petiole) sessile, elongate, subcylindrical. Metasomal 2 (Abd III = postpetiole) similar to metasomal 1, somewhat shorter, more incrassate posteriad; metasomal 3 (Abd IV) largest metasomal somite, longer than petiole and post-petiole combined; hypopygium rounded posteriad (Fig. 40) [*scabriusculus*, MA], truncate [*batesi*], subtriangular or conic [*adlerzi*]; paramere (Figs. 41-43) paddle-shaped, rounded apically, sometimes about same length of caudal metasoma; volsella (Fig. 45) mesial to paramere, bifurcate into cuspis and digitus volsellaris; cuspis volsellaris mesial to paramere, subcylindrical, sinuate, shorter than digitus, truncate apically; digitus volsellaris mesial to cuspis, compressed, hook-shaped, ventrally bent distad.

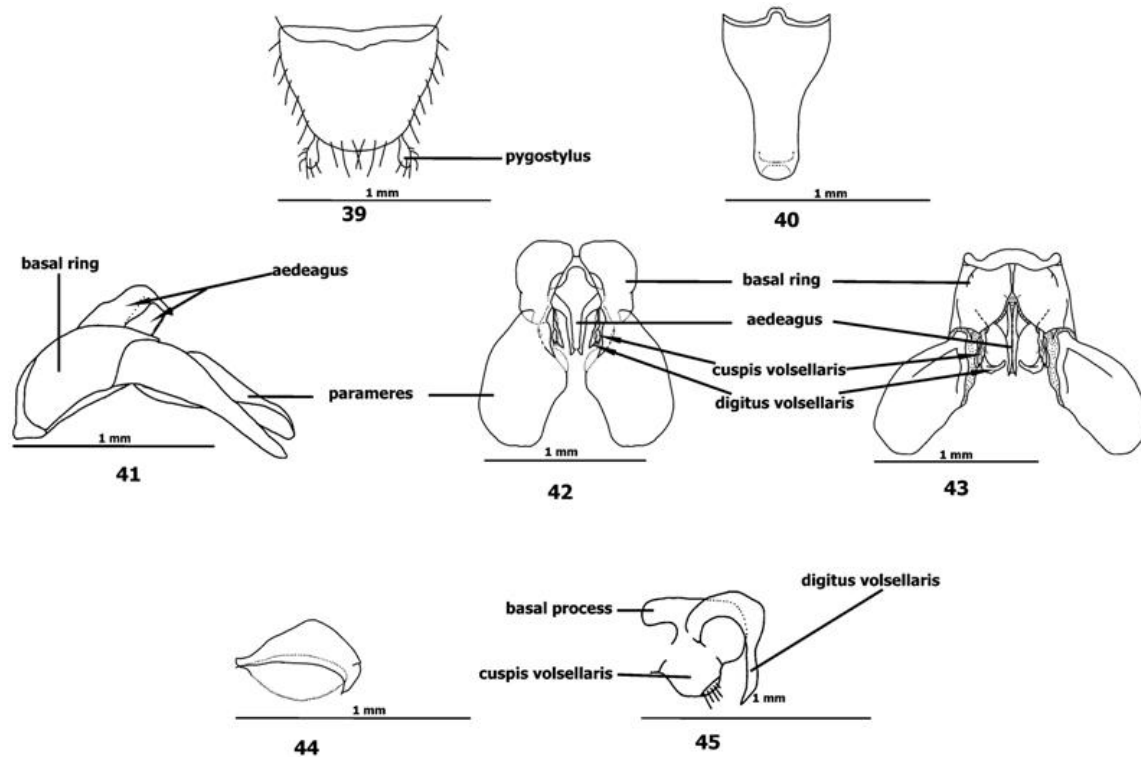


Figure 39-45. *Procryptocerus scabriusculus*. Terminalia. 39: epipygium; 40: hypopygium; 41, 42, 43: genitalia, 41: lateral, 42: dorsal, 43: ventral; 44: aedeagus; 45: volsella.

Wings (Fig. 46).

Wing shape, venation and cells similar in both male and gyne; male fore wing extending to level of posteriad caudal metasoma; hyaline [*goeldii*], or infumate [*batesi*, *mayri*, *impressus*, *scabriusculus*]. Useful, distinct variations have not been found for discriminating species within *Procryptocerus*. Fore wings with distinct anterodistad stigma; in anteroposterior sequence, proximal (proximad to stigma) longitudinal veins are C (Costa), Sc+R+Rs (Subcosta+Radial+Radiosectorial), M+Cu (Medial+Cubital), and A (Anal). Distad longitudinal

veins are R, M and Cu; distad veins do not reach apex of wing; recurrent veins are cu-a (cubital-anal) and m-cu (medial-cubital); cells formed by confluence between longitudinal veins or between longitudinal and recurrent veins; proximally, three cells present: Costal (CC), Basal (BC) or Radial (“Media”), and Subbasal (SBC) or Cubital (“Submedia”); posteriad to stigma, Submarginal-one cell (SMC1) (closed) and Submarginal-two cell (SMC2) (opened) are present; Discal cell-one (DC1) posteriad to Submarginal-one and distad to Basal cell (or Radial cell), formed by confluence of M, Cu, Rs and m-cu. Distal field without cells. Hind wing possessing proximally two distinct longitudinal veins: R+Rs and M+Cu; cu-a is basad in proximal field; Basal cell BC (or Radial cell) closed distally by M vein; Subbasal SBC cell (or Cubital cell) closed distally by cu-a and posteriorly by 1A; distal field without distinct veins.

Along with different shapes of discoidal and first submarginal cells on anterior wings, main characters that separate species are variations within external and internal genitalia, which contain well-developed hypopygium, volsellae, and parameres (Kempf 1951).

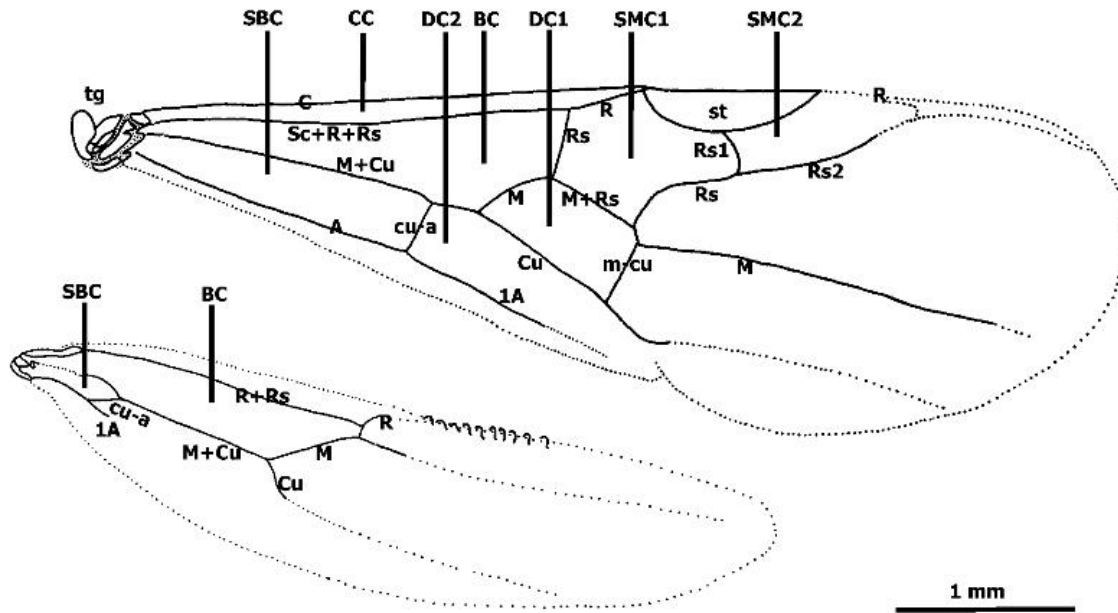


Figure 46. Male wings. Veins: C (Costa), Sc+R+Rs (Subcosta+Radial+Radiosectorial), M+Cu (Medial+Cubital), A (Anal), cu-a (cubital-anal), m-cu (medial-cubital). Cells: CC (Costal Cell), BC (Basal Cell) (or Radial), SBC (Subbasal Cell) (or Cubital) (“Media”), SMC1 (Submarginal 1 Cell), SMC2 (Submarginal 2 Cell), DC1 (Discal Cell 1), DC2 (Discal Cell 2); st: stigma.

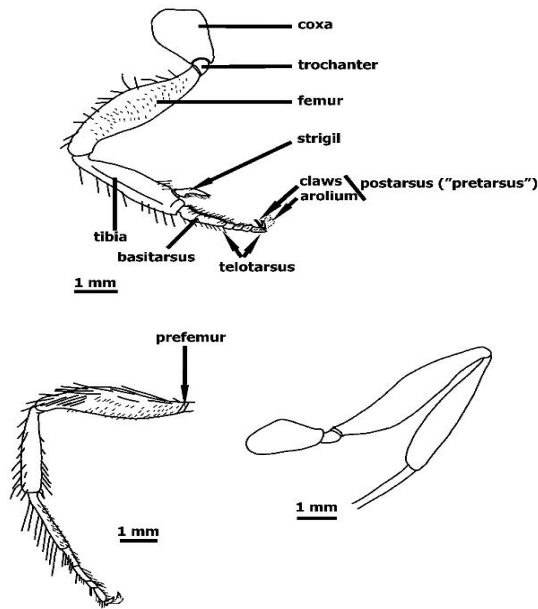


Figure 47. Male legs. Above: foreleg; lower left: middle leg; lower right: hind leg (vestiture not drawn).

Discussion.

Specific positions, relative positions, and directionality. (Fig. 2).

Specific positions such as basal, proximal, distal, apical, apicolateral, apicomesial are used exclusively for appendages such as buccal appendages, antennae, wings, legs, or genital appendages. Indications of positions such as “propodeal base”, “gastral base”, “base of declivity” should be avoided since they are referring to structures on the mesion. Other **specific positions** (anterior, posterior, dorsal, ventral, lateral, mesial, etc.) are used for body parts; **relative positions** (with the adv.ial ending *ad= toward*, such as basad, distad, anteriad, cephalad, posteriad, caudad, laterad, mesiad, anterodorsad, anteroventrad, posterodorsad, posteroventrad,

etc.), **directionality** (mesially, laterally), and **extended positions**, that involve two or more regions (dorsolaterally, dorsosternally, dorsoventrally, lateroventrally, anteroposteriorly, posteroanteriorly, lateromesially, etc.), are used for both the mesion and the appendages. In relative (*ad*) positions, such as lateroventrad, the prefix “latero” should emphasize that the structure or character state is lateral and the suffix “ventrad” indicates that it is found in the direction of venter. The opposite applies to ventrolaterad or other combinations of prefixes and suffixes indicating relative positions.

Ante, antero.

In the sense used here, ante means before (anterior to) the referred structure (e.g. antepropodeal refers to a structure anterior to the propodeum), and antero refers to the anterior portion of the actual structure. Anteropropodeum refers to the anterior region on propodeum.

Terms describing shapes.

The use of terminology for shapes is quite useful for describing different structures. A combination of technical and common (not universal) names describing shapes is present in the literature. For instance, terms such as crescentiform, fusiform, disciform, etc. are technical and therefore universal. Terms such as “neck” for a part of the antennae, “cheeks”, “apron” , etc. are not technical, not universal and therefore should be avoided.

Torulus vs. Annulus (antennalis).

Gauld and Bolton (1988) consider the torulus to be the socket, or the cephalic foramen, in which the antennal condylar bulb inserts. Bolton (1994) considers torulus to be the small annular sclerite that surrounds the antennal socket. Nichols (1989) considers the annulus (antennalis) to

be the ring sclerite of the head into which the basal segment of the antenna is inserted. Gordh and Headrick (2002) consider annulus to be the antennal sclerite forming a sclerotized ring on the head into which the basal segment (scape) of the antenna is inserted. We follow Bolton (1994).

Mesosoma.

For the second tagma, the term “alitrunk” (ali = wings) has been proposed to avoid confusion with “thorax” (Gauld and Bolton 1988, Bolton 1994, Wilson 2003). Nevertheless, a similar confusion could occur between metasoma and “abdomen”. “Alitrunk” is not recommended since worker ants do not possess wings, and mesosoma is well characterized in Apocrita (see Nauman 1991).

Notopropodeal fusion.

The mesosoma comprises the thorax plus the propodeum, the tergite of Abd I fused to thorax. The pleurites and sternite of Abd I are entirely reduced and the tergite remains. In workers of ants, the notal and propodeal sclerites are usually fused forming a tergal (notal) fusion between the notum and propodeum. This condition is a notopropodeal fusion. Externally, it is usually impossible to recognize the structures involved in the fusion. The line of fusion may be indistinct (notopropodeal fusion usually convex), obsolete or differently marked by a suture, groove, impression, depression, etc. The line of fusion has different names in the literature, such as “propodeal suture” (a suture in the propodeum), “metanotal suture” (a suture in the metanotum), “metanotal groove” (a groove in metanotum), “metanotal impression” (an impression in the metanotum), “metapropodeal suture” (suture in the posterior [meta] region of propodeum), antepropodeal suture, metanotal area, etc. Since these terms make reference to the line of fusion, we recommend using the adjective “notopropodeal” in reference to the line of fusion; for

instance: notopropodeal *suture*, notopropodeal *groove* (figure 3), notopropodeal *convexity*, notopropodeal *impression*, notopropodeal *excavation*, or otherwise make reference to the notopropodeal fusion to describe specific characters, such as *notopropodeal fusion flat*, *notopropodeal fusion convex*, etc. In several groups, e.g. some *Camponotus*, the metanotum is clear and so are the mesometanotal suture and the metanotal-propodeal suture. In these cases, a notopropodeal fusion is not apparent. A mesometanotal fusion or a metanotal-propodeal fusion can also occur.

Propodeum.

The propodeum is the first abdominal tergite fused to the thorax, which together comprise the mesosoma. The propodeum is differentiated into the anteropropodeum and the posteropropodeum. In turn, the anteropropodeum is divided into the dorsopropodeum and the lateropropodeum. The dorsopropodeum is the dorsal area of propodeum, anterior to propodeal spines and containing the anteropropodeal processes laterally. The lateropropodeum is the lateral area (laterotergite) of the anteropropodeum containing the propodeal spiracle. The posteropropodeum is located beneath the propodeal spines; it is a vertical or declivitous area.

Metasoma.

In referring to metasomal somites in ants, usually two different systems are superimposed (Bolton 1994). A general system regards homologous abdominal somites (Abd) throughout the Hexapoda. In the Formicidae, as is it in the entire Apocrita, Abd I is part of the second tagma or the mesosoma, which is formed from the thorax plus Abd I tergite. The remaining abdominal somites form the third tagma starting at Abd II (petiole). A second, specialized (functional) system divides the metasomal somites into a petiole, postpetiole and gastral segments (Bolton

1994, 2003). Because different groups of ants contain forms with one- or two-petiolate metasoma, the current specialized system of metasoma nomenclature uses the name “gaster” inconsistently and incongruently with homologous somites in the non-formicid Apocritans. This situation shows that the development of a consistent system of naming specialized metasomata has passed behind the terminology for prosoma or mesosoma. Bolton (1990) introduced the term *helcium*. A second *helcium* is characteristic of two-petiolate metasomata; when it is not present, no specialized term is available for Abd III, and hence the term *postpetiole* is inconsistently used between different castes and subfamilies. Occasionally, authors have had to explain the need of petiole and postpetiole in males without *helcial* sclerites (see de Andrade and Baroni-Urbani 2003). A simple solution to the inconsistent use of the terminology regarding postpetiole and gastral somites in ants would be to abandon the specialized system of metasoma vocabulary. However, the use of a specialized system has shown interesting advantages in the comparative morphology of ants (see Bolton 2003), and is applied in recent classifications (Bolton 2003, Perrault 2004, Ward 2007). Therefore, improvements to the specialized metasomal terminology are desirable. This work proposes a proposal of reconciliation into a single morphological specialized system for what we believe are homologous metasomata within ants and other Aculeata (Table 1).

Table 1. Specialized system proposed for naming metasomata in ants with reference to other Apocritans. *The most caudad somite is considered pygidium. In workers of ants it is Abd VII (metasomal 6).

General characterization	Examples of taxa	Divisions					
Abdomen minus Abd_I (propodeum)	Apocrita	Abd II	Abd III	Abd IV	Abd V	Abd VI	Abd VII (VIII in male ants) (pygidium)*
Abdomen minus Abd_I (propodeum)	Apocrita	Metasoma					
Petiole and metasomata	Formicidae	anterior metasoma (=metasomal 1 =petiole)	metasomal 2	metasomal 3	metasomal 4 to pygidium		

Anterior and posterior metasoma	Formicidae	anterior metasoma (=metasomal 1 =petiole)	posterior metasoma	
Three general subdivisions of metasoma	Formicidae	anterior metasoma (=metasomal 1 =petiole)	middle metasoma	caudal metasoma
Petiole and gaster	Formicinae, Dolichoderinae	Petiole	Gaster	
Petiole, postpetiole <i>sensu stricto</i> (Bolton 1990) (helcium-cinctus 3 complex present), and	Myrmicinae, Pseudomyrmecinae, Ecitoninae (except Cheliomyrmecini)	Petiole	postpetiole	Opisthogaster

opisthogaster				
Petiole, postpetiole <i>sensu lato</i> (at least cinctus 3 present), and opisthogaster	Myrmicinae, Pseudomyrmeci nae, Ecitoninae (including Cheliomyrmicini) , Ectatomminae, Amblyoponinae, Cerapachyinae, Ponerinae, <i>Paraponera</i> <i>clavata</i> , <i>Proceratium</i> , and others.	Petiole	Postpetiole	Opisthogaster

In Apocrita, the metasoma is composed of Abd II to the caudal segment, or periproct (Snodgrass 1935). Literally, “gaster” means stomach (Brown 1979). However, the word “gaster” has widely been used in the literature of Apocrita referring to the external third tagma minus the peduncle (“petiole” in no ants) (Bohart and Menke 1976, Naumann 1991). The gaster constitutes the abdomen without Abd I (propodeum) and the peduncle of Abd II (Naumann 1991).

The Abd II (petiole) is always specialized in ants (Bolton 1994). The petiole is also found in some groups of Tiphidae, Scoliidae, Vespidae, Mutillidae and other Aculeata, where Abd II is a specialized somite as well. The petiole may be nodiform, squamiform or a much reduced subcylindrical segment (Bolton 1994). Pedunculate, sessile and subsessile petioles in ants are, in general, artifacts of the anteroposterior displacement of the petiolar nodus. In groups with a pedunculate petiole (e. g. *Pheidole* or *Solenopsis*), the node is posterior. In sessile petioles (such as in *Procryptocerus*), the tergum is augmented anteriorly (nodal) usually forming an anterior nodal truncation.

The metasoma comprises two general subdivisions: the anterior metasoma constituting the petiole (Abd II), and the posterior metasoma composed of metasomal (mtm) 2 (Abd III) to pygidium. In the posterior metasoma, Abd III-IV (mtm 4-5) constitutes the middle metasoma, Abd V to pygidium constitutes the caudal metasoma. The petiole (mtm 1) contains the cinctus 1 (cinctus: constriction between pre and postsclerites, see below), the mtm 2 contains the cinctus 2, and the mtm 3 may or may not contain the cinctus 3. The petiole (Abd II) and mtm 2 (Abd III) are joined by the first helcium (Bolton 1990) in all ants. In the middle metasoma, the mtm 2 and 3 (Abd III-IV) may or may not be joined by a second helcium. The mtm 2 is usually considered the postpetiole when separated from mtm 3 by the helcium-cintus 3 complex. This state is seen in females of Myrmicinae, Pseudomyrmecinae, and others. In additional considerations of a postpetiole, the mtm 2 is separated from mtm 3 by the cinctus 3 only (e.g. see de Andrade and Baroni-Urbani 2003 for *Proceratium*). This state is known to occur in males of Myrmicinae, Pseudomyrmecinae, and in both sexes of Myrmicinae, Pseudomyrmecinae, Ecitoninae (including

Cheliomyrmicini), Ectatomminae, Amblyoponinae, Cerapachyinae, Ponerinae, *Paraponera clavata*, *Proceratium*, and others.

For the posterior metasoma, we propose the use of the name **gaster** when a postpetiole is not present (e.g. Formicinae, Dolichoderinae), and the use of postpetiole and **opisthogaster** when at least a cinctus 3 is present. The posterior metasoma is a **gaster** when its metasomata 3 to pygidium (Abd IV to pygidium) are combined as a unit (e.g. Formicinae, Dolichoderinae); i.e. the gaster constitutes the metasoma minus the petiole when a postpetiole is absent. The opisthogaster constitutes the combined caudal metasomata 4 to pygidium (Abd V to pygidium); i.e. the opisthogaster is the posterior metasoma minus postpetiole. Even in few cases, when it is not clear to associate gaster and opisthogaster to general subfamilies, tribes or genera, the two terms would stay associated to the already explained metasomata.

In summary, we propose a consistent specialized (functional) and morphological system for naming homologous metasomata in ants. When the cinctus 3 is absent in the metasomite 3 (Abd IV), we propose using **gaster** for the combined metasomata 3 to pygidium. When a postpetiole is considered, due to the presence of at least the cinctus 3, the posterior metasoma is divided into postpetiole and opisthogaster.

Cinctus 1, 2, 3 (pl. cincti) (Figs. 3, 9, 16).

Cincti are the anteriad sulci, often in the shape of a belt or girdling constriction, located on metasomal 1 (Abd II = petiole), metasomal 2 (Abd III = postpetiole) and metasomal 3 (Abd IV)

somites. The sulci separate the pre and post sclerites. Cinctus 1 is usually a dorsal, very slender sulcus concealed between the posteropropodeal lobes, anterior to the peduncle and ventropetiole process in petioles possessing these structures. In some groups (e.g. *Pogonomyrmex*) there is no apparent cinctus 1. In such cases, cinctus 1 is interpreted as the anteriormost portion of the peduncle located between the posteropropodeal lobes. In general, in sessile metasomata (e.g. *Procryptocerus*) cinctus 1 is located directly anterior to the spiracle. The cinctus 2 is located in metasomal 2, anterior to the ventropostpetiole (“subpostpetiole”) process in metasomal 2 that possesses such process. The cinctus 3 (the “girdling constriction”- Bolton 1994) is located between the pre and postsclerites of the metasomal 3, posterior to the second helcium (*sensu* Bolton 1990), in two-petiolate ants. When the cinctus 3 is present in some of the *sensu stricto* single petiolate ants, it is a very fine sulcus (e.g. different poneroids groups), or almost absent (e.g. *Odontomachus*). There are genera such as *Leptanillodes* that possess more than three cincti.

Sculpture.

Procryptocerus species bear both micro- and macrosculpture. Microsculpture (micropunctulate, micropunctate, microimbricate, microstrigate, “dotted”) covers the background of the cuticle. Microsculpture may be present on the elevations or impression of the macrosculpture, usually when the macrosculpture (e.g. costae, striae) is glossy (shiny), or, more commonly, in smooth surfaces devoid of macrosculpturing. Micropunctulae and microimbricae are fairly different, but require close inspection to interpret. The micropunctulae condition occurs as microscopic pricks more common on opaque surfaces, whereas microimbricae are either overlapping microscales (as tiles on a roof) or microreticulae (“dotted”) that give an overlapped appearance. The latter are more common on glossy surfaces. Macrosculpture can be divided into impressed, superficial,

raised and combined sculpturing with the following states. 1. Impressed macro sculpture: circular or oblong (punctate, foveate, foveolate); linear (furrow-like) (furrowed, grooved, sulcate). 2. Superficial macro sculpture (non-impressed cuticle, surface spaces between costae or carinae): linear spaces delimited by costae or ridges -costae or ridges are low and same width as striae- (striate, striolate, strigate, strigulate); non-linear spaces delimited by costae or ridges (reticulate, areolate). 3. Raised macro sculpture (carinate, carinulate, costate). 4. Combinations between impressed and raised macrosculpture: canalicular (porcate, scrobiculate); polygonal and irregularly polygonal (alveolate), or irregular porcae, irregular reticulae, irregular rugocostae-alveolate (clathrate).

Striate sculpturing refers to longitudinal lines on a non-impressed cuticle, running parallel between thin and low elevated costae or costulae; the costae (or costulae) and lines are narrow and about the same width. The sculpture should be named striate-costulate, but it is customary to call it striate. Striate is one of the most common forms of sculpturing in *Procryptocerus*; it is often present on the metasomal 3 (first opisthogastral) tergite. Costate sculpturing refers to costae (elevated ridges rounded at their edges, dim. costulae) in general running parallel or quasi parallel to each other, the interspaces are wider than costae. Rimose refers to *nearly* parallel excavations (rimae), often narrow, short or long, in the shape of wavy cracks, running into each other (Gordh and Headrick 2000); elevations between rimae are vermiculate, often wide and flat at their ridges, which are usually micropunctulate. Rimae refer to the longitudinal fissures, crack-shaped interspaces; ridges refer to the elongated elevations (costae). The costae are wavy. The combination between rimae and flat ridges, running in anastomosis, produces rimose (dim.

rimulose) or rivose (dim. rivulose) sculpturing. Combinations of character states, such as rimose-vermiculate, or rivose-vermiculate could be more specific.

Punctures are slightly impressed points (pricks) on the cuticle that appear to be made by a needle (Gordh and Headrick 2000). Punctures constitute the smallest circular-macrosculpture. Derived adjectives describing this sculpture are punctate (with punctures), punctulate (sparsely punctate), punctulate (closely punctate). When punctulate and punctate are present on the same surface, the difference between the sculptures is clear. When only one is present, the terms are interchangeable. When densely punctate, the cuticle has a farinose texture. Dots (dotted sculpturing) are non-impressed circular marks, they are superficial, rounded, and the same size as micropunctures. A costate integument emphasizes the costae and not the interspaces (striae or sulci); in these cases spaces between costae are in general wider than the costa edges and not impressed. The sculpture is porcate when a set of combinations of costae and impressions between costae are present, forming canalicular (sulcal) spaces. Anastomosed porcae are porcae that run into each other. Scrobiculate are surfaces where scrobiculae (parallel, short porcae) are uniformly organized in a contiguous, chain-like series. When there are septae within striae, the sculpturing is reticulate (quadri- or quasi quadriculate) [*belti* frons] or areolate (polygonal or quasi polygonal) [*scabriusculus* frons posteriad]. In a subsequent stage there are septae within a porcate surface, and the sculpturing is alveolate or clathrate. Alveolae are lacunose, impressed spaces delimited by irregular rugae or “costae” with sharp rims at their edges. The alveolae are regular or irregular polygons, and the sculpturing is called alveolate. Alveolate cuticle is often present on the posterior frons and petiole. Surfaces having alveolate sculpturing in *Procryptocerus* form landscapes of lacunae between ridges (ranges of “hills”) containing sharp

or obtuse edges. Clathrate sculpturing refers to the most complex, irregular combination of irregular porcae and transversal septae (crossing costae), forming deep, alveolate, cancelled holes of different and irregular diameter. In clathrate sculpture, the costae run anteroposteriorly in irregular fashion prevailing over the short transverse costae forming the septae. High density of alveolae conform clathrate sculpture. This characteristic is the most important one to differentiate clathrate and reticulate sculpturing, which could be apparently similar when both are present on frons and when looking at them through a common microscope. Clathrate sculpture may be present on the frons and mesonotum [*mayri*, *batesi*, *clathratus*]. Reticulate sculpture is usually present on frons only [*belti*, *convexus*, *hirsutus*].

When a combination of sculptures is present, it is useful to hyphenate two, sometimes three, different words qualifying sculpture (e.g. rugo-costate, costate-foveate, foveate-reticulate, micro-striolate-imbricate). In general, when differences between proportions occur, the first word should emphasize the most common sculpture, or emphasize the first sculpture when referring to an anteroposterior (or any directionality) sequence of the sculpture present on any surface. Discriminating thickness of raised sculpture (e.g. costate, carinate) and width of circular, impressed sculpture (e.g. punctate, foveate, foveolate) is often not clear when only one of these types of sculpture is present. In those cases, the closest terms might be used interchangeably (e.g. foveate or foveolate, costate or costulate, rimose or rimulose). Discrimination of those sculptures is easier when several types of sculpture are present in the same area of an ant.

Confusion occurs between sculpture texture (appearance) and sculpture structure (constitution). To recognize the constitution (nature) of the sculpture, textures (e.g. leathery, farinose, rugous, coriarius, corticinus, etc.) should be avoided. Appearance strongly depends upon the “momentary” criterion of the researcher or interpreter, and magnification, light or system (microscope, SEM images, photomontage) used to recognize it. Nonetheless, when using a common microscope or photomontage images, the appearance is sometimes quite distinct with some descriptive forms (e.g. politus, shiny, glossy, farinose). It is best to use SEM images of sculpture (For instance see <http://www.evergreen.edu/ants/genera/AntsofCostaRica.html>). On the other hand, drawings are the best way to convey information about boundaries of sclerites.

Sculpturing within *Procryptocerus* is a rich source of characters, which is helpful in stabilizing and recognizing the identity of species and could permit the formalization of hypotheses of evolutionary trends.

Glossary.

Short abbreviations for literature resources are as follow: dA-BU: de Andrade and Baroni-Urbani (1999, 2003); BO: Bolton (1990, 1994); BR: Brown (1979); dc; dictionary.com; G-B: Gauld and Bolton (1988); G-H: Gordh and Headrick (2002); G-E: Grimaldi and Engel (2005); HA: Harris (1979); H-W: Hölldobler and Wilson (1990); KP: Kukalová-Peck (1991); L-S: Longino and Snelling (2002); m-w: Merrian-Webster dictionary; S-A: Schultz and Alonso (2000); SN: Snodgrass (1935); TB: Torre-Bueno Glossary (Nichols 1989); WI: Wilson (2003.). The symbol ^ indicates information provided by D. Agosti (personal communication); the symbol ~ indicates close to; i.e.: abbreviate Latin id est (that is); alt.: alternative; e.g.: abbr. Latin exempli gratia (for example); adv.: adverbial form; adj.: adjective; dim.: diminutive; pl.: plural.

The symbol ^ indicates information provided by D. Agosti; the symbol ~ indicates close to; i.e.: abbreviation Latin id est (that is); alt.: alternative; e.g.: abbr. Latin exempli gratia (for example); adv.: adverbial form; adj.: adjective; dim.: diminutive; pl.: plural. Words enclosed between parenthesis and quotation marks (" ") are not recommended.

Abd: Abdominal segments, e.g. Abd I, II, III, IV, etc.

Acute: TB, terminating in or forming less than a right angle.

ad: adverb form, BR, suffix used to indicate "toward" in relative positions (anteriad, posteriad, dorsad, ventrad, cephalad, distad, proximad, etc.)

Aedeagus ^ G-B : in Hymenoptera, bilobate intromittent organ, penis and penis valves, or entire genitalia.

Alveolate: H-W, G-H, having lacunose, circular (alveoli), regular (honeycombed) or irregular depressions limited by costae. Angular cavities (alveoli) separated by thin partitions. Alveolae and foveae might look similar. Alveolae are holes delimited by costae, foveae are holes delimited by the matrix of the cuticle. See fovea.

Anal: wing vein (Fig. 6).

Anapleural sulcus: , a groove extended posteroanteriorly from the subalar pit to the epicnemial carina. The anapleural sulcus divides the episternum in two sclerites, the anepisternum (superior) and the katepisternum (inferior) (Snodgrass 1935). See anepisternum, katepisternum, epimeron.

Anastomose (adj.), anastomosis (noun): G-H, running into each other.

Anepisternum: the mesopleural sclerite superior to the anapleural sulcus (Fig. 16). See anapleural sulcus, epimeron, katepisternum.

Angulate, angulatus: TB, forming an angle; when 2 margins meet in an angle.

Angustate, angustatus: TB disproportionately narrow.

Annulus (antennalis): T-B the ring sclerite of the head into which the basal segment of the antenna is inserted. G-H, the sclerotized ring on the head into which the basal segment (scape) of the Antenna is inserted. The Antennal sclerite. Same as torulus (BO).

Anteclypeus ("apron"): G-H, the anterior portion of the clypeus attached to the labrum. In Procryptocerus it is composed by the discal, usually impressed, anteclypeus, and the anteclypeal carina.

Antenna cleaner[^] G-B : in adult Hymenoptera, an excavation (notch) on the interior (flexor) base of the first tarsomere of the anterior tarsus fringed with a row of bristles (antenna comb), covered by a movable process from the end of the tibia (strigilis), forming an opening through which the antenna may be drawn; any structure on the anterior tibia resembling or functioning similarly to the antenna cleaner of adult Hymenoptera.

Antennal condylar bulb: BO, the basal, rounded bulb of the antenal condyle that inserts into the torulus. The condyle (or radicle) is divided into a basal condylar bulb and a distal condylar constriction ("neck") on the base of the scape shaft. See radicle, antennal condylar constriction, scape shaft.

Antennal condylar constriction: the "neck" between antennal condylar bulb and basal shaft scape.

Antennal condyle (radicle): the basal process of the antenna formed by antennal condylar bulb and condylar constriction that is in direct contact with both the antennal fossa and the torulus (antennal sclerite). See radicle, antennal condylar bulb, antennal condylar constriction (Fig. 4).

Antennal fossa: G-H, sulcus, depression, groove or cavity in which Antenna are located or concealed; BO, The scape articulates with the head in the antennal socket (= antennal insertion).

Antennal fovea: TB, the impressed circular area surrounding "annulus" [torulus], frequently connected with the "antennal furrows" [antennal scrobes] and the lateral fovea (fovea beneath torulus). In Procryptocerus, antennal fovea is considered in Andean species possessing clypeo-torular sulcus. The antennal fovea is a C-shaped invagination composed of the clypeo-torular sulcus (a sulcus separating nasal flank and torulus) and the lateral fovea (fovea beneath torulus). In t The dorsal aspect of the C-shaped sulcus separates the torulus from the frontal lobe. In most andean Procryptocerus species there are three main foveae related to the area of antennal

insertion: antennal fovea, lateral fovea, and facial fovea. See these terms, and clypeo-torular sulcus.

Antennal scrobe ^ G-B : in some adult Hymenoptera, one of a pair of excavations on the frons, receiving the basal part of the antenna. See antennal fovea.

Antennal socket: G-H, the membraous area of the carinal wall, reinforced by a marginal ridge, in which the antenna is set.

Anteriad (adv. of anterior): S-A, toward the anterior. See the Discussion section.

Anterior humeral inflection: the mesially inflected anterior panel of lateropronotum.

Anterior metasoma: Abd II=petiole=metasomal 1. See metasoma in the Discussion section.

Anterior view: view of the head having mandibular condylae and anterior margin of clypeus in the same plane of view. In Procryptocerus, in anterior view, the discal (middle) clypeus, mandibular condylae and posterior margin of the clypeus are in the same plane of view. See the Discussion section.

Anterior: Fig. 2. See the Discussion section.

Antero: TB, dictionary.com, Merrian Webster, anterior, in front, to the front of. See the Discussion section.

Anterodorsad (position): in the front and up or on the superior side. See the Discussion section.

Anterodorsad: ((adv. of anterodorsal) (relative position), anterior and on dorsum. Anterior prevails over dorsum. See dorsoanteriad. See the Discussion section.

Anterodorsal (position or view): dc, m-w. In front and above; TB, toward the front and dorsum. (Fig. 2). See the Discussion section.

Anteroinferior: TB, dc, m-w, in front and below. See the Discussion section.

Anterolateral: TB, located anteriorly and to the side. See the Discussion section.

Anteromedial (anteromesial): TB, Be, in the front and along the midline. See the Discussion section.

Anteroposterior: (not position) dc, m-w, concerned with or extending along a direction or axis from front to back or from anterior to posterior. See the Discussion section.

Anteropronotum: The anterior region of the pronotum not including the neck. This area is usually convex from the neck until reaching the highest point on pronotum dorsally. The lateral portions of the anteropropodeum are inflexed forming the humeri. See humerus.

Anteropropodeal process: (Fig. 3), lateral lobe on anteropropodeum. See process.

Anteropropodeum: See propodeum.

Anteroventrad (position): TB, Be, in the front and underneath or on the lower side. (Fig. 2).

Anti: TB, Latin prefix; against; opposite; contrary; contrary

Apicad: TB, toward the apex.

Apical: TB, near or pertaining to the apex of any structure. (Fig. 2, 5).

Apicolateral angle of mandible: inferior angle in the apical (masticatory) margin of mandible, where the apicoinferior tooth is present in *Procryptocerus*. (Fig. 6, 7).

Apicolateral tooth of mandible: a tooth in the inferior angle of the apical (masticatory) margin of the mandible. (Fig. 6, 7).

Apicolateral: TB, located apically and to the side.

Apicomesial angle of mandible: the superior angle of the mandible opposite to the apicolateral angle or tooth. (Fig. 5-7).

Appendage: G-H, any part, portion, piece or organ attached by a joint to the body or other primary unit of structural organization (e.g. leg, antenna, wing, paramere, buccal pieces). A subordinate part of an organ.

Appressed: H-W, referring to a hair that runs parallel, or nearly parallel, to the body surface. (Fig. 35).

Arcuate: H-W, curved, bow-like. In *Procryptocerus*, the e.g. *batesi* group has an postpetiole arcuate posteriorly (dorsal view).

Areolate (areolatus): TB, BR, G-H, HA, furnished with areolae, like a network, divided into a number of small irregular spaces.

Aspect: G-H, the direction in which a fixed surface faces. E. g. inferior aspect of mandible.

Atomarius: G-H, HA, TB, with minute dots or points. In *Procryptocerus*, atomarius and puncticulate interchangeable.

Attribute: G-H, a quality, trait, characteristic or feature of an organism.

Axilla: SN, posterolateral areas of scutum posterior to the transcutal suture. In *Procryptocerus*, the two small subtriangular sclerites at the lateral angles of the prescutellum, separated from the

scutum by the transcutal suture (=transcutal articulation) and from the scutellum by the scutoscutellar sulcus. (Fig. 15, 37). See scutum, scutellum, scutoscutellar sulcus, transcutal suture.

Axillar carina ^ G-B : in adult Apocrita (Hymenoptera), carina that delineates the dorsal axillar surface from the lateral axillar surface.

Axillular scrobe ("fossa"): The lateromesially impressed grooves where the wings rest, running from wing sclerites to scutellum posteriad.

Basal ring ^ G-B : in Hymenoptera, sclerotized ring surrounding parameres proximally. (Fig. 41).

Basal: d-c, G-H, relating to, situated at, or forming the base. Pertaining to the base or point of attachment nearest the main body. (Fig. 2).

Basivolsella ^ G-B : in male Hymenoptera, the main plate of the volsella, i.e., the volsella except for chelate apex.

Bristle: G-H, setae that appear stiff, based on an impression conveyed by size and shape. Bristles are often short and blunt. Setae that are significantly larger in length or diameter than the surrounding setae or nearby setae.

Bulla: G-H, the thin, convex, roof-like sclerite over the Metapleural Gland.

Canalicular: G-H, channelled. A term applied to structure that is longitudinally grooved, with a deeper concave lines in the middles.

Carina (pl. carinae): BO, a ridge or low, keel-like crest.

Carinula: G-H, a small carina or keel-like ridge.

Carinulate: TB, with several small, elevated, longitudinal ridges or carinae.

Caudad (adv. of caudal): TB toward or in the direction of the tail; posteriad.

Caudal metasoma: abdominal segments V to pygidium. It is the group of somites posterior to the middle metasoma. See metasoma under the Discussion section, posterior metasoma, metasomal 2, postpetiole, metasomal 3, opisthogaster, middle metasoma. (Figs. 15, 37, 38).

Caudal: TB, of or pertaining to the cauda or to the anal end of the insect body.

Caudocephalic: (orientation) TB, in a line from the tail to the head.

Cephalad (adv. of cephalad): toward or in direction to the head; anteriad.

Cinctus (pl. cincti): the constriction, usually visible as entire circumference in the form of belt, which joins presclerites and postsclerites on metasomal 1 -often between posteropropodeal lobes-, metasomal 2 (postpetiole) -between first helcium and the visible metasomal 2-, and metasomal 3 -between second helcium and the visible metasomal 3-. In two-petiolate ants such as *Procryptocerus*, cincti are cinctus 1, cinctus 2 and cinctus 3. The presclerites of the metasomal 2 and 3 are inserted in the posterior foramen of the preceding segments, often leaving the cincti visible externally. (Fig. 3, 11).

Cinctus 2: See cincti

Cinctus 3 ("girdling constriction"): See cincti.

Clathrate: G-H, HA, L-S, TB, composed of high, sharp, well-separated rugae, which form irregular polygons over surface.

Clavate/claviform (antenna): BO, With the distal 1-4 (possible more segments in other genera) funicular segments enlarged.

Clypeal carina: lateral ridged margin, clypeal margin. Lateral ridged margin on *Procryptocerus nasus*.

Clypeal flank: The lateral to discal clypeus, panels of nasus (clypeus), between clypeal carina and toruli, and superior to malar and premalar space. See clypeus, clypeal carina, malar space, premalar space.

Clypeo-malar suture: clypeogenal suture = malar sulcus (Fig. 3).

Clypeo-torular sulcus: In *Procryptocerus*, the clypeo-torular sulcus is the dorsoanterior C-shaped (lateral view) sulcate stretch of the antennal fovea supra the lateral fovea (Fig. 24). It is a variable, curvate groove formed by the posterior invagination of the nasal flank in some Andean species. When the clypeo-torular sulcus is present, it contains the clypeomalar (clypeogenal) suture (Fig. 9). The clypeo-torular sulcus is in connection to both the torulus (posterior) and the lateral fovea (fovea beneath torulus). The clypeo-torular sulcus is as deep as the lateral fovea (e.g. *P. carbonarius*, *P. rudis* -Fig. 24) when the clypeal flanks are anterior (at the same plane as the discal clypeus) extending laterally toward the premalar space, and relatively hiding the torulus. When no deep clypeo-torular sulcus is present, the nasal flanks fall orthogonal to the discal clypeus, and the clypeo-torular sulcus is not as deep as the lateral fovea, hence it does not hide the torulus in anterior view. The clypeo-torular sulcus is absent when the nasal (clypeal) flank terminates fused onto the torulus posteriorly. See clypeus, premalar space, clypeomalar suture, clypeal flank, malar space. In most andean *Procryptocerus* species there are three main

foveae related to the area of antennal insertion: antennal fovea, lateral fovea, and facial fovea.
See these terms.

Clypeo-torular suture: in *Procryptocerus*, a suture between clypeus and torulus. The clypeo-torular suture is the short stretch of the clypeomalar (epistomal) suture that resides between the nasal flank and the torulus. The clypeo-torular suture is located inside of the clypeo-torular sulcus when the latter is present.

Clypeus: SN, the facial area of the cranium just above the labrum, usually separated from the frons by an epistomal suture, and sometimes divided into an anteclypeus and a postclypeus. In *Procryptocerus*, the anteclypeus is formed of a margin or a carina (anteclypeal carina); the clypeus is composed of a discal (central) lobe flanked at sides, and the lateral premalar spaces. The flanks are parallel, anterior to the toruli. See discal clypeus, clypeal flank, clypeo-torular sulcus, clypeo-torular suture, premalar space.

Compressed: lateromesially flattened.

Concolorous: H-W, of a uniform color.

Condylar bulb: BO, the ball-like bulb in the base of the scape which actually articulates within the antennal socket.

Condyle (radicle): the narrowed base of the scape formed by both a ball-like condylar bulb, the part which actually articulates within the antennal socket, and the condylar constriction ("neck") just distal of the condylar bulb, beyond which the scape shaft proper commences.

Cordate: H-W, heart-shaped.

Coriarius: HA, lather-like in sculpture, with minute cracks like the human skin.

Corrugate: HA, TB, wrinkled into furrows, with alternate ridges and channels.

Corticinus: TB, HA, bark-like sculpturing or texture.

Costa (pl. costae) G-H, an elevated ridge that is rounded at its crest. Costae are thicker or more elevated than costulae.

Costa: The anteriormost longitudinal vein of forewing (Fig. 46).

Costate: (dim. Costulate) HA, TB, furnished with longitudinal raised ribs or ridges (costae), much coarser than carinate.

Costulate: HA, with less prominent ridge or ridges than costate. (Fig. 14).

Crenate: margins with shallow rounded or blunt teeth.

Crenate: HA, having the margin evenly notched with rounded teeth.

Crenulate: margins with small rounded or blunt teeth, diminutive of crenate.

Crenulate: HA, having the margin finely notched with small, rounded teeth.

Crescentiform: G-H, crescent-shaped; lunule-shaped.

Curvate: G-H, pertaining to structure that is curve along its primay axis or margin, but not appearing broken.

Cuspis volsellaris ^ G-B : in Hymenoptera, cuspis (Figs. 42, 43).

Decumbent: H-W, referring to a hair that stands 10 to 40 degrees from the surface (Fig. 35).

Deflexed: Bent or turned abruptly downward at a sharp angle.

Denudate: HA, without hairs.

Depressed: dorsoventrally flattened.

Digitus volsellaris ^ G-B : inner, apical, moveable finger of the volsella (Figs. 42, 43).

Dim: BR, indistinct, “fuzzy”, obscure.

Disc: G-H, the central upper surface of any anatomical structure or body part; all of the surface area within the margin of a structure.

Discal cell ^ G-B : in adult Hymenoptera, first discoidal cell (DC1).

Discal: G-H, on or relating to the disc of any surface or structure.

Disciform, Discoid: G-H, disc-shape; pertaining to structure that is disc-shaped or plate-like.

Discoidal cell ^ G-B : TB, G-B, first discoidal cell, located near the middle of the wing or, one or more median cells in distal half of wing, including first discoidal cell.

Discoideous: G-H, discoidal.

Distad: W-H, located toward the distal or farthest end. See distal, proximad, proximal.

Distal: W-H, farthest away from the body. Used in appendages. The half farthest portion of and appendage. (Fig. 2). See distad, proximal, proximad.

Dorsad: (relative position) TB, in the direction of the dorsum or back of an insect.

Dorsal: (position) TB, on or of the functionally upper surface (that opposite the surface bearing the trunk appendages); of appendages, the upper surface when the appendage is fully extended horizontally from the body (Fig. 2).

Dorsellum ^ G-B : G-B, in adult Hymenoptera, central part of the metanotum.

Dorsoanteriad (adv. of dorsoanterior): (relative position), on dorsum and anterior. Dorsum prevails over anterior. See anterodorsad.

Dorsolateral: (position) TB, dc, at the top and to the sides.

Dorsomesal: (position) TB, Be, at the top and along the midline.

Dorsomeson: TB, the intersection of the meson with the dorsum of the body.

Dorsopleural line: TB, the line of separation between the dorsum and the pleural region of the body, often marked by a fold or groove.

Dorsopronotum: The dorsal surface of the pronotum. (Fig. 9).

Dorsopropodeum: See propodeum.

Dorsopropodeum: The dorsal surface of the propodeum. (Fig. 3). See propodeum.

Dorsum: TB, in general the upper surface.

Ecarinate: HA, TB, without or deprived of a keel or a carina (used to contrast carinate).

Ectal (adv. ectad): G-H, directed outward or toward the outer surface of the insect body (Fig. 6).

Edentate: without teeth.

Emarginate: BO, having a notch, impression, or indentation in a margin, border, or edge. Versus Entire.

Ental (adv. entad): G-H, descriptive of something projecting inward from the external surface of the insect body.

Entire: H-W, referring to a smoothly unbroken margin. Versus Emarginate.

Epicnemial carina: G-B, ridge more or less parallel to the anterior margin of the mesepisternum delineating anteriorly an epicnemium. (Fig. 10).

Epicnemial process: inferoanterior projection of the epicnemial carina, in *Procryptocerus* usually flanking the posterior part of the procoxae externally. (Fig. 10).

Epicnemium ^ G-B : in many adult Apocrita (Hymenoptera), portion of the mesepisternum anterior to the epicnemial carina.

Epimeron: SN, the area of the pleuron posterior to the pleural suture, sometimes divided horizontally into an anepimeron and a katepimeron. The epimeron is usually absent in worker ants. See anapleural suture, anepisternum, katepisternum.

Epipygium ^ G-B : TB, G-B, in adult Hymenoptera, the tergite of the last abdominal segment. (Figs. 9, 15, 38, 39). See hypopygium.

Episternal scrobe: G-B, in virtually all adult Apocrita (Hymenoptera), a small pit on mesepisternum, slightly anterior to the epimeron and about one-third of its length down.

Epistoma: SN, area between frontoclypeal suture and labrum formed of anteclypeus (Fig. 4) and clypeus (Figs. 3, 4, 9, 16). The lower face. See lower face.

Epistomal suture: SN, frontoclypeal suture. (Fig. 3). See frontoclypeal suture.

Erect (erect hairs): H-W, referring to a hair that stands straight up, or nearly straight up, from the cuticle (Fig. 35).

Eroded: G-H, gnawed. Pertaining to a margin with irregular teeth and emarginations.

Excavation: G-H, a cavity, pit, groove or depression in the integument.

Face ^ G-B : TB, G-B, in adult Hymenoptera, the area between the mouth margin and the median ocellus. In Procryptocerus, the area including the frons (upper face) and the clypeus (lower face). See lower face.

Facial fovea: TB, a depressed area on malar space in the preocular [malar] area. (It is different of "facial impression" sensu G-H, on which "facial impression" is synonymous of scrobal impression (=antennal scrobe)). In Procryptocerus (e.g. *P. rudis*), the facial fovea is a depressed (sunken) area, variable sculptured, laterad to the lateral fovea (fovea beneath torulus) in the malar space, and limited externally (laterally) by the malar tumulus. It is usually present in Andean species. In most andean Procryptocerus species there are three main foveae related to the area of antennal insertion: antennal fovea, lateral fovea, and facial fovea. See these terms, and malar tumulus (Fig. 24).

Farinose, farinosus: TB, dotted with many single flour-like spots; mealy.

Fastigial: G-H, descriptive of or pertaining to a fastigium. See fastigium.

Fastigium: G-H, SN, (Latin, fastigium = a slope, roof), a prominent deflexed angle between the vertex and the face. Commonly to describing vertex and frons sloping into a point. In most Procryptocerus (head lateral view), vertex and frons are united into an acute (fastigial) angle. (Fig. 3).

Fissate: (appearance) HA, with fissures or cracks, divided or cleft.

Flange: G-H, a part of a structure or sclerite that spreads out like a rim. In *Procryptocerus*, the frontal lobe is flanged in several Andean species. (Fig. 24).

Flank: BR, side.

Foramen (pl. foramina): BO, G-H, an opening or perforation in a sclerite; an opening in the body wall for the passage of a vessel or nerve.

Fovea (pl. foveae, dim. foveola): BO, a depression or impressed pit. (Fig. 15). In *Procryptocerus*, foveae and alveolae may look similar. However, the main distinction stems from the fact that foveae are holes delimited by the matrix of the cuticle; while alveolae are holes delimited by costae. See alveolae.

Foveate (dim. foveolate): with foveae (or foveolae). (Fig. 15).

Foveola: BO, diminutive of fovea; a small pit or depression (Fig. 14).

Free: d-c, unobstructed; clear. Not in contact with another structure.

frontal carina posterior lobe: The posterior lobe of frontal carina. (Figs. 3, 15, 16, 24). See frontal lobe (Fig. 24), frontovertexal corner (Figs. 3, 4).

Frontal carina ^ G-B : a longitudinal ridge on the frons, mesad of the antennae in some adult Hymenoptera, ridge-like posterior extension of frontal carina anterior lobe onto frons. See frontal lobe (Fig. 24), frontal carina posterior lobe (Figs. 3, 15, 16, 24), frontovertexal corner (Figs. 3, 4).

Frontal lobe: BO, the frontal carinae anteriorly expanded into projecting lobate extension. A lobate carina that overhung and concealed the torulus. In *Procryptocerus*, the frontal lobe is most common in the Andean species. (Fig. 24). See frontal carina posterior lobe, frontovertexal corner.

Frontal triangle: BO, a small triangular patch of cuticle located medio-dorsally on the head immediately behind the clypeus and approximately between the antennal sockets or anterior parts of the frontal carinae. In *Procryptocerus* it is a small depression located mesidorsad behind the nasus or clypeus and between toruli. It is absent in several species (Fig. 4).

Frontoclypeal suture (=epistomal suture): BO, the suture forming the posterior margin or boundary of the clypeus. In *Procryptocerus*, the lateral portion of the frontoclypeal or epistomal suture is also called clypeomalar suture, anterior to which is the premalar space. See premalar space, malar space, gena.

Frontovertexal corner: In *Procryptocerus*, the posterolateral angle between frons and vertex. (Figs. 3, 4, 16, 17). See frontal carina posterior lobe, frontal carina anterior lobe.

Frontovertexal margin: In *Procryptocerus*, a transversal border between the frons and the deflexed vertex. The frontovertexal margin may be distinct throughout (fastigial) (Figs. 3, 4, 9, 14, 15, 16-19, 25, 27, 29), indistinct throughout (Fig. 23), medially indistinct and laterally distinct (Figs. 20-22), slightly medially notched (Figs. 4, 19), crenate (Fig. 18), crenulate (Fig. 4), or flanged-biconvex. (Fig. 27).

Full face view: BO, orientation of the head in which the midpoint of the anterior clypeal margin, the midpoint of the occipital (vertexal) margin, and the midpoints of the sides are in focus at the same time. Due to the formation of an expanded nasus, in *Procryptocerus* the anteclypeal carina

is anteroventrad and the frontoclypeal (epistomal) suture anterodorsad. Therefore, it is not possible to focus on these two planes at the same time. In groups such as *Procryptocerus*, it is not possible to focus on full face view as it is defined elsewhere. See full frons view.

Full frons view: In *Procryptocerus* and other ants possessing an anterior expanded nasus, a view of the frons, which is dorsal or dorsoanterior in its entire extent and allows visualization of the frontovertexal margin, frontal carinae and frontoclypeal (epistomal) suture, or the inter-torular space, at the same time. This view does not include the lower face or epistoma (clypeus plus anteclypeus). See full face view, epistoma, clypeus, anteclypeus, lower face.

Fungiform: fungus-like in physical appearance.

Furred: TB, covered with short, dense decumbent hair resembling fur (the dressed hairy coat of a mammal [syn: pelt]).

Furrow: BR, channel, groove.

Fused: TB, run together; as when 2 normally separated markings or sclerites become confluent and have a common outline.

Fusiform: TB, spindle-shaped, i.e. broad at the middle and narrowing toward the ends. In *Procryptocerus* normally referring to the shape of femora.

Gaster: In the sense proposed here gaster equates posterior metasoma (metasomal 2 [Abd III] to pygidium) in ants where a postpetiole is not considered. The posterior metasoma is gaster when its metasomites 2 to pygidium (Abd IV to pygidium) are combined as a unit. On the other hand, the opisthogaster constitutes the combined metasomites 3 (Abd IV) to pygidium in Formicidae. See the metasoma under the Discussion section. See anterior metasoma, posterior metasoma,

metasomal 1 (petiole), metasomal 2, postpetiole, metasomal 3, middle metasoma, opisthogaster, and caudogaster.

Gastral ^ G-B : in adult Apocrita (Hymenoptera), of or pertaining to the gaster. See the metasoma in the Discussion section.

Gena: G-H, the sclerotized area on the side of the head below the compound eye and extending to the gular suture. In ants the gena comprises the area anterior to the eye (the malar space) and the ventral area (ventral gena) which forms the genal bridge. (Figs. 3, 4). In Procryptocerus, the ventral gena is ventrad to both malar space and eye. See ventral gena, malar space, genal bridge, postgena, postgenal bridge, temple.

Genal bridge: G-B, in some adult Hymenoptera, bridge formed posterior to the labium (Fig. 7) by the fusion of the [ventral] genae; see hypostomal bridge, ventral gena, and postgenal bridge.

Genal sulcus: G-B, in adult Hymenoptera, the malar sulcus. The subocular sulcus.

Genitalia: G-H, the external components of the reproductive system which are derived from Ectoderm.

Glabrous: HA, smooth, devoid of pubescence (sens. str.).

Globoid: having a globelike shape; spheroid.

Glossy, Nitid : HA, shiny, reflecting light.

Goffered: TB, HA, with regular impressions, closely set, and separated by narrow edges; waffling or honeycombs.

Guard setae (= guard hairs): BO, specialized setae that traverse and protect the orifice of the metapleural gland.

Gyne: dA-BU, a female caste devoted primarily to reproduction. When there are not soldiers the two female castes are termed workers and gynes.

helcial: referring to the helcium.

Helcium: BO, "the much-reduced collar-like pretergite and the accompanying presternite of abdominal segment 3, which anteriorly is socketed in, and articulates with the posterior end of segment 2 (the petiole) ." (Fig. 9). "In taxa such as the Myrmicinae, where abdominal segment 3 is also very reduced in size (postpetiole) the articulatory pretergite plus presternite of segment 4 may also be very small and specialized, and in this condition may be referred to as the second helcium or helcium of abdominal segment 4." (Figs. 9, 16). In *Procryptocerus*, the reduced, collar-like, specialized presclerites of first and second helcium are anterior to cincti 2 and 3. (Figs. 9, 16). See cinctus.

Hirsute: G-H, clothed with long, strong, shaggy setae.

Hispid: G-H, bristly or sparsely set with short, stiff setae.

Homodynamous: G-H, structures of the body segments that are serially homologous. The homology of metameres (somites).

Humeral angle: BO, the anterolateral dorsal angles of the pronotum (Figs. 3, 15). See humerus.

Humerus (Pl. humeri): G-H, the anterior part of the pronotum. In *Procryptocerus*, the humeri are formed by the mesial inflexion (inflection) of the anterior area of the pronotum anteriorad to lateropronotum. The humeri and the postgenae couple together when the head is deflexed.

Hypopygium ^ G-B : last visible abdominal sternum, being sternum IX in males and sternum VII in females. (Figs. 9, 38, 40). See epipygium.

Hypostoma: BO, the anteroventral region of the head; the area of cuticle immediately behind the buccal cavity and forming its posterior margin (Fig. 7).

Hypostomal bridge: G-B, bridge formed posterior to labium by the fusion of the hypostomae.

Hypostomal carina ^ G-B : in adult Hymenoptera, ridge delimiting hypostoma laterally.

Hypostomal teeth: BO, one or more pairs of triangular or rounded teeth that project anteriorly from the anterior margin of the hypostoma.

Imbricate: G-H, structures arranged or appear as the scales on a fish or the shingles on a roof. In *Procryptoceus*, imbricate or microimbricate (with smaller scales) are common on the scape.

Immarginate: Not having a distinctive margin or border.

Impressed: HA, having a shallow depressed area or margin.

Incrassate: G-H, thickened. Pertaining to a structure that is expanded or swollen at some one point, especially near the apex.

Indistinct (indistinctus) ^ G-B : obscure, not clear, dim.

Inermis: H. unarmed; without striae, spines, or any other sharp processes.

Inferior mandible scrobe: In *Procryptoceus*, a glossy, usually hirsute scrobe on the lateral (inferior) aspect of the mandible.

Infero: prefix, positioned below. Infra.

Infra infero): TB prefix; below. Positined below.

Infumated, infumatus: TB smoke-colored; clouded, as with smoke.

Infusate, infuscated, infuscatus: TB smokey gray-brown, with a blackish tinge.

Ingens: TB, unusually large or disproportionate in size.

Intertorular space: In *Procryptocerus*, the area of frontoclypeus between toruli.

Intra: TB within; between.

Iso: TB equal.

Katepisternum: the mesopleural sclerite inferior to the anapleural sulcus. (Figs. 9, 10, 16, 38).

Lacunose (adj.), lacuna (pl. lacunae) (noun): G-H, HA, with scattered and irregular broad, shallow cavities.

Laevigatus: see levigate.

Lamina volsellaris ^ G-B : in Hymenoptera, basivolsella. (Fig. 45).

Laterad: Towards the side. (Fig. 2).

Lateral fovea: G-H, a pit of each side of the head near the antennal scrobes and sometimes connected with them by a short furrow. In *Procryptocerus*, lateral fovea is a glossy, subcircular sunken pit beneath the torulus, the inferior part of the antennal fovea (Fig. 24) visible from lateral and not from dorsal (frontal) view. It marks the most anterior point of the antennal scrobe, and is present in most *Procryptocerus* species. The lateral fovea is usually bigger in *Procryptocerus* species from northern South America to Mexico. In most Andean

Procryptocerus species there are three main foveae related to the area of antennal insertion: antennal fovea, lateral fovea, and facial fovea. See these terms and clypeo-torular sulcus.

Lateral mesoscutal lobes ^ G-B : in adult Hymenoptera, parapsides. Usually not in ant workers.

Lateral: Located on the side. (Fig. 2).

Lateropronotum: In *Procryptocerus*, the pronotal side panel of the pronotum (Figs. 9, 38).

Lateropropodeum: In *Procryptocerus*, the area lateral to the dorsopropodeum, including the spiracle. See propodeum (Figs. 9, 10).

Laterotergite: G-H, a lateral sclerotization of the dorsum distinct from a principal median tergum.

Levigata (alt. levigatus, laevigatus, laevis): TB, a smooth surface, sometimes somewhat shiny or polished; without elevations or depressions.

Lobate, lobatus: TB, with lobes; divided by deep, undulating and successive incisions.

Lobe: G-H, any prominent, rounded process or excrescence along a margin or the surface of a structure; a wing area (near posterior edge) defined by two convex margins separated by a notch. e. g. frontal lobe (Fig. 24), and frontal carina posterior lobe (Figs. 3, 16, 17, 24).

Lobose (=lobiform H-W): WI, shapelike a lobe, as for instance rounded frontal lobe, or surrounded by a lobe, for instance as a lobose projection from the humerus. e. g. frontal lobe (Fig. 24), and frontal carina posterior lobe (Figs. 3, 16, 17, 24).

Lower face: G-B, in adult Hymenoptera, area of face between the mouth margin and margin of toruli. In *Procryptocerus*, the epistoma (anteclypeus, plus clypeus).

Malar space ^ G-B : TB, G-B, in adult Hymenoptera, the shortest distance between the base of the mandible and the ventral margin [or the nearest margin to the mandible] of the compound eye. It is the lateral portion of the gena between eye and mandible. (Figs. 3, 4, 9, 14). In Procryptocerus, a very short premalar space, anterior to the malar space, is also characterized by a different sculpturing than malar space, and being the most lateral portion of the epistoma (clypeus) terminating into the mandible condyle (Figs. 3, 4). See gena, premalar space.

Malar sulcus: G-B, subocular sulcus; genal sulcus.(Fig. 9).

Malar tumulus: In Procryptocerus, a small costate or costulate elevation of cuticle on malar space, laterad to facial fovea, midway between facial fovea, eye, and mandibular condyle. See tumulus.

Manubrium: In all the ants, an anteriorly specialized structure of the segment II, which articulates with the propodeum. The tergite always consists of only one sclerite, whereas the sternite is made of one or two parts, the presternite and the poststernite, which are adjusted without interposition of a membrane (Perrault 2004).

Marginate: BO, having a sharply defined rim, edge, or margin separating one face of a sclerite, segment, or tagma from another.

Medial line (medial plane): a line or plane which divides animals into right and left parts. (Fig. 2).

Mediodorsal: dc, relating to the median plane and the dorsal plane.

Mesad (mesiad) (adv. of mesal=mesial): (direction) TB, toward or in the direction of the meson of the insect body. BO, medially, toward the middle, towards the midline. G-H, descriptive of something near an imaginary line (meson) dividing a body into left and right halves.

Mesal (mesial): (position) TB, pertaining to, situated on, or in the meson (Fig. 2).

Mesially: (position) G-H, at or to the middle or midline of a structure.

Mesocoxal cavity: A ventral foramen or fossa in the body wall of the mesothorax for the insertion of the mesocoxa. (Fig. 12).

Mesometanotal suture: A suture between the mesonotum and the metanotum, usually not distinct in worker ants when a notopropodeal fusion is present. (Fig. 16). See notopropodeal fusion.

Meson (mesion): TB, Be, midline of the body; G-H, an imaginary middle plane dividing the insect body into right and left parts.

Mesonotal process: The lateral process on mesonotum. (Figs. 3, 9, 10). See process.

Mesopleural-coxal excavation: the mesopleural coxal process (Snodgrass 1935) invaginated into an excavation. (Fig. 10).

Mesopleuron: BO, the largest pleurite. It may consist of a single sclerite running almost the entire height of the mesothorax or may be divided by a transverse groove ("anterior oblique sulcus" [anapleural sulcus]) into an upper anepisternum and a lower katepisternum. The pleuron of the mesothorax. In *Procryptocerus*, the mesopleuron is divided into the anepisternum supra and the katepisternum infra (Figs. 9, 10, 16, 38). The pleural suture and the epimeron (the area of the pleuron posterior to the pleural suture) are usually absent in worker ants. See anapleural sulcus, anepisternum, epimeron, katepisternum.

Mesoscutum: G-H, the scutum of the mesothorax. See scutum, scutellum, transcutal suture, axilla.

Metacoxal cavity: (Fig. 12). A ventral foramen or fossa in the body wall of metathorax for the insertion of the metacoxa.

Metakatepisternum: The inferior region of metapleuron when a longitudinal suture (the metanapleural suture) is present dividing both sclerites: the metanepisternum and the metakatepisternum. (Fig. 16). The metakatepisternum is referred as metapleuron in ants. See metapleuron, metanepisternum.

Metanepisternum: The superior region of metapleuron when a longitudinal suture (the metanapleural suture) is present dividing both sclerites: the metanepisternum and the metakatepisternum. (Fig. 16). In Procryptocerus, the metanepisternum is clear in gynes. See metapleuron, metakatepisternum.

Metanotal-propodeal suture: The dorsolateral suture present between metanotum and propodeum. (Fig. 16). In Procryptocerus, the metanotal-propodeal suture is only present in gynes and males; in workers of some other groups (i.e. some Camponotus), the metanotal-propodeal suture is present as well.

Metapleural gland: BO, "an exocrine gland whose orifice is usually situated in the posteroventral corner of the side of the mesosoma, above the level of the metacoxa and below the level of the propodeal spiracle. The swollen bulla of the metapleural gland is often more conspicuous than the gland's orifice, taking the form of a shallow blister or convexity on the metapleuron and sometimes reaching almost to the propodeal spiracle. The orifice of the metapleural gland may be a simple pore, or may be protected by cuticular flanges or other outgrowths, or by guard setae

traversing the orifice". In *Procryptocerus* (i.e. *P. scabriusculus*), the orifice of the metapleural gland is a narrow slit protected dorsally by guard setae; the slit runs from the dorsum of the metapleural bulla goes posteriorly and turns down ventrally surrounding the gland; then ventrally (not seeing from lateral or dorsal view), it runs forward (under the metapleural gland scrobe) to the mesopleural-coxal excavation. (Fig. 12). See Mesopleural-coxal excavation, Metapleural gland scrobe.

Metapleural gland bulla: (Fig. 12). See Metapleural gland.

Metapleural gland scrobe: In *Procryptocerus*, it is a longitudinal cannalicular area of the inferior region of the metapleuron, above the metacoxa, running from metapleural gland bulla to the mesopleural-coxal excavation. (Fig. 10, 12). The metapleural gland scrobe is delimited supra and infra by two longitudinal carinae; the infra carina is located between the metapleural gland scrobe, lateral, and the metapleural gland slit, ventral. See Metapleural gland bulla, Mesopleural-coxal excavation, Metapleural gland slit.

Metapleural gland slit: (Fig. 12). See Metapleural gland.

Metapleuron: BO, the metapleuron (pleuron of the metathorax) is the lateral sclerite located posteriorly on the side of the mesosoma ("alitrunk"), below the level of the propodeum. (Fig. 10).

Metasoma: Abdominal segments II to pygidium (Figs. 3, 9). See metasoma under the Discussion section.

Metasomal 1: Abdominal segment II =anterior gaster =petiole. See posterior metasoma, metasomal 2, postpetiole, metasomal 3, opisthogaster, middle metasoma, caudal metasoma. (Figs. 3, 15, 37, 38).

Metasomal 2: Abdominal somite III. It is also called the postpetiole when a second helcium (sensu Bolton 1990) is present, or when an opisthogaster is considered, as in the present study. See metasoma under the Discussion section, posterior metasoma, postpetiole, metasomal 3, opisthogaster, middle metasoma, caudal metasoma. (Figs. 3, 15, 37, 38).

Metasomal 3: abdominal segment IV. The metasomal 3 is the second segment of the posterior metasoma (Fig. 3,9, 15, 16, 37, 38) (the biggest metasomite in Procryptocerus), or the first somite of the opisthogaster when an opisthogaster is considered. See metasoma in the Discussion section, posterior metasoma, metasomal 2, postpetiole, opisthogaster, middle metasoma, caudal metasoma.

Metatibial gland: BO, a presumably exocrine gland located ventrally on the metatibia just posterior to the tibial spur in several ant subfamilies. When present it varies considerably in shape and size.

Microimbricate: See imbricate.

Middle metasoma: Usually the largest region of metasoma formed by abdominal segments III and IV. See metasoma under the Discussion section, posterior metasoma, metasomal 2, postpetiole, metasomal 3, opisthogaster, caudal metasoma. (Figs. 37, 38).

Nasal flank: In Procryptocerus, lateral panel of clypeus, orthogonal to discal clypeus, anterior to torulus. (Figs. 3, 4, 38).

Nasus: TB, G-H, in certain Hymenoptera, the anterior termination of the face; a snout-like, anterior termination of the face in certain species. In *Procryptocerus*, the nasus is a protrusion of the discal clypeus forming the broad nasus. (Figs. 3, 4, 9, 16, 24, 36, 38). See clypeus, epistoma, lower face, nasal flank.

Nodal truncation: In *Procryptocerus*, the anterior truncate face of the node of the petiole (metasomal 1), often delimited by dorsolaterally extended costa or margen (Fig. 3). See truncate.

Notaulus (pl. notauli, SN: notaulices): G-H, Paired longitudinal cuticular forrows on the mesoscutum that converge posteriad and divide the mesoscutum into a medial and lateral areas. (Fig. 37).

Notch: G-H, an indentation, cut or incision in a surface.

Notopropodeal excavation: In workers of *Procryptocerus*, the dorsolateral cavities formed on each side of the notopropodeal fusion, where the mesosoma is constricted anterior to the propodeum. (Fig. 3). See notopropodeal fusion.

Notopropodeal fusion: In workers, the tergal fusion of the thoracic notum and the anterior region of propodeum (Fig. 3). The line of fusion has different names in the literature, such as “propodeal suture” (a suture in the propodeum), “metanotal suture” (a suture in the metanotum), “metanotal groove” (a groove in metanotum), “metanotal impression” (an impression in the metanotum), “metapropodeal suture” (suture in the posterior [meta] region of propodeum), antepropodeal suture, metanotal area, etc. Since these terms make reference to the line of fusion, we recommend using the adjective “notopropodeal” in reference to the line of fusion; for instance: notopropodeal suture, notopropodeal groove (Figs. 3, 9), notopropodeal convexity, notopropodeal impression, notopropodeal excavation; or otherwise make reference to the

notopropodeal fusion to describe specific characters, such as notopropodeal fusion flat, notopropodeal fusion convex, etc. In several groups, e.g. some Camponotus workers, the metanotum is clear and so are the mesometanotal suture and the metanotal-propodeal suture. In these cases, a notopropodeal fusion is not apparent. A mesometanotal fusion or a metanotal-propodeal fusion can also occur. See notopropodeal excavation, mesometanotal suture, metanotal-propodeal suture.

Notopropodeal groove: A transversal groove on the notopropodeal fusion. (Fig. 3, 9).

Nude, naked: TB, HA, devoid of hair, scales or other surface vestiture.

Oblong: having the longitudinal diameter more than twice the length of the transverse diameter; longer than broad.

Obsolete: G-H, pertaining to structure which is indistinct, not well developed or almost absent.

Occiput: G-H, the posterior portion of the head between the vertex and the foramen magnum. (Fig. 15).

Omaulus ^ G-B : in adult Hymenoptera, epicnemial carina. See epicnemial carina, epicnemium.

Opisthogaster (adj. opisthogastral): Abd IV to pygidium, when a postpetiole is considered. (Figs. 3, 15, 32, 38). See metasoma under the Discussion section, posterior metasoma, metasomal 2, postpetiole, metasomal 3, opisthogaster, middle metasoma, caudal metasoma.

Oral fossa ^ G-B : G-B, in adult Hymenoptera, preoral cavity.

Ovatus: BR, egg shape.

Palp formula (= palpal formula) ^ G-B : in adult Hymenoptera, 2 numbers, the former indicating the number of segments in the maxillary palpus (Fig. 8), the latter the number of segments in the labial palpus (Fig. 8). In Procryptocerus workers and gynes, the palpifer is usually half length of the first palpomere; therefore, it could be mistakenly recognized as the first palpomer of the maxilla.

Paradiscal: (BR, para: beside, near, by), beside of the disc or discal area.

Paramere(s) (=gonostylus): G-B, in Hymenoptera, paired appendages forming a conical capsule containing the more delicate parts of the genitalia. In Procryptocerus, the parameres are the posterior, paired, paddle-like appendages of the external genitalia (Fig. 37, 38).

Paramedial: (BR, para: beside, near, by), beside of the medial area. (Fig. 2).

Parapsidal line: G-B, in numerous Apocrita (Hymenoptera), a marking, or furrow lateral to notaulus, typically extending anteriorly from posterior region of mesoscutum. (Figs. 15, 16, 37).

Pecten: TB, G-H, any comblike structure or organ; in adult Hymenoptera, rigid, incurvate setae on the basal parts of maxilla and labium.

Pectinate: BO, comb-like.

Peduncle (of petiole): BO, the relatively narrow anterior section of the petiole which begins immediately behind the propodeal-petiolar articulation and runs back to the petiolar node or scale. It is very variable in length and thickness but when present in any form the petiole is termed pedunculate. When the peduncle is absent, so that the node or scale of the petiole immediately follows the articulation with the propodeum, the petiole is termed sessile. If an extremely short peduncle occurs the petiole is termed subsessile.

Petiole: BO, Morphologically, the second abdominal segment [Abd II]; the segment immediately following the mesosoma, which is usually reduced and always isolated. Generally the petiole takes the form of a node (nodiform) or of a scale (squamiform of varying shape and size, but in some taxa it may be very reduced represented by only a narrow, subcylindrical segment that may be overhung and concealed by the gaster) [or by the opisthogaster]. The petiole bears the second abdominal spiracle and usually consists of a distinct tergite and sternite. The former may have differentiated laterotergites low down on the side. In some groups the petiolar tergite and sternite have fused together. In Procryptocerus, the petiole is the anterior metasoma or metasomal 1 and has the cinctus 1 and usually a ventropetiolar process. In Procryptocerus, the anterior metasoma or petiole is a syntergosternite. (Figs. 3, 9). See metasoma under the Discussion section, metasomal 2, postpetiole, middle metasoma, caudal metasoma, gaster, opisthogaster, caudal metasoma.

Phragmotic: H-W, Sharply truncated as seen in the overall front of the head of some stem-dwelling ants. In most Procryptocerus, the discal clypeus forms a phragmotic nasus. See nasus, clypeus.

Piligerous (piliferous): bearing hairs.

Plectrum: See stridulatory system.

Pilosity: G-H, A covering of long, stout setae, typically standing above a vestiture of smaller, finer setae. Pilosity (Figs. 26, 30, 31) refers to long, erect, suberect, subdecumbent, decumbent (Fig. 35) or appressed hairs. In Procryptocerus, both stiff and flexuous pilosity are present. See pubescent.

Pleurosternite (lateroventrite): the lateral part of a definitive thoracic sternite. See ventropleurite, propleuron.

Propleuron: G-H, the lateral portion (sclerite) of an insect's prothorax. (Fig. 9). See ventropleurite, pleurosternite.

Politus: (Polished): HA, smooth shiny.

Porca (dim. porcula), BR, ridge between two furrows. See porcate.

Porcate: HA, G-H, a mix between sulcations and ridges (costae) or carenae, furrows are deep and wider than ridges; with several parallel, longitudinal ridges with deep, broad sulcations.

Posteriad (adv. of posterior): TB, toward the posterior end.

Posterior metasoma: Abd III (metasomal 2) to pygidium. See anterior metasoma (metasomal 1=petiole=Abd II), metasomal 2, metasomal 3, opisthogaster, middle metasoma, caudal metasoma.

Posteropropodeal lobe (BO, Propodeal lobes = metapleural lobes = inferior propodeal plates): when present they are situated infra the declivity, one on each side of the propodeal-petiolar articulation.

Posterior: TB, Be, hinder or hindmost, opposed to anterior; hind or rear part of a structure. (Fig. 2).

Posterodorsad ((adv. of posterodorsal): A relative position. On the direction of the back and dorsum. (Fig. 2).

Posterodorsal: dc, a rear part on the back (Fig. 2).

Posteroventrad (adv. of posteroventral): A relative (ad) position. On the direction of the back and venter. (Fig. 2).

Posteroventral (position or view): a rear part on the direction of the venter. (Fig. 2)

Posteropropodeum: See propodeum (Fig. 3, 10).

Postgena: G-H, the portion of the cranium immediately posteriad of the gena. In Procryptocerus, the postgena is the inferior area of the occiput beneath the occipital foramen within the occipital carina. (Fig. 7, 15). In lateral view, the postgenal bridge and the genal bridge meet ventrally into an angle or curve. See gena, genal bridge, ventral gena, postgenal bridge, temple.

Postgenal bridge: G-B, in some adult Hymenoptera, ventral bridge of head formed by median fusion of postgenae.

Postnodus: In Procryptocerus, the postpetiolar node. (Fig. 16).

Postpetiolar node: In Procryptocerus, the postnodus. (Fig. 16).

Postpetiole: BO, abdominal segment III [Abd III] being specialized by developing the second helcium. In Procryptocerus, it is the metasomal 2 (Abd III). (Fig. 3, 9, 15). See petiole (=anterior metasoma =metasomal 1, =Abd II), middle metasoma, posterior metasoma, metasomal 2, metasomal 3, opisthogaster, caudal metasoma.

Postsclerite: the posterior, distinct part of a sclerite. In Procryptocerus, the postsclerites (posttergites and poststernites) of the metasomal 2 (Abd III) and 3 (Abd IV) form the main regions of the postpetiole and first opisthogastral segments respectively (Figs. 3, 9, 15, 16, 38); they are separated from the first and second helcium by the cincti 2 and 3 respectively. The

posttergites, and usually the poststernites, of the metasomal 4, 5, and 6 are separated from the presclerites (pretergites and presternites) by a costa. See cinctus.

Preapicolateral tooth: In the mandible, tooth #2 from the apicolateral to the apicomesial angles of the apical (masticatory) margin.

Prefemur ("trochantellus"): KP, leg segment located at the base of the femur, distad to the trochanter (Figs. 9, 47). In *Procryptocerus*, the prefemur is an independent segment in the middle and hind legs.

Premalar space: In *Procryptocerus*, the very short, most lateral area of the clypeus, laterad to the anteclypeus, anterior to the malar space, terminating at the level of the condyle of mandible and separated from the malar space by the clypeomalar suture (Fig. 9). Usually, this small area is recognized by the difference of sculpturing compared to that of the malar space (Figs 3, 4). See clypeus, discal clypeus, clypeal flank, clypeo-torular sulcus, clypeo-malar suture, malar space.

Presclerite: SN, the anterior, distinct part of a sclerite. In *Procryptocerus*, the presclerites (pretergites and presternites) of the metasomal 2 (Abd III) and 3 (Abd IV) form the first and second helcium respectively; they are separated from the posttergites (the main regions of the postpetiole and first opisthogastral segment) by the cincti 2 and 3. Furthermore, the pretergites, and usually the presternites, of the metasomal 4, 5, and 6 are separated from the postsclerites (posttergites and poststernites) by a costa. See cinctus.

Prescutal suture ^ G-B : in adult Hymenoptera, notaulus. See notaulus.

Prescutellum (~axillae): the region between the transcutal suture and the scutoscutellar sulcus. In gynes and males of *Procryptocerus*, the prescutellum comprises a short dorsomedial area and the

lateral areas of the prescutellum, which are the axillae (axillae: SN, posterolateral areas of scutum posterior to the transcutal suture). (Fig. 15, 37). See axilla, scutoscutellar sulcus, transcutal suture, scutellum.

Process: G-H, Any prominent part of the body which projects from the surface but which is not otherwise definable; a bump; a hump; a wart; a tubercle. See mesonotal process (Figs. 3, 9, 10), anteropropodeal process (Fig. 3).

Profile: BO, orientation of part of the body in side (lateral) view so that the anterior, posterior, dorsal, and ventral outlines are in focus at the same time.

Premalar space: In *Procryptocerus*, a very short area anterior to the malar space, being the most lateral portion of the epistoma (clypeus) terminating into the mandible condyle (Figs. 3, 4). It is characterized by different sculpturing than malar space. See gena, malar space.

Prescutellum (~axillae): the region between the transcutal suture and the scutoscutellar sulcus. The prescutellum forms axillae laterally (Fig. 15, 37). See axilla, scutoscutellar sulcus, transcutal suture, scutellum.

Promesonotal excavation: In workers of *Procryptocerus*, the lateral cavities on each side of the promesonotal suture or fusion. (Fig. 3).

Promesonotal sclerite: G-B, in some adult Hymenoptera, the united pronotum and the mesonotum.

Promesonotal suture: BO, the transverse suture across the dorsal mesosoma that separates the pronotum from the mesonotum. (Fig. 3, 9). In *Procryptocerus*, the promesonotal suture is distinct in some workers as a superficial line or costa, or it is even obsolete in others.

Promesonotum: BO, the pronotum and mesonotum are fused with little or no sign of separation. (Fig. 9).

Pronotal lobe ^ G-B : in many adult Aculeata and Evanoidea (Hymenoptera), posterolateral region of the pronotum extending over the lateral edge of the mesepisternum (Fig. 9) so as to cover the mesothoracic spiracle.

Pronotal side panel (lateropronotum): G-B, lateral part of the pronotum. Lateropronotum.

Propodeal foramen ^ G-B : in adult Apocrita (Hymenoptera), socket of propodeum in which metasoma articulates.

Propodeal lobe: BO, "(= metapleural lobe, = inferior propodeal plate)". Posteropropodeal lobe (Fig. 12). According to Bolton (1994) these lobes should not receive the name of metapleural lobes "as they are formed from the propodeum and not the meta-pleuron". In Procryptocerus, a rounded infra area on each side of the posteropropodeum.

Propodeal spines ("epinotal spines") ^ G-B : in adult Myrmicinae (Hymenoptera ^ G-B : Formicidae), spines on propodeum ("epinotum") which protect the petiole ("pedicel").

Propodeum ^ G-B : TB, in adult Apocrita (Hymenoptera), the first abdominal segment when it forms a part of the mesosoma. We consider the propodeum divided into both the anteropropodeum, anterior to the propodeal spines, extended from dorsal (dorsopropodeum) to lateral (lateropropodeum-including spiracle) areas, and the posteropropodeum (declivitous or vertical area under propodeal spines, between posteropropodeal lobes). (Fig. 3, 9, 10, 15, 37, 38). See anteropropodeum, dorsopropodeum, lateropropodeum, posteropropodeum.

Propodeum: BO, morphologically, the tergite of the first abdominal segment, fused to the thorax and forming most of the posterior section of the mesosoma. The sloping posterior surface is the posteropropodeum, represented by a declivity. Most common of these is the development of a pair of [postero] propodeal lobes (= metapleural lobes, = inferior propodeal plates). When present they are situated infra of the declivity, one on each side of the propodeal-petiole articulation. The side of the propodeum bears the propodeal spiracle.

Protruding: dc, extending out above or beyond a surface or boundary; projected.

Protrusible: G-H, something capable of being protruded, or put out.

Proximal (Used for appendages): located on an appendage on the half section closest to the body (mesion). (Fig. 2). See proximad, distad, distal.

Proximad (adv. of proximal used for appendages): located toward the proximal portion of an appendage. (Fig. 2). See proximal, distal, distad.

Psilate: G-H, integument smooth, not pitted or with submicroscopic pits.

Pubescence: G-H, small to minute hair-like cuticular projections which are not socketed basally.

State of being pubescent. See Seta.

Pubescent: G-H, H-W, covered with soft, short, fine, closely set setae; it refers to the exceptionally short, fine hairs forming second layer beneath pilosity.

Punctate : HA, set with fine, impressed points or punctures appearing as pin-pricks. (Fig. 33).

Puncticulate (punctulate): HA, TB, finely punctate; with numerous minute and close set punctures. (Figs. 32, 33).

Punctura (=puncture): BR, prick, a small pointlike depression.

Pygidium: the group of the two most posterior visible sclerites of the metasoma composed by the tergite (epipygium) and the sternite (hypopygium). (Fig. 9).

Pygostylus: G-H, appendicular sensory structures on Abdominal IX. (Figs. 38, 39).

Quasi: BR, appearing as if, simulating.

Radicle ^ G-B G-B (=condyle): narrowed base of antennal scape, e.g. in adult Hymenoptera with geniculate antennae. Radicle is composed of antennal condylar bulb and antennal condylar constriction. See these terms.

Reticulate: G-H, sculpture made up of net quadricle or net-like sculpture.

Rimose: HA, with minute, narrow and nearly parallel excavations (rimae) running into each other; chinky; resembling the cracked bark of a tree.

Rivose (dim. rivulose): HA, marked with sinuate furrows, like rivulets, not running in a parallel direction.

Ruga (pl.rugae): G-H, sculpture consisting of a wrinkle, fold.

Rugate: H-G, the integument covered with a wrinkled surface.

Rugocostae: rimose costae running in anastomosis. (Fig. 15).

Rugulae: Small wrinkles.

Rugose (dim. rugulose): HA, TB, H-G, pertain to a surface covered with wrinkles, wrinkled.

Rugulose, rugulosus: HA, TB minutely rugose; minutely wrinkled.

Scabrous (dim. scabriculous): HA, TB, BR, rough; irregularly and roughly rugose; possessing short, sharp projections or wrinkles.

Scape shaft: scape excluding the radicle.

Scrobiculae (adj. scrobiculate): HA, short, trench-like depressions limited by parallel costae. uniformly covered with short, oblong or trench-like hollows. In *Procryptocerus*, scrobiculate surfaces are those where scrobiculae are parallel (parallel porcae), uniformly organized in a contiguous series (chain-like) and separated by costae. They are usually present on the border areas of vertex, temple, postgena, metanotal groove, posteriad on petiole and postpetiole, cinctus 2, and cinctus 3. (Scrobiculate has different meaning elsewhere (G-H)). Porcae are similar but usually the limiting costae are not uniformly parallel.

Scutellum: G-H, the sclerite posterior of the transcutal suture. In ants it is present in workers and males (Figs. 15, 37, 38). See scutum, transcutal suture, axilla, mesoscutum, prescutellum.

Scutoscutellar sulcus: In males and gynes, a transversal, inverted V-shape groove on the scutum, with the arms diverging posteriorly, dividing the mesonotum into scutum and scutellum. (Figs. 15, 37). See scutum, scutellum, transcutal suture, prescutellum (~axilla).

Scutum ^ G-B : in certain Hymenoptera, the major portion of the alinotum set off by a transscutal suture, but not identical to the scutum of generalized insects. In *Procryptocerus*, the scutum comprises a major area anterior to the transcutal suture, the prescutellum and the posterolateral areas of the scutum (axillae in SN). The scutum is present in gynes and males. (Fig. 15, 16, 37, 38). See transcutal suture, prescutellum (~axilla), scutellum.

Securiform: G-H, Outline shape – Ax-shaped, triangular-compressed.

Septum (pl. septae): G-H, a wall, partition or broad internal projection within a cavity.

Sessile ^ G-B : attached directly without a stem or petiole, e.g., in Symphyta (Hymenoptera), having the abdomen broadly attached for nearly its full width to the thorax.

Seta (pl. setae): G-H, hollow, often slender, hair-like cuticular projections produced by Epidermal cells of the Integument. A setal complex is composed of three differentiated cells: A Trichogen, a Tormogen and a Sense Cell. The Trichogen is the prominent, cuticular, sensory receptive portion of the device. BO, any stout hair that is socketed basally. Generally, the terms seta and hair are interchangeable, but care must be taken to differentiate between setae and pubescence, as the latter may also be referred to as hairs. See pubescence, pubescent.

Shagreened: H-W, covered with a fine but close-set roughness, like shark leather.

Sharp: TB, with a pointed tip or thin edge.

Squamiferous (squam.: scale): bearing a scale.

Squamiform: In the form of a scale.

Stria (pl. striae; adj. striate) : G-H, dc, a thin sunken line or band, especially one of several that are parallel or close together; any fine, long, channelled line on a surface (Fig. 15). G-H, the insect's integument that is marked with numerous parallel, fine, impressed lines. Striae in Procrptocerus are lines between low costae or costulae when they are the same width as the line in between. A clear example are the striae on metasomal 3 (=first opisthogastral=Ab IV) tergite.

Striate: possessing striae.

Stridulating organs: G-H, hardened parts of the insect body that are used in making sounds. Typically, one part is a file-like surface and the opposing one a scarper or rasp.

Stridulatory system: BO, a sound-producing system present in a number of ant subfamilies. The system consists of a plectrum (= stridulatory file), located on the posterior margin of the third abdominal segment (usually, but not always, on the tergite), and a finely grooved stridulitrum or sounding board on the anterior portion of the fourth abdominal segment.

Stridulitrum: see stridulatory system.

Striga (strigate): G-H, a narrow, transverse line or slender streak, either raised or impressed (Fig. 15).

Strigate: Having strigae. See striga.

Strigil: G-H, a curvate, comb-like (pectinate) movable spur on the distal end of the fore tibia that is adapted for cleaning the antenna.

Strigula: G-H, a fine, short, transverse mark or line.

Strigulate: H. finely or minutely strigate; with numerous short and fine transverse lines either raised or impressed.

Striola (pl. striolae): G-H, a rudimentary stria. See striolate.

Striolate: H, G-H, minutely or finely striate; with numerous parallel and very fine longitudinal impressed lines or furrows.

Sub: TB, prefix, slightly less than, or not quite so.

Subdecumbent: See pilosity. (Fig. 35).

Subdiscal: G-H, below or beneath the disc of any surface or structure.

Subdorsal: TB, SN, below the dorsum and above the spiracles.

Subequal: TB similar but not equal in size, form or length.

Suberect: See pilosity. (Fig. 35).

Subgenital plate ^ G-B : in Hymenoptera, the abdominal sternum VII. In Procryptocerus it is the hypopygium.

Subocular sulcus ^ G-B : in adult Hymenoptera, the malar sulcus (Fig. 9).

Subterete: G-H, nearly but not quite cylindrical. (alternative Subteres).

Sulcus (pl. sulci) (adj. sulcate): G-H, A furrow or groove; a groove-like excavation. Typically, a groove in the insect Integument. Any externally visible line formed by the inflection of Cuticle.

Supra: dc, above, over, on top of.

Suture: G-H, a seam or seam-like line of contact between two sclerites or hardened body parts that makes those body parts immovably connected. 2. The anatomical feature which serves as a boundary to separate distinct parts of the body wall.

Syntergosternite: SN, tergite and sternite fused. In Procryptocerus, the petiole forms a syntergosternite.

Tectiform: G-H, outline form – roof-like.

Tegula ^ G-B : a sclerite found at the extreme base of the costa of the forewing, being very large and overlapping the wing base.

Temple ^ G-B : the part of the head above and behind the compound eyes. In *Procryptocerus*, the temple is the area under the antennal scrobe posteroinferiad to eye, finishing on the occipital carina.

Tentorial fovea: T-B, tentorial pit.

Terete: G-H, tapering and cylindrical in cross section.

Terminalia: G-H, terminal abdominal segments (and their parts) modified to form the genital segments of the sex. (Figs. 39-45).

Tibial spur: BO, a socketed spur located at the apex of each tibia. The forelegs have a single pectinate tibial spur, modified into an antennal cleaning device, the strigil. When present the spurs may be pectinate or barbed. See strigil.

Torulus: (BO: = torular sclerite, = antennal sclerite). BO, the small annular sclerite that surrounds the antennal socket (this is the definition followed for *Procryptocerus*). [Figs. 4, 14]. The torulus may be horizontal, or the part closest to the midline of the head may be elevated, in some cases to such an extent that the torulus is almost vertical. In the latter condition the highest part of its arc may form a laterally projecting small lobe. The lobe may or may not be covered by the frontal carina anterior lobes [frontal carina anterior lobes]. B-G, a socket from which projects the multisegmented antenna. G-H, the basal socket joint of the Antenna upon which the organ is articulated for movement in all directions. T-B, basal socket of antenna.

Transcutal suture: G-H, [in males and gynes] a transverse thoracic suture which separates the posterior part of the mesoscutum from the anterior part of the scutellum. (Figs. 15, 16, 37). In *Procryptocerus*, the transcutal suture is not a synonymous of the scutoscuteellar suture or sulcus; the latter is an inverted V-shaped groove with the arms diverging posteriorly, dividing the mesonotum into scutum and scutellum. See scutoscuteellar sulcus.

Trulleum. BO, a basin-shaped depression near the base of the mandible dorsally, bounded distally by the mesial ("basal") margin of the mandibular blade. (Fig. 5).

Truncate: TB, G-H, structures which end abruptly as if cut at a right angle to the longitudinal axis. See nodal truncation.

Tubercle: BO, a small, rounded prominence or protuberance.

Tuberculate: bearing one or more tubercles.

Tuberculate: TB, covered or furnished with rounded, projecting lobes; more strongly projecting than granulate, papillate, or pustulate.

Tuberculiform: BO, having the form or appearance of a tubercle.

Tubulose: G-H, descriptive of something formed as a tube.

Tumulus (pl. tumuli): BO, a prominent, small, mound-like or rounded hill-like to subcorneal, but not acutely pointed, cuticular excrescence (Fig. 24). In *Procryptocerus*, the malar tumulus is a small costulate elevation of cuticle on malar space, lateral to facial fovea, midway between facial fovea, eye and mandibular condyle.

Ventrad: TB, toward the venter; in the direction of the venter.

Ventral: TB, pertaining to the under surface of a body part; pertaining to the under surface of the body (Fig. 2).

Ventral gena: In Procryptocerus, the area forming the genal bridge posteriad to the hypostomal bridge, anteriad to the postgenal bridge and ventrad to the malar space, the eye and the temple. See these terms.

Ventroanteriad (adv. of ventroanterior): in direction to the venter and anteriad.

Ventropetiolar (BO: "subpetiolar") process: BO, an anteroventral projection on the petiole or its peduncle; sometimes absent but when present very variable in shape and size (Fig. 9).

Ventropleurite: the ventral part of a definitive thoracic pleurite. In Procryptocerus, the propleuron (Fig. 9) is extended to the venter forming a ventropleurite (Fig. 11). See pleurosternite (laterosternite), propleuron.

Ventroposteriad (adv. of ventroposterior): in direction to the venter and posteriad.

Vermiculate: HA, with superficial, tortuous markings resembling the tracks of a worm.

Vestiture: It refers to the surface clothing, whether hairy, pubescent or scaly in character. In Procryptocerus, two kinds of vestiture are present: pilosity (Figs. 26, 30, 31) refers to long, erect, suberect, subdecumbent, decumbent (Fig. 35), or appressed hairs, and pubescence refers to exceptionally short, fine hairs forming second layer beneath pilosity.

Volsella: G-H, either of the median pair of the genital appendages. Some authors in Aculeata make reference to it as "stipes"; however, stipes is the second segment of the maxilla in the insect head.

Waist: H-W, BO, WI, a collective [non morphological] term involving the region between mesosoma and gaster in one-petiolate ants, or the region between mesosoma and opisthogaster in two-petiolate ants, including the petiole and postpetiole when present.

Wrinkle: G-H, a twisting, winding, or sinuous formation.

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chapter 2

SPECIES GROUPS IN THE ANT GENUS *PROCRIPTOCERUS*

Introduction.

Systematics of the tribe Cephalotini.

Procriptocerus and *Cephalotes* are presently the only two genera included in the tribe Cephalotini (de Andrade and Baroni Urbani 1999; Longino and Snelling 2002). The tribe was established by Forel (1892), and is restricted to the Neotropics. The closest phylogenetic tribe relative to Cephalotini is Cataulacini composed of the single genus *Cataulacus*, with 69 valid species distributed in the Afrotropical, Oriental, Malagasy and Indo-Australian regions (Bolton et al. 2006).

Recently a morphology-and-behavior based cladistic analysis demonstrated the monophyletic origin of Cephalotini and Cataulacini, and the individual monophyly of the two tribes (de Andrade and Baroni Urbani 1999). The two clades are probably derived from a vicariant event followed by allopatric speciation (de Andrade and Baroni Urbani 1999). A unique proventriculus may be synapomorphic, establishing the tribe Cephalotini as a monophyletic lineage (Emery, 1924; de Andrade and Baroni Urbani 1999).

No fossil *Procryptocerus* have been found. Within the closely related genus *Cephalotes*, eleven fossil species have been described from Dominican and Mexican amber (de Andrade and Baroni Urbani 1999), which date from the early Miocene, 15-20 millions years ago (MYA) (Moreau et al. 2006). The studies of de Andrade and Baroni Urbani (1999) suggested that *Cataulacus* originated earlier than *Procryptocerus* and *Cephalotes*; while a subsequently molecular cladistic analysis suggested the emergence of the genus *Procryptocerus* in the late Cretaceous, around 60 MYA (Moreau et al. 2006). The major lineage Myrmicinae is considered to be as old as between 80 to 90 MYA (Brady et al. 2006).

Taxonomy of the tribe Cephalotini.

Kempf (1951) provided a complete history of the study of the taxonomy of Cephalotini since the diagnosis of *Formica atrata* [= *Cephalotes atratus*] in Linne's *Systema Naturae* (1758: 10th edition). Kempf (1951) remarks on the progress of taxonomic studies of the tribe for almost two hundreds years (1758-1951) pointing out the main contributions of F. Smith, G. Mayr, C. Emery, A. Forel and F. Santschi.

In the second half of the twentieth century the tribe Cephalotini was reduced from six to two genera. Kempf (1951) produced the most comprehensive revisionary study of the entire Cephalotini, recognizing 166 forms between species, subspecies and varieties included into the six genera *Procryptocerus*, *Cephalotes*, *Zacryptocerus*, *Hypocryptocerus*, *Paracryptocerus* and *Eucryptocerus*. Two decades later, Brown (1973) proposed the only two genera *Procryptocerus* and *Cephalotes* to be valid for Cephalotini. In the same year, Kempf (1973) synonymized the

genera *Hypocryptocerus* and *Paracryptocerus* under *Zacryptocerus*, separating the tribe Cephalotini into the four genera: *Procryptocerus*, *Cephalotes*, *Zacryptocerus* and *Eucryptocerus*. Finally, almost three decades later, de Andrade and Baroni Urbani (1999) used a cladistic analysis to demonstrate due to the generic similarity among the genera *Cephalotes*, *Eucryptocerus* and *Zacryptocerus* considered that only the two genera *Cephalotes* and *Procryptocerus* can be recognized as valid within Cephalotini, and revised *Cephalotes*.

Cephalotes is composed of 134 valid species, while *Procryptocerus* presently possesses 43 valid species (Bolton et al. 2006).

Procryptocerus is characterized by the following synapomorphies: the male is larger than the gyne; the male mandibles are strongly convex and apically rounded; in workers there is a secondary loss of the subterminal tubercle of the oblong plate (de Andrade and Baroni-Urbani 1999). Other cited non-synapomorphic characters that allow separation of *Procryptocerus* from *Cephalotes* are: the frontal carinae of female is reduced, not covering the malar space; the humeral pronotal angles of female are unarmed; the basal ridge of sting is absent or reduced in worker; and the adult transport behavior is absent (de Andrade and Baroni Urbani 1999). The genus *Procryptocerus* can be separated from *Cephalotes* by the combination of the following worker and queen characters: the clypeus is protruded into a broad nasus; the toruli are located directly posterior to the flanks of the nasus opposite to each other; the vertex is deflexed (truncate) (in *Cephalotes* this condition is only present in soldiers); the eyes are located midway on the parietals between the mandible base and the frontovertexal corner bounding the malar space anteriad and the temple posteriad. Other characters considered in Kempf (1951), de

Andrade and Baroni Urbani (1999) and Longino and Snelling (2002) in females are as follows: the antennal scrobe extend almost to the margin of vertex; the eyes are situated below the scrobe; the pronotum without spines or teeth; the metatarsus is not compressed, and the petiole and postpetiole without projecting spines, teeth, or tubercles. *Procryptocerus* workers are monomorphic (Wheeler, 1984). The larvae of several species of *Procryptocerus* have been described by Wheeler and Wheeler (1954, 1973), but no features unique to the genus have been identified.

Genus *Procryptocerus* Emery

Procryptocerus is a lineage of ants inhabiting rain forests from the Isthmus of Tehuantepec in Mexico to northern Argentina. They are confined to tropical climates, living inside twigs. Their wide distribution and obligated associations with trees suggest that these ants play important ecological roles in the resilience of rain forests. Due to their cryptic habits, most of the species have been infrequently collected (Kempf 1951, Mackay and Vinson 1989) and many are known only from the types. At present, most species are known from Central America (Kempf 1951, Longino and Snelling 2002), Colombia (data not published) and Brazil (Kempf 1951, 1957, 1960, 1964a, 1964b, 1969). The current taxonomy of the species into this genus is insufficient, which impedes any approach to the knowledge of the biology of the species.

Taxonomy of the Genus *Procryptocerus*.

Procryptocerus has been the object of two revisionary studies. Kempf (1951) revised the entire genus and Longino and Snelling (2002) the Central American species. Kempf (1951) recognized 28 species and 8 subspecies, while for Central America Longino and Snelling (2002) recognized 14 species, described four new species, synonymized two species, and elevated two subspecies to species level. Currently, 56 nominal taxa are included in the genus (Bolton et al. 2006).

Procryptocerus Emery, 1887: 470 (footnote). Type species *Meranoplus striatus* Smith, 1860 designated by Wheeler, 1911.

Meranoplus [in part] F. Smith, 1858, Cat. Hym. Brit. Mus. vol. 6, p. 191.

Cataulacus [in part] Mayr, 1866, Verh. Zool.-bot. Ges. Wien, vol. 16, p. 908.

Procryptocerus Emery, 1887, Ann. Mus. Stor. Nat. Genova, vol. 25, p. 470 note.

Wheeler, 1911, Ann. N. Y. Acad. Sci. vol. 21, p. 171; Emery, 1922, Gen. Insect. Hym. fasc. 174c, pp. 301-302; Borgmeier, 1928, Arch. Mus. Nac. Rio de Janeiro, vol. 29, p. 110 (Catalog of Brazilian Ants); Eidmann, 1936, Arb. phys. angew. Ent. Berlin-Dahlem, vol. 3 (2), pp. 81-83, 103; Wheeler, 1984, Psyche 91:171– 192 (Behavior of *Procryptocerus scabriusculus*); de Andrade and Baroni-Urbani, 1999, Stuttgarter Beitrage zur Naturkunde. Serie B (Geologie und Palaontologie), Nr. 271, 889 pp.; Longino and Snelling, 2002, Contributions in Science, Nr. 495, pp. 1–30 (Revision of the *Procryptocerus* of Central America).

The *Procryptocerus* species groups.

Kempf (1951) did a preliminary grouping of the 28 species of *Procryptocerus* he recognized into 5 groups considering shared similarities, and 4 species of incertae sedis groups. Currently the genus contains 76 species (including undescribed species) and is grouped here into 9 groups. From Kempf's (1951) grouping, only the *hirsutus*, *coriarius* and *sulcatus* groups could be retained with the additions and suppressions of some species into those arrangements.

Materials and Methods.

Collections.

Type material was loaned to the Department of Biological Sciences at The University of Texas at El Paso (UTEP), El Paso, TX, by the following museums and institutions. Codens are followed by names and locations of the museums.

AMNH. American Museum of Natural History, New York, NY, U.S.A. Courtesy James Carpenter.

BMNH. Natural History Museum, London, U.K. Courtesy

CASC. California Academic of Sciences. Courtesy Robert Zaparco and Briand Fisher.

MCZC. Museum of Comparative Zoology, Harvard University, Cambridge, Mass. Courtesy of Mr. Stefan Cover.

USNMNH. Smithsonian Institution National Museum of Natural History. Department of Entomology

FSCA. Florida State Collection of Arthropods

CUIC. Cornell University Insect Collection, Ithaca, NY, U.S.A.

CWEM. Collection of W. & E. Mackay, El Paso, TX, U.S.A.

INBio. Instituto Nacional de Biodiversidad, San José, Costa Rica.

MIZA. Instituto de Zoología Agrícola, Universidad Central de Venezuela, Maracay, Venezuela.

Courtesy Dr. John Lattke.

JTLC. J.T. Longino Collection, Evergreen State College, Olympia, WA, U.S.A.

LACM. Natural History Museum of Los Angeles County.

MHNG. Mus'eum d'histoire naturelle. Department of Entomology. Ville de Geneve, Switzerland.

NMW. Naturhistorisches Museum, Vienna, Austria. Courtesy of Dr. R. Contreras-Lichtenberg.

Naturhistorisches Museum Wien , Austria.

MSNG. Museo Civico di Storia Naturale "Giacomo Doria", Genoa. Courtesy of Dr. Roberto Poggi.

MPEG. Museu Paraense Emílio Goeldi, Belém (Pará), Brazil. Courtesy of Dr. Ana Y. Harada.

MZSP Museu de Zoologia, Universidade de São Paulo. Courtesy of Prof. Carlos Roberto Ferreira Brandao.

NHMB. Naturhistorisches Museum, Basel, Switzerland. Courtesy of Dr. Michel Brancucci.

CIPW. P.S. Ward Collection, University of California at Davis, CA, U.S.A.

QCAZ. Universidad Católica del Ecuador, Quito, Ecuador

UNAB. Universidad Nacional Agronomía Bogotá. Museo Entomológico.

UNCM (meflg). Universidad Nacional Ciencias Medellín. Museo Entomológico “Francisco Luis Gallego”, Colombia. Courtesy John A. Quiroz.

USMNH. United States National Museum of Natural History.

UNIQUEINDIO: Universidad del Quindio, Colombia

UNICAUCA: Universidad del Cauca, Colombia

UNIVALLE: Universidad del Valle, Cali, Colombia.

CENICAFÉ: Centro de Investigaciones del Café, Colombia.

IAvH: Instituto de Investigaciones y Recursos Biológicos Alexander von Humboldt. Colombia. Courtesy Dr. Diego Perico and Monica Ospina.

I visited the museums MCZ, LACM, CAS in The United States of America and MZSP in Sao Paulo, Brazil. I revised most of the specimens housed at these institutions. An important group of specimens were loaned to others researchers at the moment I visited these museums.

Specimens were compared under a 60X-magnification microscope.

For species delimitation, the following concepts were employed. Species remain reproductively isolated in the wild because of behavioral differences. Species exhibit sufficient morphological both qualitative and quantitative (size) differentiation to be considered separate species. Species exhibit differences in their range of geographical distribution.

Characters.

Logical character-statement syntax of neomorphic and transformational characters follows Sereno (2007). Qualitative characters were used for both a cladistic analysis and descriptions of groups and species (See description of the species of the *subpilosus* group in the Appendix 2.1). Quantitative characters were used for descriptions of species. Lists of qualitative and quantitative characters are as follows.

Qualitative characters.

1. Worker and gyne, head, outline shape (full frons view), taking into consideration margins of gena, eyes, frontal carina posteriad and frontovertexal margin: oblong (subsquared) or trapezoid (wider posteriad) (0), subcircular or circular (1).
2. Worker and gyne head, profile general shape: oblong or subsquadrata (0), ellipsoid or globular (1).
3. Worker and gyne, malar tumulus: absent (0), present (1)
4. Worker and gyne, temple, shape: convex or non inflected (0), slightly or markedly inflected as lateropronotum (occipital carina and humeral carina touch each other when head deflected) (1).
5. &. Worker and gyne, anteclypeal carina appearance: indistinct or almost absent (0), bilobate or emarginate (1).
6. Worker and gyne, clypeal carina (or costa): absent (0), present (1).
7. Worker and gyne, nasal (clypeal) flanks, position: orthogonal (nasus laterally truncate) (0), lateral (same plane) (1) to discal clypeus, variable (?).

8. Worker and gyne, lateral clypeofrontal notch: absent (torulus visible from anterior view but no notch is formed between clypeus and frontal lobe) (0), present (from anterior view, torulus visible through a notch formed between clypeus and frontal lobe) (1).
9. Worker and gyne, clypeotorular sulcus: absent or shallowing furrow line present (0) (a groove is not present laterally, behind clypeus, separating clypeus and torulus), present, (1) (canalicular, forming antennal fovea: a circular groove leaves torulus free from nasal flank and frontal lobe, channel is often as deep and wide as lateral foveola and connected to it), variable (?).
10. &. Worker and gyne, torulus complex conformation: torulus without clypeotorular sulcus, torulus free anteriorly and ventrally, and fused dorsally to anteriormost part of frontal carina (frontal lobe) (no distinction between frontal lobe and nasal (clypeal) flank) (0); torulus without clypeotural sulcus and fused (not free) to frontal lobe and nasal flank but distinct, distal part of torular annulus visible, and no any kind of sulcus is present (1); torulus no distinct, fused (not free) to frontal lobe and nasal flank, and no any kind of sulcus is present (2), torulus with clypeotorular sulcus, free: torulus, frontal lobe and clypeal flank completely freely by a sulcal arc in between (torular cylinder is visible from the base) (3); torulus with any kind of sulcus present in its entire ring, and with partial dorsal fusion (not completely free) to frontal lobe (part of frontal lobe flang and part of torulus free) (4).
11. Worker and gyne, nasal lateral fovea (fovea under torulus): absent (0), present (1).
12. Worker and gyne, frontoclypeal suture -between toruli- , appearance: indistinct (0), clearly distinct (1).
13. Worker and gyne, frontal triangle, appearance: indistinct (0), distinct (1).
14. Worker and gyne, frons triangle area, impression shape: in line with frons (0) shallow or clearly impressed (1).

15. Worker and gyne, frons discal area (lateral view), shape: shallow or clearly depressed (0), in line (convex or flat) with frons general surface (1).
16. Worker and gyne, frontovertexal margin, shape: evenly rounded or obtuse (profile view) (0), medially indistinct, or faintly distinct (1), distinct (acute) throughout (fastigial) (2).
17. Worker and gyne, frontal carina (frontal view), shape from frontal lobe to frons posterior lobe (not including frontovertexal corner): straight or quasi straight (0), sinuate (1).
18. Worker and gyne, frontal carina immediately posteriad to torulus (in profile), thickness: thinner or same thickness (0), or thicker (1), than the beginning of frons posterior lobe.
19. Worker and gyne, posterior lobe of frontal carina (lateral view), orientation: straight, nearly straight or evenly convex (0); strongly bent down, forming almost a perpendicular angle (1), slightly down turned, non evenly convex with the carina anteriad (2).
20. Worker and gyne, fastigium (frontal or posterior view), shape: non fastigial (frontovertexal margin sometimes dentate) (0), crenate, marginate-crenate or crenulate (1), entire-convex, entire-biconvex (medially notched) or entire-marginate (2).
21. Worker and gyne, frontovertexal corners shape: blunt, obtuse, or truncate (0), angulate (usually spiniform) (1).
22. Worker and gyne, antennal scrobe notch posterior condition: "opened" reaching the occipital carina, sometimes temporal sculpture occupies posterior scrobal notch (0), "closed" interrupted by vertex extension or templal-vertexal sculpture (1).
23. Worker and gyne, vertexal surface shape: flat (0), concave or slightly concave (1), convex (2).
24. Worker and gyne, malar space swollen (dorsal view): Less swollen than eye (0), similar or more swollen than eye (1).

25. Worker and gyne, eye bulging: entire surface flat (at level of malar surface) or almost flat (0), all or part of eye swollen or protruded (1).
26. Worker and gyne, eyes visible dorsally (dorsal view, scape accommodated into scrobe): not visible (0), completely or partially visible (1), less than 1/4 of eye visible (2).
27. Worker and gyne, eye greatest diameter related to malar space length: shorter than malar space (0), subequal, equal or longer than malar space (1).
28. Worker and gyne, eye perimeter shape: circular or almost circular (0); elongate or fusiform (1).
29. Worker and gyne, eye faces: one evenly convex surface (0), two faces (dorsal and ventral faces produced by protruding transversal margin [sometimes obtuse] in the middle of eye) (1).
30. Worker and gyne, eye dorsal face shape: convex similar to ventral face (0), depressed (flat), or bigger than ventral (1), concave (2).
31. Worker and gyne, scape basal lamella relation to condyle: not overlapping the condyle constriction or lamella absent (0), overlapping the condyle constriction (1).
32. Worker and gyne, scape width: similar throughout or slightly narrower and tapered proximad (0); narrower and cylindrical proximad than distad (terete) (1).
33. Worker and gyne, humeral angle shape (dorsal view): excavate or angulate (0), rounded (1).
34. Worker and gyne, epicnemial carina shape: protruded anteriorly into a short or pronounced lamella, angle or lobe flanking procoxa (0), protruded anteriorly into a truncate (squared or falcate) process forming a scrapper (1).
35. Worker, mesonotal processes presence: absent (0), present (1).
36. Worker, mesonotum dorsal shape (profile view): depressed, flat or quasi flat, similar to dorsopropodeum (0), variably convex (1).

37. Worker, notopropodeal fusion lateral excavations conformation (dorsal view): more excavate on mesonotum than on propodeum (0), similarly excavate in both mesonotum and propodeum or clearly more excavate on propodeum (1).
38. Worker, mesonotum width between apices of mesonotal processes vs. dorsopropodeum width between apices of propodeal processes comparison: mesonotum clearly narrower than propodeum (0), mesonotum varying between been only slightly narrower than dorsopropodeum, or same width, or mesonotum wider than dorsopropodeum (1).
39. Worker, notopropodeal profile shape: mesonotum and dorsopropodeum in line or slightly in line to each other (0), dorsopropodeum at lower level than mesonotum (1).
40. Worker, dorsopropodeum profile: horizontal (flat dorsally) (0), convex or slightly convex (1)
41. Worker, notopropodeal groove presence in middle: absent or indistinct (0), present (1).
42. Worker, posteropropodeum supra and infra declivitous areas relation size: supra longer than infra or no infra area (0), supra and infra areas subsimilar length (1).
43. Worker, propodeal spines apices lateromesial orientation: paralell (0), slightly or clearly divergent (1).
44. Worker, propodeal spines apices dorsoventral orientation: horizontal or upturned (0), down turned (1), species with the two conditions (?).
45. Worker and gyne, spiracle shape: clearly free either laterally (externally) or mesially and laterally (tubulose) (0), all spiracle fused to lateropropodeum (only the distal ring visible) (1).
46. Worker and gyne, spiracle diameter size: smaller than propodeal spine diameter at middle length (0), larger than propodeal spine diameter at middle length (1).
47. Worker and gyne, nodal truncation conformation: obtuse (anterior face forming a even anteroposterior curvature until reaching the summit), diagonal, vertical (orthogonal to dorsum),

- concave (usually laterally lobate), or truncation divided into a short infra area above cinctus 1 and a supra, bigger, vertical or diagonal area until reaching the truncation summit (0), absent (1).
48. Worker and gyne, petiole summit position: anteriad (0), in middle or clearly posteriad (1).
49. Worker and gyne, petiole lateral margins shape (dorsal view): parallel (0), convex (barrel shape) (1).
50. Worker and gyne, postpetiolar node (postnodus) presence: absent (0), present (1).
51. Worker and gyne, postpetiole shape: narrower or slightly narrower posteriad (narrow postnodus) (0), clearly same width throughout or wider in middle or posteriad (1).
52. Worker and gyne, postpetiole dorsal and posterior (declivitous after postnodus) surface shape (profile view): evenly curvate until reaching metasomal 3 (Abd IV) posttergite (0), non evenly curvate (posterior surface orthogonal to dorsum or usually forming a subnodal, shallow constriction emphasizing the postpetiolar node; sometimes a posterior, small, laminate lobe may be present as well) (1).
53. Worker and gyne, petiole and postpetiole (only posttergite) length comparison: petiole shorter than postpetiole, equal or subequal than postpetiole (0), petiole clearly longer than postpetiole (1).
54. &. Worker and gyne, posttpetiolar node orientation: posterodorsad (tergum usually convex) (0), posteriad (dorsal area of tergum horizontal, posterior area of tergum vertical and narrower at the summit) (1).
55. Worker and gyne profemur shape: tectiform, non strongly compressed compared to meso- and metafemora, or interior (mesial=anterior) face flat and dorsum non keeled, or fusiform (spindle-shaped), dorsal margin obtuse and non compressed, usually shape similar to meso- and

metafemora (0), compressed disciform (disc-shape), dorsal margin non keeled or keeled distad, and strongly curved and skewed proximad (1).

56. &. Worker and gyne, meso and meta tibiae shape: sub cylindrical (0), incrassate in middle (1).

57. Worker, postpetiole (Abd III posttergite) anterolateral corners shape (dorsal view): orthogonal to cinctus or so (0), notched (1).

58. Worker and gyne, petiolar posterior margin shape (profile view): vertical (0), sinuate (1).

59. Worker, ventropostpetiolar process shape: conic (usually unilobate) or bilobate (0), transversally truncate (1).

60. Worker, opisthogaster (Abd IV to pygidium) shape (dorsal view): subcircular (0), ovoid, oblong (1).

61. Worker and gyne, Abd IV (mtm 3) posttergite anterior corners shape (dorsal view): evenly convex as the remaining posttergite (0), slightly depressed (thinner and angulate anterolaterally) in comparison to the remaining posttergite (1).

62. Worker and gyne, nasus anterior sculpture: ecarinate (0), costate-striate, striolate (1).

63. Worker and gyne predominant frons sculpture: non raised and sunken sculpture (micro"dotted", micropunctulate, microstriolate, microimbricate, punctate or punctulate, shallow areolate and micropunctulate, foveate or foveolate) (0), striate or striolate, costate or costulate, reticulate or clathrate, rugocostate, rugocostate in anastomosis (1).

64. Worker and gyne, malar space predominant sculpture: macrosculpture noncostate, predominantly with circular or subcircular impressions (alveolate, areolate, foveate or foveolate, punctate) (0), predominantly linear macrosculptured with rugocostae or rugocostulae, or two or more linear and subcircular (alveolae) macrosculpturing combined (clathrate) (1).

65. Worker and gyne, preocular costa (between eye and scrobe) presence: absent (0), present (1).
66. Worker and gyne, genal bridge sculpturing: smooth, levigate (0), with some type of sculpture (costulate or costate, irregular costulate or costate) (1).
67. Worker and gyne, mandible distal sculpturing: ecarinate or quasy (0); costate or costulate (1).
68. Worker and gyne, dorsopronotum sculpturing: glossy or predominantly ecarinate (0), with some type of sculpture: predominantly costate, porcate or costulate, predominantly areolate, alveolate or foveate, costate and foveate, or clathrate (1).
69. Worker and gyne, lateropronotum predominantly sculpturing: laevigate, predominantly ecarinate or smooth (0), predominantly alveolate, foveate, costate, porcate or costulate (1)
70. Worker, notopropodeal sculpture continuity: broken down by notopropodeal groove (0), not broken down by notopropodeal groove (1).
71. Worker and gyne, mesonotal and dorsopropodeal sculpturing: smooth, alveolate or foveolate (0), striate or costate, rimosus costate-porcate or clathrate, strigate or transversally costate (1), combination between 0 and 1 (2).
72. Worker and gyne, meso- and metapleural sculpture: ecarinate (0), costate (costulate or costate throughout, supra ecarinate and infra costulate or costate, or opposite) (1).
73. Worker, propodeal spines sculpture: levigate, ecarinate (may be microsculptured, and sometimes costulate basad) (0), costate or costulate proximad (first half of the spine) (1).
74. Worker, posteropropodeum sculpturing: smooth or supra sculptured (striate-costate or strigate-costate) (0), costate, striate or strigate throughout (1).

75. Worker and gyne, meso- and metatibia sculpture: ecarinate, smooth or farinose (microtuberculate or micropunctulate) (0), rugocostate in anastomosis, rugocostulate, or uniformly costate or costulate (1).
76. Worker and gyne, nodal truncation sculpture: ecarinate (glossy or micropunctulate) (0), macrosculptured (strigate, striate, costate) (1).
77. Worker and gyne, tergal petiole predominant sculpture: costate (parallel costate or porcate, rugocostate or rugocostulate), costate-tuberculate (0), alveolate or areolate (1), species with conditions 0, 1 (2).
78. Worker and gyne, tergal postpetiole predominant sculpture: costate (parallel costate or porcate, rugocostate or rugocostulate) (0), alveolate or areolate (1), species with conditions 0, 1 (2).
79. Worker and gyne, cinctus 2 (on mtm 2 = Abd III) dorsal sculpture: predominantly ecarinate or levigate (0), costate (scrobiculate) (1).
80. Worker and gyne, mtm 3 (Abd IV) posttergite sculpturing: smooth throughout or striate-costate anteriad, or striolate-costulate anteriad, smooth posteriad, smooth on disc and striate anteriad and posteriad, punctate or punctulate (0), costate-striate, or costulate-striolate, throughout (longitudinally striate throughout, striate-concentricus throughout, other) (1), variable (?).
81. Worker and gyne, Abd IV (mtm 3) poststernite sculpturing: smooth or punctulate throughout (0), sculptured (longitudinally striate or striolate to sides, striate-concentricus, other) (1).

82. Worker and gyne, Abd V, VI posttergites sculpturing: smooth levigate (0), sculptured (costate, striate or striolate, strigate or strigulate, microtuberculate (farinose), puncticulate or micropuncticulate) (1).
83. Worker and gyne, epipygium (Abd VII), sculpture: smooth levigate (0), sculptured: striate or striolate, strigate or strigulate, microtuberculate (farinose), puncticulate or micropuncticulate (1).
84. Worker and gyne, frons, vestiture density: less than 60 hairs (0), more than 60 hairs (1).
85. Worker, medial line of mesonotum, dorsopropodeum, petiole and postpetiole; vestiture: denudate (0), pilose (1).
86. Worker and gyne, malar space, pilosity: absent (0), more than 4 hairs (1), 4 or less hairs (2).
87. Worker and gyne, genal bridge, vestiture: pubescent (0), combination of stiff or flagellate pilosity and pubescent (1), stiff or flagellate pilosity (2), glabrous (3).
88. Worker and gyne, mandible pilosity distal-ectal (distal-external) surface: few scatter (less than 10) hairs or glabrous (0), hispid or flagellate scatter hairs (1).
89. Worker, mesonotum posteromedial stiff (sometimes flagellate) setae, orientation: parallel (0), slightly convergent (1), clearly convergent (2).
90. Worker and gyne, coxae, vestiture: hairs only (0), pubescent and hairy on any face (1), glabrous (2).
91. Worker and gyne, dorsum of profemur pilosity presence and predominant orientation: denudate (0), decumbent or subdecumbent (1), suberect or erect (2), any combination between 1 and 2 (3).
92. Worker and gyne, petiole and postpetiole dorsal vestiture, orientation: predominantly erect and/or suberect (0), predominantly subdecumbent or decumbent (1).

93. Worker and gyne, mtm 3 (Abd IV) posttergite vestiture presence: absent or scarce hairs (15 or less than 15 rows) (0), present throughout (more than 15 rows) (1).
94. Worker and gyne, Abd IV poststernite, vestiture: denudate (0), pubescent (1), pubescent and short, or long, flagellate hairs (2), only long hairs (3).
95. Worker and gyne, Abd V, VI, and VII posttergite hairs, predominant length apparence: short (0), or long (1) compared to that on petiole and postpetiole
96. Worker and gyne, hypopygium, vestiture: denudate (0), pubescent and flagellate or stiff hairs, flagellate or stiff hairs (1).
97. Worker and gyne, general lustre: opaque (0), shinny or predominantly shinny (1).
98. Worker, appendages (antenna, oral palp, mandible distally, leg), color: black or mostly black (0), black and rufous, dark brown or mostly brown, rufous, or yellow (1).
99. Gyne, appendages color: black or mostly black (0), dark brown or mostly brown or yellow (1).
100. Male, metatibial spurs presence: absent (0), present (1), male not known (?).
101. Male, parameres pilosity orientation: turning ventrad forming a basket (0), posteriad directed not forming a basket (1), male not known (?).
102. Male, eyes lateral position: anteriad (0), posteriad (vertexad) (1), male not known (?).
103. Male, eyes position: lateral (0), lateral, slightly extended dorsally and ventrally (1), male not known (?).
104. Male, hypopygium shape: angulate posteriad (conical) (0), rounded posteriad (1), truncate posteriad (2), male not known (?).
105. Gyne wings color: hyaline (0), infumate (1), gyne not known or non alate (?).
106. Male wings color: hyaline (0), infumate (1), male not known (?).

107. Worker, vertex aspect: non deflexed (0), deflexed (1).
108. Worker, in full frons view, occipital carina visibility: non visible (0), visible (1).
109. Worker, dorsopropodeum in full dorsal view, spiracles visibility: non visible (0), visible (1).
110. Worker, eyes and frontal carina relative position: eyes over frontal carina (0), eyes posteriad to antennal scrobe or posteroinferiad (1), eyes under frontal carina (2).
111. Worker, pronotal processes presence laterally: absent (0), present (1).
112. &. Worker, mesonotal processes presence laterally: absent or short rounded tumulus (0), present (spiniiform, angulate or lobate) (1).
113. &. Worker, anteropropodeal processes presence laterally: obsolete or indistinct (0), present (1).
114. Worker, petiolar processes presence laterally: absent (0), present (1).
115. Worker, postpetiolar processes presence laterally: absent (0), present (1).
116. Worker, promesonotal suture presence: obsolete or absent in middle or to sides (0), present throughout (1).

The symbol & indicates characters that were eliminated given that the character statements either did not convey clear discriminations, or happened to be redundant.

Quantitative characters.

Most attributes regard workers. Males and gynes are indicated.

HL- Head length, measured laterally between clypeal carina and frontovertexal corner (not including any process at frontovertexal corner).

FW1- Frons width1, width of frons between frontal carinae immediately after toruli.

FW2- Frons width2, width of frons between frontal carinae at level of posterior lobes.

FW3- Frons width3, width of frons between frontal carinae at level of frontovertexal corners (measured immediately posterior to eyes in males).

CI: cephalic index (FW2/HL).

SL- Scape length (including radicle).

FCL- frontal carinal length, measured in profile view from level of epistomal (frontoclypeal) suture to frontovertexal corner apex.

SCI: scape-frontal carina index (SL/FCL).

NL- Nasus length, measured laterally from anteclypeus to superior level of toruli bases.

NW- Nasus width, measured anteriorly in a transversal line between clypeal carinae.

NI: nasal index (NL/NW).

EL- Eye length, maximum dimension.

EW- Eye width, maximum dimension.

EI: Eye Index (EL/EW).

PW- Promesonotum width. Maximum width of promesonotum measured directly from above.

PML- Promesonotum length, from groove (in middle) of neck to middle notopropodeal fusion or groove.

MW- Mesonotum width, between mesonotal process apices.

NPEW-Notopropodeal-excavations width, width of mesosoma between mesial “vertexes” of notopropodeal excavations.

PrL- Dorsopropodeum length, from notopropodeal fusion or groove (in middle) to an imaginary line across propodeal spine bases.

PW1- Dorsopropodeum width 1, measured across widest part, anterior to propodeal spines (including anterolateral processes if present).

PW2- Dorsopropodeum width 2, measured immediately posteriad to anteropropodeal processes.

PSL- propodeal spine length, from base to apex.

PSI: propodeal spine index (PSL/PRL).

PI: Propodeum index (PrL/PW).

PFL- Profemur length, measured in posterior view along longitudinal axis, from ventral juncture of femur and trochanter to apical extremity of femur.

PFW- Profemur width, measured along a transversal axis of maximum width from ventral to dorsal edges.

PFI: Profemur index (PFL/PFW).

MFL- Metafemur length, posterior view, measured along longitudinal axis from ventral juncture of femur and trochanter to apical extremity of femur (not including prefemur).

MTL- Metatibia length, measured along outer surface.

PtH- Petiole height, measured in lateral view perpendicular to line from anterodorsal to posterodorsal margin from summit of dorsal convexity to ventral margin of sternum.

PpH- Postpetiole height, measured in lateral view in a diagonal between summit of postnodus and apex of sternopostpetiolar process.

PtL- Petiole length, measured in lateral view from anterodorsal to posterodorsal margin.

PpL- Postpetiole length, measured in lateral view, from anterodorsal to posterodorsal margin (not including helcium: only posttergite).

PtW- Petiole width, measured in dorsal view across widest point.

PpW- Postpetiole width, measured in dorsal view across widest point.

AL- abdominal IV (=metasomal 3: mtm 3)-posttergite length, measured from cinctus 3 posteriad to mtm 3 posterior border.

AW- abdominal IV-posttergite width, measured in dorsal view at widest width.

AI- abdominal IV-posttergite index (AL/AW).

ASD – abdominal IV-striae density: # of striae on disc of mtm3 (Abd IV) posttergite per mm.

Gyne, FWLg- Forewing length.

Gyne, HWL- Hindwing length.

Male, FWLm- Forewing length.

Male, PL- Paramere length, measured parallel to long axis from level of distalmost part of basiparamere to level of apex of paramere.

Male, HWL-Hind wing length.

Cladistic Analysis.

A matrix of 78 taxa and 110 characters using the qualitative characters (Appendix 2.1) was produced for a cladistic analysis. The species *Cataulacus brevisetosus* (Cataulacini) and *Cephalotes atratus* (Cephalotini) were used as outgroups.

The program PAUP was used for the analysis. The following are the criteria employed. Optimality criterion = parsimony; Character-status summary: Of 110 total characters: All characters are of type 'unordered'. All characters have equal weight. “?” were treated as "missing" or “unknown”.

Results.

I studied a total of 3604 ants. 5% of specimens were gynes and males. 90% of specimens represent only 5% of species. 80% of species are represented by less than 10 individuals in each species.

In this study, 76 species are recognized for the genus *Procryptocerus*. In previous revisions (Kempf 1951, Longino and Snelling 2002), and Bolton et al. (2006)'s catalog, a total of 45 species were recognized for the entire genus.

Taxonomic synopsis of species treated in this study.

P. attenuatus (F. Smith, 1876). Costa Rica to Bolivia, Amazonia

P. batesi Forel, 1899. Costa Rica, Colombia

P. balzani. Bolivia, Peru.

P. belti. Mexico to Panama, Ecuador.

P. carbonarius. Colombia.

P. clathratus. Brazil (Santa Catarina, Paraná, Sao Paulo).

P. convergens. Southern Brazil (Paraíba, Santa Catarina, Rio de Janeiro, Minas Gerais).

P. convexus. Brazil (Amazonas, Pará).

P. coriarius. Costa Rica, Colombia.

P. curvistriatus. Brazil (Espiritu Santo).

P. eladio. Costa Rica

P. elegans. Southern Brazil (Paraná, Rio de Janeiro, Sao Paulo).

P. ferreri. Colombia. Magdalena, Valle del Cauca.

P. gibbosus. Southern Brazil. Espiritu Santo, Rio de Janeiro.

P. goeldii. Southern Brazil (Bahia, Minas Gerais, Paraná,
Rio de Janeiro, Rio Grande do Sul, Santa Catarina, Paraguay

P. gracilis. Northern Brazil. Amapá, Pará.

P. hirsutus. Northern Brazil (Amazonas, Bahia, Goias, Pará).

P. hylaeus. Panama to southern Brazil. Paraguay, Bolivia, Brazil, Colombia, Guyana,
Panama, Paraguay, Peru, Trinidad, Venezuela.

P. impressus. Nicaragua, Costa Rica, Panamá, Colombia, ,

P. kempfi. Costa Rica, Panama.

P. mayri. Colombia, Venezuela.

P. nalini. Costa Rica, Peru.

P. paleatus. Costa Rica, Panama, Mexico.

P. pictipes. Costa Rica to Bolivia, Brazil (Amazonas, Bahia, Goias, Pará, Pernambuco),
Colombia, Ecuador, Guyana, Panama, Peru, Trinidad, Venezuela.

P. regularis. Southern Brazil, Paraguay.

P. scabriusculus. Mexico to Venezuela

P. schmitti. Venezuela, Brazil (Bahia, Pernambuco).

P. seabrai. Southern Brazil (Rio de Janeiro, Sao Paulo).

P. spiniperdus. Brazil, Colombia, Perú, Trinidad and Tobago. Ecuador, Guyana

P. striatus. Brazil (Rio de Janeiro).

P. subpilosus. Brazil (Amapá, Amazonas, Bahia, Mato Grosso, Pará, Rondonia), Ecuador,

Guyana, Peru, Trinidad.

P. tortuguero. Costa Rica. Colombia.

FS01. COLOMBIA: Santander.

FS02. COSTA RICA: Puntarenas.

FS03. COSTA RICA: Heredia.

FS04. Colombia. Caldas, Risaralda.

FS06. Colombia. Risaralda.

FS07. Colombia. Narino.

FS08. Colombia. Santander.

FS12. Ecuador.

FS14. Brazil (Bahía).

FS15. Brazil (Pará, Mato Grosso, Pernambuco, Santa Catarina)

FS17. Brazil (Bahía, Minas Gerais)

FS18. BRAZIL (Piaui).

FS19. Brazil (Paraná, Sao Paulo, Minas Gerais).

FS20. Ecuador (Napo.)

FS21. Brazil (Espiritu Santo).

FS22. Brazil (Paraná, Rio de Janeiro, Sao Paulo).

FS28. Ecuador (Napo).

FS29. Venezuela (Amazonas) Panamá (Darién).

FS30. Venezuela (Amazonas).

FS31. Ecuador (Napo).

FS33. Colombia (Caquetá).

FS34. Brazil (Bahía).

FS35. Bolivia (Pando).

FS36. Bolivia (Beni).

FS37. Perú (Lima).

FS39. Ecuador (Napo).

Cladistic Analysis.

A heuristic parsimony search and UPGMA hierarchical clustering yielded the best cladograms.

PAUP* output Page 6

Branch-swapping algorithm: tree-bisection-reconnection (TBR)

1 character is constant

4 variable characters are parsimony-uninformative

Number of parsimony-informative characters = 105

Starting tree(s) obtained via stepwise addition.

Addition sequence: simple (reference taxon = FS one)

Number of trees held at each step during stepwise addition = 1

Branch-swapping algorithm: tree-bisection-reconnection (TBR)

Steepest descent option not in effect

Initial 'MaxTrees' setting = 10000

Branches collapsed (creating polytomies) if maximum branch length is zero

'MulTrees' option in effect

Topological constraints not enforced

Trees are unrooted

Heuristic search completed

Total number of rearrangements tried = 7556712

Score of best tree(s) found = 1152

Number of trees retained = 120. Time used = 42.16 sec

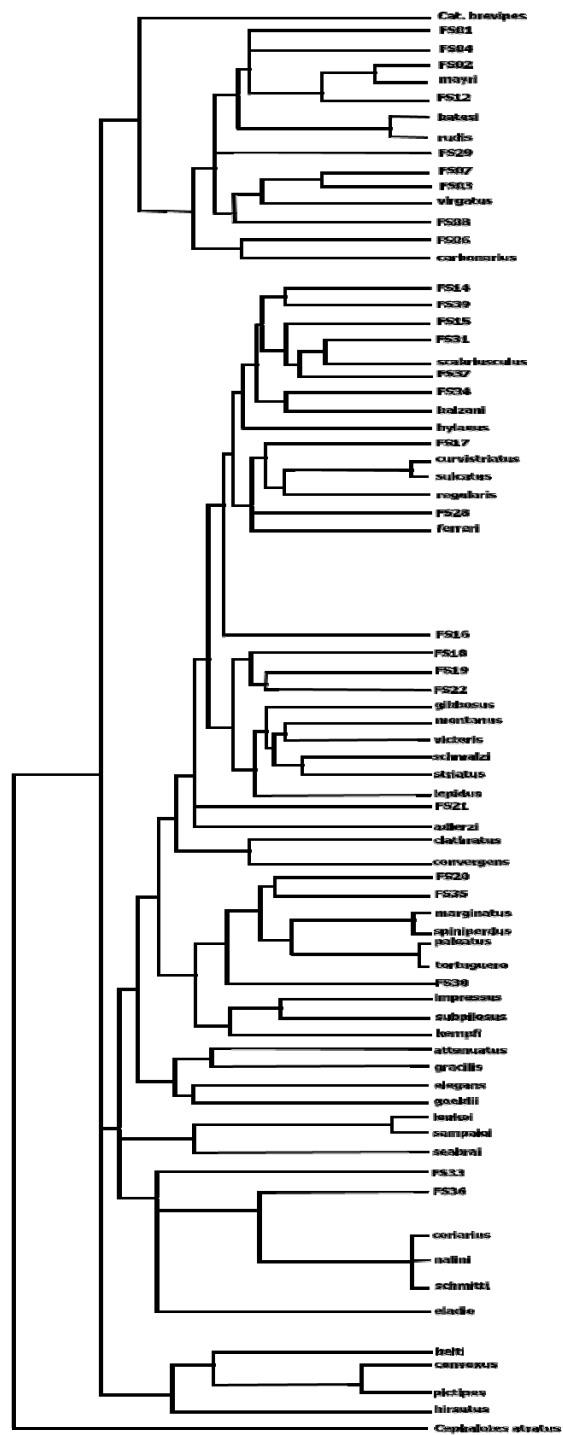


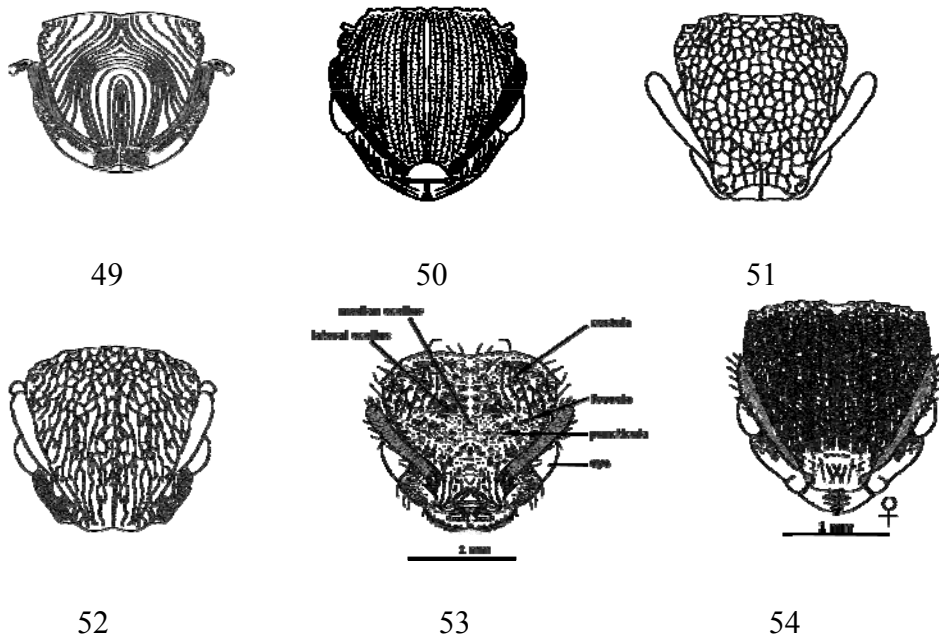
Figure 48. UPGMA dendrogram produced in the analysis of *Procryptocerus* spp.

The species complexes produced in the analysis were treated as the following groups. *Procryptocerus mayri* group, *P. rudis* group, *P. hirsutus* group, *P. coriarius* group, *P. gracilis* group, *P. subpilosus* group, *P. balzani* group, *P. striatus* group, and *P. sulcatus* group. Species account including for the *subpilosus* group are included in the Appendix 2.1.

Key to the species groups of the genus *Procryptocerus* (Hymenoptera: Formicidae).

(Based on workers. Most characters states apply to gynes).

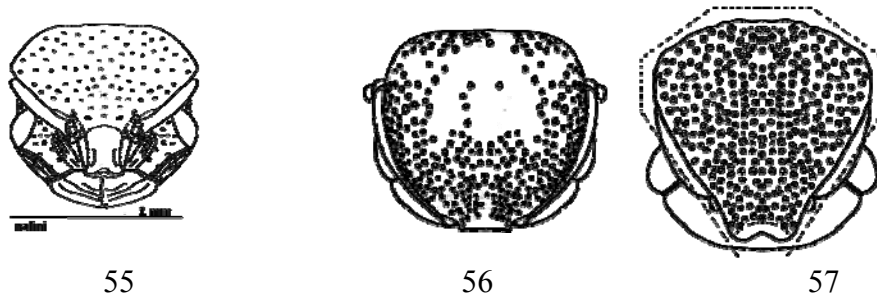
1. Frons predominantly costate, costulate, or reticulate (Figures 48-54); scattered shallow areolae or foveolae may be present as well (Figure 53) ... 2



Figures 49-54. Frons sculpture.

1'. Frons foveate, foveolate, areolate, or alveolate (Figure 55-57)...

8



Figures 55-57. Frons sculpture (continued).

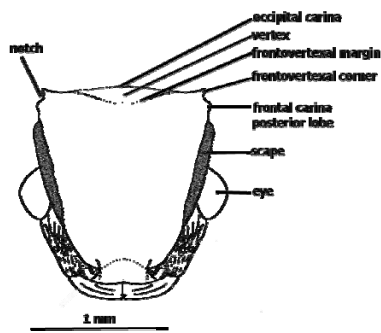
2. Frons reticulate, or clathrate (longitudinal costae and reticulae) (Figures 3-7), or clathrate-alveolate... 3

2'. Frons predominantly costate or costulate (Figures 1, 2) ...

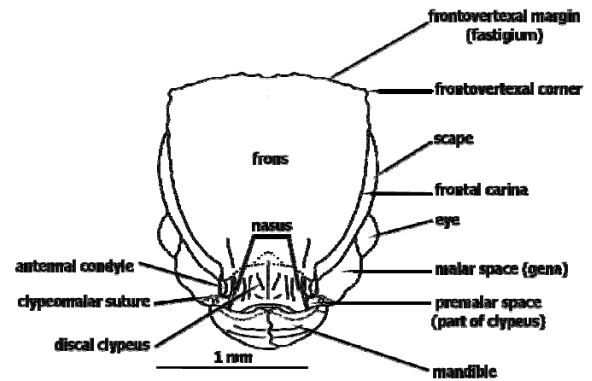
5

3. Frontovertebral margin interrupted in middle; occipital carina easily seen from full frontal (dorsal) view (Figure 58); profemur fusiform, similarly compressed to meso and metafemora... 4

3'. Frontovertebral margin well defined across vertex (Figure 59); occipital carina not or barely visible from full frontal view; profemur more compressed than meso and metafemora... *hirsutus* group (except *P. pictipes*).



58



59

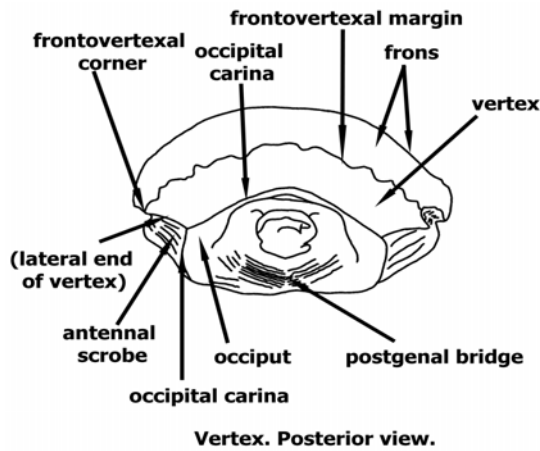
Figures 58-59. Two different shapes of vertex.

4. Frons usually only costate on nasus and reticulate-alveolate (clathrate) from frontal triangle area (depressed short area posteriad to clypeus) to frontovertexal margin (Figure 4) (also in FS03 from *mayri* group, with dorsopropodeum trapezoidal); frontovertexal corner usually spiniform and forming a notch with posterior lobe of frontal carina (10); anterior corner of postpetiole (dorsal view) usually forming little notch with cinctus 2; postnodus (postpetiole posteriad) usually: wider than long, broader than petiole, similar length as petiole, somewhat elevated, directed posterodorsally; anterior corner of opisthogaster (dorsal view), laterad to cinctus 3, slightly truncate, not evenly curvate with the remaining postergite ... *rudis* group.

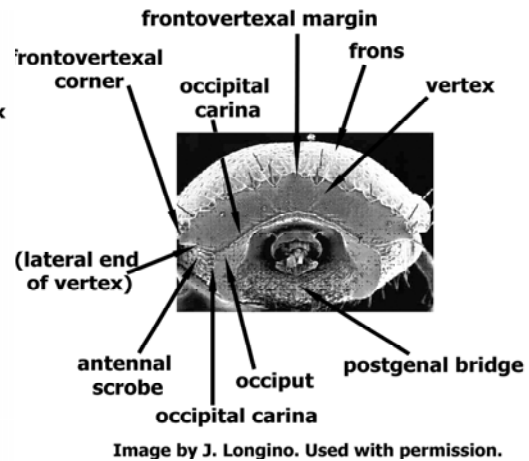
4'. Frons costate from nasus to frons disc, usually to level of eyes (uniformly costate from nasus to occipital carina in *P. mayri* [part]); usually reticulate-alveolate (clathrate) from frons disc to vertexal margin; frontovertexal corners usually only angulate, non spiniform and not forming a notch with posterior lobe of frontal carina; anterior corner of postpetiole usually perpendicular to cinctus 2, not forming notch with cinctus 2; postnodus usually: horizontal (lateral view), narrowing posteriad, directed posteriorly; anterior corner of opisthogaster, laterad to cinctus 3 (dorsal view), evenly curve with the remaining postergite ... *mayri* group.

5. Dorsopropodeum longer than wide or subquadrate; vertex not extended lateroinferiad (Figures 60-61) (not horseshoe-shaped in posterior view as in Figure 14); temple near scrobe continuing to the occipital carina, not interrupted vertex (Figures 12-13) ...

subpilosus group



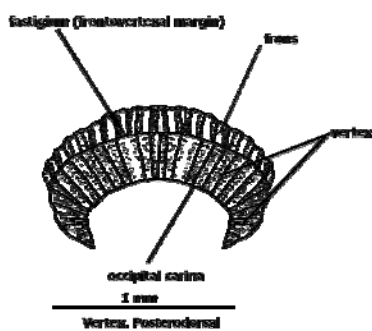
60



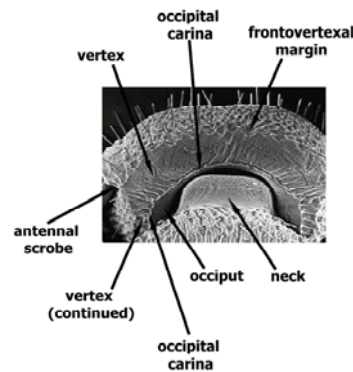
61

Figures 60-61. Vertex not extended lateroinferiad.

5'. Dorsopropodeum usually wider than long or subquadrate; vertex slightly extended lateroinferiad (horseshoe-shaped in posterior view-Figures 62-63); temple near scrobe not continuing to the occipital carina, interrupted by vertex (Figure 15)... 6



62

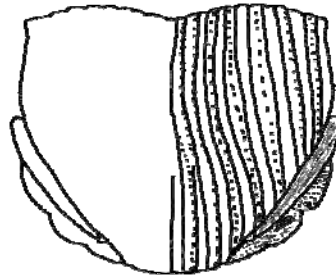


63

Figures 62-63. Vertex extended lateroinferiad.

6. Costae on frons longitudinal, wider than the interstriae, and usually flat at the ridge; with no more than 13 costae between frons disc and frontovertexal corner (Figure 16)...

sulcatus group



64

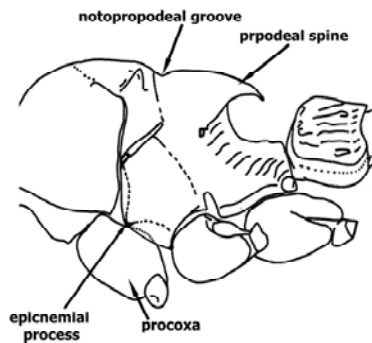
Figure 64. Frons sculpture in the *sulcatus* group.

- 6'. Costae on frons diverging from disc, or concentricus (e. g. Figure 1), or transversal across the frons posteriad, usually thinner than the interstriae and obtuse at the ridge; with 14 or more striae between frons disc and frontovertexal corner (Figure 1)... 9

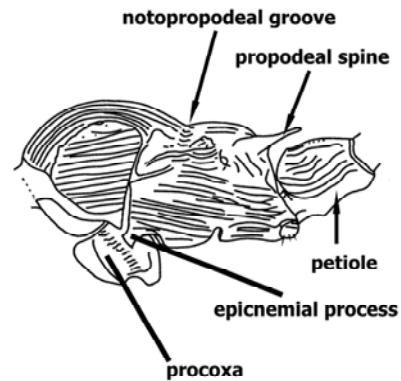
7. Epicnemial process lobose or laminate slightly flanking procoxa laterally; dorsal mesosoma usually flat; dorsopropodeum wider than long or subquadrate, shorter than posteropropodeum, flat dorsally; notopropodeal groove usually straight (dorsal view); propodeal spines thick tapering distad ... *balzani* group

- 7'. Epicnemial process truncate or subquadrate, projected anteriorly, flanking procoxa laterally; dorsopropodeum subquadrate, similar length as posteropropodeum, usually convex

lateromesially (lateral or posterodorsal view), lateral margins slightly converging posteriad; notopropodeal groove usually slightly curvate; propodeal spines thin, apically obtuse, upturned, usually divergent.... *striatus* group



65



66

Figures 65-66. Lateral mesosoma in the *balzani* (65) and *striatus* (66) groups.

8. Frons outline (frontal view) subrhomboidal (e. g. Figure 9); both frontovertexal margin and frontovertexal corner (head in profile) acute or spiniform (obtuse in *P. gracilis*) ...

.....*gracilis* group

- 8'. Frons and head outline rounded (scapes accommodated into scrobes -Figure 8); both frontovertexal corner and frontovertexal margin widely rounded, obtuse, entire...

coriarius group and *P. pictipes* from *hirsutus* group (frontovertexal margin acute).

Group of *Procryptocerus mayri*

The *mayri* group contains 7 species divided into two subgroups: (1) subgroup *mayri* (3 species): *P. mayri* Forel 1899 (Colombia, Venezuela), *P. virgatus* Kempf 1964 (Costa Rica, Colombia, Ecuador, Perú, Bolivia), FS08 (Colombia). (2) subgroup FS02 (3 species): FS02 (Costa Rica, Ecuador, Mexico), FS03 (Costa Rica: Heredia, Ecuador: Pichincha), FS07 (Colombia: Nariño: Tajadas), FS12 (Ecuador).

Description.

Head profile globose or ellipsoid (subgroup *mayri*), oblong subquadrate (subgroup FS02); frons dorsally subtrapezoidal to trapezoidal, wider posteriad; frons disc shallowly depressed (FS02 subgroup); frons profile markedly convex (*P. mayri* subgroup), or shallow (FS02); frontovertexal boundary concave mesially (frontovertexal margin not defined across), leaving occipital carina visible (full frontal view); clypeo-torular sulcus absent or obsolete; clypeal flank flat, perpendicular to clypeus disc (nasus), not forming antennal fovea (invagination for torulus), torulus fully exposed in anterior view; antennal scape shaft terete proximally terminating in a lobose lamella; lamella not overlapping condylar constriction or not overlapping half of condylar bulb; malar tumulus (full anterior, nasal view) obsolete or slightly developed; facial fovea present; eyes globose, different sizes in different species, more projected than posterior lobe of frontal carina, except for some individuals of *P. mayri*; frontal lobe in contact with (resting on top) torulus, apparently continuing with lateral clypeal carina; both frontal carina and antennal

scrobe deflexed posteriad (head in profile); posterior lobe of frontal carina present; frontovertexal corners vary from tumuloses, slightly angulate to spiniform in different species, posteromesiad to posterior lobes of frontal carina, usually as developed as humeral angles; vertex flat, or shallowly concave, non excavate (*P. mayri* subgroup), somewhat excavate (FS02 subgroup); humeral angles well developed; pronotum dorsolateral margin well defined, eroded; lateropronotum vertical (*P. mayri* subgroup), inflexed (FS02 subgroup); mesonotum profile horizontal (non convex) (FS02 subgroup), dorsally shallow or flat, obliquely sloping on approach to notopropodeal groove (except *P. virgatus* and FS08); only pronotal lobe covering mesospiracle (promesonotal excavation present), or mesospiracular lobe larger than pronotal lobe (promesonotal excavation absent) in *P. virgatus*; mesonotum and dorsopropodeum same width at level of mesonotal and anteropropodeal processes; notopropodeal groove well impressed, or shallow (*P. virgatus*, FS02); anteropropodeal processes obsolescent into anterolateral angles, rounded or subangulate; dorsopropodeum flat, subsquadrated or subtrapezoidal, longer than wide, wider anteriad, anterior margin straight across, lateral margins subparallel, slightly convergent posteriad (*P. mayri*, FS02 subgroup), or margins obsolete (*P. virgatus*, FS08); propodeal spines vary from horizontal (Colombia) and parallel to slightly upturned (Central America), usually longer than dorsopropodeum; propodeal spiracles hidden (*P. mayri*, FS02) or visible from above (*P. virgatus*, FS08), metacoxa usually similar in length to petiole; nodal truncation curving dorsoposteriad terminating at petiolar summit; petiole (in profile) higher anteriad, petiole (dorsal view) usually subhexagonal or barrel-shaped, expanded medially, narrowing posteriad, dorsal surface depressed from middle to posteriad, constricted posteriorly; postpetiole flat dorsally, anterolateral corners perpendicular to cinctus 2, in profile helcium and posttergite horizontal, or forming faint incline until reaching postnodus; postnodus

directed posteriorly, lobose, narrowing posteriorly, in dorsal view slightly or greatly overhanging posterior aspect of postpetiole, and usually projected over metasomal 3 posttergite; postpetiole posterior margin slightly or strongly carinate; first opisthogastral tergite (dorsal view) wider than long, subcircular, subovate, or ovate, narrowing anteriorly; mtm 3 spiracles visible from above.

Frons costate throughout or clathrate posteriorly, usually from disc to frontovertexal margin; malar space costate, or costate-clathrate; gena and vertex costate; frontovertexal margin indistinct across (*P. mayri* subgroup), eroded or crenate to sides (FS02 subgroup), frontovertexal corners angulate (*P. mayri* subgroup) or spiniform (FS02 subgroup), pronotum costate or clathrate anteriorly; lateropronotum costate; dorsolateral margin of pronotum usually eroded-crenate (FS02); lateropronotum and pleura costate; dorsomesosoma costate, sculpture usually not interrupted by notopropodeal groove; posteropropodeum usually with 2 or 3 transversal supra costae between spine bases, infra levigate; nodal truncation strigate (Central America) or glossy (Mexico and South America); petiole and postpetiole clathrate, costate or costulate; opisthogaster levigate, glossy and shining; hair hispid, long, erect, especially on tibiae, petiole and postpetiole; shorter on frons, more flexuous or pubescent on coxae and ventral opisthogaster. Meson black, appendages red, rufous, or yellow.

Distributed from Mexico, Central America, and in the northern Andes of South America from 400 m to 2200 m (Colombia, Ecuador, Perú and Venezuela).

Discussion.

Longino and Snelling (2002) noted differences in size, head shape, form of sculpture, frontovertexal margin shape, hair abundance, eye size, metasomal 3 posttergite shape, and color

in *P. mayri* specimens from Colombia, Venezuela and Central America, even though clear cut differences for the separation of these forms as species was elusive. A black form (head length 1.4 mm, n= 4), with an oblong head (in profile) from Central America and two larger, red-legged forms, with a globose head from South America are considered here to be three distinct species. I consider the form from Colombia (lectotype of *P. mayri* worker and 2 additional workers), head length 1.785 mm, and 3 workers from Rancho Grande (Venezuela) (head length 1.50 mm) with red legs, and a red one, also large, but with small eyes to be conspecific with *P. mayri*. Another form (head length 1.4 mm) with globose eyes, from Colombia (Santander: Virolín) is considered a new species, FS08. The largest *P. mayri* (represented by the lectotype-MHNG), with a large rounded head and small eyes (0.35 mm -greatest diameter) and another worker with larger eyes (0.40 mm) in Colombia (Santander: Virolín-IAvH) and Venezuela (Aragua: Rancho Grande-MIZA) are found in the Cordillera Oriental (Colombia) and Cordillera of Mérida (Venezuela). The black form “*P. mayri*” (HL 1.450-1.525) from Costa Rica, and other slightly larger forms from Mexico, Costa Rica, Panamá, Colombia and Ecuador are considered here to be FS02 species. The “*P. mayri*” from Mexico (Veracruz, Volcán San Martín, 400 m alt., and Veracruz, Los Tuxtlas, San Fernando, 1140 m alt.-P. Rojas coll.) are more similar to the Colombian *P. mayri* in size and color, than to the Costa Rican “*P. mayri*”, which are smaller. The “*P. mayri*” from Mexico has obsolete posterior notch of frontal carina and a very short, spiniform frontovertexal corner. A specimen from Costa Rica, Puntarenas, Cotobrus, Las Alturas (INBio) is similar to the type of “*P. reinchespergeri*” (the black *P. mayri*) in size (larger than typical Costa Rican *P. mayri*), with the frons longitudinally costate; however, it possesses a tenuous, clypeo-torular sulcus, a condition lacking in *P. mayri*. The Costa Rican *P. mayri* possesses higher frontal lobes than the Mexican, Colombian or Ecuadorian “*P. mayri*”. However Longino

and Snelling's *P. mayri* from Costa Rica looks conspecific with the forms from Ecuador and western Colombia (Valle). The lectotype of *P. mayri* from Colombia (probably from Santander) looks closer to the one from Mexico, Veracruz and Costa Rica (Puntarenas: Las Alturas), than with the majority of *P. mayri* from Costa Rica. Clearly the *P. mayri* from Virolín is very similar to the lectotype, the metasomal tergite 3 is wider than long and glossy, possessing very thin, separate flagellate hairs; the frons is clearly with separate costae; the frontovertexal corners are more angulate than spiniform. The head and opisthogaster are globose, opisthogaster is wider than the head.

I transferred the specimens from Colombia, Nariño, La Planada 1800 m alt. from *P. mayri* to *P. virgatus* since they have a mesospiracular lobe larger than both the pronotal lobe and the mesonotal process, a clear character of *P. virgatus*. This character state is only present in forms in the Andes from over 1600 m alt. The specimens also have a tenuous clypeotorular sulcus, which is a character not present in the typical *P. mayri* but is in *P. virgatus*. The postpetiole declines posteriad in an even curve and not strongly narrowed posteriorly as it is usually the case in other forms of *P. mayri* in the Andes.

The "*Procryptocerus mayri*" (Costa Rica, Puntarenas, 1100 m alt., J. Longino) with the anterior frontal lobes crested and elevated are considered here to be FS02. The main diagnosis is: black; head in profile oblong and dorsally flat; head length 1.490 mm, head width (frontovertexal corners) 1.36 mm, head width (posterior frontal lobes) 1.630 mm, head width (at nasus level) 0.51 mm, mtm 3 posttergite width 1.615 mm, mtm posttergite 3 length 1.84 mm.

The *Procryptocerus mayri* lectotype (Colombia) (MHNG) and the type of *P. m. reichenspergeri* (synonymized under *P. mayri*- Longino and Snelling 2002) has the anterior frontal lobes not crested, not elevated; head length 1.78 mm, width (frontovertexal corners) 1.73 mm, width (frontal carina posterior lobes) 2.04 mm, width (at nasus level) 0.58 mm, metasomal 3 width 1.85 mm, metasomal 3 length 2.10 mm. *Procryptocerus mayri* from Aragua: Portachuelo, 1100 m alt. (Venezuela-MIZA): red; anterior frontal lobes not crested, not elevated; head length 1.496 mm, head width (frontovertexal corners) 1.36 mm, head width (frontal carinae posterior lobes) 0.578 mm, head width (at nasus level) 0.544 mm; mtn 3 width 1.564 mm, mtn 3 length 1.7 mm.

Procryptocerus mayri also has a narrow, flat levigate glossy occiput, mesiad to the occipital carina. The occiput, also present in the *P. rudis* group, is not concave, as it is in the *P. subpilosus* group. In the *P. mayri* and *P. rudis* groups, the inferior part of propleurosternum (lateral view) is neither acute (angulate), nor anterior to the base of the procoxa, while in the *P. subpilosus* group it is acute and anterior to the base of the procoxa. In the black “*P. mayri*” from Central America (FS02), the anterolateral corners of metasomal 3 are evenly rounded anterior to the spiracle, not defining as short truncation approaching the cinctus 3 as they are in the *P. rudis* group. There are two different males associated with the Costa Rican black “*P. mayri*”, one is bulkier than the other. The two workers associated with the males are very similar. The followings characters account for some of the differences in the males. The hypopygium is truncate posteriorly, and the metacoxa is longer (0.8 mm) and “thicker”; the petiole (0.65 mm) and postpetiole (0.70 mm) are bulkier. The associated worker has a clypeo-torular sulcus, and the mesonotal processes are laminar in the anteroposterior aspects, and truncate apically; the frontovertexal corner is formed into a curvate laterally directed spine forming a hook that

emphasizes the posterior notch of the frons between the posterior lobe of the frontal carina and the spine on the frontovertexal corner. The slender male from Heredia, 500 m (1 worker, 1 male) (LACM) has the hypopygium posteriorly rounded, and the metacoxa “slender” and shorter (0.6 mm); the petiole (0.55 mm) and postpetiole (0.65) are slender (in the worker the clypeo-torular sulcus is absent and the mesonotal processes are laminar in the lateromesial aspects, and angulate; the frontovertexal corner is developed into a small spine). I placed the bulky male from Heredia, 5400 m (1 worker, 1 male) (LACM) into the *mayri* group as species inquirenda.

The head of the FS02 subgroup is subsquadrata in profile, elongate, the frons is trapezoidal dorsally, wider posteriorly, the disc of frons is flat; the clypeo-torular sulcus is absent; the posterior lobe of the frontal carina is well developed, longer and with the same lateral expansion as the eye, sometimes it is fenestrate (FS03); the vertex is excavate and costate; the frontovertexal corners are spiniform and the carina notched between the posterior lobe of the frontal carina and the spine of the frontovertexal corner; the frontal carina and the antennal scrobe are deflexed posteriad (profile view).

Considerable variation is present in the FS02 subgroup. I examined 8 samples from Mexico, Costa Rica, Panamá, Colombia and Ecuador and consider that they represent different but very similar populations of the FS02 subgroup forms. The main data associated to these specimens are as follows: COLOMBIA: Valle, bosque montaña, 1300 m (1 worker) (MIZA); Nariño, Orito, Territorio Kofán, 1000 m (1 worker) (IAvH). COSTA RICA: Heredia, 16 km SSE La Virgen, 1050-1150 m (1 gyne) (INBio); Heredia, 5400 m (1 worker, 1 male) (LACM); Puntarenas, Est.

Pittier Send. a Rio Canasta, 1.4 Km NNO de la Estación, 1750-1800 m (INBio); San José, Las Nubes de Santa Elena, Sendero Rio, 1380 m (1 worker) (INBio). ECUADOR: Pichincha, Rio Toachi (1 worker) (900 m) (QCAZ). PANAMA: Bocas del Toro: Sendero Divisa, 1250 m (1 worker) (CIPW).

These forms were previously considered to be *P. mayri* (data on labels). I decided to leave them as species inquirenda in the FS02 subgroup. These forms are closer to the FS02 subgroup than to the *mayri* subgroup. The specimens from Las Nubes de Santa Elena (Costa Rica, San José) and Rio Canasta (Costa Rica, Puntarenas) are intermediate between the two subgroups. They possess a mesospiracular lobe, a condition found in *P. virgatus* (*mayri* subgroup) from Colombia and Ecuador, and an oblong head in profile, a condition of the FS02 subgroup from Mexico to Colombia.

I agree with Longino and Snelling (2002) when stating that different specimens from Colombia, Ecuador, and Perú begin to blur the distinction between *P. mayri* and other related forms.

Group of *Procryptocerus rudis*

The *rudis* group contains 7 species divided into two subgroups: (1) subgroup *rudis* (5 species): *P. rudis* (Mayr 1870) (Colombia), *P. batesi* Forel 1899 (Costa Rica, Colombia), FS06 (Colombia), FS01 (Colombia), *P. carbonarius* (Mayr 1870) (Colombia). (2) subgroup FS29 (2 species): FS29 (Panamá, Venezuela: Amazonas); FS04 (Colombia).

Frons trapezoidal (dorsal view); head oblong (lateral view); frontovertexal margin obsolete and concave mesially (frontovertexal margin not defined across), leaving occipital carina visible (full frontal view); malar space (dorsal view), little curvate, almost straight; malar tumulus present (full anterior, nasal view); frontal carinae straight, anterior and posterior ends rounded mesad; frontal lobe terminating into torulus dorsoposteriorly, laterally projected (*P. rudis*, FS01, *P. carbonarius*, *P. batesi*) reduced (FS04, FS06, FS29); posterior lobe of frontal carina not rounded, subtruncate, and deflexed posteriorly; posterior notch of frontal carina present (*P. rudis*, *P. batesi*, FS06), indistinct or absent (*P. carbonarius*, FS04, FS29); eyes very convex; antennal fovea complete (*rudis* subgroup): clypeo-torular sulcus distinct, as deep or almost as deep as lateral fovea [fovea beneath torulus] and relatively enclosing torulus, sometimes partially hiding torulus [anterior, full nasal view]), or antennal fovea incomplete (FS29 subgroup): clypeotorular sulcus present but indistinct; in anterior, full nasal view clypeal flank not entirely flat, not forming completely perpendicular angle with premalar space, clypeal flank falling in declivity into premalar space; lateral fovea similar in size to antennal condylar bulb; malar tumulus present, sometimes indistinct (FS29), laterad to facial fovea; frontovertexal corners spiniform, laterally directed; scape basal lamella angulate, overlapping half of condylar bulb externally; antennal scape shaft terete proximally; mesonotal processes usually larger than anteropropodeal processes (similar in size in FS01); notopropodeal groove shallow mesially, anteropropodeal processes (dorsal view) usually obsolete (dorsopropodeal sides convex), well developed in *P. rudis* and *P. batesi*; dorsopropodeum subquadrate (dorsal view), similar length as posteropropodeum (lateral view); anteropropodeal processes usually midway on dorsopropodeum; propodeal spines diverging or parallel, horizontal or upturned; profemur longer

than maximum width of mesosoma; slightly compressed, fusiform, not obtuse dorsally; petiole and postpetiole similar in length; petiole barrel-shaped (dorsal view); postpetiole broad and rounded posteriorly forming postnodus directed dorsoposteriorly; anterolateral lobes of postpetiole slightly projected anteriorly, overlapping part of cinctus 2 laterally, forming notch with cinctus (dorsal view), or notch absent or indistinct (FS01), anterolateral borders of metasomal 3 posttergite (dorsal view) falling perpendicular to cinctus 3 (distinct in *P. batesi* and FS04, indistinct in *P. carbonarius*, *P. rudis*, FS06, FS29).

Frons longitudinally costate anteriorly, clathrate posteriorly; promesonotum clathrate or rugocostate; posteropropodeum supra costate-strigate, or levigate (*P. carbonarius*, FS04); profemur, and sometimes meso and metafemora costate in posterolateral aspect; nodal truncation costate-strigate, or rugocostate (FS29); metasomal 3 posttergite fulgid, faintly costulate anteriorly, fading discally, or costate throughout; pilosity long, fine, sparse, suberect, uniform, shortest hairs on mtm 3 posttergite, completely pubescent in FS29; mtm 3 poststernite pubescent or bearing flagellate hairs. Black or testaceous; appendages black, black and rufous, or testaceous.

Discussion.

Procryptocerus batesi, FS01, FS06, and *P. rudis* are four very closely related species. These species are distributed in the Cordilleras of Colombia between 1200 to 2220 m. *P. batesi* is also considered to have its distribution in Costa Rica, and Panamá below 1200 m (Longino and Snelling 2002). *P. batesi* and FS01 have a distinct deep clypeo-torular sulcus and antennal fovea

(the invagination surrounding the torulus); the frontal lobe (dorsal or lateral view) is expanded laterally, not elevated, and producing a prominent mesiad curve when reaching the clypeal (nasal) carina, and passing over and distant from the torulus without any contact (lateral view); the frontal lobe overlaps the torulus completely, hiding it from above. In *P. rudis* and FS06 the clypeo-torular sulcus is shallow, and the antennal fovea is lacking, because there is not a complete invagination surrounding the torulus; the frontal lobe is not expanded and does not form a curve when approaching the nasus; the frontal lobe approaches the clypeal carina passing over the torulus, and comes in contact with the torulus without hiding it from above. *Procryptocerus batesi* has ovoid opisthogaster (dorsal view) and globose in profile; the mtm 3 posttergite is levigate throughout or striolate anteriad and shining. FS01 has an oblong opisthogaster, slightly wider posteriad (subquadrate), sides subparallel (a similar condition in *P. rudis*), and the mtm 3 posttergite and sternite are costate-striate throughout. Although the opisthogasters in *P. rudis* and FS01 are similar in shape, in *P. rudis* it is levigate laterally and sometimes also posteriad. In FS06 the opisthogaster is ovoid dorsally narrowing posteriad; the costae turning from longitudinal anteriad to forming concentric costulae posteriad, to levigate cuticle. Specimens from Colombia: Santander: Virolín: Cuchilla de Faca, 1800 m (IAvH), and one specimen “Paratype” of Kempf (1951) (S. Fe, Bogotá, Coll. G. Mayr, “rudis” G. Mayr type –NMW) match the FS01 character states. Based on these findings and character states, I transfer the one specimen “Paratype” of Kempf (1951) (S. Fe, Bogotá, Coll. G. Mayr, “rudis” G. Mayr type –NMW) from *P. rudis* to FS01, and leave the *P. rudis* Lectotype of Kempf (same data), and the other three *P. rudis* type specimens (same data, “Lindig”) (NMW) as *P. rudis*.

Within the *Procryptocerus batesi* specimens, I find at least three forms: a small one (head length 1.207 mm), intermediate (HL 1.300 mm), and a large (HL 1.500 mm) one with red or black legs.

The smallest and the intermediate forms are from Panamá and Costa Rica respectively; the largest form is from Colombia and is clearly conspecific with the type from Colombia (type locality is probably in the department of Santander). The smallest form was first recognized as *P. carbonarius laeviventris* from Panamá (Type locality Chiriquí). *Procryptocerus carbonarius laeviventris* was synonymized under *P. carbonarius* (Kempf 1951) and later under *P. batesi* (Longino and Snelling 2002). However, *P. laeviventris* could be shown to be a valid species. *Procryptocerus laeviventris* has the metasomal 3 tergite slightly cylindrical on dorsal view, sides somewhat parallel, slightly flat on the dorsum and the sternite convex (lateral view). The posterior notch of frontal carina is absent (but it is clearly present in *P. batesi*); the posterior lobes of frontal carina are not rounded, but subtruncate, testaceous; the frons is clathrate, and the frontal lobes are elevated; the frontovertexal corner is spiniform, directed lateroposteriorly; in the typical *P. batesi* it is directed laterally; the anteropropodeal processes are not completely anteriad, in *P. batesi* changing from indentate (Puntarenas, Costa Rica) to lobose (San José, La Fuente, Costa Rica, MSNG); the profemur of *P. batesi* is costate or costulate on the posterior aspect. *Procryptocerus laeviventris* has the profemur laevigate and similar to the meso and metafemora, the petiole and postpetiole are clathrate. The intermediate form blurs the distinction between *P. laeviventris* and *P. batesi*. In both the intermediate form from Central America and the largest forms (black and red legs) from Colombia, the sides of the metasomal 3 posttergite are somewhat rounded, and the discal surface is convex (lateral view). The posterior notch of the frontal carina is not present in one specimen of *P. batesi* from Heredia (Costa Rica), 1050-1150 m alt. (INBio) but present in specimens from other places. In *P. laeviventris* the posterior notch of the frontal carina is absent or obsolete. The smallest *P. batesi* is the *P. laeviventris* type (Panama, Chiriquí, BMNH, MHNG), head length 1.207 mm, metasomal 3 posttergite length

1.458 mm, and width 1.188 mm. Similar specimens in Costa Rica are from Las Mellizas, Puntarenas (INBio) with the head length 1.139 mm, metasomal 3 posttergite length 1.598 mm, width 1.326 mm. Some specimens of *P. laeviventris* (i.e. Costa Rica, Puntarenas, Monteverde, 1350 m alt., LACM) are intermediate between the *P. laeviventris* form and *P. batesi* from La Fuente, Costa Rica. The intermediate form has no clear posterior notch of the frontal carina, but it is present in the specimens from La Fuente. Hence, it is difficult to associate the intermediate to any of these forms. The intermediate *P. batesi* (n= 4) has head length 1.2 mm, mtm 3 posttergite length 1.5 mm, width 1.3 mm. Specimens from La Fuente are very similar to the Colombian type, and probably conspecific. The *P. batesi* holotype (black) (Colombia, Landolt) and another black specimen (Colombia, N. Santander, 1516 m alt. IAvH) are very similar in color, shape and measurements, and clearly conspecific: head length 1.33 mm, metasomal length 1.58 mm, metasomal width 1.48 mm, head width (level of frontovertexal corners) 1.156 mm, head width (frontal carina posterior lobes) 1.36 mm, head width (at nasus level) 0.442 mm. The red form of *P. batesi* (legs, scape, opisthogaster and flagellum dark brown) from Santander, Colombia, 1750 m alt. is also clearly conspecific with the *P. batesi* holotype although slightly larger: head length 1.360 mm; metasomal width 1.581 mm, metasomal length 1.768 mm, head width (frontovertexal corners) 1.496 mm, head width (posterior frontal lobes) 1.598 mm, and head width (at nasus level) 0.544 mm.

In *Procryptocerus*, males are longer than females. There are different males associated with the smallest and intermediate forms of *P. batesi* from Central America. The male (Puntarenas, Monteverde, 1500 m alt.) associated with the smallest worker resembles *P. laeviventris* in measurements and most characters. Three males in Costa Rica are associated with *P. batesi*

forms: Puntarenas, San Luis de Monteverde, 1100 m alt. (LACM); Puntarenas, Monteverde, 1500 m alt. (LACM); and Monteverde, 1500 m alt., (LACM 1 worker, 1 male on same pin). The male with the worker (Costa Rica, Puntarenas, Monteverde, 1500m alt., coll. J. Longino), is very small (head length 0.7 mm) from base Md to vertex), and therefore does not match with males (head length 1.1 mm) typically associated with *P. batesi* in Central America. Also, it has a hypopygium posteriorly truncate, whereas in males of *P. batesi* it is conic. The species is not *P. batesi*, but I am not sure if the male belongs to *P. laeviventris*, since its associated worker does not match all characters of *P. laeviventris*, particularly the sculpture. The worker has less clathrate sculpture on the frons, and metasomal 3 tergite is slightly more convex than that of *P. laeviventris*, and costulate anteriorly. The male is different enough to be considered a different species. Even though the uniqueness of the male supports the hypothesis that it is a distant species from *P. batesi*, the similarity of the workers with those of *P. batesi laeviventris* and lack of sufficient material contradicts the decision to separate them. Therefore, a new species cannot be recognized here until more material of these forms is collected.

A *Procryptocerus batesi* gyne from Colombia, W. Cali, Valle, 1630 m alt. (IAvH) has no posterior frontal notch, nor clypeotorular sulcus. Apparently, it represents a bridge between *P. mayri* and *P. batesi*.

In the FS29 subgroup, the clypeo-torular sulcus is absent or indistinct and the nasal flanks are not strictly perpendicular to the discal clypeus producing a shallow, usually indistinct antennal fovea; the anteropropodeal processes are not angulate and the sides are parallel. In this subgroup, a clear separation of the clypeo-torular sulcus is obscure.

To distinguish the *P. rudis* group from its nearest, the several characters of *P. mayri* ought to be taken into consideration. The postnodus is broad and dorsoposteriorly directed in *P. rudis* subgroup. In the *P. mayri* group the postpetiole is flat dorsally, the postnodus usually narrowing posteriad and posteriorly directed. A combination between the shape of the outline of the dorsopropodeum or between the shapes of the clypeo-torular sulcus, dorsopropodeum, and deepness of notopropodeal groove are also reliable characters for most species.

In the *Procryptocerus rudis* group, the dorsopropodeum is usually wider than long or subquadrate (less common), shorter than the posteropropodeum; the anteropropodeal processes are developed into lobes, usually occupying half the length of the lateral sides of dorsopropodeum; the anterior corners of the dorsopropodeum are obtuse (not angulate as in *P. mayri* and FS02 subgroup) forming the anterior margins of the lobate anteropropodeal processes. In the *P. rudis* group, the notopropodeal groove is shallow mesially, usually at the same level as the mesonotum or dorsopropodeum. In the *P. mayri* group, with the exception of *P. virgatus* and FS08, which have no anteropropodeal processes and have the mesospiracular lobes well developed; the notopropodeal groove is deep and straight.

In *Procryptocerus mayri* and the FS02 subgroup, the dorsopropodeum is subquadrate or subtrapezoidal, usually similar in length to the posteropropodeum, with the anterior margin wider and the anterior corners (anteropropodeal processes) angulate, not clearly projected laterally, occupying only the anterior corners of the dorsopropodeum, the sides are parallel, the anterior

margin of the dorsopropodeum is nearly sharply defined, it looks truncate, falling into the usually deep, wide and straight notopropodeal groove. In *P. virgatus* and FS08, the notopropodeal groove is shallow mesially and the dorsopropodeum subquadrate, more similar to the *P. rudis* group; the anteropropodeal processes are obsolete or absent.

Two important situations account for difficulties understanding intra and interespecific variation in the *P. mayri*, *P. rudis* groups, especially in *P. batesi*. There is wide variation between populations, as was previously recognized by Longino and Snelling (2002), and the boundaries between species are subtle among workers and gynes. Despite the existence of important material collected in Costa Rica (J. Longino) and Colombia (IAvH, UNAB), there are few collections from other Central America countries, and from northern South America. Few males have been collected and no clear morphological correlations exist between them and the females. These situations impede understanding the uniquenesses and identity of these species. Habitats for these forms are in Central America to Mexico up to 400 m and in the Andes over 600 m, and probably not above 1700 m. Variation in size, color, frontal lobe shape, presence or absence of a posterior notch of the frontal carina, and position and size of the frontovertexal corners account for differences. These characters overlap in the range of distribution between different forms leading to the recognition of widely distributed species from Mexico to Perú. Longino and Snelling (2002) conclude: “Collections occur from Venezuela, through Colombia and Ecuador, south to Peru, but they are too few to draw conclusions about communities of sympatric species or the nature of character variation. Character variation is high even within Costa Rica, and discordant character variation occurs across the material from South America. Each local mountain range may host a unique community, shaped by a combination of dispersal history,

local selection, and perhaps hybridization. As a result, a clear taxonomy of these forms may be elusive". The concepts of *P. mayri* and *P. batesi* we have are so nebulous that extreme forms within *P. batesi* and within *P. mayri* connect the two species, as well as *P. virgatus* from Andes of Colombia, Ecuador and Bolivia, making it difficult to recognize a clear distinction between *P. batesi* and *P. mayri*. However, when the concept about the beforementioned clypeo-torular sulcus, the form of the dorsopropodeum and their variations are understood, it is clear that the two species belong to two different groups. Furthermore, several *P. batesi* and *P. mayri* workers from Costa Rica, Panamá, Colombia and Ecuador are distant from those of the type locality of both species (Colombia, probably Santander). Putting these specimens into either *P. mayri* or *P. batesi* would be an arbitrary decision. I tend to think that several forms might represent new species. A few different males that are available, and supposedly related to these forms, suggest that more species should be recognized for these groups. I have a few series from Perú and Bolivia, in which workers are indistinguishable, but the males are clearly different. Additional collections and matching males with workers and gynes are necessary. In particular, there are constant characters in workers and gynes such as the sculpture of the frons, elevation of the frontal lobes, shape of the dorsopropodeum, and form and orientation of the frontovertexal corners that could be taken into account for the placement of several forms into the same species. Without males, and the few collections available in most countries, it is difficult to resolve these forms. Apparently the problem is more difficult in the *P. batesi*; therefore, at least for *P. batesi*, I decided to follow the species characterization in Longino and Snelling (2002).

Group of *Procryptocerus hirsutus*

The *hirsutus* group contains 5 species: *P. hirsutus* Emery 1896 (Brazil, Guyana, Trinidad), *P. pictipes* Emery 1896 (widely distributed), *P. belti* Forel 1899 (Mexico to Panama, Ecuador), *P. convexus* Forel, 1904 (Brazil: Amazonas, Pará), FS24 (Brazil: Mato Grosso).

Total body length less than 4.5 mm. Frons trapezoidal, wider posteriad, subcircular in *P. pictipes*; head profile oblong subquadrate; genal-postgenal angle almost perpendicular; malar space (dorsal view) almost straight, scarcely convex; frons (profile) shallow convex, flat in *P. pictipes*. In *P. hirsutus* nasus profile at torulus level protruded anteriorly to torulus for almost same diameter as condylar bulb, other species in group without such protrusion, less protruded at level of anteclypeus; shallow clypeo-torular sulcus present; lateral fovea similar in size as condylar bulb; frontal triangle shallow concave (depressed dorsally) between nasus and frons disc; frontal carina (dorsal view) straight, not overhanging any part of eye, divergent posteriad; frontovertexal corner sharply angulate or spiniform, deflexed laterally downward on temple, almost reaching occipital carina; eye subcircular, large in proportion to head, similar in size and convexity as malar space, non protruded; posterior lobe of frontal carina and antennal scrobe deflexed posteriad almost at perpendicular angle; promesonotum markedly convex (*P. belti*, FS04) flat or subconvex (*P. hirsutus*, *P. pictipes*, *P. convexus*); notopropodeal excavations deep, more excavate on mesonotum, mesosoma strongly constricted anteriorly to propodeum; lateral margins of mesonotum converging posteriad, mesonotal processes obsolete or angulate; dorsopropodeum

wider than long, wider than mesonotum; dorsopropodeum profile horizontal, at lower level than promesonotum; anteropropodeal processes less developed than propodeal spiracle; propodeal spiracle completely (*P. hirsutus*), partially (*P. convexus*, *P. belti*, FS04) or not (*P. pictipes*) visible from above; propodeal spines subparallel, horizontal or upturned; petiole cylindrical, longer than wide, sides subparallel, longer and markedly narrower than postpetiole; postpetiole almost twice as wide as long, transversal, subrectangular or vase-shaped with lateral borders curvate lateroposteriorly; opisthogaster (dorsal view) subcordate. Cuticle background largely micropunctulate; frontovertexal margin crenate; frons largely areolate, shallow foveolate in *P. pictipes*; promesonotal suture markedly by anteriad angulate costa (*P. pictipes*, *P. convexus*, FS04), or costa indistinct (*P. hirsutus*, *P. belti*); mesosoma largely costate (*P. hirsutus*, *P. pictipes*, *P. convexus*), or promesonotum clathrate (*P. belti*, FS04), petiole and postpetiole rugocostate; vertex, nodal truncation, and femora levigate, glossy; posteropropodeum largely levigate, glossy, costate in some *P. pictipes* individuals; nodal truncation sharply maginate by costa; opisthogaster punctate, punctulate or micropunctulate, striate in some *P. pictipes* individuals, punctulae never forming rows; pilosity on head and thorax stiff, erect, abundant, uniformly separate, shorter on frons, longer on petiole, postpetiole and opisthogaster; curved lateroposteriad and subdecumbent on opisthogaster. Black, shining, appendages testaceous or yellow.

Discussion.

Procryptocerus hirsutus (Eastern Amazon), *P. convexus* (Western Amazon), FS24 (Mato Grosso), and *P. belti* (Central American) are very closely related species and probably form a

unique lineage with the frons profile subconvex, dorsally trapezoidal, areolate, the frontal carinae are straight, and uniformly hispid, whereas *P. pictipes* is widely distributed in the neotropics and seems to be a separate lineage with a subcircular frons, shallow areolate or foveolate, flat dorsally and sparse separate hairs. *P. pictipes* seems to be a connection between the *hirsutus* and *coriarius* groups. The transversal vase-shaped or subrectangular dorsally flat postpetiole, the usually reticulate or striate-costate frons (except *P. pictipes*) and the subcordate or subcircular opisthogaster separate the *hirsutus* group from the *coriarius* and *balzani* groups.

Distribution: Central American, Andes, Amazon, Central and South Brazil.

Group of *Procryptocerus coriarius*.

The *coriarius* group contains 7 species: *P. coriarius* (Mayr 1870) (Costa Rica, Colombia), *P. attenuatus* 1 (Smith 1876) (Costa Rica to Bolivia, Amazonia), *P. attenuatus* 2, *P. nolini* Longino & Snelling (2002) (Costa Rica, Peru), *P. schmitti* Forel 1901, FS33 (Colombia), FS36 (Bolivia).

Total body length less than 4.5 mm; head (frontal view, scapes accommodated into scrobe) circular; head in profile elongate, dorsal and ventral aspects (profile) curvate; frons in profile from convex to shallowly depressed on disc; eyes subcircular, convex or subconvex, large compared to head, slightly anterior (profile view); frontovertexal margin (head in profile) not fastigial, obtuse or posterior of declivity of frontovertexal margin, vertex (posterior view)

forming narrow, horseshoe-shaped strip; antennal scrobe “closed” posteriad, scrobe notch not reaching occipital carina; frontovertexal corners widely convex mesolaterally, generally obtuse (angulate in *P. attenuatus*); humeri (dorsal view) curvate posteriad; dorsolateral margin of pronotum rounded, not sharply defined (except in *P. attenuatus*); promesonotum uniformly convex; promesonotal suture absent; mesonotal processes lobate or angulate, shorter than anteropropodeal lobes; notopropodeal groove distinct and straight or indistinct (notopropodeum uniformly convex); dorsopropodeum flat, or slightly impressed mesially (*P. schmitti*), at lower level than mesonotum, or convex, in line with promesonotum; anteropropodeal processes markedly larger than mesonotal processes, lobose or angulate; dorsopropodeum transversal or as long as wide, shorter than posteropropodeum (lateral view); propodeal spines parallel, horizontal in profile, barely surpassing level of posteropropodeal lobes; profemur fusiform; petiolar (dorsal view) lateral margins slightly curvate (petiole barrel-shaped), shorter or longer than postpetiole; nodal truncation (in profile) indistinct (*P. nolini*) or distinct angulate anteriorly, curving dorsoposteriorly; summit midway on petiole; postpetiole subquadrate or vase-shaped; opisthogaster elongated or subcircular.

Body largely micropunctulate; frons punctate or foveolate; gena foveate, or foveate-costate; notopropodeum foveate, foveolate or foveate-rugocostate; lateropronotum costate or costate-foveate; legs levigate and shining, petiole and postpetiole foveate or rugocostate-foveate; mtm 3 posttergite and poststernite levigate, punctulate or punctate, shining; posteropropodeum and nodal truncation levigate; frons almost glabrous; promesonotum with scattered flexuous or stiff short hairs; dorsopropodeum usually hairy with suberect or subdecumbent flexuous long or short stiff hairs; legs usually hairy with stiff subdecumbent hairs; longest hairs on petiole and postpetiole; mtm3 posttergite and poststernite from almost glabrous to possessing scattered

subdecumbent flexous hairs or pubescence; legs hirsutus or glabrous. Black, shining or opaque (FS33).

Discussion.

Procryptocerus coriarius (Central America and northern South America) is very similar to *P. schmitti* (Amazon basin and Brazil). *Procryptocerus coriarius* has the frons disc less foveate than in *P. schmitti*. FS33 is opaque and frons disc is shallowly depressed; the other species are shiny. This group is distributed from Costa Rica to northern Brazil (Amazon) and Bolivia. Its placement falls between the *hirsutus* and *gracilis* groups. The subcircular head, the widely rounded frontovertexal corners, the obtuse frontovertexal margin, the narrow vertex forming a horseshoe-shaped strip, the uniformly convex promesotum, the foveate and absence of costae on the frons, the foveate-costate dorsomesosoma, and the usually obtuse dorsolateral margin of the pronotum separates *coriarius* group from its nearest relatives, *hirsutus* or *gracilis* group.

Group of *Procryptocerus gracilis*

The *gracilis* group contains 4 species: *P. gracilis* (Smith 1858) (Amazon), *P. goeldii* Forel 1899 (South Brazil), *P. hylaeus* Kempf 1951 (Panama to southern Brazil, Paraguay), *P. eladio* (Costa Rica: Alajuela).

Frons (dorsal view) elongate, subrhomboidal, narrowing anteriorly; head in profile elongate or oblong, frons convex; nasus markedly protruded (nasal flank 1.5 length diameter of condylar bulb) in *P. gracilis* and *P. eladio*, less protruded in *P. hylaeus* and *P. goeldii*; frontal “triangular” area depressed in *P. gracilis* and *P. eladio*; frontal carina sinuate; posterior lobe of frontal carina not projecting laterally past eye; eye convex, oblong, partially visible in dorsal view (scape accommodated into scrobe); frontovertexal margin sharp (obtuse in *P. gracilis*); region of frontovertexal corner deflexed, terminating in angle or spiniform (obtuse in *P. gracilis*); vertex flat (*P. goeldii*, *P. hylaeus*), subexcavate (*P. eladio*), or obtuse (*P. gracilis*); dorsolateral margin of pronotum not sharply marginate, or indistinct (*P. eladio*); promesonotum variably convex; promesonotal suture absent or obsolete; promesonotal excavations shallow; mesonotal processes angulate, obtuse, shorter or similarly projected laterad as anteropropodeal processes, or absent (*P. eladio*); notopropodeal groove deep, straight; dorsopropodeum wider than long, flat, depressed mesially (convex in *P. hylaeus*), shorter than posteropropodeum; anteropropodeal processes longer than wide, lobose or terminating posteriorly into tiny spine (*P. hylaeus*); propodeal spines parallel and horizontal (slightly upturned in *P. eladio*); profemur fusiform; petiole and postpetiole variably sized and shaped; aspect of nodal truncation usually curvate posteriorly, in profile angulate infra-anteriorly, short and not curvate in *P. eladio*; postnodus absent (*P. gracilis*), obsolete (*P. goeldii*) or distinct (*P. hylaeus*, *P. eladio*); opisthogaster (dorsal view) elongate (*P. gracilis*, *P. goeldii*), or subcircular (*P. hylaeus*, *P. eladio*).

Frons with scattered and uniform foveolae with largely smooth micropunctulate matrix between; promesonotum, dorsopropodeum, petiole and postpetiole foveate or foveolate, or intermixed between foveate or rugocostate-alveolate; lateropronotum costate (foveate-costae in

P. eladio), pleura predominantly costate; mtm 3 posttergite striate or striolate anteriorly transitioning into levigate posteriorly, largely micropunctulate or completely levigate and shining (*P. eladio*); mtm 3 poststernite costulate to sides or laevigate throughout; femora levigate; tibiae rugocostate (*P. hylaeus*), rugostriolate (*P. gracilis*, *P. goeldii*) or levigate (*P. eladio*); vertex levigate or costate; posteropropodeum infra levigate or throughout, nodal truncation strigate or levigate, micropunctulate. Black shining (*P. hylaeus*, *P. eladio*) or testaceous opaque (*P. gracilis*, *P. goeldii*); appendages testaceous or black.

Almost glabrous, with scattered sparse hairs on petiole and postpetiole.

Discussion.

The subrhomboidal shaped frons (frontal view) and the uniformly scattered foveate or foveolate frons are the main characters that allow grouping the four species into the *P. gracilis* group. These characters separate this group from the closest *coriarius* or *hirsutus* groups. *Procryptocerus goeldii* is closer to *P. gracilis* than *P. hylaeus* regarding the similar shape and sculpture of the mesosoma. *Procryptocerus eladio* is the most similar to *P. gracilis* on the basis of the similarities of the markedly protruded nasus. *P. eladio* is restricted to Costa Rica (Alajuela). *P. hylaeus* is a widely distributed species from Costa Rica to the Southern Brazil; *P. goeldii* is restricted to the Southern Brazil; whereas *P. gracilis* is restricted to the Amazon basin of Ecuador, Colombia, and Brazil (Amazonas, Pará).

Group of *Procryptocerus subpilosus*

(All species of this group are described in this chapter in the Appendix 2.1)

The *subpilosus* group contains 10 species divided into two subgroups: (1) *subpilosus* subgroup: *P. subpilosus* (Smith 1860) (Amazon basin of Ecuador, Colombia, Brazil), *P. paleatus* Emery 1896 (Costa Rica, Colombia), *P. impressus* Forel 1899 (Costa Rica, Panamá, Colombia), *P. tortuguero* Longino and Snelling 2002 (Costa Rica, Perú), *P. kempfi* Longino and Snelling 2002 (Costa Rica). (2) *spiniperdus* subgroup: *P. spiniperdus* Forel 1899 (Amazon basin), *P. marginatus* (Amazon basin and Brazil) Borgmeier 1948, FS20 (Ecuador), FS30 (Venezuela: Amazonas), FS35 (Venezuela, Bolivia).

Antennal scrobe open posteriorly, reaching occipital carina; vertex excavate or flat; occipital carina marginate crested; in profile view juncture of postgenal bridge and genal bridge forming acute angle; postgenal bridge similar length as genal bridge, and both excavate posteriad; temple inflexed to occipital carina; postgenal bridge forming levigate shining, occiput (sclerite laterad to neck); lateropronotum inflexed, dorsolateral margin of pronotum sharply defined, overhanging and hiding lateropronotum as seen from above; anterior aspect (panel) of humerus flat. When head deflected ventrally anterior aspect of humerus tightly overlapping occiput, both structures hidden; same view temporal and lateropronotal costae matching together; tightly overlapping areas and disciform profemur probably forming stridulatory organ; promesonotum convex or flat; mesonotal processes obsolete in *subpilosus* subgroup, laminiform upturned in *spiniperdus* subgroup; notopropodeal groove straight, deep or shallow, usually interrupting notopropodeal sculpture; dorsopropodeum flat, subhexagonal, slightly longer than wide; anteropropodeal processes lengthened, half length of dorsopropodeum, subtruncate laterally or angulate posteriad, lateral margins of dorsopropodeum slightly converging posteriad, forming subhexagon sides;

posteropropodeum (lateral view) perpendicular to dorsopropodeum (propodeum box-shaped); propodeal spines horizontal, subparallel, slightly diverging in *subpilosus* subgroup, length barely surpassing posteropropodeal lobes in *subpilosus* subgroup, longer and nearly parallel in *spiniperdus* subgroup; profemur compressed disciform, marginate dorsally; meso and metafemora tectiform; petiole (dorsal view) cylindrical, sides subparallel, longer than postpetiole; postpetiole subquadrate; opisthogaster oblong in *subpilosus* subgroup, subovate in *spiniperdus* subgroup. Hairs shortest on frons, longest on dorsum of petiole and postpetiole, white and sparse in *subpilosus* subgroup, golden and abundant, uniformly distributed in *spiniperdus* subgroup; bristly, usually obtuse, subspatulate in most species except some of *spiniperdus* subgroup; posterior mesonotal transverse hair line or mesial pair of hairs convergent from base in most species except some of *spiniperdus* subgroup. Frons from levigate to sparsely foveolate, costulate or costate; malar space and temple usually costate; ventrad gena usually costate; frontovertexal margin crenulate, crenate or serrate; vertex levigate and glossy; mesosoma largely costate, notopropodeal groove costate or levigate, posteropropodeum levigate; profemur levigate anteromesially, costate posterolaterally; meso and metafemora usually levigate and glossy, tibiae rugocostate in anastomosis, petiole and postpetiole costate dorsally, levigate ventrally; opisthogaster from micropunctulate to largely striate-costate. Black and shining or subshining.

Discussion.

The two subgroups are easily separated. The *subpilosus* subgroup has the dorsopropodeum longer than wide, subhexagonal. Also, it usually has white spatulate hairs; the posterior transversal line of mesonotal hairs or the posteromesial pair of hairs is convergent from the base.

In the *spiniperdus* subgroup, the hairs are usually flagellate or stiff, and parallel on mesonotum and golden in color. The open scrobes posteriorly, reaching the occipital carina, and the usually longer than wide dorsopropodeum (subhexagonal or subquadrate) separate the *subpilosus* group from its nearest, the *balzani* group. These are rarely collected ants. Most material has been collected in Costa Rica, and Colombia. Most species of the *spiniperdus* subgroup are only known from the types. The distribution is from Costa Rica to the Western Andes to Ecuador and in the Amazon from Ecuador to Bahia (Brazil).

Group of *Procryptocerus balzani*.

The *balzani* group contains 22 species: *P. balzani* Emery 1894 (Bolivia), FS15 (Brazil: Pará, Mato Grosso), *P. scabriusculus* Forel 1899 (Mexico to Venezuela), *P. lepidus* Forel 1908 (Brazil), *P. elegans* Santschi 1921 (Brazil), FS18 (Brazil: Piauí), FS28 (Ecuador), FS31 (Ecuador), FS32 (Venezuela), FS34 (Brazil: Bahia), FS37 (Perú), FS39 (Ecuador), FS40 (Venezuela: Amazonas), *P. adlerzi* (Mayr1887) (Brazil: São Paulo), *P. regularis* Emery 1888 (Brazil: Santa Catharina; Argentina: Misiones), FS17 (Brazil: Bahia, Minas Gerais), FS14 (Brazil: Bahia), FS16 (Brazil: Pernambuco), FS23 (Rio de Janeiro), FS21(Espírito Santo), *P. montanus* Kempf 1957 (Brazil: São Paulo), *P. clathratus* Emery 1896 (Brazil: Santa Catharina, São Paulo).

Head (profile) oblong; frons (frontal view) trapezoidal, more than twice wider posteriorly than anteriorly or subquadrate; frons flat, subconvex, or convex posteriad; nasal (clypeal) flank

orthogonal to discal clypeus; lateral fovea (fovea under torulus) present; frontoclypeal suture, between toruli, indistinct; frontal triangular area (shallow depressed area posteriad to clypeus) indistinct, in line with frons; frontovertexal margin distinct throughout, sometimes fastigial; frontal carina slightly sinuate or straight; posterior lobe of frontal carina (lateral view) evenly convex, not deflexed posteriad; frontovertexal corners angulate, sometimes spiniform; posterior notch of antennal scrobe "closed", not reaching occipital carina, interrupted by vertex lateroinfral extension; vertexal surface flat to rarely excavate; malar space (dorsal view) convex or straight; eye subcircular or oblong, partially visible or hidden in dorsal view (scape accommodated into scrobe), longest diameter subequal to malar space, in anterior full nasal view, from completely flat to protruding, evenly convex or forming two faces (superior -dorsad- and inferior -ventrad- faces produced by protruding obtuse transversal margin on equator), dorsad face convex, flat in declivity, or excavate, larger than ventral surface, ventral surface convex or flat in declivity; basal lamella of scape shaft not overlapping condyle constriction; humeral angle (dorsal view) acute; epicnemial carina forming lamella, lobe or truncation slightly flanking procoxae externally; mesonotum and dorsopropodeum (in profile) usually in horizontal line; mesonotum flat dorsally; mesonotal processes varying from obsolete to lobose or spiniform; notopropodeal excavations (dorsal view) more excavate on mesonotum than on propodeum; notopropodeal groove same depth across; dorsopropodeum wider than long, usually wider than mesonotum, profile horizontal (flat dorsally), markedly wider than long, shorter than posteropropodeum; anteropropodeal processes subtriangular to sublobose or lobose, directed laterally or anterior margin curve lateroposteriorly, usually same length anteroposteriorly than space between lobe and propodeal spine base; propodeal spines parallel or subparallel, usually horizontal, rarely diverging; petiole and postpetiole (only posttergite) subequal in size or petiole longer;

dorsolateral margin of nodal truncation varying from sharply delimited by curvate dorsolateral costa to absence of costa or margin; nodal truncation (profile) curvate anteroposterioly or angulate anteriad; petiolar summit midway or posteriad; petiolar lateral margins subparallel or slightly convex (petiole barrel-shaped); postpetiole wide in middle, slightly narrowing posteriad on postnodus or sides parallel, subconvex dorsally; postnodus usually directed posterioly, rarely posterodorsally; postpetiole posterior aspect (declivity after postnodus -profile view) forming slightly subnodal constriction emphasizing postnodus; profemur compressed disciform, usually keeled dorsally; opisthogaster (dorsal view) oblong, convex to subconvex in profile; metasomal 3 posttergite anterior corners evenly convex in line with remaining posttergite.

Frons costate, rugocostate, costulate, rugocostulate or costate-striate, with few scattered punctae; frontal lobe obsolete; posterior lobe of frontal carina usually covering projected eye, not deflexed posteriorly (lateral view); malar space rugocostae and foveolate; genal bridge costate; fastigium (frontal or posterior view) crenate, crenulate, entire, slightly notched in middle, or marginate; dorsopronotum rugocostate; promesonotal suture obsolete or distinct, curvate anteriad; lateropronotum predominantly costate-porcate; dorsomesosomal sculpture costate-porcate, not interrupted by notopropodeal groove; notopropodeal groove straight or rarely poorly curvate posteriad; epicnemial carina projected anteriorly into angle, lobe or truncated lamella slightly flanking procoxa externally (subquadrate and well projected in *P. clathratus*); meso- and metapleura costate; posteropropodeum levigate; tibiae rugocostate; nodal truncation usually strigate; petiole and postpetiole predominantly rugocostate. Frons usually with fewer than 60 short sparse stiff hairs; petiole and postpetiole hairs suberect or subdecumbent; mtm 3 posttergite

with fewer than 15 rows of subdecumbent stiff hairs. Black or brown, shining or subopaque; appendages black or brown.

Discussion.

This is the largest group of *Procryptocerus* spp. Except for *P. scabriusculus*, all species are from South America, mainly Brazil, and below 1500 m. The flat notopropodeum, the wider than long dorsopropodeum, which is shorter than the posteropropodeum, the well developed (usually acute) anteropropodeal processes, and the usually straight across notopropodeal groove allow separation of the *balzani* group from its closest relative, the *striatus* group. *Procryptocerus clathratus* has a subquadrate, well projected epicnemial process. This sharp characteristic is distinctive in the *striatus* group. *Procryptocerus clathratus* can be separated from the *striatus* group by the crenate-dentate fastigium (the sharp frontovertexal margin), the excavate vertex, the very flat dorsomesosoma and the opisthogaster, which is striate-costate anteriorly merging to levigate and shining posteriorly. Unique characters of the *balzani* group are elusive and it is unlikely to be a monophyletic lineage.

A specimen representing a species in this group from Colombia, Magdalena, 750m (CIPW) falls between *scabriusculus* and FS39. The specimen does not represent an intergrade but it is difficult to know if it is a variant of any of those species. It possesses an eye convexity and general form of sculpture and shape of meso and metasoma more similar to *scabriusculus*, but the frontovertexal margin fastigial and the rugocostate frons sculpture puts the specimen close to FS39.

Group of *Procryptocerus striatus*.

The *striatus* group contains 8 species into two subgroups: *striatus* subgroup (5 species): *P. striatus* (Smith 1860) (southern Brazil), *P. victoris* Kempf 1960 (Brazil: São Paulo), *P. schmalzi* Emery 1894 (Brazil: São Paulo), *P. gibbosus* Kempf 1949 (Brazil: Espiritu Santo), FS22 (Brazil: São Paulo, Paraná); *convergens* subgroup (3 species): *P. convergens* (Mayr, 1887) (Brazil: Santa Catharina), FS19 (Brazil: Río de Janeiro), FS38 (Brazil: São Paulo).

Head outline shape (full frons view) subcircular to subquadrate, flat dorsally (in profile), head profile oblong; eye convex, subcircular, of similar protrusion and subequal in length as malar space, in dorsal view (scape accommodated into scrobe) eye hidden or partially visible; frontovertexal corner angulate or spiniform, vertex flat; malar tumulus absent; nasal (clypeal) flanks perpendicular to clypeal disc; clypeo-torular sulcus absent or with shallow furrow line present; lateral fovea (fovea under torulus) present; frontoclypeal suture, between toruli, indistinct; frontal triangle area indistinct, shallowly impressed; frons discal area (lateral view) subconvex or flat; frontovertexal margin distinct or fastigial, convex in frontal or posterior view; frontal carina slightly sinuate; posterior lobe of frontal carina not as laterally expanded as eye, evenly convex or slightly deflexed downward; antennal scrobe "closed" posteriorly, interrupted by vertex infra extension; vertexal surface flat or shallowly concave; basal lamella of scape small, not overlapping condyle constriction; scape slightly narrower and tapered proximally; humerus angulate, non spiniform; epicnemial process truncate into tiny quadrate lamella forming

scrapper, flanking procoxa externally; promesonotum convex, rarely subconvex, pronotal dorsolateral margin rough, not sharply carinate; mesonotum variably convex; mesonotal processes lobose; mesonotum and dorsopropodeum convex; notopropodeal groove mesially obsolete (*convergens* subgroup) or shallow (*striatus* subgroup); dorsopropodeum narrower than mesonotum, slightly longer than wide (*striatus* subgroup) or wider than long (*convergens* subgroup), convex lateromesially, similar in length to posteropropodeum, sides (posteriad to anteropropodeal processes) slightly convergent; anteropropodeal processes lobose (*striatus* subgroup) or spiniform laterally or directed posteriorly (*convergens* subgroup); propodeal spines diverging (parallel in FS22) and upturned, thin, cylindrical from base, usually obtuse apically; posteropropodeum narrower than long, usually slightly longer than dorsopropodeum; petiole and postpetiole (only posttergite) subequal in length or postpetiole longer; nodal truncation (in profile) lobate anteriad, curving dorsoposteriad; petiole summit midway; petiole (dorsal view) with lateral margins convex (barrel-shaped) or subparallel (cylindrical); dorsal postpetiole wider posteriad, in profile dorsal and posterior aspect (declivity after postnodus) not evenly curvate; subnodal, shallow constriction emphasizes postnodus or evenly curvate until reaching mtm 3 posttergite (postnodus absent, only in *P. convergens*); profemur compressed disciform, dorsal margin not keeled; sternopostpetiolar process short, not or slightly overlapping cinctus 2, usually transversally truncate; opisthogaster (Abd IV to pygidium - dorsal view) oblong; Abd IV (mtm 3) posttergite anterior corners evenly convex as remaining posttergite.

Body largely micropunctulate; frons predominantly costate, costate-rimulosous, or costate-strigate; malar space usually rugocostae; preocular costa (between eye and scrobe) usually present; genal bridge rugocostate; vertex variably costate or levigate; dorso and lateropronotum costate; notopropodeal sculpture not interrupted by notopropodeal groove, rimosous or costate-

porcate; meso- and metapleura costate throughout; meso- and metatibiae rugocostate in anastomosis; posteropropodeum usually costate; nodal truncation usually strigate; petiolar tergite costate-tuberculate; tergal postpetiole costate; mtm 3 posttergite uniformly striate-costate; mtm 3 poststernite usually costate or costulate to sides; Abd V, VI posttergites costate micropunctulate; epipygium (Abd VI) strigate-micropunctulate.

Fewer than 60 hairs on frons; malar space with fewer than 4 hairs; genal bridge with flagellate pilosity and pubescent; mandible distal-ectal (disti-external) surface bristly with scattered hairs; coxae pubescent with flagellate hairs on anterior and lateral aspects; dorsum of profemur pilosity decumbent with stiff hairs; dorsopropodeum with uniformly separate suberect stiff hairs, sometimes more abundant than on promesonotum; dorsal petiole and postpetiole hairs erect and suberect. Black, some species with appendages testaceous.

Discussion.

All species in the *striatus* group are distributed in southern Brazil. The characteristic truncate epicnemial process is the best character to separate this group from its most closely related, the *balzani* group; other characteristics which support the separation: the notopropodeum converging posteriad, convex dorsally, the usually lateromesially convex dorsopropodeum, the slender, apically obtuse, upturned and usually divergent propodeal spines, and the dorsopropodeum is usually longer than wide in the *striatus* subgroup.

Group of *Procryptocerus sulcatus*

The *sulcatus* group contains 6 species: *P. curvistriatus* Kempf, 1949 (Brazil: Espiritu Santo); *P. ferreri* Forel, 1912 (Colombia); *P. lenkoi* Kempf, 1969 (Brazil: São Paulo); *P. sampaioi* Forel, 1912 (Brazil: São Paulo); *P. sulcatus* Emery, 1894 (Brazil: Minas Gerais, Rio de Janeiro), *P. seabrai* Kempf 1964 (Brazil: Floresta da Tijuca).

Frons outline (dorsal view) from subcircular to subtrapezoidal; frontal carinae sinuate; frontovertexal margin fastigial (*P. sampaioi*, *P. ferreri*, *P. curvistriatus*, *P. sulcatus*), or obtuse (*P. lenkoi*, *P. seabrai*); humeri (dorsal view) angulate (obtuse in *P. seabrai*); dorsomesosoma evenly convex; notopropodeal groove absent, or obsolete (*P. lenkoi*, *P. seabrai*); dorsolateral margin of pronotum well defined, rough (absent in *P. seabrai*); lateropronotum vertical, non inflexed; mesonotal processes absent (*P. lenkoi*, *P. seabrai*), lobose or spiniform; promesonotal excavations obsolete or shallower than notopropodeal excavations; dorsopropodeum subquadrate, convex, in line with promesonotum (profile view); anteropropodeal processes absent, obsolete, lobose, or lobose-laminate (more expanded than mesonotal processes); margins between dorsopropodeum and lateropropodeum and between dorsopropodeum and posteropropodeum not sharp, obtuse or obsolete; propodeal spines tiny (one third of dorsopropodeum length) (*P. lenkoi*, *P. seabrai*), or longer than dorsopropodeum, thin (cylindrical) from base, or narrowing distally; profemur compressed fusiform obtuse dorsally (*P. lenkoi*, *P. ferreri*, *P. seabrai*), disciform and keeled dorsally (*P. sulcatus*, *P. curvistriatus*);

petiole and postpetiole of similar length (petiole longer than postpetiole in *P. seabrai*); petiole (dorsal view) variable in shape, from cylindrical to barrel-shaped; postpetiole narrowing posteriad on postnodus, or broad posteriad; postnodus absent (*P. lenkoi*, *P. seabrai*), obsolete (*P. sampaioi*), present (*P. sulcatus*, *P. curvistriatus*); opisthogaster usually elongate, or subcircular.

Body largely micropunctulate; dorsum and lateral mesosoma, and dorsometasoma uniformly porcate, costae thick, usually flat at ridge, interstriae of similar width to costae; frons varying between porcate to rimulose-costate, scattered with shallow areolae (*P. ferreri*); between 20 and 30 costae on frons; vertex usually strigate-costate; porcate sculpture on dorsomesosoma not interrupted on notopropodeal fusion; notopropodeal groove absent (*P. sulcatus*, *P. curvistriatus*, *P. ferreri*), obsolete (*P. lenkoi*, *P. seabrai*); opisthogaster porcate dorsally (punctulate not forming lines in *P. seabrai*), costate-striate ventrally; hairs generally short, uniformly distributed, from flexous suberect to stiff suberect or subdecumbent; first opisthogastral sternite with flexous or stiff hairs, or pubescent (*P. ferreri*).

Black, shining, or opaque (*P. ferreri*).

Discussion.

This group is unlikely to be a monophyletic lineage. The uniformly convex dorsomesosoma, the heavy regular usually porcate sculpture, and the absence or obsolete notopropodeal groove are the character states that allow them to be grouped. These characteristics are more likely to be caused by local adaptations than to common ancestry. The epicnemial process, considered here as a more reliable character, is different in shape in almost each species, from truncate or lobose angulate, to laminate; the shape and orientation of the propodeal spines are also variable;

the vestiture is markedly variable in details, the pubescence of mtm 3 sternite of *P. ferreri* indicates that this species could belong to a different species complex; also *P. ferreri* is the only species in the Andes with these characteristics; the rest of the species in the group are from southern Brazil. *P. seabrai* possesses very unique characteristics. It has no costae on the opisthogaster, the frontal carina is strongly mesially curvate anteriorly and the frontal lobes are absent leaving the torulus completely exposed in its entire annulus. *Procryptocerus curvistriatus* could be a variant of *P. sulcatus*, but the holotype is the only known specimen, which does not allow any conclusion concerning the variation.

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Appendix 2.1. Species accounts for the *Procryptocerus subpilosus* group.

Group of *Procryptocerus subpilosus*

The *subpilosus* group is composed of 10 species: *P. subpilosus* (Smith 1860), *P. paleatus* Emery 1896, *P. impressus* Forel 1899, *P. tortuguero* Longino and Snelling 2002, *P. kempfi* Longino and Snelling 2002, *P. spiniperdus* Forel 1899, *P. marginatus* Borgmeier 1948, FS20, FS30, and FS35. The species accounts are as follows.

***P. FS20* Serna, new species**

HOLOTYPE WORKER. ECUADOR: Napo: 25 km WSW Loreto, 1050 m, 8-viii-1991, P.S. Ward (1w) [PSWC].

DISTRIBUTION. Ecuador.

ETYMOLOGY. (This dissertation is not considered to be a formal publication to naming new species).

DESCRIPTION OF WORKER. Worker measurements: HL 1.5, FW1 0.725, FW2 1.675, FW3 1.55, CI 1.116, SL 1.1, FCL 1.35, SCI 0.814, NL 0.35, NW 0.525, NI 0.666, EL 0.375, EW 0.275, EI 1.363, PW 1.25, PML 1.15, MW 0.95, NPEW 0.5, PrL 0.6, PrW 0.8, PrI 0.75, PFL 1.125, PFW 0.425, PFI 2.647, MFL 1.2, MTL 1.2, PtH 0.575, PpH 0.65, PtL 0.5, PpL 0.55, PtW 0.475, PpW 0.625, AL 1.2, AW 1.5, AI 0.8, ASD 0.

Head outline (full frons view) trapezoid; head profile general ellipsoid; malar tumulus absent; clypeal carina present; frontovertexal margin posterior lobe and frontal carina posterior lobe in orthogonal angle. nasal (clypeal) flanks orthogonal (nasus laterally truncate) to discal clypeus; lateral clypeofrontal notch absent (torulus visible from anterior view but no a notch is formed between clypeus and frontal lobe); clypeotorular sulcus absent; lateral fovea (fovea under torulus) present; frontoclypeal suture -between toruli- clearly distinct; frontal triangle indistinct; frons triangle area impression in line with frons; frons discal area (lateral view) in line, convex with frons general surface; frontovertexal margin distinct (acute) throughout (fastigial); frontal carina from frontal lobe to frons posterior lobe (frontal view) (not including frontovertexal corner) quasi straight; frontal carina immediately posteriad to torulus thicker than beginning of frons posterior lobe; frontal carina posterior lobe direction (lateral view) quasy straight; fastigium (frontal or posterior view) marginate-crenate; frontovertexal corners angulate non spiniform; antennal scrobe notch posterior "opened" reaching the occipital carina, sometimes temporal occupies posterior scrobal notch; vertexal surface concave; malar space (dorsal view) similar swollen than eye; eye swollen; eyes dorsum (dorsal view, scape accommodated into scrobe) partially visible; eye longest diameter subequal than malar space; eye quasi circular; eye with one evenly convex surface; eye dorsal face obtuse, similar to ventral face; scape not overlapping condyle constriction; scape slightly narrower and tapered proximad; humeral angle (dorsal view) angulate; epicnemial carina inferior angle lamella flanking procoxa; mesonotal process present; mesonotum dorsal (profile view) flat similar to dorsopropodeum; notopropodeal fusion lateral excavations (dorsal view) more excavate on mesonotum than on propodeum; notopropodeal profile dorsopropodeum at lower level than mesonotum; dorsopropodeum profile horizontal (flat dorsally); notopropodeal groove present in middle; posteropropodeum supra

declivitous area longer than infra; propodeal spines apices parallel; propodeal spines apices dorsoventral horizontal; all spiracle fused to lateropropodeum (only the distal ring visible); petiole node similar width than posteropropodeum; obtuse (anterior face forming a even anteroposterior curvature until reaching the summit); petiole summit in middle; petiole lateral margins (dorsal view) convex (barrel shape); postpetiolar node (postnodus) present; dorsum postpetiole wider in middle; postpetiole dorsal and posterior (declivitous after postnodus) surface (profile view) non evenly curvate (posterior surface orthogonal to dorsum; petiole shorter than postpetiole; profemur compressed, disciform (disc-shape), dorsal margin non keeled; petiolar posterior margin (profile view) vertical; sternopostpetiolar process blunt; opisthogaster (Abd IV to pygidium) (dorsal view) oblong; Abd IV (mtm 3) posttergite anterior corners evenly convex as the remaining posttergite. Postpetiole wider in middle and posteriad. Dorsopronotum strigate antieriad; costate in anastomosis in middle; stiff suberect hairs on propodeal spines dorsoproximally; nodal truncation costate porcate; frontal carina stright, or very slightly curvate downward posteriad (lateral view), not bended posteriolly; temple and lateropronotum inflected; dorsolateral pronotal margin crested, marginate and crenulate (dorsal view); pronotum strigate; strigulate antieriad and costate after pronotal disc to mesonotum; area between mesonotum and dorsopropodeum declivitous, microstriolate-punctate.

Frons rugocostate-striate; malar space costate-porcate; preocular costa absent; genal bridge; mandible costate distally; dorsopronotum costate; lateropronotum predominantly costate-porcate; notopropodeal interrupted by notopropodeal groove; mesonotum and dorsopropodeum costate-striate; meso- and metapleura supra ecarinate and infra costulate; spines costulate basad; posteropropodeum smooth; meso- and metatibia rugocostate in anastomosis and

micropunctulate; nodal truncation costate; tergal petiole costate; tergal postpetiole rugocostate; cinctus 2 (on mtm 2 = Abd III) glossy; mtm 3 (Abd IV) posttergite punctuate; Abd IV (mtm 3) poststernite smooth throughout micropunctulate; Abd V, VI posttergites punctulate; epipygium (Abd VII) punctulate; frons with more than 60 hairs; medial line of mesonotum, dorsopropodeum, petiole and postpetiole pilose; malar space less than 4 hairs; genal bridge flagellate pilosity; mandible distal-ectal (distal-external) surface few scatter (less than 10) hairs; mesonotum posteromedial stiff (sometimes flagellate) setae slightly convergent; coxae pubescent and hairy; dorsum of profemur with subdecumbent hairs; petiole and postpetiole dorsal with erect and suberect hairs; mtm 3 (Abd IV) posttergite with hairs throughout; Abd V, VI, and VII posttergites with long hairs compared to those on petiole and postpetiole; hypopygium denudate; general lustre shinny; appendages black; overlapping the condyle constriction; scape width slightly narrower and tapered proximad; humeral angle (dorsal view) angulate; epicnemial carina inferior angle lamella flanking procoxae; mesonotal processes present; mesonotum dorsal (profile view) flat similar to dorsopropodeum; notopropodeal fusion lateral excavations (dorsal view) more excavate on mesonotum than on propodeum; notopropodeal profile dorsopropodeum at lower level than mesonotum; dorsopropodeum profile horizontal (flat dorsally); notopropodeal groove in middle present;

posteropropodeum supra and infra declivitous areas relation size supra longer than infra; propodeal spines apices lateromesial parallel; propodeal spines apices dorsoventral horizontal; spiracle all spiracle fused to lateropropodeum (only the distal ring visible); petiole node width similar width than posteropropodeum; obtuse (anterior face forming a even anteroposterior curvature until reaching the summit); petiole summit in middle; petiole lateral margins (dorsal view) convex (barrel shape); postpetiolar node (postnodus) present; dorsum postpetiole wider in

middle; postpetiole dorsal and posterior (declivitous after postnodus) surface (profile view) non evenly curvate (posterior surface orthogonal to dorsum or usually forming a subnodal, shallow constriction emphasizing the postpetiolar node; petiole and postpetiole (only posttergite) length comparison shorter than postpetiole; profemur compressed disciform (disc-shape), dorsal margin non keeled; petiolar posterior margin (profile view) vertical; sternopostpetiolar process blunt; opisthogaster (Abd IV to pygidium) (dorsal view) oblong; Abd IV (mtm 3) posttergite anterior corners evenly convex as the remaining posttergite; frons rugocostate-striate; malar space costate-porcate; preocular costa or costula (between eye and scrobe) absent; genal bridge glossy; mandible distal costate; dorsopronotum costate; lateropronotum predominantly costate, porcate; notopropodeal continuity broken down by notopropodeal groove; mesonotal and dorsopropodeal costate, striate; meso- and metapleural supra ecarinate and infra costulate;

spines costulate basad; posteropropodeum smooth; meso- and metatibia rugocostate in anastomosis and micropunctulate; nodal truncation costate; tergal petiole costate; tergal postpetiole rugocostate; cinctus 2 (on mtm 2 = Abd III) glossy; mtm 3 (Abd IV) posttergite punctuate; Abd IV (mtm 3) poststernite smooth throughout micropunctulate; Abd V, VI posttergites punctulate; epipygium (Abd VII) punctulate; frons vestiture more than 60 hairs; anteclypeal pecten lateral hairs direction convergent; pilosity on medial line of mesonotum, dorsopropodeum, petiole and postpetiole pilose; eyes pilosity absent; malar space pilosity less than 4 hairs; genal bridge vestiture flagellate pilosity; mandible pilosity distal-ectal (distal-external) surface few scatter (less than 10) hairs; mesonotum posteromedial stiff (sometimes flagellate) setae slightly convergent; coxae vestiture pubescent and hairy on any face; dorsum of profemur pilosity and subdecumbent; petiole and postpetiole dorsal vestiture predominantly erect and suberect; mtm 3 (Abd IV) posttergite vestiture present throughout; Abd V, VI, and VII

posttergites vestiture length compared to that on petiole and postpetiole long hairs; hypopygium vestiture denudate; general lustre shinny; appendages color black.

COMMENTS. Only a worker has been collected.

BIOLOGY. on recently felled trees. Rainforest

P. FS30 Serna, new species

HOLOTYPE WORKER. VENEZUELA: Amazonas, Cerro Yutajé, 1750 m, 17-24-ii-1995, J.L. García (1w) [MIZA].

DISTRIBUTION. Venezuela.

ETYMOLOGY. (This dissertation is not considered to be a formal publication to naming new species).

DESCRIPTION OF WORKER. Worker measurements: HL 1.35, FW1 0.55, FW2 1.45, FW3 1.3, CI 1.074, SL 0.875, FCL 1.175, SCI 0.744, NL 0.3, NW 0.475, NI 0.631, EL 0.325, EW 0.3, EI 1.083, PW 1.05, PML 1.1, MW 0.75, NPEW 0.475, PrL 0.45, PrW 0.775, PFL 0.5, PFW 0.375, PFI 1.333, MFL 1.1, MTL 1, PtH 0.4, PpH 0.5, PtL 0.35, PpL 0.45, PtW 0.35, PpW 0.525, AL 1.475, AW 1.375, AI 1.072, ASD 0.

Head outline (full frons view) subcircular; head profile subglobular; malar tumulus absent; clypeal carina (or costa) absent; nasal (clypeal) flanks orthogonal to discal clypeus; lateral clypeofrontal notch absent (torulus visible from anterior view but no a notch is formed between clypeus and frontal lobe); clypeotorular sulcus present, canalicular, forming antennal fovea (a circular groove leaves the torulus free from nasal flank and frontal lobe, the channel is often as deep and wide as the lateral foveola and connected to it); lateral fovea (fovea under torulus)

present; frontoclypeal suture -between toruli- indistinct; frontal triangle indistinct; frons triangle area impression in line with frons; frons discal area (lateral view) in line convex with frons surface; frontovertexal margin distinct (acute) throughout (fastigial); frontal carina from frontal lobe to frons posterior lobe (frontal view)(not including frontovertexal corner) quasi straight; frontal carina immediately posteriad to torulus thicker than beginning of frons posterior lobe; frontal carina posterior lobe (lateral view) strongly bended downward, describing almost an orthogonal angle; fastigium (frontal or posterior view) crenulate; frontovertexal corners angulate; antennal scrobe notch "opened" posteriorly reaching the occipital carina; vertexal surface flat; malar space (dorsal view) less swollen than eye; eye swollen; from dorsal view eyes partially visible (scape accommodated into scrobe); eye longest diameter subequal than malar space; eye quasi circular; eye faces one evenly convex surface; eye dorsal face convex, similar to ventral face; scape basal lamella not overlapping the condyle constriction; scape slightly narrower and tapered proximad; humeral angle (dorsal view) angulate; epicnemial carina inferior angle lamella flanking procoxae; mesonotal processes present; mesonotum (profile view) convex; notopropodeal fusion lateral excavations (dorsal view) more excavate on propodeum; notopropodeal profile dorsopropodeum at lower level than mesonotum; dorsopropodeum profile convex; notopropodeal groove present in middle; posteropropodeum infra declivitous area absent; propodeal spines apices lateromesial parallel and horizontal; spiracle free laterally; petiole node width less wide than posteropropodeum; nodal truncation obtuse (anterior face forming a even anteroposterior curvature until reaching the summit); petiole summit anteriad; petiole lateral margins (dorsal view) parallel; postpetiolar node (postnodus) present; dorsum postpetiole wider posteriad; postpetiole dorsal and posterior (declivitous after postnodus) surface (profile view) forming a subnodal, shallow constriction emphasizing the postpetiolar node;

petiole (only posttergite) subequal length than postpetiole; profemur compressed disciform (disc-shape), dorsal margin keeled distad, and strongly curved and skewed proximad; petiolar posterior margin (profile view) vertical; sternopostpetiolar process lobate; opisthogaster (Abd IV to pygidium) (dorsal view) oblong; Abd IV (mtm 3) posttergite anterior corners evenly convex as the remaining posttergite; predominant frons rugocostate-foveolate-micropunctulate; malar space rugocostate, preocular costa (between eye and scrobe) absent; genal bridge costate; mandible costate distally; dorsopronotum rugocostate-micropunctulate; lateropronotum predominantly costate-porcate-micropunctulate; notopropodeal interrupted by notopropodeal groove; mesonotal and dorsopropodeum rugocostate-macropunctulate, with few areolae on mesonotum; meso- and metapleura costate macropunctulate; propodeal spines ecarinate, macropunctulate; posteropropodeum smooth; meso- and metatibia rugocostate in anastomosis, micropunctulate; nodal truncation ecarinate, micropunctulate; tergal petiole rugocostate-micropunctulate; tergal postpetiole rugocostate-micropunctulate; cinctus 2 (on mtm 2 = Abd III) costate (scrobiculate); mtm 3 (Abd IV) posttergite smooth punctulate; Abd IV (mtm 3) poststernite smooth, micropunctulate; Abd V, VI posttergites micropunctulate-microstriolate; epipygium (Abd VII) micropunctulate-microstriolate; frons with more than 60 hairs; medial line of mesonotum, dorsopropodeum, petiole and postpetiole pilose; malar space less than 4 hairs; genal bridge with flagellate pilosity; mandible (distal-ectal: distal-external) with flagellate, scatter hairs; mesonotum posteromedial stiff (sometimes flagellate) setae parallel; coxae pubescent and hairy; subdecumbent hairs on profemur dorsally; petiole and postpetiole vestiture suberect; mtm 3 (Abd IV) posttergite with vestiture present throughout (more than 15 rows) abundant flagellate, golden hairs resembling pubescent; Abd V, VI, and VII posttergites with

long hairs, when compared to those on petiole and postpetiole; hypopygium with flagellate hairs; shinny; appendages color black.

BIOLOGY. Unknown.

P. FS35 Serna, new species

HOLOTYPE. BOLIVIA Pando Mapiri, J. Ldg (1g) [MSNG].

PARATYPE. BOLIVIA Pando Mapiri, J. Ldg (1g) [MSNG].

DISTRIBUTION. Bolivia.

ETYMOLOGY. (This dissertation is not considered to be a formal publication to naming new species).

DESCRIPTION OF GYNE. Gyne measurements HL 1.7, FW1 0.8, FW2 1.875, FW3 1.75, CI 1.102, SL 1.125, FCL 1.45, SCI 0.775, NL 0.3, NW 0.6, NI 0.625, EL 0.425, EW 0.35, EI 1.214, PW 1.55, PML 1.9, PrL 0.325, PrW 1, PrI 0.325, PSL 0.375, PSI 1.363, PFL 1.05, PFW 0.375, PFI 2.8, MFL 1.4, MTL 1.3, PtH 0.5, PpH 0.675, PtL 0.55, PpL 0.65, PtW 0.5, PpW 0.675, AL 2.2, AW 1.875, AI 1.173, FWL 5.95, HWL 4.45, PSL 0.3, PSI 0.923.

Head outline (full frons view) subsquared, globular in profile; postgena concave; temple angulate at inferior margin (postgenal angle); malar tumulus absent; temple markedly inflected as lateropronotum (occipital carina and humeral carina touching each other when head deflected); clypeal carina absent; nasal (clypeal) flanks lateral (same plane) to discal clypeus; lateral clypeofrontal notch absent (torulus visible from anterior view but no a notch is formed between clypeus and frontal lobe); nasal lateral fovea (fovea under torulus) present; frontoclypeal suture -

between toruli- distinct; frontal triangle indistinct; frons triangle area in line with frons; frons discal area (lateral view) convex, in line with frons general surface; frontovertexal margin distinct (acute) throughout (fastigial) and crested; frontal carina from frontal lobe to frons posterior lobe (frontal view) (not including frontovertexal corner) quasi straight; frontal carina immediately posteriad to torulus same thickness as beginning of frons posterior lobe; frontal carina posterior lobe (lateral view) slightly turned downward, not evenly convex with the carina anteriad; fastigium (frontal or posterior view) marginate-crenate; frontovertexal corners obtuse; antennal scrobe notch posterior condition "opened" reaching the occipital carina, temporal occupies posterior scrobal notch; vertexal surface excavate; malar space (dorsal view) similarly swollen than eye; eye swollen; eye dorsum (dorsal view, scape accommodated into scrobe) partially visible; eye longest diameter subequal length than malar space; eye elongate; eye one evenly convex surface; eye dorsal face convex, similar to ventral face; scape basal lamella overlapping the condyle constriction; scape slightly narrower and tapered proximad; humeral angle (dorsal view) acute; epicnemial carina lamellate, flanking procoxa; dorsomesonotum (profile view) quasi flat; posteropropodeum truncate, not declivitous area; propodeal spine apices parallel (dorsal view), horizontal (lateral view); spiracle fused to lateropropodeum (only the distal ring visible); spiracle diameter smaller than propodeal spine at middle length; petiole node similar width than posteropropodeum; nodal truncation obtuse (anterior face forming an even anteroposterior curvature until reaching the summit); petiole summit in middle (lateral view); petiole lateral margins (dorsal view) parallel; postpetiolar node (postnodus) present; dorsopostpetiole wider in middle; postpetiole dorsal and posterior (declivitous after postnodus) surface (profile view) non evenly curvate, forming a subnodal, shallow constriction emphasizing the postpetiolar node; petiole and postpetiole (only posttergite) subequal length than postpetiole;

profemur compressed disciform (disc-shape), dorsal margin keeled distad, and strongly curved and skewed proximad; postpetiole (Abd III posttergite) anterolateral corners perpendicular to cinctus; sternopetiole ("subpetiole") process present; petiole posterior margin (profile view) sinuate; sternopostpetiole process conic; opisthogaster (Abd IV to pygidium) (dorsal view) oblong, narrowed anteriorly; Abd IV (mtm 3) posttergite anterior corners evenly convex as the remaining posttergite.

Anteclypeus striolate costulate; frons rugocostate, scatter areolate, micropunctulate; malar space costate; preocular costa, between eye and scrobe, absent; genal bridge smooth; mandible costate distally; dorsopronotum rugostriate; lateropronotum predominantly porcate; mesonotum and dorsopropodeum rugocostate; meso- and metapleurae costate throughout; propodeal spines ecarinate; posteropropodeum smooth, glossy; profemur costate-porcate-micropunctulate on posterior face; meso- and metatibiae costate-micropunctulate; nodal truncation ecarinate, glossy; tergal petiole rugocostate-micropunctulate; tergal postpetiole rugocostate-micropunctulate; cinctus 2 (on mtm 2 = Abd III) ecarinate, glossy; mtm 3 (Abd IV) posttergite smooth throughout, punctulate; Abd IV (mtm 3) poststernite smooth throughout; Abd V, VI posttergites punctulate; epipygium (Abd VII) punctulate.

Abundant golden, erect, stiff and flagellate hairs on entire body; shorter, more flagellate and whitish on frons, goldenly shiny and thicker on opisthogaster; frons with more than 60 hairs; medial line of mesonotum, dorsopropodeum, petiole and postpetiole pilose; malar space with less than 4 hairs; genal bridge with flagellate pilosity; mandible with distal-ectal (distal-external)

flagellate scatter hairs; mesonotum posteromedial stiff (sometimes flagellate) setae convergent; coxae pubescent; dorsum of profemur with subdecumbent hairs; posterior face of profemur with scatter long stiff hairs; petiole and postpetiole dorsal with suberect hairs; mtm 3 (Abd IV) posttergite vestiture less than 15 rows; Abd IV poststernite with long, flagellate hairs; Abd V, VI, and VII posttergites with long hairs compared to those on petiole and postpetiole; hypopygium with flagellate hairs; golden, subdecumbent and abundant on opisthogaster; general lustre shiny; appendages color black; wings color infumate;

COMMENTS. Similar to FS29.

BIOLOGY. Unknown.

Procryptocerus subpilosus (Smith, F. 1860)

Original combination: *Meranoplus subpilosus* Smith (1860c): 78, pl. 4, Figure 2 (w described). Combination in *Cataulacus*: Mayr (1886c): 361. Combination in *Procryptocerus*: Emery (1887h): 470. Lectotype and Paralectotype (Designated here). **Two** workers; Brazil: Amazon R., Egas (Tefe) (H. W. Bates) [NHM] (examined). Kempf (1951): 60. Senior synonym of *impressus*: Kempf (1963c): 435. Queen described: Longino and Snelling (2002): 28.

Distribution. Brazil, Ecuador, Guyana, Perú, Trinidad and Tobago.

DESCRIPTION OF WORKER. Worker measurements: HL 1.3, FW1 0.55, FW2 1.3, FW3 1.15, CI 1, SL 0.7, FCL 0.9, SCI 0.777, NL 0.25, NW 0.425, NI 0.588, EL 0.3, EW 0.25, EI 1.2, PW 0.975, PML 0.95, MW 0.775, NPEW 0.5, PrL 0.5, PrW 0.75, PSL 0.225, PSI 0.45, PdW 0.6, PI 1.2, PFL 0.85, PFW 0.35, PFI 2.428, MFL 0.8, MTL 0.8, PtH 0.4, PpH 0.55, PtL 0.375, PpL 0.45, PtW 0.365, PpW 0.5, AL 1.45, AW 1.3, AI 1.115, ASD 0.

Head subovate, narrowed anteriorly, oblong and dorsoventrally compressed; antennal scrobe open posteriorly, reaching occipital carina; vertex excavate; occipital carina marginate crested and widely overhanging vertex and occipital carina; in profile view juncture of postgenal bridge and genal bridge forming acute angle; postgenal bridge similar length as genal bridge, and both excavate posteriad; temple inflexed to occipital carina; postgenal bridge forming levigate shining occiput (sclerite laterad to neck); lateropronotum inflexed; dorsolateral margin of pronotum

sharply defined, overhanging and hiding lateropronotum as seen from above; anterior aspect (panel) of humerus flat; when head deflected ventrally anterior aspect of humerus tightly overlapping occiput, both structures hidden; same view temporal and lateropronotal costae matching together; tightly overlapping areas and disciform profemur probably forming stridulatory organ; promesonotum flat, horizontal in lateral view; propodeal spines straight, stout, acute directed posteriad mesonotal processes obsolete; notopropodeal groove straight, deep, interrupting notopropodeal sculpture; dorsopropodeum flat, subhexagonal, slightly longer than wide; anteropropodeal processes lengthened, half length of dorsopropodeum, angulate posteriad, lateral margins of dorsopropodeum slightly converging posteriad, forming subhexagon sides; posteropropodeum (lateral view) perpendicular to dorsopropodeum (propodeum box-shaped); propodeal spines horizontal, subparallel, slightly diverging, length barely surpassing posteropropodeal lobes; profemur compressed disciform, marginate dorsally; meso and metafemora tectiform; petiole (dorsal view) cylindrical, sides subparallel, longer than postpetiole; postpetiole subquadrate; opisthogaster oblong. Frons from levigate to sparsely foveolate, costulate or costate; malar space and temple costate; ventrad gena usually costate; frontovertexal margin crenulate; vertex levigate and glossy, with few shallow striations; mesosoma largely costate-striate; notopropodeal groove costate or levigate, posteropropodeum levigate; profemur levigate anteromesially, costate posterolaterally; meso and metafemora levigate and glossy, tibiae rugocostate in anastomosis, petiole and postpetiole irregularly and coarsely costate-rugose, with longitudinal striations dorsally, levigate ventrally; opisthogaster micropunctulate, finely striate. Hairs shortest on frons, longest on dorsum of petiole and postpetiole, white and sparse, usually obtuse, subspatulate, glittering, pale; posterior mesonotal transverse hair line or mesial pair of hairs convergent from base.

COMMENTS. Female and male unknown. The closest species are *Procryptocerus tortuguero*, *P. paleatus* and *P. impresss*. In these species the frontovertexal margin not overhangs the vertex widely, and the vertex is not excavate.

BIOLOGY. Unknown.

ADDITIONAL MATERIAL EXAMINED: BRAZIL: Amapá: Amapá, 3 M, 11-vii-1959, J. Lane (1w) [MZSP]; Rio Amaparí, km 185, 10-vii-1955, J. Lane (1w) [MZSP]; **Amazonas:** Manaus, 31-viii-1958, K. Lenko (1w) [MZSP]; same locality, ix-1962, K. Lenko (1w) [MZSP]; **Mato Grosso do Sul:** Sinop, 30-ix-1970, M. Alvarenga (1w) [MZSP]; same locality, x-1974, M. Alvarenga (5w) [MZSP]; same locality, ii-1976, O. Roppa (1w) [MZSP]; Vila Vera, 30-ix-1969, M. Alvarenga (1w) [MZSP]; same locality, x-1973, M. Alvarenga (1w) [MZSP]; **Rondônia:** Vilhena, 31-x-1969, M. Alvarenga (1w) [MZSP]; same locality, xi-1973, M. Alvarenga (1w) [MZSP]. **Trinidad and Tobago:** Trinidad B.W. I., 2-xii-1934, N.A. Weber (1w) [MZSP].

***Procryptocerus impressus* Forel, 1899.**

New status, status revalidated: Longino and Snelling (2002). *Procryptocerus puncticeps* race *impressus* Forel, 1899:47– 48. Syntype worker, queen: Panama, Bugaba (Champion) [BMNH] (examined, worker designated Longino and Snelling (2002) (**lectotype**, gyne **paralectotype**). *Procryptocerus subpilosus impressus*: Forel, 1911:263; Kempf, 1951:63. *Procryptocerus subpilosus* (F. Smith) (part): Kempf, 1964a:435–436 (incorrectly synonymized under *P. subpilosus*) (Longino and Snelling 2002). **PARALECTOTYPE worker. PANAMA: Chiriqui:** Bugaba, Champion (1g) [BMNH] (examined). *P. impressus puncticeps* Sm. r. *impressus* Forel. ♀Type.

DISTRIBUTION. Colombia, Costa Rica, Nicaragua, Panamá.

DESCRIPTION OF WORKER. Worker measurements

MEASUREMENTS. WORKER. Worker measurements: HL 1.3, FW1 0.6, FW2 1.4, FW3 1.2, CI 1.076, SL 0.85, FCL 1.15, SCI 0.739, NL 0.25, NW 0.45, NI 0.555, EL 0.325, EW 0.25, EI 1.3, PW 1, PML 1, MW 0.75, NPEW 0.5, PrL 0.45, PrW 0.75, PSL 0.25, PSI 0.555, PdW 0.575, PI 0.782, PFL 0.4, PFW 0.4, PFI 1, MFL 0.45, MTL 0.45, PtH 0.45, PpH 0.55, PtL 0.4, PpL 0.425, PtW 0.35, PpW 0.5, AL 1.45, AW 1.35, AI 1.074, ASD 0.

DESCRIPTION OF WORKER. BASED ON Kempf (1951), and Longino and Snelling (2002).

Head subcircular, tending to triangular; vertex concave; head more fulgid and ridged frons, between the punctures, which are less apparent, sparse and distinct; vertex strongly differentiated from frons by sharp frontovertexal margin; face evenly convex; clypeus little differentiated from face, curving ventrad but not sharply so, following general curve of face in lateral view; anteromedian portion of clypeus slightly impressed, with a discrete tuft of golden setae; frontal carina thickened and laterally flattened just posterior to torulus, ending on dorsum of torulus; frontovertexal margin entire and coarsely crenulate; mesonotum strongly impressed in saucer-like fashion, on the entire median portion unto the mesoepinotal suture; postpetiole wider than long. Opisthogaster densely reticulate-punctate and feebly striate; coarse and long setiform and golden pubescence covers opisthogaster, more abundant in propodeum, petiole and postpetiole.

vertex completely smooth and shining or with 2–3 obscure rugae medially; face very shallowly sculptured with a mixture of somewhat irregularly distributed, large foveae (these reminiscent of lunar craters) and fine, irregular, longitudinal rugae, rugae stronger near occipital border; interspaces very finely and superficially microareolate; sculpture on clypeus similar to that on face, but with foveae more obscure; genae and mandibles coarsely longitudinally striate; scape with a flanged lamella at base, partially covering condylar constriction and condylar bulb; scape subterete proximally, distad to basal lamella, expanding distally to a broad, flat apex; scape finely and superficially microareolate, like interspaces of face. Promesonotum in dorsal view with rounded anterior margin, straight to somewhat convex sides which converge to base of propodeum; in lateral view, mesonotum slopes throughout entire length to deep propodeal suture; lateral lobes of mesonotum in the form of horizontal flanges which are blunt, posteriorly directed, and project over the propodeal suture, such that in side view their vertically concave

posteroventral margins obscure the median portion of the suture; dorsal face of propodeum with produced lateral lobes which extend about half the length of the dorsal face; posterior border of lobes subrectangular, toothlike, to gently rounded; propodeal spines about 0.4 times length of dorsal face; posterior face of propodeum perpendicular to dorsal face, concave, and completely smooth and shining; entire dorsal surface of mesosoma longitudinally striate; sides of pronotum flat to concave, meeting dorsal face at distinct angle; lateral face with coarse longitudinal striae on lower half, extending onto anepisternum, and onto metapleural region of propodeum; rest of side smooth and shining, superficially, finely microareolate; femora very strongly swollen, spindle-shaped; forefemur compressed, flattened; exterior surfaces of tibiae coarsely rugose; distal half of posterior face of forefemur weakly rugose, rest of legs smooth and shining. Petiole short and squat, anterior face completely smooth and shining, posterior face and dorsum of postpetiole longitudinally striate, but striae nearly effaced by dense, coarse, piligerous puncta; first gastral tergite longitudinally striate throughout, striae slightly irregular, occasionally anastomosing; interspaces microareolate, giving a subopaque or granular appearance to gaster; longitudinal striae on second gastral tergite variably developed; first gastral sternite subopaque to somewhat shiny, with microareolate sculpture becoming denser near lateral margins; lateral margins with a few faint rugulae. Setae very dense and conspicuous; setae present on legs, mandibles, scapes, lateral and posterior margins of face (absent on disc), entire mesosomal dorsum, petiole, postpetiole, and gaster; setae all stiff, those on dorsal surfaces strongly flattened (although always linear, never spatulate), suberect to decumbent; those on first gastral tergite dense enough to obscure the underlying sculpture; setae which lie on the same longitudinal line on first gastral tergite overlap up to half their length; setae on first gastral sternite abundant, subdecumbent, thinner than those on dorsum; integument entirely black, setae yellowish-white.

COMMENT: In Costa Rica, it is sympatric with the very similar *P. paleatus* and *P. tortuguero*. (Longino and Snelling 2002). Male unknown.

BIOLOGY. This species inhabits primary rainforest, where workers are encountered on low vegetation and in treefalls. Malaise, Foggin, clay loam soil nests in twigs, manual.

ADDITIONAL MATERIAL EXAMINED. COLOMBIA: Cauca: PNN Gorgona, Alto El Mirador, 180 m, 26-vi-18-vii-2000, H. Torres (1g) [IAvH]; same data, 4-24-iii-2000, R. Duque (1w) [IAvH]; same locality, El Helechal, 30 m, 12-28-ix-2001, H. Torres (1w) [IAvH]; same locality, Mancora, 60 m, 18-i-03-ii-2001, H. Torres (2w) [IAvH]; same data, 18-vii-03-viii-2000, H. Torres (1w) [IAvH]; same data, 08-30-xi-2000, H. Torres (1w) [IAvH]; **Chocó:** Lloró, 115 m, 26-ii-2002, Y. Palacios; O. Mena (1w) [UNAB]; **Valle del Cauca:** San Miguel, Azufrado, 08-v-1990, M. Baena (1w) [IAvH]. **COSTA RICA: Heredia:** 11km ESE La Virgen, 5-xi-1999, J. Longino (1w) [JTLC]; 11km SE La Virgen, 19-ii-1999, ALAS (1w) [INBIO]; same locality, 15-ii-1999, ALAS (1g) [INBIO]; same locality, 10-iii-1999, ALAS (1w) [INBIO]; same locality, 21-ii-2000, ALAS (1w) [INBIO]; Casa Plastico, 17 km S Pto. Viejo, 550 m, 19-i-1985, J. Longino (1w) [JTLC]; La Selva Biological Station, 22-vii-1972, H. Hespenheide (7w, 1g) [LACM]; same locality, 19-iii-1976, H. Hespenheide (1w) [LACM]; same locality, 17-vii-1978, H. Hespenheide (1w) [LACM]; same locality, 30-vii-1978, H. Hespenheide (19w) [LACM]; same locality, 1-viii-1978, H. Hespenheide (1w) [LACM]; same locality, 21-vi-1982, H. Hespenheide (1w) [LACM]; same locality, 27-vi-1982, H. Hespenheide (2w) [LACM]; same locality, 28-vi-1982, H. Hespenheide (5w) [LACM]; same locality, 17-vi-1982, J. Longino (1w) [JTLC]; same locality, 14-x-1987, J. Longino (1w) [INBIO]; same locality, 18-x-1987, J.

Longino (1w) [INBIO]; same locality, 30-vii-1988, H. Hespenheide (1w) [INBIO]; same locality, 7-viii-1988, J. Longino (2w) [INBIO]; same locality, 30-xii-1988, H. Hespenheide (1w) [INBIO]; same locality, 4-iii-1989, ALAS (17w, 1g) [INBIO]; same locality, 13-iv-1989, J. Longino (1w) [INBIO]; same locality, 3-vii-1989, ALAS (7w, 1g) [INBIO]; same locality, 2-ix-1989, ALAS (2w) [INBIO]; same locality, 3-ix-1989, ALAS (1w) [INBIO]; same locality, 5-xi-1989, ALAS (4w) [INBIO]; same locality, 8-xi-1989, ALAS (1w) [INBIO]; same locality, 21-i-1990, J. Longino (1w, 1g) [JTLC]; same locality, 13-x-1990, ALAS (1w) [INBIO]; same locality, 17-x-1990, ALAS (1w) [INBIO]; same locality, 18-x-1990, ALAS (1w) [INBIO]; same locality, 19-x-1990, ALAS (1w, 1g) [INBIO]; same locality, 21-x-1990, ALAS (1w) [INBIO]; same locality, 23-x-1990, ALAS (1w) [INBIO]; same locality, 1-xi-1990, ALAS (1w) [INBIO]; same locality, 2-xi-1990, ALAS (1w) [INBIO]; same locality, 29-xii-1995, ALAS (1w) [INBIO]; same locality, HA Hespenheide (3w) [INBIO]; 3 km S Puerto Viejo, 23-vii-1976, H.A. Hespenheide (1w) [LACM]; Heredia: Estación Biológica La Selva, 3 km S Puerto Viejo, 23-vii-1976, H.A. Hespenheide (1w) [LACM]; **Limón:** Hitoy Cerere Biol. Reserve, 100 m, 31-viii-1981, J. Longino (1w) [JTLC]; Penshurst, 10 km N Cahuita, 13-15-iv-1983, D. Ubick (1w) [CAS]; Rio Toro Amarillo, vic. Guapiles, 24-ii-1962, W.L. Brown, Jr. (1g) [MCZ]; Tortuguero N.P., Est. Cuatro Esquinas, 5 m, J. Solano (1w) [INBC]. **Puntarenas:** 10 km W Piedras Blancas, 100 m, 31-v-1985, P. Hanson (1w) [MUCR]; **NICARAGUA:** Rio San Juan, Bartola, 5,1 miles se El Castillo, 47 m, 13-vii-2003, W.E. Mackay (1w, 1g, 1m) [CWEM]. **PANAMA:** **Chiriquí:** Chiriquí, 31-iii-1919, F.M. Gaige (1w) [LACM].

***Procryptocerus kempfi* Longino & Snelling, 2002**

Original combination: *Procryptocerus kempfi*: Longino & Snelling (2002): 18 (w, g described).

HOLOTYPE WORKER. COSTA RICA: Heredia: Casa Plastico, 17km S Pto. Viejo, 19-i-1985, J. Longino (1w) [INBC].

PARATYPES. PANAMA: Cerro campana, 850 m, 26-vi-1977, H.A. Hespenheide (3w, 1g) [BNHM, INBIO, MZSP, MCZ] (examined).

DISTRIBUTION. Costa Rica, Panamá.

MEASUREMENTS OF WORKER. Worker measurements: HL 1.05, FW1 0.55, FW2 1.15, FW3 1, CI 1.095, SL 0.7, FCL 1, SCI 0.7, NL 0.25, NW 0.4, NI 0.625, EL 0.3, EW 0.25, EI 1.2, PW 0.85, PML 0.825, MW 0.6, NPEW 0.4, PrL 0.45, PrW 0.625, PSL 0.2, PSI 0.444, PdW 0.375, PI 1.2, PFL 0.8, PFW 0.3, PFI 2.666, MFL 0.95, MTL 0.825, PtH 0.35, PpH 0.4, PtL 0.4, PpL 0.425, PtW 0.3, PpW 0.4, AL 1.35, AW 1.15, AI 1.173, ASD 29.

DISTRIBUTION. Costa Rica, Panama, Perú.

DESCRIPTION OF WORKER. BASED ON Longino and Snelling (2002). Frons sculpture shallow; frons to frontovertexal margin with evenly dispersed, discrete foveae, distance between foveae subequal to fovea diameter; interspaces subopaque, with fine areolate etchings; short,

subparallel, longitudinal rugae on posteriormost one sixth of face, at vertex margin; clypeus weakly bent ventrad, anterior margin with a semicircular impression from which a median tuft of small setae emerges; clypeus weakly longitudinally striate; genae longitudinally striate; genal bridge longitudinally striate; mandible longitudinally striate; scape flattened as in *P. attenuatus*, as wide at base as at apex; flat surface of scape with microareolate sculpture; vertex margin sharply angulate and somewhat crenate; vertex almost entirely smooth and shiny or with variably developed longitudinal striae medially and laterally; eye shallowly and evenly convex. In dorsal view, anterior and lateral margins of promesonotum evenly rounded; mesonotum with lateral lobes which have straight lateral margins nearly parallel to the longitudinal body axis, meeting flat posterior margin at slightly less than a right angle, weakly projecting; propodeum with shallow lateral lobes which extend approximately half the length of the dorsal face; mesosomal dorsum longitudinally striate over most of surface, becoming somewhat irregular and with a few foveae at anterior margin of pronotum; propodeal suture deep, V-shaped in profile, breaking longitudinal striae that cross it; posterior face of propodeum perpendicular to dorsal face, slightly concave, completely smooth and shining; dorso and lateropronotum meet at an angle; lateropronotum somewhat inflected, smooth on upper half, coarsely longitudinally striate on ventral half; anepisternum striate; katapisternum striate with variable amount of upper portion smooth; lateral face of propodeum somewhat concave, smooth on upper half, coarsely longitudinally striate on ventral half; coxae smooth or with variable presence of weak striae; hind femur strongly swollen medially, disciform; outer surfaces of tibiae coarsely rugose, subopaque; posterior face of forefemur smooth and shining or with a few oblique rugocostae at upper distal margin. Petiole subcylindrical, longer than high, with a weakly convex posterodorsal face; ventral margin weakly concave with a low, blunt anterior tooth; postpetiole with a long, gently

sloping anterior face, and a broad, rounded summit near the posterior margin; ventral margin short, with a prominent, acute anterior tooth; anterodorsal face of petiole curvate posteriorly, smooth and shiny; posterodorsal face of petiole and postpetiolar dorsum coarsely longitudinally striatorugose; first opisthogastral tergite longitudinally striate, underlain with microreticulate sculpture to give slightly granular texture, striae fading to leave narrow smooth band at posterior border; first opisthogastral sternite with anterolateral patches of oblique rugocostulae, remainder with microreticulate sculpture and sparse piligerous puncta; second opisthogastral tergite with microreticulate sculpture and a few weak rugulae laterally.

Dorsal setae short, stiff, somewhat flattened, yellowish; frons nearly devoid of setae, with one or two near margin of vertex; promesonotum with clusters of about six on humeri and a pair near lateral lobes; pair of converging setae in notopropodeal groove; dorsal face of propodeum with about 10 setae; relatively denser and longer setae on petiole and postpetiole and on first opisthogastral tergite near postpetiolar insertion; setae sparse and short on rest of first opisthogastral tergite, becoming longer at caudogaster; first opisthogastral sternite with sparse subdecumbent and decumbent setae; color entirely shining black.

COMMENTS.

BIOLOGY. Wet forest; strays. montane wet forest, sweeping.

Procryptocerus spiniperdus Forel, 1899

Original combination: *Procryptocerus spiniperdus* Forel (1899d): 43 (footnote w, m described).

Gyne described: Wheeler (1922e): 11.

See also: Kempf (1951): 55.

Lectotype. (uppermost worker on pin). Designated here. TRINIDAD AND TOBAGO: (4w, 2m) [MHNG] (examined).

DISTRIBUTION. Brazil, Colombia, Perú, Trinidad and Tobago. Ecuador, Guyana

DESCRIPTION OF WORKER. Measurements (minor vs. major worker. Indexes separated by semicolon [;]) (n=3): HL 1.5-1.7, FW1 0.9-1, FW2 1.75-1.2, FW3 1.6-1.85, CI 1.166; 1.176, SL 1-1.1, FCL 1.2-1.425, SCI 0.701; 0.916, NL 0.275-0.3, NW 0.6-0.625, NI 0.458-0.48, EL 0.4-0.45, EW 0.3-0.35, EI 1.285; 1.333, PW 1.4-1.6, PML 1.15-1.275, MW 1-1.15, NPEW 0.475, PrL 0.55-0.65, PrW 0.95-1, PSL 0.3-0.35, PSI 0.538; 0.545, PdW 0.7-0.775, PI 0.785; 0.838, PFL 0.6-0.7, PFW 0.5-0.55, PFI 1.2; 1.272, MFL 1.325-1.35, MTL 1.3-1.35, PtH 0.25-0.45, PpH 0.6-0.65, PtL 0.5-0.6, PpL 0.55-0.625, PtW 0.425-0.475, PpW 0.6-0.65, AL 1.85-1.95, AW 1.75-1.8, AI 1.057; 1.083, ASD 39.

DESCRIPTION OF WORKER. BASED ON KEMPF (1951). Head [Figure 21 subopaque. Mandibles longitudinally rugulose, finely reticulate-punctate. Clypeus broadly and shallowly emarginate mesally; posterior border marked by a faint transverse suture; a fine transverse ridge parallel to the anterior border, the rest rather finely, distantly longitudinally striolated, and very

finely reticulate-punctate. Frontal area obsolete. Frontal carinae sinuate, not projecting above the antennal socket; posterior end evenly rounded mesad to meet small, but conspicuous, recurved occipital tooth on each side. Upper surface of head with widely 56 K e m p f, The ant tribe Cephalotini separated longitudinal rugae which rarely anastomose; intervals finely reticulate-punctate, about **3** rows of punctures between the ridges. Cheeks, in front view, slightly arcuate, longitudinally rugose. Eyes moderately, evenly convex, situated completely before the half of the median head length. Lower surface of head longitudinally striato-rugose. Occipital border moderately arcuate, sharply marginate and crenulate, slightly impressed mesad; slightly overhanging the occipital truncation, which is scarcely excavated, smooth, fulgid, finely, superficially reticulate, with a few short, perpendicular ridges around the occipital foramen. ' Scape somewhat depressed, not expanded, nor lobed at base; its length slightly less than $\frac{2}{3}$ of median head length; finely, but sharply reticulate-punctate. Thorax [Figure 211 subopaque; about $1\frac{1}{3}$ times as long as maximum width. Anterior border of pronotum slightly arcuate; shoulders angulate. Pronotum projecting laterally a considerable distance above the sides; lateral border, between shoulders and anterior angle of expansion rectangularly excised, between anterior rounded and posterior acute subacute angle of projection, slightly concave, and sharply marginate. Promesonotal suture vestigial. Mesonotum postero-laterally, with a large, projecting, somewhat flattened and upturned, projecting tooth. Thorax greatly constricted laterally between mesonotum and epinotum; mesoepinotal suture distinct, sharply impressed. Basal face of epinotum, in profile, at somewhat lower level than promesonotum; flat, slightly more than 1.5 times as wide as long, with basolateral lobes, projecting somewhat, -rounded anteriorly, slightly emarginate laterally, subdentate posteriorly and occupying about one-half of length of basal face. Epinotal spines rather slender, straight, slightly raised, subparallel, somewhat shorter than basal

face. Upper surface of thorax longitudinally striato-rugose. Sides of thorax, including laterotergites of pronotum, distinctly excavated, lower half longitudinally striated, upper half almost smooth, finely reticulate-punctate. Declivous face smooth, finely reticulate. Femora completely smooth, to shallowly punctured; fore femora with a few, longitudinal striae on upper half of posterior face. Hind femora distinctly shorter than maximum width of thorax. Petiole longer than wide, sides and dorsum scarcely convex, coarsely and longitudinally rugose; anterior face finely reticulate-punctate, almost smooth. Postpetiole broader than long; anterior corners, from above, ubangulate, sides and dorsum moderately convex, longitudinally rugose.

Gaster subopaque, elliptical. The first tergite and exposed portion of remaining tergites, finely, densely longitudinally striato-rugose, with a noticeable row of fine punctures within the striae. Sternites similarly sculptured laterad.

Upper surface of head with stout, stiff, blunt, abundant suberect whitish setae. Upper surface of thorax and upper surface and sides of peduncle with similar, but somewhat longer, more pointed, suberect to oblique setae. On gaster, above similar to peduncle, but denser, decumbent. Oblique setae on appendages. Short pile beneath head and peduncle. A few erect hairs on 2-4 gastric tergites and sternites.

COMMENTS. This species is closely related to the Brazilian *marginatus*, from which it is differentiated by the sculpture of the upper surface of head, the smaller size, the slender epinotal spines, and the sharp mesonotal tooth. *P. marginatus* could be a synonymous of *P. spiniperdus*. Gyne unknown.

BIOLOGY. Malaise, canopy fogging.

ADDITIONAL MATERIAL EXAMINED: BRAZIL: Amazonas: Rio Taruma Mirim, 11-i-1972, J. Adis (1w) [LACM]; **Bahía:** Uruçuca, 30-xii-1943, P. Silva (3w, 1g, 1m) [LACM, MCZ, MZSP]; **Espirito Santo:** Linhares, 31-viii-1968, M. Alvarenga (1w) [MZSP]; **Mato Grosso do Sul:** Vila Vera, 30-ix-1969, M. Alvarenga (1w) [MZSP]; **Pará:** Tucuruí, Margem esq., 12-iii-1975, W.L. Overal (1w) [LACM]; **Rio de Janeiro:** São Bento, 01-xii-1945, G.R. Gonçalves (1g) [MZSP]; **Rondônia:** Rio Madeira, Madeira-Mamore R.R.Co. Camp 39, W.M. Mann & Baker (1w) [MCZ]; Santa Cruz, 03-xi-1981 (1w) [MZSP]. **COLOMBIA: Amazonas:** PNN Amacayacu, 150 m, 31-iii-1998, A. Felix (1w) [IAvH]; same locality, Centro de visitantes "Yewae", 150 m, 1-10-iii-2004, T. Pape; D. Arias (2w) [IAvH]; **Putumayo:** PNN La Paya, La nueva Paya, 210 m, 31-i-3-ii-2003, C. Sarmiento (2w) [IAvH]; **Vaupés:** Estación Biológica Mosiro-Itajura (Caparú), Antigua cabaña, 60 m, 09-25-ii-2003, J. Pinzón (1w) [IAvH]; same locality, Terrazas, 60 m, 22-ix-07-x-2002, L. Benavides (1w) [IAvH]. **GUYANA:** Kartabo, 30-vi-1916, W.M. Wheeler (1w) [MCZ]. **PERÚ: Huanuco:** Tingo Maria, 22-ix-1950, Schlinger & Ross (1w) [LACM]; **Madre de Dios:** Tambopata, 290 m, 21-iii-1978, T. L. Erwin (1g) [LACM]; same data, 28-ii-1978, T. L. Erwin (6w) [LACM].

***Procryptocerus paleatus* Emery, 1896**

Procryptocerus paleatus Emery, 1896:97. Holotype worker: Costa Rica, Atirro, near Jimenez [MSNG] (examined). *Procryptocerus paleatus*: Kempf, 1951:53–55, Figure 1, 20, 50, 67. *Procryptocerus paleatus* (part under *P. tortuguero*); worker and gyne described: Longino and Snelling 2002, fig 1E, 3C,D.

DISTRIBUTION. Central America from Costa Rica to Mexico.

Worker measurements: HW 1.537, HL 1.455, SL 0.800, EL 0.332, MeL 1.716, MeW 1.119, PrW 0.741, PrL 0.483, PrS 0.218, PrT 0.702, MTL 1.034, PtL 0.492, PtW 0.436, PpW 0.593, PtH 0.422, AL 1.746, AW 1.419, ASW 0.031.

WORKER DESCRIPTION. BASED ON Kempf (1951) and Longino and Snelling (2002). Frontal carinae sinuate; frontovertexal margin crenulate; vertex slightly excavated, smooth and fulgid; pronotum expanded laterally, overhanging the excavated laterotergites; anterior angle of expanded portion more or less distinct, always separated from humeral angle; notopropodeal groove sharply impressed, interrupting the sculpture; dorsomesosoma longitudinally rugocostate; tibia costate in anastomosis; petiole longer than wide; postpetiole almost as long as wide; pilosity whitish, stiff, stout, abundant, decumbent on gaster; black; mandibles distally and tibiae fuscous; head subopaque; mandibles longitudinally striated; clypeus convex, finely longitudinally striated, and finely reticulate-punctate; anteclypeus shallowly emarginate mesad, posterior border indicated by faint, curvate suture; frontal carinae slightly sinuate; antenae not projecting above the antennal scrobe; posterior lobe of frontal carina bent mesad towards frontovertexal corner,

which is slightly denticulate; frons finely reticulate-punctate, with larger, shallow foveolae between which run longer or shorter longitudinal fine costulae; frontovertexal margin moderately arcuate, crenulate, sharply marginate, projecting slightly over the somewhat excavate, fulgid, mostly smooth vertex; malar space (frontal view) moderately curvate, longitudinally striated; eyes moderately convex; genal bridge longitudinally striated; scape slightly curvate, somewhat depressed, distad, finely reticulate-rugulose on outer (anterior) face; mesosoma subopaque; anterior margin of pronotum moderately arcuate; humeral angle acute; dorsolateral margin of pronotum strongly convex, strongly marginate, overhanging the somewhat excavated laterotergites at the side; promesonotum slightly wider than long, moderately longitudinally convex; promesonotal suture vestigial; mesonotum with laterally projecting, acute, triangular, somewhat upturned mesonotal lateral process; notopropodeal groove deeply impressed; mesosoma greatly constricted between mesonotum and propodeum; dorsopropodeum as long as wide at the base of propodeal spines, with little projecting, anteriorly rounded, posteriorly acutely angulate, long, anteropropodeal processes; propodeal spines shorter than half of the length of the dorsopropodeum, parallel, straight; upper surface of mesosoma longitudinally striato-rugose, somewhat irregular and forming meshes on anterior portion of pronotum; meso and metapleurae longitudinally striated, striae rather coarse anteriorly, finer to obsolete posteriorly; upper portion, contiguous with dorsum, smooth; posteropropodeum finely reticulate, submarginate above, smooth, fulgid; coxae striated above; profemur disciform, a few supra striae on posterior face; tibiae coarsely rugose; petiole distinctly longer than wide, sides slightly divergent caudad, constricted behind; nodal truncation finely reticulate-punctate, oblique, continuous with dorsal surface; dorsal petiole convex coarsely rugocostate dorsal and laterally; anterior ventral tooth vestigial; postpetiole slightly wider than long, upper face oblique, flat, longitudinally striated,

abruptly bent downwards behind, shortly in front of the posterior margin, coarsely rugose laterally and behind; postpetiole anterior corners subangulate, sides somewhat convex; opisthogaster ovate, short, subopaque; tergites finely, but sharply reticulate-punctate, with vestigial, short, longitudinal rugulae, especially apically on the first tergite. First sternite similarly sculptured laterad, smooth discally; mandibles, clypeus, cheeks, upper surface of head with short, suberect, yellowish white, setae which are slightly longer, stouter, denser, oblique to subdecumbent on mesosoma and appendages, and still longer on petiole, postpetiole and opisthogaster, on the latter mostly decumbent, especially discad; oblique setae on tergites and sternites 2-4 of opisthogaster.

BIOLOGY. *Procryptocerus paleatus* inhabits rainforest on low vegetation and in treefalls. At Corcovado National Park occurred workers are present in treefall or canopy sample. *P. paleatus* has been commonly collected in canopy fogging samples from La Selva Biological Station (Longino and Snelling 2002).

COMMENTS. The long, subquadrate dorsopropodeum, as long as wide at the base of propodeal spines, the extremely short, triangular propodeal spines, shorter than half the length of the basal face, the less expanded promesonotal disc, and the distinctive sculpture of frons and gaster, separate at once *paleatus* from the others in the *subpilosus* subgroup. Hairs are thinner in *paleatus* and fewer than in *impressus*; posttergites puncticulate in *paleatus* and striolate-puncticulate in *impressus*; epipygium strigulate-puncticulate in *impressus*. Gyne and male unknown. Differing from *P. impressus* in the following respects: clypeus somewhat differentiated from frons, slightly impressed at level of clypeofrontal suture, interantennal region slightly protruding, forming a stronger curve than in *P. impressus*; mesonotal lateral processes

small, squared-off posteriorly, well before notopropodeal groove; notopropodeal groove shallow, mesonotum and dorsal face of propodeum in same plane; setae similar to *P. impressus* in form and distribution, but less dense, particularly on first opisthogastral tergite; setae on disc of first opisthogastral tergite sparse, widely spaced, not overlapping. Differing from *P. subpilosus* in the relatively shorter petiole and from *P. tortuguero* in the absence of erect setae on frons. Also, unlike both *P. subpilosus* and *P. tortuguero*, the striae on the first opisthogastral tergite extend to the posterior margin.

ADDITIONAL MATERIAL EXAMINED. COSTA RICA: Heredia: Casa Plastico, 17 km S Pto. Viejo, 108189N, 848029W, 550 m (J. Longino) [JTLC]; 22 km N Volcán Barba, 108209N, 848049W, 500 m (J. Longino) [LACM]; La Selva Biological Station, 108269N, 848019W, 50 m (H.A. Hespenheide) [CHAH, JTLC, LACM]; same data (ALAS) [INBC, JTLC]; same data (J. Longino) [JTLC, INBC, LACM]; Puntarenas: Sirena, Corcovado National Park, 88299N, 838369W, 5 m (G. Fonseca) [INBC]; same data (J. Longino) [LACM]; Bijagual, Carara 24 m Contributions in Science, Number 495 Longino and Snelling: Central American Procyonotocercus Biol. Reserve, 98479N, 848369W, 500 m (P. Hanson) [MUCR]; same data (P.S. Ward) [PSWC]; 5 km N Ciudad Neily, 88429N, 828579W, 780 m (P.S. Ward) [PSWC]; San Jose': Carrillo, Braulio Carrillo Nat. Park, 108099N, 838559W, 500 m (J. Longino) [LACM]. MEXICO: Veracruz: Los Tuxtlas, 10 km NNW Sontecomapan, 188359N, 958059W, 200 m (H. Hespenheide) [CHAH, LACM]. PANAMA: Chiriquí: Chiriquí, 88249N, 828199W (F.M. Gaige) [LACM].

***Procryptocerus marginatus* Borgmeier, 1948**

Procryptocerus marginatus Borgmeier, 1948, Rev. de Ent. vol. 19, p. 201-202, Figure 26 [worker, female, male; Brazil: -State of Bahia, Urucuca]. Description of worker Kempf (1951).

MEASUREMENTS. (see *P. spiniperdus*).

Worker (lectotype) Kempf (1951). Worker, female, male; Brazil: State of Bahia, Urucuca; 1947 Pedrito Silva) [Coll. T. Borgmeier] . Quite distinct. Sculpture of the upper surface of head coarsely reticulate-rugose, all the longitudinal rugae converging mesad to a point, just a little in front of the occipital crest; the meshes broad, containing occasionally large, shallow, circular depressions; the- rugae more separate from one another than in *spiniperdus*. Promesonotal disc less convex, the mesonotum almost flat. Lateral border of expanded portion of pronotum sharply marginate, straight, not emarginate. Mesonotal tooth rounded at apex, lobe-like. Lateral border of basal face of epinotum, behind the baso-lateral lobes, continuous with the outer border of spines, distinctly converging caudad. Epinotal spines broad at base, not upturned. Pilosity similar, somewhat more abundant than in *spiniperdus*, about 40 setae on basal face of epinotum (less than 30 in *spiniperdus*).

COMMENTS. Very close to *spiniperdus* from Trinidad. Although *marginatus* is hairier and more opaque than *spiniperdus* it is likely that *spiniperdus* and *marginatus* are conspecific.

***Procryptocerus tortuguero* Longino & Snelling, 2002**

Original combination: *Procryptocerus tortuguero* Longino and Snelling (2002): 28, Figure 1f (worker, gyne described). *Procryptocerus paleatus* (part): Kempf, 1951:53–55, Figure 1, 20, 50, 67 (Emery) (description of worker: Costa Rica, Zent [Mann], misidentified as *P. paleatus*): Longino and Snelling (2002): 28.

HOLOTYPE WORKER. COSTA RICA: Limón: Tortuguero, 108329N 838319W 5 m, 1–5-vii-1985, J. Longino [INBIO], 5 m, 1–5 Jul 1985 (Longino #382) [INBC]. Barcode: LACM ENT 141741.

PARATYPES. COSTA RICA: iii-1924, W.M. Mann (3w) [USNM] (examined); **Limón:** Tortuguero, 5 m, 1–5-vii-1985, J. Longino (1g) [INBIO] (no examined); same data (7w, 1g) [LACM, MCZ, MZSP] (examined); same data (14 w) [BMNH, CPDC, JTLC, MHNG, NHMB, PSWC, USNM]. **PARATYPES.** One alate queen, LACM ENT 141766 [INBC]; one worker and one dealate queen (Longino and Snelling 2002), LACM ENT 141755 [LACM]; two workers, LACM ENT 141765 [BMNH]; two workers, LACM ENT 140647 [CPDC]; two workers, LACM ENT 141742 [MCZC]; two workers, LACM ENT 141743 [MHNG]; two workers, LACM ENT 141744 [MZSP]; two workers, LACM ENT 141745 [NHMB]; two workers, LACM ENT 141746 [PSWC]; two workers, LACM ENT 141747 [USNM]; two workers, LACM ENT 141748 [JTLC]; two workers, LACM ENT 141749 [CHAH].

DISTRIBUTION. Costa Rica, Colombia.

WORKER MEASUREMENTS: HL 1.45, FW1 0.6, FW2 1.5, FW3 1.25, CI 1.034, SL 0.875, FCL 1.7, SCI 0.514, NL 0.3, NW 0.5, NI 0.6, EL 0.35, EW 0.275, EI 1.272, PW 1.1, PML 1.05, MW 0.8, NPEW 0.5, PrL 0.5, PrW 0.775, PSL 0.25, PSI 0.5, PdW 0.55, PI 0.909, PFL 1, PFW 0.425, PFI 2.352, MFL 1.05, MTL 1, PtH 0.45, PpH 0.525, PtL 0.425, PpL 0.475, PtW 0.425, PpW 0.55, AL 1.675, AW 1.5, AI 1.116, ASD 27.

DESCRIPTION OF WORKER. BASED ON Kempf (1951) (under *P. paleatus*) and Longino and Snelling (2002). Frontal carinae sinuate; frontovertexal margin crenulate; vertex slightly excavated, smooth and fulgid; pronotum somewhat to greatly expanded laterally, overhanging the excavated lateropronotum; notopropodeal groove sharply impressed, interrupting the sculpture; dorsomesosoma longitudinally striato-rugose; tibiae costate in anastomosis; petiole longer than wide; postpetiole almost as long as wide; pilosity whitish, stiff, stout, abundant, decumbent on opisthogaster. entire disc of frons with evenly dispersed erect setae; frons sculpture, head shape, mesosomal profile, mesonotal teeth, propodeal suture, mesosomal sculpture, petiole shape and sculpture, and postpetiole shape and sculpture similar to *P. paleatus*; striae on the first gastral tergite fade out distally and posteriorly, similar to *P. subpilosus*; density of pilosity on opisthogaster intermediate between *P. impressus* and *P. paleatus*, setae aligned on longitudinal axis subcontiguous, not or barely overlapping, but not as widely spaced as on *P. paleatus*. Kempf (1951:53).

BIOLOGY. Malaise, wet forest in dead branches. A nest series was collected from lowland rainforest (Longino and Snelling 2002). The ants inhabited the dead terminus of a

branch, just distal to the live portion. The live stem was solid, and the ants were in chambers excavated either by themselves or by a previous stem-boring insect. The entire nest was sampled and contained 108 workers, one dealate queen, one alate queen, and brood. The other specimens from the type locality were collected from low vegetation. Workers from 17 km south of Puerto Viejo were in the crown of a recent treefall in primary wet forest (Longino and Snelling 2002).

ADDITIONAL MATERIAL EXAMINED: COLOMBIA: Cauca: PNN Gorgona, El Roble, 30 m, 22-iii-13-iv-2001, R. Duque (2w) [IAvH]; same locality, 130 m, 13-iv-7-v-2001, T. Helmer (2w) [IAvH]; same locality, 12-27-vi-2001, H. Torres (1w) [IAvH]; same locality, 15-vii-09-viii-2001, H. Torres (1w) [IAvH]. **COSTA RICA: Limón:** Tortuguero, 4-vii-1981, J. Longino (1w) [MZSP].

COMMENTS. Similar to *P. impressus*, *P. paleatus*, and *P. subpilosus*. In most respects, *P. tortuguero* it is described under *P. paleatus* by Kempf (1951).

Appendix 2.2. Matrix character coding for the species of *Procryptocerus*. See Methodology.

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FS01 0 0 1 0 0 1 1 1 1 0 0 1 1 1 1 0 1 0 1 0 1 0 1 1 1 0 0 0 1 1
FS04 0 0 1 ? 1 0 0 1 1 0 0 1 1 1 1 0 1 0 1 0 1 0 1 1 0 0 0 0 1 1
FS06 0 1 1 ? 1 0 0 0 1 0 0 1 0 1 1 0 1 0 1 0 1 0 1 1 1 1 0 0 1 1
FS07 0 1 1 ? 1 0 0 0 1 0 0 1 1 1 1 0 1 0 1 0 1 0 1 1 0 1 0 0 0 1
FS03 0 0 0 0 1 0 0 0 1 0 0 1 1 1 1 0 1 0 1 0 1 0 1 1 0 0 0 0 0 1
FS02 0 0 1 0 1 0 0 0 1 0 0 1 0 1 1 0 1 0 1 0 1 0 1 1 1 1 0 0 1 1
FS12 0 1 1 ? 1 0 0 ? 1 0 0 1 1 1 1 0 1 0 1 0 1 0 1 1 1 0 0 0 0 1
FS08 0 1 0 ? 1 1 0 0 1 0 0 1 1 0 1 0 1 0 0 0 0 0 1 1 0 0 0 0 0 1
FS1? 1 1 0 0 1 0 0 0 1 0 0 0 1 2 1 1 0 1 1 1 0 0 1 1 1 1 0 1 0 0
FS15 0 0 0 0 1 0 0 0 1 0 0 1 1 2 1 0 0 1 1 1 0 0 1 1 0 1 1 1 0 0
FS16 1 1 0 0 1 0 0 0 1 0 0 1 1 2 1 1 0 2 1 1 0 1 1 1 1 1 0 1 0 1
FS17 1 0 0 0 1 0 0 0 1 0 0 1 1 2 0 0 0 1 1 1 0 1 1 1 1 1 1 2 0 0
FS18 0 0 0 ? 1 0 0 0 0 0 0 0 1 2 1 0 0 1 1 1 1 1 1 2 0 0 0 1 0 0
FS19 1 1 0 ? 1 0 0 0 1 0 0 1 1 1 1 0 0 2 1 0 1 1 1 1 1 0 0 0 0 0
FS20 0 1 0 ? 1 0 0 0 1 1 0 0 1 2 0 1 0 1 1 0 1 1 2 1 1 0 0 0 0 0
FS21 1 1 0 ? 1 0 0 0 0 0 0 1 1 1 1 1 2 1 0 1 0 1 0 1 1 0 1 1 0 0
FS22 1 1 0 ? 1 0 0 0 0 0 0 0 1 2 1 1 2 2 1 1 0 1 1 1 1 0 0 0 0 1
FS28 1 1 0 ? 1 0 0 1 1 1 0 1 1 2 0 0 2 2 1 1 0 1 1 2 1 1 1 0 0 0
FS29 0 0 1 ? 1 0 0 0 1 1 1 1 1 1 1 0 1 0 1 0 1 0 1 1 1 0 0 0 0 1
FS30 1 1 0 ? 0 0 0 1 1 0 0 0 1 2 0 1 1 1 1 0 0 0 1 1 1 0 0 0 0 0
FS31 0 0 0 1 1 0 0 0 1 1 0 1 1 2 1 1 0 1 1 1 0 1 0 0 1 0 0 1 1 0
FS39 0 1 0 0 1 0 0 0 1 0 0 0 0 2 1 1 0 1 1 1 0 1 1 1 1 0 1 1 0 0
FS33 1 0 0 0 1 0 0 0 1 0 0 0 0 2 0 0 1 1 0 1 1 1 1 0 1 0 1 1 1 0
FS3? 0 1 0 0 1 0 0 0 1 0 0 0 1 2 0 0 2 1 1 1 1 0 1 1 1 1 0 0 0 0
FS35 0 1 0 1 0 1 0 ? 1 1 0 0 1 2 0 0 2 1 0 0 1 1 1 1 1 1 0 0 1 0
FS36 1 1 0 0 1 0 0 0 0 0 0 1 1 0 0 0 0 0 0 1 0 1 1 1 1 1 1 0 0 0

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```

FS01 1 0 1 0 1 1 1 0 0 0 0 1 0 1 0 ? 1 1 1 1 1 0 0 0 0 0 0 0 1 1 1
FS0? 0 0 1 0 0 ? 0 0 1 0 1 0 1 ? ? 1 1 1 1 1 0 0 ? 1 0 1 1 0 1 1
FS06 0 0 1 0 1 ? 0 0 0 0 1 0 0 ? ? 0 1 1 0 1 0 0 ? 0 1 1 1 0 1 1
FS07 0 0 1 0 0 ? 1 0 1 0 1 0 0 ? ? 1 0 1 0 1 0 0 ? 1 1 1 0 1 1 1
FS03 0 0 1 0 0 1 0 0 1 1 1 0 0 0 ? 1 1 1 0 1 0 0 0 1 0 1 0 1 1 1
FS02 0 0 1 0 0 1 0 0 1 0 0 0 1 0 ? 0 1 1 0 1 0 0 0 0 0 0 0 1 1 1
FS12 0 0 1 0 0 ? 0 0 1 0 0 0 1 ? ? 0 1 1 1 1 0 0 ? 0 0 0 0 1 1 1
FS08 0 0 1 0 0 ? 0 1 0 0 1 0 0 ? ? 1 1 1 0 1 0 0 ? 1 0 0 0 0 1 1
FS1? 0 0 1 0 0 0 1 1 1 0 0 0 1 0 0 1 1 1 1 1 0 1 0 0 0 1 0 1 1 0

```

FS15 001000001000100011110110?10110
 FS16 011001001000100011100100110110
 FS17 001110001000000101110110010111
 FS18 00110?1000100?00111101?1110111
 FS19 00110?1110100?01111101?1110?11
 FS20 00100?1010001?01111101?0010?11

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FS21 00?1???1?0200?00011111?1010?10
 FS22 00?10?1000100?01111101?0100?11
 FS28 00100?0010000?00111101?0110?11
 FS29 00110?1010100?10111101?0110?11
 FS30 00111?1110000?00011101?0010?11
 FS31 001001001000000011110110010110
 FS39 001001001000010111110100010111
 FS33 001100111010000011100011010100
 FS3? 00?001001010000011110001010111
 FS35 00?0?????000100101110101010111
 FS36 00?100010100000001011011110000

90

FS01 01111011111110011111012001101?
 FS0? 11111011101100101111102001101?
 FS06 01111021011110011001000101101?
 FS07 01011111001000000111102000201?
 FS03 010111110000000000011110013002
 FS02 011111111111100000011121011011
 FS12 01111111101010000101112001200?
 FS08 11011111110010100001002101201?
 FS1? 111111110010000111101020001001
 FS15 111111111011001011100031021000
 FS16 110111110010000111110221111102
 FS17 111011111010001010000020101002
 FS18 11111111110100011111122111200?
 FS19 11111111101100011110021101100?
 FS20 00111011001100000111122011201?
 FS21 11111?110010000011?0000101200?
 FS22 11111111011200011110001101200?
 FS28 101111111001000111000001011110?
 FS29 111111110011221001111101?1201?
 FS30 01111011001000100111122101201?
 FS31 11111111101102011110000101100?
 FS39 111111110010000011100021011002
 FS33 111110010111111011100021011001
 FS3? 1011111110010000111100031101002
 FS35 00111?110010000001111221211002

FS36 1 0 1 1 1 1 2 1 0 0 0 0 0 2 0 0 1 1 1 0 1 0 0 0 1 1 1 1 2

110

FS01 1 1 0 0 ? ? ? ? ? ? ? ? 1 1 0 2 0 0 0 0
FS0? 1 1 1 0 ? ? ? ? ? ? ? ? 1 1 0 2 0 0 0 0
FS06 1 1 1 1 0 ? ? ? ? ? ? ? ? 1 1 1 2 0 0 0 0
FS07 1 1 1 0 ? ? ? ? ? ? ? ? 1 1 1 2 0 0 0 0

110

FS03 1 1 1 1 ? ? ? ? ? ? ? ? 1 1 1 2 0 0 0 0
FS02 1 1 1 0 1 0 0 0 1 1 1 1 1 1 1 2 0 0 0 0
FS12 1 1 1 0 1 ? ? ? ? ? ? 1 ? 1 1 0 2 0 0 0 0
FS08 1 1 1 1 ? ? ? ? ? ? ? ? 1 1 1 2 0 0 0 0
FS1? 1 1 1 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 1
FS15 0 1 1 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS16 0 ? 1 0 ? ? ? ? ? ? ? ? 1 0 1 2 0 0 0 0
FS17 1 1 1 1 1 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS18 1 1 1 1 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS19 1 1 0 0 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS20 1 0 1 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS21 1 ? 1 ? 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 ?
FS22 1 1 1 1 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS28 0 0 1 1 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS29 1 1 1 0 ? ? ? ? ? ? ? ? 1 1 1 2 0 0 0 0
FS30 1 1 1 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS31 1 1 1 1 ? ? ? ? ? ? ? ? 1 1 0 2 0 0 0 0
FS39 1 1 1 0 ? ? ? ? ? ? ? ? 1 1 0 2 0 0 0 0
FS33 1 1 0 1 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS3? 1 1 1 0 ? ? ? ? ? ? ? ? 1 0 0 2 0 0 0 0
FS35 1 1 1 ? 0 ? ? ? ? ? ? 1 ? 1 0 0 2 0 0 0 ?
FS36 1 1 1 1 ? ? ? ? ? ? ? ? 1 0 1 2 0 0 0 0

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FS37 0 1 0 0 1 0 0 0 1 0 0 0 1 2 1 1 0 1 1 1 0 1 0 2 1 1 0 0 ? ?
adlerzi 1 1 0 0 1 0 0 0 1 0 0 1 1 2 0 0 0 2 1 1 1 0 1 1 1 1 2 1 0
attenuatus 1 1 0 0 1 0 0 0 1 1 1 1 1 ? 1 1 0 2 0 1 0 1 1 0 1 1 0 0 0 0
balzani 0 1 0 1 1 0 0 0 0 0 0 1 0 2 0 0 0 1 1 1 0 1 1 1 1 1 1 0 0
batesi 0 0 1 1 1 1 1 1 1 1 0 0 1 1 1 0 0 1 0 1 0 1 0 0 1 0 0 0 0 1 1
belti 1 0 0 1 1 0 0 0 1 1 0 1 1 2 0 0 0 0 1 0 0 0 1 2 1 0 0 0 1 0
carbonarius 0 0 1 1 0 1 1 1 1 1 1 1 1 0 1 1 0 1 0 1 0 1 0 1 1 1 0 0 0 1 1
clathratus 0 1 0 1 1 0 0 0 1 1 0 1 1 2 0 1 2 1 1 1 1 0 1 1 0 0 0 0 0 0
convergens 1 1 0 0 1 0 0 0 1 1 1 1 1 2 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0
convexus 0 0 0 1 1 0 0 0 0 1 0 1 1 2 1 0 1 1 1 0 0 0 1 2 1 0 0 0 1 1
coriarius 1 1 0 0 1 0 0 0 0 1 0 1 1 0 0 0 2 0 0 1 0 1 1 0 1 1 0 0 0 0

curvistriatus 0 1 0 0 1 0 0 0 1 1 0 1 1 2 0 0 0 1 1 1 0 1 1 1 1 1 0 0 1 0
 eladio 0 0 0 0 1 0 0 1 1 1 1 1 0 2 1 1 0 2 1 0 1 0 1 1 1 0 0 0 1 0
 elegans 1 0 0 0 1 0 0 0 0 1 0 0 0 2 1 0 0 2 1 1 0 1 1 2 1 0 0 0 0 0
 ferreri 1 1 0 0 1 0 0 0 0 0 0 0 1 2 1 0 2 2 1 1 0 1 1 1 1 0 0 0 0 0
 gibbosus 0 0 0 0 1 0 0 0 0 0 0 0 1 2 0 0 2 2 1 1 0 0 1 1 1 1 0 0 0 0
 goeldi 0 0 0 0 1 0 0 0 0 0 0 0 1 2 1 0 0 2 1 1 0 0 1 1 1 0 0 1 0 0
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 hirsutus 0 0 0 0 1 0 1 1 1 1 1 0 0 0 1 0 1 1 1 0 0 0 1 1 1 1 0 0 1 0
 hylaeus 0 1 0 0 1 0 0 0 0 0 0 1 1 2 1 0 0 1 1 1 0 1 1 2 1 1 0 0 0 0
 impressus 0 0 0 1 1 0 0 0 0 0 0 0 1 2 0 2 1 1 0 1 1 1 2 2 1 1 0 0 0 0

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kempfi 1 0 0 1 1 0 0 0 1 1 0 1 1 2 1 1 2 2 1 0 0 1 0 0 1 1 0 0 0 0
 lenkoi 1 1 0 0 1 0 0 0 1 0 1 1 1 0 0 0 0 ? 0 1 2 1 1 0 1 0 0 0 0 0
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 marginatus_s 0 1 0 1 1 0 0 0 1 1 0 0 1 2 0 0 2 1 1 0 1 0 1 0 0 0 0 0 0 0
 mayri_2 0 1 1 0 1 0 0 0 0 0 0 0 1 0 1 0 1 2 1 0 2 0 1 1 1 1 0 0 1 1
 montanus 0 0 0 0 1 0 0 0 1 0 0 1 1 2 0 1 0 2 1 1 0 1 0 2 1 0 0 0 0 0
 nalini_c 1 1 0 0 1 0 0 0 0 1 0 1 1 0 0 0 2 0 0 1 0 1 1 0 1 1 0 0 0 0
 paleatus_t 0 1 0 1 1 0 0 0 1 1 0 0 1 2 0 1 1 1 1 0 1 1 1 0 1 1 0 0 1 0
 pictipes_c 1 0 0 0 1 0 0 0 0 1 0 1 0 2 1 0 1 2 1 0 0 1 1 2 1 0 0 0 0 1
 regularis 1 1 0 0 1 0 0 0 0 1 1 1 1 2 0 1 0 2 1 1 0 1 1 2 1 1 1 1 0 0
 rudis_b 0 0 1 1 1 1 1 1 1 1 0 0 1 1 1 0 0 1 0 1 0 1 0 0 1 0 0 0 0 1 1
 sampaioi^l 1 1 0 0 1 0 0 0 1 0 1 1 1 0 0 0 0 ? 0 1 2 1 1 0 1 0 0 0 0 0
 scabriusculus 0 0 0 0 1 0 0 0 1 0 0 1 1 2 1 1 0 2 1 1 0 1 1 2 1 1 0 1 0 0
 schmalzi 0 0 0 0 1 0 0 0 1 0 ? 1 1 2 1 0 2 2 1 1 0 1 1 1 0 0 0 1 0 0
 schmitti_c 1 1 0 0 1 0 0 0 0 1 0 1 1 0 0 0 2 0 0 1 0 1 1 0 1 1 0 0 0 0
 seabrai 1 1 0 0 1 0 1 0 1 0 0 1 1 0 1 0 0 0 0 1 2 0 1 1 1 1 0 0 0 0
 spiniperdus 0 1 0 1 1 0 0 0 1 1 0 0 1 2 0 0 2 1 1 0 1 0 1 0 0 0 0 0 0 0
 striatus 0 0 0 0 1 0 0 0 1 0 0 1 1 2 1 0 0 2 1 1 0 0 1 1 1 0 0 0 0 0
 subpilosus 0 0 0 1 1 0 0 0 0 1 0 0 1 2 0 1 2 1 0 0 1 1 1 2 1 1 0 0 0 0
 sulcatus_c 0 1 0 0 1 0 0 0 1 1 0 1 1 2 0 0 0 1 1 1 0 1 1 1 1 1 0 0 1 0
 tortuguero 0 1 0 1 1 0 0 0 1 1 0 0 1 2 0 1 1 1 1 0 1 1 1 0 1 1 0 0 1 0
 victoris 0 0 0 0 1 0 0 0 1 1 0 1 0 2 1 1 0 2 1 1 0 1 1 1 1 0 0 0 0 0
 virgatus 0 1 1 0 1 ? 1 1 1 0 0 1 1 1 0 0 2 0 1 0 1 0 1 1 0 0 0 0 1 1
 Cephalotes_atratus 0 0 0 0 0 0 0 0 1 1 1 0 1 0 0 0 0 ? 1 1 2 0 1 1 0 0 0 0 0 1
 Cataulacus_brevisetosus 0 1 0 1 0 ? 0 0 1 0 0 0 1 1 1 0 0 0 1 0 0 ? 0 ? 1 1 0 ? 0 1

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FS37 0 0 1 1 0 1 1 0 1 0 0 0 1 0 0 0 1 1 1 1 0 ? 0 0 ? 1 0 1 1 1
 adlerzi 0 1 1 0 0 0 0 0 0 0 0 ? 0 0 0 1 0 1 1 1 0 1 0 1 0 1 1 1 1 1
 attenuatus 0 0 1 0 0 1 0 0 1 0 1 0 0 0 0 1 1 0 1 0 0 0 0 0 0 1 0 1 0 0
 balzani 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 0 1 1 1 1 0 0 0 1 0 1 0 1 1 1
 batesi 0 0 1 1 0 1 0 0 0 0 1 0 1 0 0 1 1 1 1 1 0 0 1 1 0 0 1 1 1 1

belti 001100111000100001110010000000
 carbonarius 101011010000100011000010011111
 clathratus 011101101000100001110100000111
 convergens 011101111010100010100100100111
 convexus 001000101110000001111110101001
 coriarius 00?100111100000011110011011100
 curvistriatus 001100110000000011010100110111
 eladio 000100111000000011111011010000
 elegans 001001101000000000100010010111
 ferreri 001110010000000000110110110111
 gibbosus 110100111010000011110100110111
 goeldi 001000001000000000100100010000
 gracilis 011101001010100010100001010000
 hirsutus 001011101000000001111110010100
 hylaeus 0011010111000000?1110110011100
 impressus 001001101000100000100110010000
 kempfi 001001001100100001000100010001
 lenkoi 010111010000000000101000010111
 lepidus 011010011110001010100100110111
 marginatus_s 001001001000100001110100010111
 mayri_2 001001001000100011010000000111
 montanus 111101100010000001110100110111
 nalini_c 00?100111100000011110011011100
 paleatus_t 001001001000100000100101010111
 pictipes_c 001000101100000001111110101001
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 striatus 011101011010000011110110110111
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 sulcatus_c 001100110000000011010100110111
 tortuguero 001001001000100000100101010111
 victoris 011101111011000001110100110111
 virgatus 001011000010000001010000110111
 Cephalotes_atratus 00001?111010110010000?00011?00
 Cataulacus_brevisetosus 0?01?11100101000?10100000111111

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 adlerzi 101111110000021111100201111102

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Chapter 3.

DISTRIBUTIONAL PATTERNS OF THE ANT GENUS *PROCRIPTOCERUS*

Abstract.

Hypothesizing explanatory mechanisms for the distributional patterns of species interfere with the study of area-relationships, a main goal of biogeography. Several biogeographical studies involving phylogenetic analyses have shown both congruent and contradictory schemes of area-relationships (components) in the Neotropics. To discover areas of endemism and area-relationships, a direct exploration of the raw data has been suggested. This approach is here followed in the study of the ant genus *Procriptocerus*. The genus is endemic to the Neotropics from central Mexico to northern Argentina, excluding the Caribbean islands, except Trinidad and Tobago. The species distribution depicts a northward (Mesoamerica-Northwestern South America) component and southward (Panama to southern Brazil) component. The two components overlap between Costa Rica, Panama, Colombia, Ecuador and Venezuela. South America is subdivided into the South America-northern Andes component and a component including Southeastern Colombia and Ecuador, and southern Venezuela to southern Brazil. In turn, this component shows congruent distribution of several endemic species forming a northern Amazonian subcomponent and a southern Paraná Forest in southern Brazil that includes a narrower endemic area, the Brazilian Atlantic Forest. Most species are recorded at low elevations

below 1300 m, but the higher elevations Northern Andes of South America are considered to harbor high diversity and endemism. Richness and distribution of species are considered to be more related to ecological conditions than to elevation or latitude. These ants are tree-branch dependent as a nest site. Most species of plants have been recorded for Mesoamerica and Northern South America including cloud rain forests. The relationship between areas combining the presence and absence of species into Morrone's (2006) scheme of provinces as endemic areas, and running a euclidean cluster analysis, showed the following results. The Paraná Forest, Atlantic Forest in southern Brazil, Napo (Ecuador), Cauca (Colombia, Ecuador), Magdalena (Colombia) and Choco (western of Panamá, Colombia and Ecuador) provinces were independent from each other. Mesoamerica resulted in a unified area, as well as the large region composed by northern, central and southern Amazon with the Chacoan Subregion (Cerrado, Caatinga). This study shows that *Procryptocerus* is a poorly explored genus and more collections are required to reach a better understanding of its taxonomy and biogeography.

Introduction.

Biogeography describes distributional patterns of specific and supraspecific groups and attempts to explain how they were formed by hypothesizing historical and ecological processes (Lomolino et al. 2006). Biogeography ought to explain the distributional patterns of biota, the relationships between the areas containing those biota (classification of areas), and the processes or mechanisms (Chorology - Williams and Ebach 2008) by which the biota is distributed. Two branches of Biogeography deal with these aims. Descriptive Biogeography documents the distributional patterns of biological diversity and produces classifications of bioregions. This

scope is called Provincialism. The second branch, known as Interpretative Biogeography, attempts to explain the underlying processes causing the distributional patterns (Lomolino et al. 2006). While Descriptive Biogeography discovers the patterns of relationships between areas in hierarchical arrangements, Interpretative Biogeography looks for both geological (tectonic dynamics) and biological (ecological) phenomena to explain the processes relating to disjunctive distributions (Whittaker and Fernández-Palacios 2007).

The study of the mechanisms or processes (Chorology) that explain the distribution of current biotas is based on two models, Dispersal and Vicariance. Dispersalism takes into consideration the centers of origin, vagility of species, routes of displacement, geographical barriers, subsequent differentiation of populations, and eventually further extinctions (Darlington 1957, Cranston and Nauman 1991), while vicariance involves the evolution of natural barriers within once widespread populations with the subsequent differentiation of populations due to the barriers (Cranston and Nauman 1991).

The study of both dispersalism (dispersion: the dispersed taxa) and vicariance is known as Historical biogeography (Cranston and Naumann 1991, Morrone 2006). Besides their explanatory role in Biogeography, dispersalism and vicariance are used to explain speciation processes. Allopatric speciation is explained by the two possibilities dispersal or vicariance after the populations have dispersed or separated by way of vicariance. Species evolving in sympatry have not gone through dispersal nor vicariant events. Other explanations for speciation or distributional patterns come from the concepts of parapatry and peripatry (Mayr and Ashlock 1991).

Croizat (1964) explored the explanatory processes through demonstrating the spatial relationships of distributional patterns of species with tectonic dynamics. His method was later developed as Panbiogeography. Parsimony analysis of endemism (PAE) is a method that joins areas by their shared taxa and arranges them into a cladogram. This method is considered a quantitative implementation of Panbiogeography (Morrone 2006). PAE has received substantial criticism since the method is not phylogenetic (Nehei 2004), or it assumes that vicariance is the predominant process for distribution (Brook and van Veller 2003).

Ebach and Humphries (2002) and Williams and Ebach (2008) consider that the interpretation of dispersal and vicariance events is not based on observation, but on speculations. They emphasize that vicariance and dispersal both cause the same patterns. Williams and Ebach (2008) include the two mechanisms, vicariance and dispersal, into chorology (the explanatory processes), and stress that biogeography regards the classification of areas through the study of their inter-relationships, whereas chorology searches for the mechanisms (processes) explaining current distribution by identifying centers of origin of the taxa. These authors conclude that neither dispersal nor vicariance have explained the processes of distribution because the two concepts involve the origin of taxa. Origin is not a testable hypothesis; therefore it is not an empirical study. If biogeography concerns the classifications of areas, it looks for relationships (area homologies).

Bates et al. (1998) point out that studies in biogeography of the Neotropics have paid too much attention on finding processes that explain the Neotropical diversification when there is little knowledge of the patterns. According to Costa (2003) not a single model can explain speciation. Given the little known phylogenies of groups in the Neotropics Costa (2003) calls for recording

specific biogeographical patterns rather than looking for identifying processes of diversification, or Chorology (Williams and Ebach 2008).

Ebach and Humphries (2002) propose the separation of hierarchical relationship from evolutionary history by searching for geographical congruence among the geographical distributions, which are defined as the ecological or physical range boundaries of a taxon. Finding geographical congruence supports the theory of evolution, as it is evidence for evolution (homology). Williams and Ebach (2008) emphasize that biogeography requires empirical studies based on the analysis of data independently of both explanatory mechanisms and methods. It is essential to develop a practice of describing area morphology to understanding any particular area and its barriers for biogeographical analysis. William and Ebach (2008) propose that instead of explanatory processes or area concepts, area morphology is necessary, which is empirical and independent of explanatory mechanisms. Areas are like taxa, groups of biota that share closer relationships with each other than they do to another biota in a different area.

Endemicity, Biotic elements, and area morphology.

An endemic taxon is restricted to a region and is found nowhere else (Szumik et al. 2002). Endemicity is the known geographical distribution of a taxon (Ebach and Humphries 2002); it can be of wide or more restricted distribution (Cranston and Nauman 1991). Areas of endemism are regions defined by the occurrence of groups of taxa found nowhere else (Nelson and Platnick

1981, Bates et al. 1998, Szumik et al. 2002). Alternatively, areas of endemism can be defined in terms of spatial coincidence among areas of distribution of different taxa (Nihei 2008). Hausdorf (2002) introduced the concept of biotic element, a group of taxa whose ranges are significantly more similar to each other than to those of taxa of other such groups. He considers that biotic elements can be determined by using distribution data alone. Biotic elements are “biogeographic units”.

Distribution of *Procryptocerus* spp.

Procryptocerus is a genus endemic of the Neotropics excluding most Antillean islands except Trinidad and Tobago. The northern limit coincides with the Isthmus of Tehuantepec in southern Mexico (Kempf 1951), about 19 degrees north latitude (Southeastern Veracruz (San Andrés Tuxtla 18° 26' 60N, 95° 13' 0W), Western of Oaxaca (San Pedro Pochutla 15° 43' 60N, 96° 28' 0W), and Western of Chiapas and Tabasco). The Isthmus of Tehuantepec emerged during the Cretaceous (about 60-70 MYA), and the Isthmus of Panamá, a very important corridor connecting biodiversity between South and Central America, during the Cenozoic (about 3 MYA) (Halfter 1987). Southern limits of *Procryptocerus* coincides with the provinces of Misiones (Wanda 25° 58' 0S and Loreto 27° 19' 0S) and Corrientes in Argentina.

More than half a century ago, records of the genus were lacking for Honduras, French Guiana, Surinam, Ecuador, Peru, Chile, Paraguay, and in more than half of Brazil (Kempf 1951). Chile is not considered part of the Neotropics (Morrone 2006). Today there are records for all continental

countries in the Neotropics. No species of *Procryptocerus* has been recorded as invasive (established long-term populations that expand their range upon introduction into new areas) or transferred -‘tramp’- ants (widespread geographical populations closely tied with urban areas) (McGlynn 1999).

To date, the most complete collections of *Procryptocerus* are from Costa Rica (Longino & Snelling 2002), Colombia (unpublished data), and Brazil (Kempf 1951, 1957, 1958, 1960, 1964a, 1964b, 1969, 1973, 1974). Nonetheless, most species have been described from Brazil. Fewer records correspond to the largest savannas in South America such as Llanos (Colombia and Venezuela), Roraima, Pantanal, Cerrado, Caatinga, and Llanos de Mojos (Brazil), which are considered the second largest biome in South America after the Amazon (Cardoso Da Silva and Bates 2002). No records are known from the provinces of Maracaibo (Venezuela) and Arid Ecuador.

Methodology.

To explain the patterns of distribution of *Procryptocerus* spp. I follow the ideas of Bates et al. (1998), Ebach and Humphries (2002), Hausdorf (2002), Costa (2003), Williams and Ebach (2008), and Nelson (2008) in which I seek to recognize congruent distributions by the direct analysis of the distributional data and compare it with other authors.

To compare the areas of distribution of *Procryptocerus* spp. I used the biogeographical province scheme of Morrone (2006) (Fig.1). In his proposal, Morrone (2006) used data from different

publications regarding panbiogeographic and cladistic analyses of insects (Coleoptera, Odonata, Diptera, Hymenoptera, Hemiptera, Phthiraptera, Orthoptera, and Lepidoptera), for Latin American and the Caribbean islands, identifying biogeographic areas on the basis of endemism and arranged them hierarchically in a system of five Regions, eight Subregions, five Dominions, and 70 Provinces. According to this classification, *Procryptocerus* is currently found in the Neotropical region in the followings four Subregions, two Dominios and 28 Provinces (Fig. 1): Caribbean Subregion (Mesoamerican Dominio): Mexico Gulf (MexGulf) southward, Chiapas, Eastern Central America (ECentralAm), Western Panamanian Isthmus (WPanaIsthmus); Caribbean Subregion (Northwestern South American Dominio): Choco, Venezuelan Coast, Trinidad and Tobago (Tri.Tob), Magdalena, Venezuelan Llanos, Cauca; Amazonian Subregion (Northwestern South American Dominio): Napo, Imeri, Guyana, Humid Guyana (Hu.Gu.), Roraima, Amapá, Varzea, Ucayali, Madeira, Tapajos-Xingu (Ta.Xi.), Pará, Pantanal; Chacoan Subregion: Caatinga, Cerrado, Chaco; Parana Subregion: Brazilian Atlantic Forest (BrazAtlFor), and Parana Forest. Lattke (2003) mentions that many similar Formicidae species have been registered for the entire biogeographic region of Choco (the Pacific coast of northern Ecuador, Colombia, and Panamá). Moreover, southeastern Brazil is considered very important in endemic ants (Lattke 2003, Kempf 1978). Sympatric and parapatric distributions have been reported for *P. belti* and *P. hirsutus* (Longino and Snelling 2002).

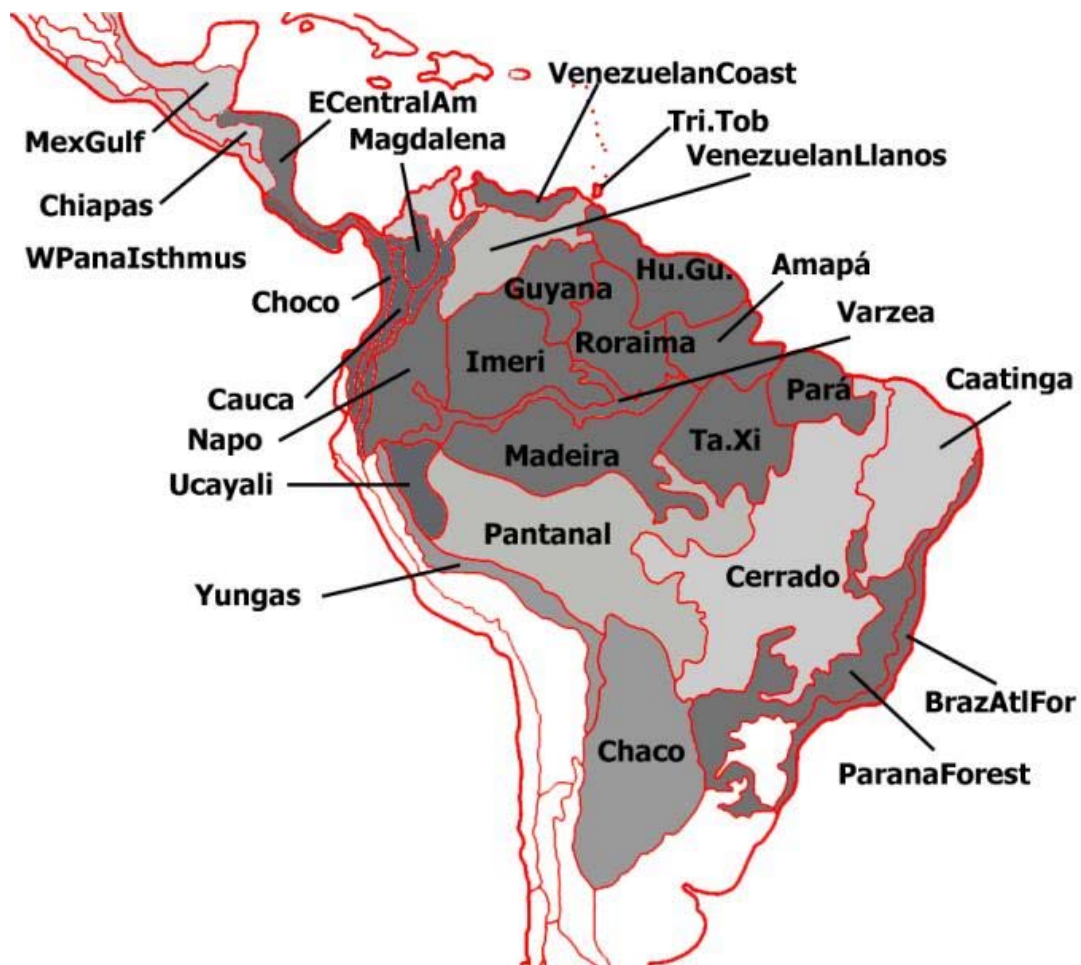


Fig. 67. *Procryptocerus* spp. distribution in the biogeographical Provinces of Morrone (2006).

Darker gray color indicates more species comparatively.

I approach the analysis of the distribution of the genus *Procryptocerus* using the following steps:

The concept of Endemicity was used to identify large and inclusive narrower areas of distribution of *Procryptocerus* spp. I depict the general distribution of the genus using the DIVA-GIS program, recognize large patterns of widely distributed species, recognize distributional patterns in elevation, organize subcomponents into widely distributed components, group smaller areas into the subcomponents, and compare those components with the Morrone's (2006) proposal.

To explore relationships between areas, I used the provinces of Morrone (2006) as endemic areas, and applied a variation of the methodology followed in Aguilar-Aguilar (2003). The matrix for this study was prepared by coding taxa for the absence (0) or presence (1) in each of Morrone's (2006) provinces (Appendix 3.1). Taxa found in a single province do not provide any information of area relationships, and so were excluded from the matrix. Hierarchical and non-hierarchical similarity cluster analyses were carried out with "R" and Minitab

Results.

In table 1 I show the number of species of *Procryptocerus* found in the biogeographical provinces considered in Morrone (2006) and the endemic species of those areas. The distribution by countries is shown in Appendix 2. The richest areas (7 to 17 species) correspond to the Provinces of Western Panamanian Isthmus, Cauca, Magdalena, Napo, Brazilian Atlantic Forest, and Parana Forest (Table 1). The highest endemcities are also found in these areas. The highest endemcity of the entire genus belongs to the Brazilian Atlantic Forest containing 82% (14 out of 17) of its species recorded nowhere else. It is followed by Napo (63%: 5 out of 8 species), and Parana Forest (50%: 6 out of 12 species). Except for the Brazilian Atlantic Forest, which has received more attention in collections (Kempf 1978), all endemic species of Choco, Napo and Ucayali are new species; an indication of the lack of knowledge we have about the taxonomy and distribution of the genus *Procryptocerus*.

Table 2. Number of species of *Procryptocerus* and the endemic species known from the biogeographical provinces considered in Morrone (2006).

Provinces	# of species	endemicity
Caribbean Subregion (Mesoamerican Dominio)		
Chiapas (southern Mexico, Guatemala, Honduras, El Salvador, and Nicaragua, and also the Sierra Madre de Chiapas, which range in altitude from 500 to 2000 m)	3	
Eastern Central America (eastern Central America, from Guatemala to Panama)	5	
Western Panamanian Isthmus (Western Central America, from Costa Rica to western Panama).	13	<i>P. eladio</i> , <i>P. kempfi</i>
Caribbean Subregion (Northwestern South American Dominio)		
Cauca (western Colombia and Ecuador).	10	FS04,FS06, <i>P.carbonarius</i> , <i>P. ferreri</i>
Choco (the Pacific coast of northern Ecuador, Colombia, and Panama).	5	FS07,FS12
Magdalena (western Venezuela and northwestern Colombia).	7	FS01,FS08
Maracaibo (northern Colombia and northwestern Venezuela).	3	
Venezuelan Coast (northern Venezuela and Colombia).	1	

Trinidad and Tobago (the two islands).	4	
Arid Ecuador (western Ecuador and southwestern Colombia).	1	
Tumbes -Piura (southern Ecuador and northern Peru).	1	
Amazonian Subregion (Northwestern South American Dominio)		
Napo (northern Peru, southwestern Colombia, and Eastern Ecuador).	8	FS20, FS28, FS31, FS33, FS39
Imeri (southern venezuela, southwestern Colombia, northeastern Peru, and northern Brazil	4	
Guyana (northwestern South America, in the guyanan Shield, between venezuela, Colombia, Guyana, Surinam, and northern Braxzil).	2	
Humid Guyana (southwestern Venezuela, northern Brazil, Surinam, and Guyana).	3	
Roraima (northern Brazil, southeastern Venezuela, Surinam, and Guyana).	4	
Amapá (Surinam and northeastern Brazil).	4	
Yungas (western slopes of the Andes, from northern Peru to northwestern Argentina, at altitud ranging from 300 to 3500)	4	FS37, <i>P. balzani</i>
Varzea (northwestern Brazil and northeastern Peru).	3	
Ucayali (eastern Peru, northern Bolivia, and western Brazil).	5	FS35, FS36
Madeira (northwestern Brazil, bordered to the north by the Amazon river, to the west by the Madeira and Beni rivers, to	3	

the east by the Xinguy river, and to the west by the Oriental Cordillera of Bolivia).		
Tapajos-Xingu (northwestern Brazil).	2	
Pará (northwestern Brazil, bordered to the north and west by the Tocantins and Araguaia rivers, to the so Serra do Burupi and the Grajau river, and to the east by the Guana river).	5	
Chacoan Subregion		
Caatinga (northeastern Brazil (Bahia, Sergipe, Alagoas, Pernambuco, Paraíba, rio Grande do Norte, Ceara, Piaui, and Minas Gerais).	5	
Cerrado (southcentral Brazil (the states of Minas Gerais, mato Grosso, Goias, Sao Paulo, Parana, Maranhao, and Piaui), northeastern Paraguay, and Bolivia)).	3	
Chaco (southern Bolivia, western Paraguay, southern Brazil, and northcentral Argentina).	4	
Parana Subregion (northeastern Argentina, eastern Paraguay, and southern and eastern Brazil):		
Brazilian Atlantic Forest (a narrow strip along the Brazilian Atlantic coast east of the coastal cordillera, between latitudes 7 and 32 degrees south).	17	<i>P. convergens</i> , <i>P. curvistriatu</i> , <i>P.gibbosus</i> , <i>P. lenkoi</i> , <i>P. montanus</i> , <i>P. sampaioi</i> , <i>P.shmalzi</i> , <i>P. seabrai</i> , <i>P. sulcatus</i> , <i>P. victoris</i> , FS16, FS21, FS22, FS34.
Parana Forest (southeastern Brazil, northeasternArgentina, and eastern Paraguay).	12	<i>P. adlerzi</i> , <i>P. goeldii</i> , <i>P. lepidus</i> , <i>P. regularis</i> , FS14, FS19.

Distributional Patterns.

The general distribution of the genus is represented in Fig. 68 by the three widest distributed species *Procryptocerus scabriusculus* (Mexico to Colombia and Venezuela), *P. hylaeus* (Panama to southern Brazil, Paraguay), and *P. pictipes* (Costa Rica to Bolivia, Brazil).

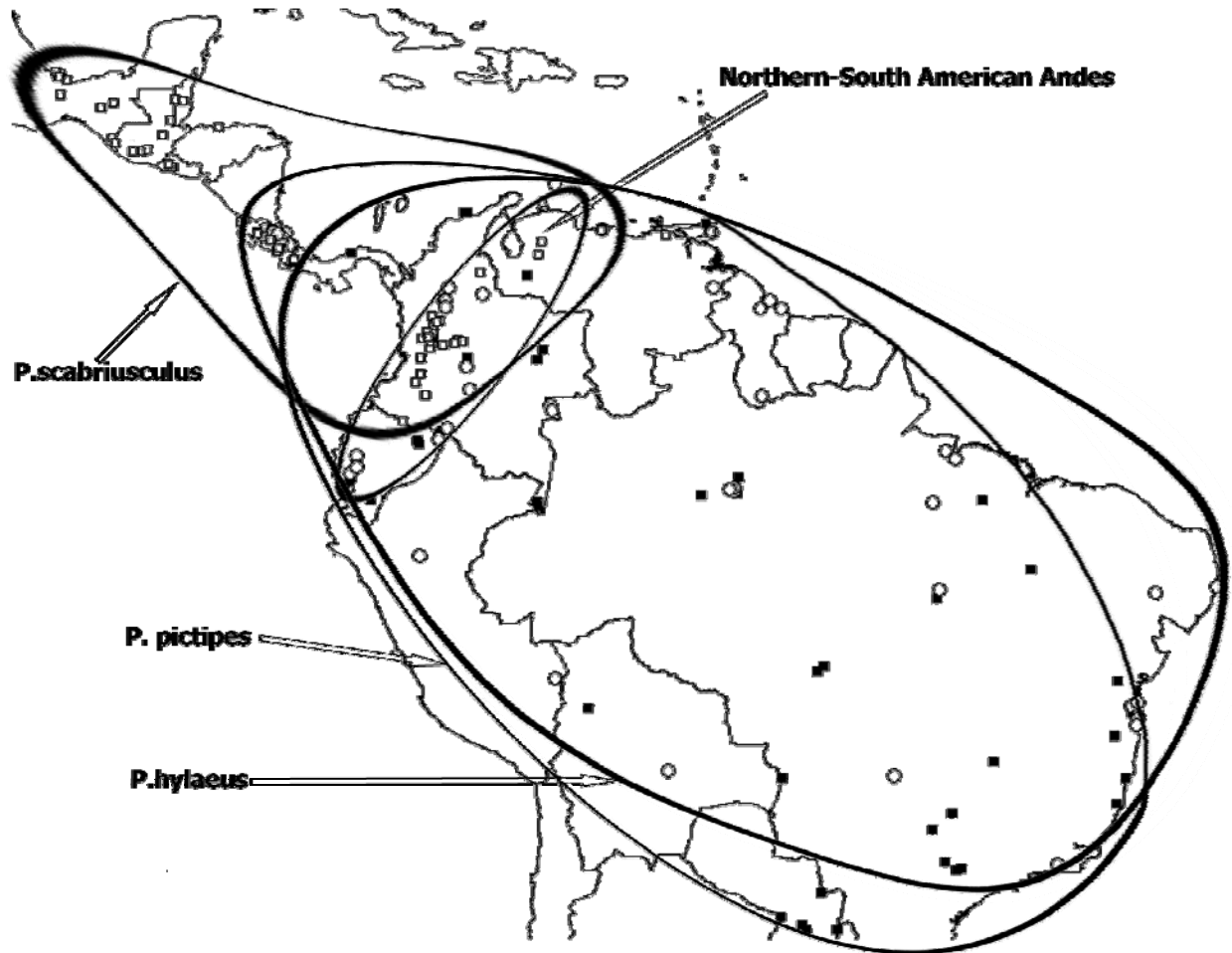


Fig. 68. Two main biogeographical components depicted by the distribution of the three widest distributed species of *Procryptocerus*, *P. scabriusculus*, *P. pictipes*, and *P. hylaeus*, and the Northern-South American Andes biogeographical subcomponent.

The distribution encompasses the northern and southern limits of the neotropical region considered in Morrone (2006). Two main biogeographical components can be recognized based on these distributions. *Procryptocerus scabriusculus* shares a Mesoamerica-Northwestern South American distribution with the *mayri* and *batesi* groups (Chapter 2), and the species *P. coriarius*, *P. belti*, *P. impressus* and *P. tortuguero* suggesting a Mesoamerica-Northwestern South American component (“northward” component), from 19° northern latitude to 12° northern latitude including the Provinces Sierra Madre del Sur (southward), Mexican Pacific Coast, Mexican Gulf (southward), Chiapas, Eastern Central America, Western Panamanian Isthmus, Choco, Magdalena, and Cauca. The northward component has its southern limits in the northern Andes of Ecuador, Colombia and Venezuela from below 2200 m alt. agreeing with the Caribbean and Northwestern South American Subregions of Morrone (2006).

The second and largest component (“southward” component) is represented by the congruent, although disjunctive, distribution of *P. hylaeus* and *P. pictipes* from Isthmus of Panamá (9° North Latitude) to southern Brazil (26° South Latitude) including the Provinces of Western Panamanian Isthmus, Cauca, Choco, Magdalena, Trinidad and Tobago, Tumbes–Piura, Napo, Imeri, Guyana, Humid Guyana, Roraima, Amapá, Yungas, Varzea, Ucayali, Madeira, Tapajos-Xingu, Pará, Caatinga, Cerrado, Parana Forest and Brazilian Atlantic Forest (Fig. 67). The southward component includes the northern Andes of Ecuador, Colombia and Venezuela and the Amazonian, Chacoan, and Parana Subregions (Morrone 2006). The two components overlap in the northern Andes, Panamá and Costa Rica (Fig. 67).

Similar patterns have been considered in other groups. Analyzing patterns of distribution of several animal groups, Amorim and Pires (1996) postulated a Northwestern and Southeastern components. The Northwestern component including the three subcomponents Andean-Mesoamerican, Southwestern Amazonia and Northern Amazonia, and the Southeastern component constituting the Southeastern Amazonia and the Atlantic Forest. The northward and southward components depicted here agree with the Mesoamerican and Northwestern South American dominions considered in Morrone's (2006) proposal.

The northward subcomponents.

The Mesoamerica-Northern South American subcomponent is composed of a mosaic of distribution patterns. The species *P. scabriusculus* (Mexico to Colombia), *P. batesi* (rudis group) (Costa Rica, Panamá, Colombia), *P. impressus* (Nicaragua, Costa Rica, Panamá, Colombia), *P. tortuguero* (Costa Rica, Colombia), *P. paleatus* (Mexico, Costa Rica, Colombia) (*subpilosus* subgroup), *P. coriarius* (Costa Rica, Colombia), *P. nolini* (Costa Rica, Perú), and FS02 (Costa Rica to Ecuador) connect the Mesoamerican domains (Mexico to Panamá) with the Province of Choco (Panamá and the Pacific coast of Colombia and northern Ecuador) and apparently with part of Yungas in northern Peru. *Procryptocerus belti*, *P. eladio*, *P. kempfi*, and FS03 are only known for Mesoamerica and except for FS03 (Costa Rica), depict a similar distribution between Mexico-Guatemala to Panamá.

The northern-South American Andes subcomponent extends from the Andes of northern Bolivia to the Andes of Colombia and Venezuela from over 1500 m. The species include FS08 (Colombia), *P. rudis* (Colombia), *P. carbonarius* (Colombia), *P. virgatus* (Ecuador, Colombia)

and several specimens considered here as species inquirenda (Bolivia, Ecuador, Colombia, Venezuela). These species are closely related to *P. virgatus*, FS02, and *P. mayri*. The species in the Andes are usually shiny, yellow, rufous or red-appendaged, the opisthogaster is levigate and shining, erect-haired, with the mesonotal lateral processes obsolete, and with a conspicuous mesospiracular lobe. In Colombia, the subcomponent coincides in part with the provinces of Cauca and Magdalena.

The southward subcomponents.

Fig. 69 shows the congruent but disjunctive distribution of *Procryptocerus hirsutus*, *P. spiniperdus*, *P. subpilosus* and *P. schimitti* depicting a general area that joins the Amazon basin with the savannas of Cerrado and Caatinga in south central and eastern Brazil and the southern Parana Subregion including the Parana Forest and the Atlantic Forest Provinces (Fig. 1). The disjunctive distributions of these four species in the northern, central and southern Amazon, and in the southern savannas could be natural or an artifact of scarce collections in these areas. In either case, this large biogeographical area from the Amazon basin to southern Brazil has been recovered in other groups. Studies in the arboreal beetles *Agra* spp. (Coleoptera: Carabidae) (Erwin and Pogue 1988), wasps of the genera *Montezumia* and *Monobia* (Hymenoptera: Eumenidae) (Willink 1988), and anurans (Ron 2000) among others have shown close relationships between the Parana and Amazonian subregions.



Fig. 69. Distribution of *Procryptocerus hirsutus*, *P. spiniperdus*, *P. subpilosus* and *P. schmitti*.

The general area considered in Fig. 69 is divided into the three congruent subareas shown on Fig. 70. A northern Amazon subcomponent includes Napo (Ecuador), northeastern Perú, southeastern Colombia, southern Venezuela, Guyana, Surinam, French Guiana, and northern Brazil including the provinces of Napo, Imeri, Guyana, Humid Guyana, Roraima, and Amapá (Morrone 2006) (Fig. 1). The northern Amazon, bordered to the south by the Amazon river, is an endemic area of *Procryptocerus* harboring species found nowhere else such as *P. gracilis*, *P. convexus*, FS20, FS28, FS30, FS31, FS33, FS39.

Two endemic areas are defined in southern Brazil (Fig. 70) agreeing with the Provinces of Parana Forest and Brazilian Atlantic Forest (Fig. 67); nonetheless, from the *Procryptocerus* distribution perspective the Brazilian Atlantic Forest is included into the larger Parana Forest in a hierarchical arrangement. *Procryptocerus adlerzi*, *P. lepidus*, *P. goeldii* and *P. regularis* are distributed in the two provinces, while *P. convergens*, *P. curvistriatus*, *P. gibbosus*, *P. lenkoi*, *P. montanus*, *P. sampaioi*, *P. schmalzi*, *P. seabrai*, *P. sulcatus* and *P. victoris* are restricted to the Brazilian Atlantic Forest forming an endemic biogeographical ribbon along the Atlantic coast between 19° South latitude to 32° South latitude (Fig. 70).

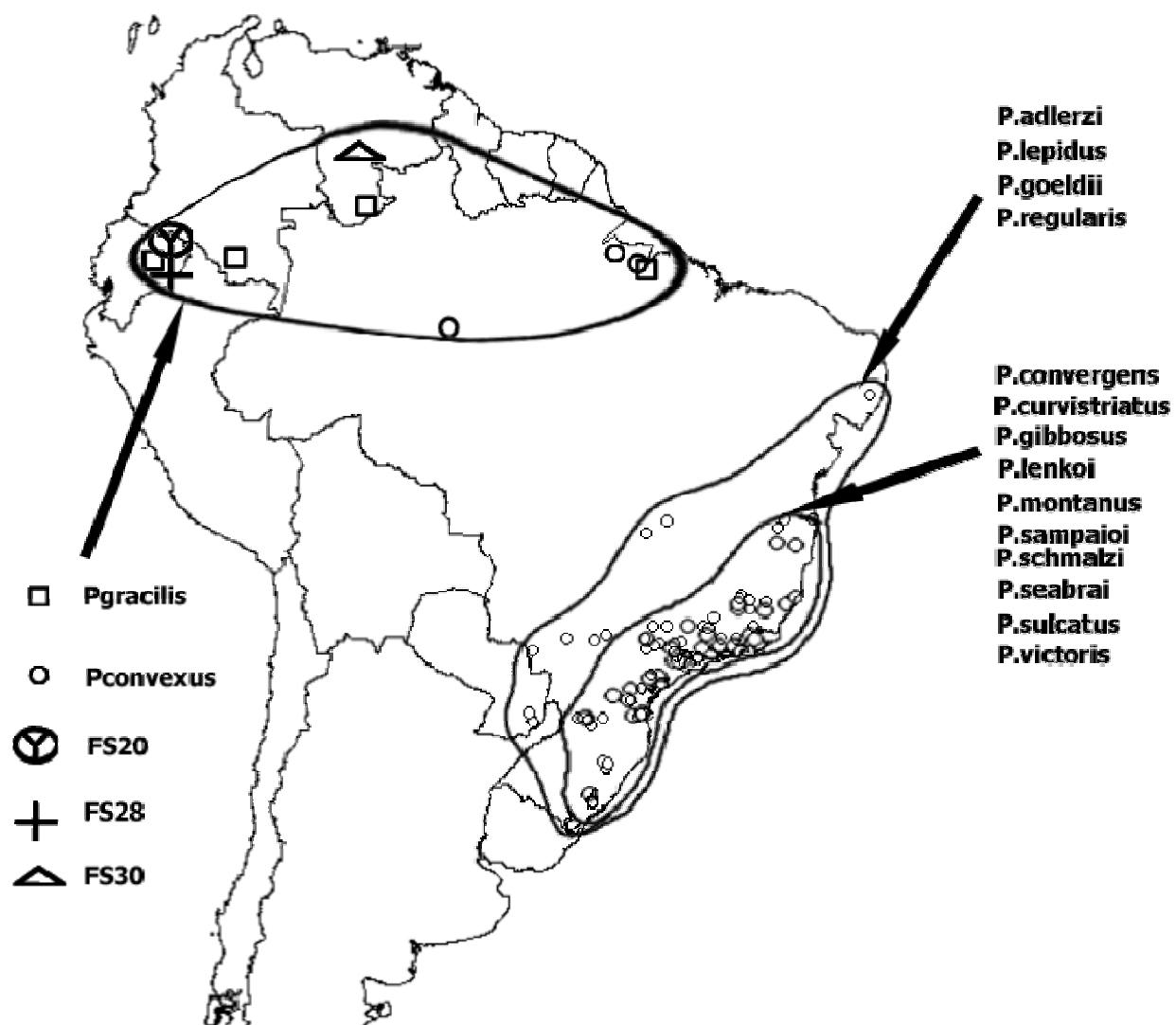


Figure 70. Three congruent areas in the southward biogeographical component depicted by the species of *Procryptocerus*.

The Brazilian Atlantic Forest is a narrow strip along the Brazilian Atlantic coast east of the coastal cordillera, between latitudes 7° and 32° South (Morrone 2006). This biogeographic region has been recovered accordingly in different biogeographic insect studies, such as arboreal

beetles *Agra* spp. (Erwin and Pogue 1988), Drosophilidae flies (Val and Kaneshiro 1988), peiratine bugs (Hemiptera: Reduviidae) (Morrone and Coscarón 1996), among others.

Distribution in elevation.

In fig. 71, the Y axis shows the ranges between lowest and highest elevations in the biogeographic provinces (X axis) of Morrone (2006), where *Procryptocerus* spp. have been recorded. In the right Y axis the number of species is represented at specific elevations. The vast majority of species have been recorded at low elevations below 1300 m altitude in Central America and the southward component. The highest elevations correspond to the northward component in the northern-South American Andes (2200 m alt.) and Mesoamerica (1800 m alt.). In the southward component, the highest elevations correspond to southern Brazil in the savannas of the Cerrado and Caatinga and the Parana Forest. The lowest elevations correspond to the northeastern Brazilian coast (Pará) and the Brazilian Atlantic Forest.

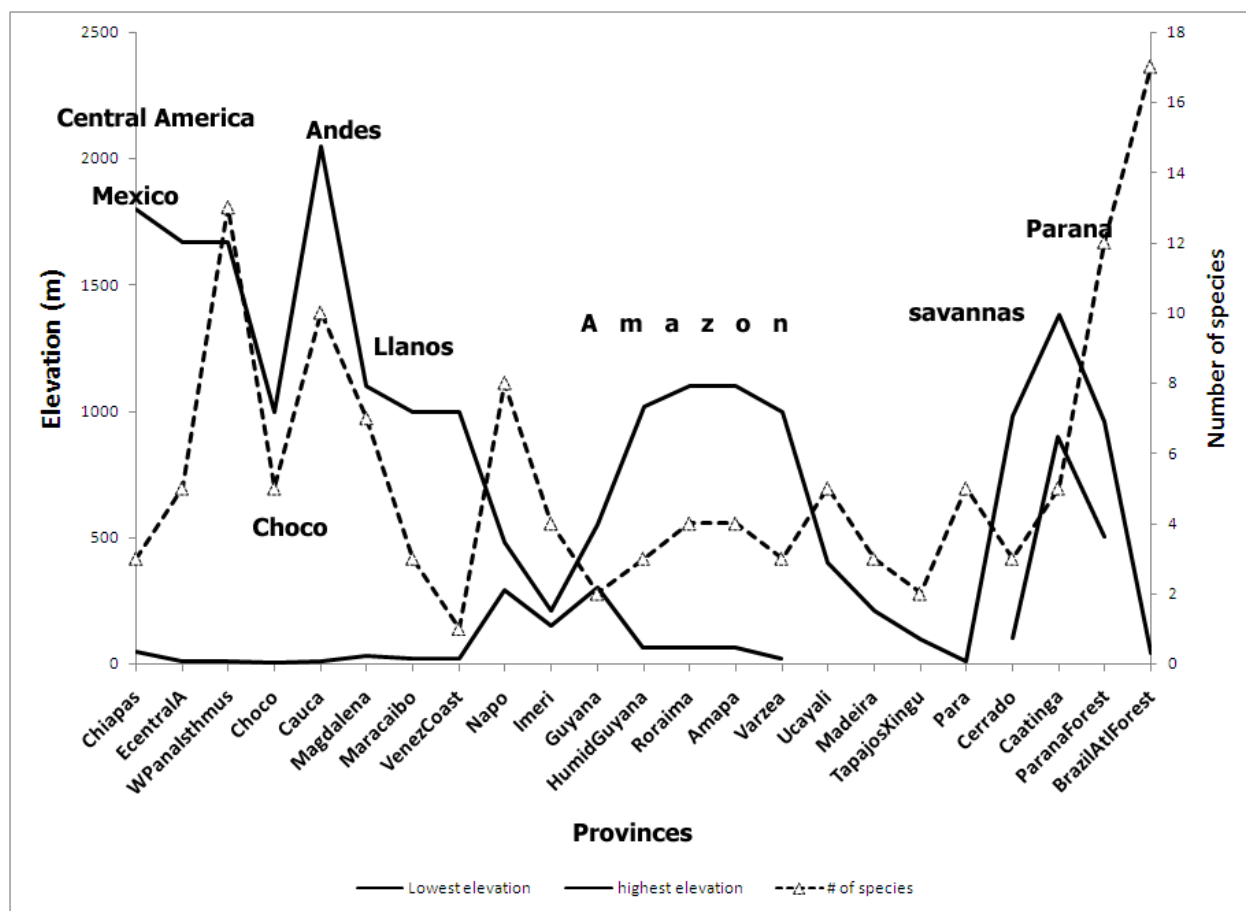


Figure 71. Ranges of elevations for the distribution of *Procryptocerus* spp. in the biogeographical provinces of its distribution. Left Y axis represents lowest and highest elevations in which the species have been recorded. Right Y axis represents number of species found at specific elevations.

The highest concentration of species is found in Central America (between 8 and 13 species) in a range of 1000 and 1800 m of altitude and, in a range of 40 and 960 m of altitude, in the Parana Forest and Atlantic Forest of southern Brazil (between 10 and 17 species). In general, high human activity such as farming or urbanization is common in these areas. The Parana Forest and the Brazilian Atlantic Forest have received better attention in collections and the species have an

important number of specimens represented in different museums such as MZSP, LACM, CAS, MZC and others.

The minimum number of species is found in the Venezuelan coast, Humid Guyana, Central-western (Varzea) and farther eastern (Pará) Amazon. The scarcity of species (between 2 and 5) in these provinces of the Amazon is likely due to lack of collections. Pinto-da-Rocha and Bernardino da Silva (2005) consider that the invertebrates in the Amazon are poorly studied. Likewise, Kusnesov (1963) emphasizes that the ants of the Amazon basin are scarcely known and recorded the following species of *Procryptocerus* for the region: *P. hirsutus*, *P. schmitti*, *P. pictipes*, *P. goeldii*, *P. gracilis*, *P. paleatus*, and *P. subpilosus*. I recognize 8 new species for the entire Amazon represented in collections by only 1-3 specimens.

Ants of *Procryptocerus* at elevations mostly from over 1500 m altitude in Central America and the Northern-South American Andes are usually larger (4.5-8.5 mm) than those at lower elevations (usually 3-5.5 mm). Ants in higher elevations are shiner and erect and long-haired. Appendages (mandibles distally, antennae, oral palps, and legs) of these ants are usually rufous or orange. The profemur is long and fusiform and the opisthogaster levigate. The frons is usually clathrate or costate in anastomosis. In contrast, ants from below 1500 m of altitude in the entire distribution of the genus are usually uniformly black, opaque or less shiny; the profemur is fusiform or mostly disciform; the body is smooth, striate, striate and foveolate, or foveolate, and the hairs are shorter and usually suberect or subdecumbent; the clypeo-torular sulcus is absent and the lateral fovea is either absent or present.

An interesting character evolving in Central America and the northern Andes of South America from over 1500 m altitude is the clypeo-torular sulcus. This structure is present in most species of the *rudis* group and part of the *mayri* group. When the clypeo-torular sulcus joins the lateral fovea (fovea under the torulus), it forms a circular invagination (the antennal fovea) surrounding the torulus, where the latter is inserted. This is the case in the *rudis* subgroup. A shallower clypeo-torular sulcus is present in part of the *mayri* group, where it is separated from the lateral fovea, and therefore not forming an antennal fovea.

Another important character present in cloud forest from over 1700 m of altitude is the mesospiracular lobe. In all species at lower elevation the mesothoracic spiracle is covered by the pronotal lobe, and a clear promesonotal lateral excavation is present (dorsal view). In the higher-elevation cloud forests of Bolivia, Ecuador and Colombia, the mesospiracle is usually visible (lateral view) and delimited by a lobe (the mesospiracular lobe). In dorsal view, the mesospiracular lobe occupies the promesonotal lateral excavation and may be larger or similar sized to the pronotal lobe. This condition is correlated with the reduction of the propodeal spines, obsolete in some individuals. *Procryptocerus virgatus*, and several other individuals close to this species, possess such condition.

Morphological boundaries between those species (especially *mayri* group) from over 1500 m in Central America and northern-South American Andes are elusive. A combination of character states including shape of frontal lobe, frons posterior lobe, shape of clypeo-torular sulcus, head

length, color patterns, shape of petiole and postpetiole, shape of opisthogaster, and form of sculpture have to be invoked to separate species. Usually, not a single or few character states can function as diagnostic of a species in these areas. Several of these observations are also stressed by Longino and Snelling (2002).

Distribution of *Procryptocerus* plant-hosts.

The diversity of *Procryptocerus* seems to correspond more to ecological conditions of the areas where they are found rather than to elevation or latitude. Most species have been collected in humid forest at both low elevations in Central America, Northern South America, Amazon, Parana and Brazilian Atlantic Forest, and high elevations in the cloud forest of northern Andes of South America. Shelter of *Procryptocerus* is plant-branch dependent. The shape of the architecture of plants, especially branches in woody trees is the nesting source. Collections using fogging on canopy vegetation have shown new species in Costa Rica and Ecuador. J. Longino (<http://www.evergreen.edu/ants/genera/AntsofCostaRica.html>) and Longino and Snelling (2002) record important information of several species with regards to location of nests in branches, number of colonies, and number of individuals of both brood and adults found in different nests. In table 3 I present the species of plant where species of *Procryptocerus* have been collected. The majority of plant species are recorded and restrictedly distributed for Central America and Northern South America (Fig. 72). It has been considered that the composition of the invertebrate fauna in the canopy may vary comparatively more across forest types than across biogeographical regions (Basset 1998).

Table 3. Species of *Procryptocerus*, their associated plants, distribution of the plants by countries, and references. * indicates records from this study.

Species	of Plant	Plant distribution	Reference
<i>Procryptocerus</i>			
<i>P. adlerzi</i>	<i>Ocotea</i> (Lauraceae)	sp. --	*
<i>P. attenuatus</i>	<i>Clibadium</i> <i>surinamense</i> (Asteraceae)	Bolivia, Brazil, Caribbean, Colombia, Costa Rica, Ecuador, Guyana, French Guiana, Guatemala, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, Venezuela	*
	<i>Eucalyptus</i> (Myrtaceae)	sp. --	
	<i>Luehea seemannii</i> (Tiliaceae)	Belize, Colombia, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela	
	<i>Vismia</i> (Clusiaceae)-carate	sp. --	

<i>P. batesi</i>	<i>Cecropia insignis</i>	--	
<i>P. belti</i>	<i>Anacardium</i>	sp. --	*
	(Anacardiaceae)		
	<i>Brosimum</i>	sp. --	
	(Moraceae)		
	<i>Croton</i>	sp. --	
	(Euphorbiaceae)		
	<i>Ficus</i> sp. (Moraceae)	--	
<i>Inga leiocalycina</i>	Bolivia, Brazil, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, Venezuela		
<i>Luehea seemannii</i>	Belize, Colombia, Guatemala, Honduras, Mexico, Nicaragua, Panama, Venezuela		
<i>Ochroma</i>	sp. --		
	(Bombacaceae)		

Protium sp. --
(Burseraceae)

<i>P. coriarius</i>	<i>Coffea arabica</i>	Throughout tropical American at	*
	(Rubiaceae)-coffee	elevations over 1300 m	

<i>P. goeldii</i>	<i>Cattleya</i> sp. --		*
	(Orchidiaceae)		
	<i>Epidendrum</i> sp. --		
	(Orchidiaceae)		

<i>P. hylaeus</i>	Rubiaceae	--	*
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<i>Baccharis trinervis</i>	Argentina, Belize, Bolivia, Brazil,	*
(Asteraceae)	Colombia, Ecuador, El Salvador,	
	Guatemala, Guyana, Honduras,	
	Mexico, Panama, Paraguay, Peru,	
	Venezuela	

<i>P. mayri</i>	<i>Cecropia obtusifolia</i> --	Longino and Snelling (2002).
	(Cecropiaceae)	
	<i>Cecropia polyphlebia</i> Costa Rica, Ecuador, Panama	*
	(Cecropiaceae)	
	<i>Acanthaceae gangly.</i> --	*
	Compositae --	*
	Melastomataceae --	*
	<i>Baccharis trinervis</i> --	Longino and Snelling (2002).
	(Asteraceae).	

<i>P. pictipes</i>	<i>Ceiba pentandra</i> Belize, Bolivia, Caribbean, Costa	*
	(Bombacaceae)-ceiba Rica, Ecuador, El Salvador,	
	de agua o barrigona French Guiana, Guatemala,	
	Guyana, Honduras, Madagascar,	
	Mexico, Panama, Peru, Suriname,	
	Venezuela	
<i>P. pictipes</i>		
(continued)	<i>Clibadium</i> Bolivia, Brazil, Caribbean,	
	<i>surinamense</i> Colombia, Costa Rica, Ecuador,	
	(Asteraceae) Guyana, French Guiana,	
	Guatemala, Honduras, Mexico,	

Nicaragua, Panama, Peru,
Suriname, Venezuela

<i>P. regularis</i>	<i>Hibiscus</i>	Belize, Brazil, Ecuador, El	*
	<i>pernambucensis</i>	Salvador, Mexico, Panama,	
	(Malvaceae)	Venezuela	
<i>P.</i>	<i>Acacia</i>	<i>iwig</i> --	*
<i>scabriusculus</i>	(Mimosaceae)		
	<i>Cattleya</i>	sp. --	*
	(Orchidiaceae)		
	<i>Cecropia</i>	sp.	<i>Longino and</i>
	(Cecropiaceae)		<i>Snelling (2002)</i>
	<i>Coffea arabica</i>	Throughout tropical American at	*
	(Rubiaceae)-coffee	elevations over 1300 m	
	<i>Cyathea</i>	sp. --	*
	(Cyatheaceae)		
	<i>Inga</i>	sp. --	*
	(Mimosaceae)		

Mangifera indica -- *

(Anacardiaceae)-

mango

Oncidium Guatemala, Honduras, Mexico *

cavendishianum

(Orchidiaceae)

P. schmitti *Coffea arabica* Throughout tropical American at *

(Rubiaceae)-coffee elevations over 1300 m

P. FS04 *Coffea arabica* Throughout tropical American at *

(Rubiaceae)-coffee elevations over 1300 m

P. FS12 *Croton magdalenensis* Colombia, Ecuador *

(Euphorbiaceae)

P. FS17 *Rapanea* sp. -- *

(Myrsinaceae)

<i>P. sp.</i> (with no ID yet)	<i>Anacardium occidentale</i> (Anacardiaceae)- <i>caracoli</i>	--	*
<i>P. sp.</i> (with no ID yet)	<i>Heliconia</i> (Heliconiaceae)	sp. --	
<i>P. sp.</i> (with no ID yet)	<i>Quercus</i> (Fagaceae)	sp. --	
<hr/>			
<i>P. attenuatus</i>	<i>Luehea seemannii</i> (Tiliaceae).	--	Longino and Snelling 2002
<i>P. sp.</i>	<i>Cecropia polyphlebia</i> (Cecropiaceae)	--	*

*. This study.

--. Specific name not known or no clear information about the distribution was found.

The information of *Procryptocerus* and plant association for the Amazon region and the entire country of Brazil (southward component, Fig. 72) is almost completely lacking. The Brazilian Atlantic Forest is the richest center of species of *Procryptocerus*, but no one of their associated

trees has been recorded. In the northward component most recorded plants belong to woody genera including *Ocotea* sp. (Lauraceae), *Eucalyptus* (Myrtaceae), *Vismia* (Clusiaceae), *Anacardium* (Anacardiaceae+), *Croton* (Euphorbiaceae), *Ficus* (Moraceae), *Inga* (Fabaceae), *Ochroma* (Bombacaceae+), *Protium* (Burseraceae+), *Cecropia* (Cecropiaceae), *Ceiba* (Bombacaceae+), *Acacia* (Mimosaceae), *Mangifera* (Anacardiaceae+), *Rapanea* (Myrsinaceae), and *Quercus* (Fagaceae). Families with + symbol are Gondwanan families having an essentially Amazonian distribution (Hodkinson 1989). In Mexico, Guatemala, Nicaragua, and Argentina (W. Mackay), Costa Rica (J. Longino), and Ecuador (D. Donoso, P. Ward) researchers have associated *Procryptocerus* species to their nests and identified the corresponding plants. Interestingly, most data refer to nests in either fallen branches or trees. *Coffea arabica*, *Croton magdalenensis*, *Anacardium* spp., *Cecropia* spp., *Baccharis* spp., *Ocotea* sp., *Luehea* sp. and *Vismia* sp. account for most of the *Procryptocerus* plant-hosts.



Figure 72. General distribution of the combined species of plants recorded as hosts of *Procryptocerus* spp. in table 2. (Encyclopedia of Life: <http://www.eol.org>)

Area relationships.

A non hierarchical cluster analysis of the matrix in appendix 1, using Euclidean distance and 25 repetitions for clustering, produced a dendrogram for the relationship between the provinces of the distribution of *Procryptocerus* spp. (Fig. 73). The Amazonian Subregion, except the Napo Province was more related to the Chacoan Subregion, including the Caatinga, Cerrado and Chaco provinces in southern Brazil, than to the Napo province of the Amazonian dominion or the Northwestern South American dominion. The Napo and the Northwestern South American

dominion (except Choco and Cauca provinces) are more related to the Amazonian and Chacoan Subregions than to the Choco and Cauca. The Provinces of Choco (Panamá, Colombia), Cauca (Colombia) and the Parana forest (southern Brazil) were independent of each other, showing no relationship between them or with other groups. In turn, these two provinces are more related to the Parana Forest province of the Parana Subregion than to the Mesoamerican dominion from Mexico to Panama. As was predicted from the raw data, the dendrogram clustered a Mesoamerican dominion containing the Provinces of Mexican Gulf, Mexican Pacific coast, Chiapas, Eastern Central America, and Western Panamanian Isthmus (Morrone 2006). The Mesoamerican dominion forms an independent group from the rest of the distribution of *Procrystocerus* in South America. Finally, the Brazilian Atlantic Forest province of the Parana Subregion showed no relationship with any other grouping.

The Napo province in the Amazonian subregion between northern Peru, southwestern Colombia, and Eastern Ecuador constitutes a unique biogeographical area. The province did not show a strong affinity to the rest of the Amazonian basin (Fig. 73). In this study 8 species are recorded from this province, including 5 new species only present in the area. This high endemism suggests that the Amazon is largely unexplored with regards to the *Procrystocerus* species.

The separation of Choco (Panama, Colombia, Ecuador) and Cauca (Colombia, Ecuador) in the dendrogram is due to the few species shared with other areas (endemism) and the new species. Four out of 10 endemic species were found in Cauca and 2 out of 5 in Choco. Most localities of Cauca are located at higher elevations than those of Choco (Fig. 71).

On the other hand, the Parana Forest is the third richest area in *Procryptocerus* with 12 species, after the province of Western Panamanian Isthmus containing 13 species. The Parana Forest contains a remarkable endemism of 6 species. This endemism separated this area from others. Distributional patterns found by Morrone (2003) for the decapods Trichodactylidae and by Nihei and De Carvalho (2005) for the flies *Polietina* (Muscidae) are congruent with the classification of Morrone (2006) considering the Amazonian, Chacoan and Paraná subregions, and the biogeographic boundaries between the three subregions.

Amorim and Pires (1996) consider north-west Amazon related to Mesoamerica, and south-east Amazonia to the Atlantic Forest. Nihei and de Carvalh (2007) consider Amazonia as a composite area agreeing with Amorim and Pires (1996) interpretation in which northwest Amazonia is closely related to the Caribbean subregion, whereas southeast Amazonia is closely related to the Chacoan Paraná. Accordingly, Nihei and de Carvalh (2007) propose the classification of the Neotropics into the following 5 subregions: Caribbean, north-west Amazonia, southeast Amazonia, Chacoan and Paraná.

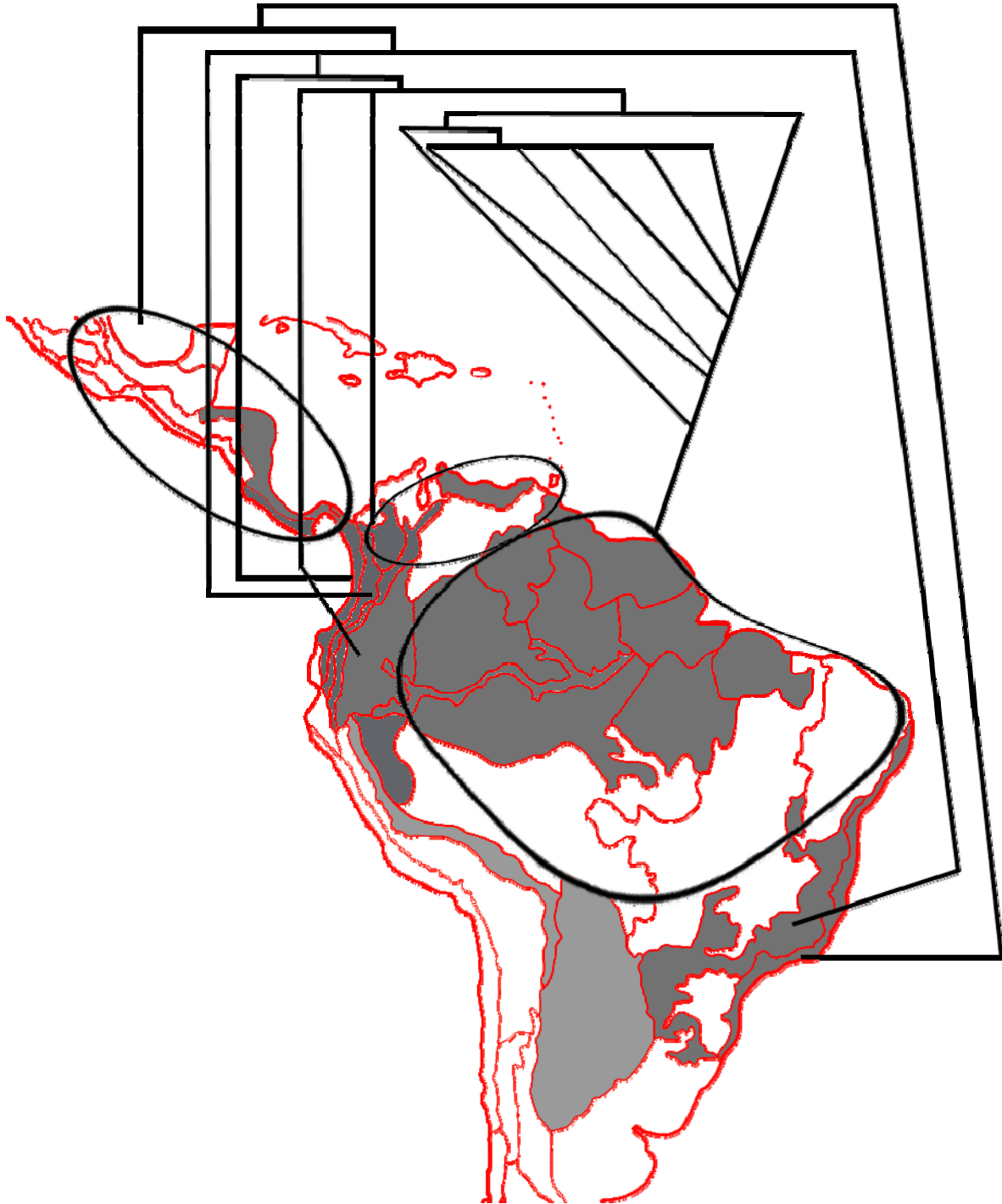


Figure 73. Area relationships of the ant genus *Procryptocerus*, based on the cluster analysis.

Discussion.

I examined the distribution of *Procryptocerus* using the raw distributional data without regards to Chorology (the explanatory processes). Higher concentrations of species of *Procryptocerus* in regions such as Costa Rica, Napo, and southern Brazil in the Parana Forest and Brazilian Atlantic Forest (Table 2) are probably an artifact of comparatively better collections in those areas. Richness is the most common measure of species diversity because it is relatively easy to compile (Lamoreux et al. 2005). The richest provinces are Western Central America (13 species), Cauca (Colombia) (10 species), Magdalena (Colombia) (7 species), Napo (8 spp.) (Ecuador, Colombia), Parana Forest (Brazil) (12 species), and Brazilian Atlantic Forest (17 species).

For the rest of the provinces few species of *Procryptocerus* have been recorded. Mainly two reasons account for these lack of records. Few collections have been done in those areas, and the largest areas such as Chaco, Pantanal, Cerrado, or Caatinga in the Central-southern Brazil consist of mosaics of open savannas with patches of low (shrubs) and high vegetation, or xerophytic vegetation (Costa 2003). Species of *Procryptocerus* live in trees (Table 3). The Caatinga of northeastern Brazil consists of heterogeneous arid and semi-arid formations surrounded by more mesic phytogeographic formations. The isohyets averaged 800 mm from approximately 3° to 16° south latitude and from 35° to 45° west longitude. The total area encompasses 650000 Km².

The general distribution of *Procryptocerus* (Fig. 68) and the arboreal beetles *Agra* (Coleoptera: Carabidae, sections *Erythropus* and *Feisthanmeli*) (Erwin and Pogue 1988: 166, fig 2) are remarkably similar. Both groups contain similar gaps of collecting records in the savannas of

Venezuela and Colombia, the southern Amazon and the southern savannas (Cerrado and Caatinga) in southern Brazil. Higher numbers of species in both groups show coherent components in Central America, Northern Andes of South America, Northern Amazon basin and Parana Forest and Brazilian Atlantic Forest. In both groups the defined biogeographical components are considered an artifact of few collecting records (Erwin and Pogue 1988, and this study). More collections of *Procryptocerus* are necessary to support or reject these patterns of distribution.

The analysis of distributional data produced northward and southward components that overlap in northwestern South America. The overlapping region harbors elements distributed in Central America, Amazon and Southern Brazil. There are unique faunas in the north and south forming several subcomponents. This study discriminates the followings: Mesoamerica, Northern-South American Andean, Northern Amazon, Parana Forest, and Brazilian Atlantic Forest.

In historical biogeography, questions regarding areas of endemism and their relationships are considered the most elementary issues (Nelson and Platnick 1981). Any consistent analysis of area relationships requires areas of endemism to be a priori defined from the raw data. An endemic area indicates that common factors have caused speciation processes in the different groups, but knowledge of the factors is not a necessary to identifying the existence of the area of endemism itself (Szumik et al. 2002). If endemic areas are delimited by the coincidence of several taxa found nowhere else, the endemities shown in table 1 sustain the following provinces of Morrone (2006). Western Panamanian Isthmus (*P. eladio*, *P. kempfi*), Cauca

(FS04, FS06, *P.carbonarius*, *P. ferrerii*), Choco (FS07,FS12), Magdalena (FS01, FS08), Napo (FS20, FS28, FS31, FS33, FS39), Yungas (FS37, *P. balzani*), Ucayali (FS35, FS36), Brazilian Atlantic Forest (*P. convergens*, *P. curvistriatus*, *P.gibbosus*, *P. lenkoi*, *P. montanus*, *P. sampaioi*, *P.shmalzi*, *P. seabrai*, *P. sulcatus*, *P. victoris*. FS16, FS21, FS22, FS34), and Parana Forest (*P. adlerzi*, *P. goeldii*, *P. lepidus*, *P. regularis*, FS14, FS19).

In the analysis of areas of endemism, usually conflicting general patterns emerge with respect to the history of those areas, thus reflecting a complex history of that biota (Cracraft 1988). Conflicting methodologies showing different relationships of areas in the Neotropics suggest that simple methodologies combined with direct analysis of data can reflect congruent relationships. The similarity index is taken as the proportion of the biota of an area that is shared with another area, a proportion that is measured directly by the Jaccard coefficient. The species are recorded as present or absent in each area, and the resulting matrix is used to compute the similarities among areas. These similarities are then used to cluster the areas (Linder 2001). The cluster analysis on Fig. 73 suggests consistent biogeographical subcomponents in Mesoamerica, Northwestern-South America and Amazon-South Brazilian savannas. Higher endemities in the areas separated from clustering the provinces of Choco, Cauca, Napo, Parana Forest and Atlantic Forest. This arrangements need to be corroborated with more data.

The association of *Procyonotus* species to woody plants is clear (Table 3). For Central America and Northern South America, collections should be focused on canopy vegetation or fallen branches of woody plants of the genera and species recorded on Table 3. Explorations are

required for new vegetation especially for the entire biogeographical southward component depicted in Fig. 69. Distributions of many of these plant species appear to be limited by humid conditions in the rain forest. Hodkinson (1989) calls for the attention that should be paid to host-specific arboreal insects. These groups are particularly interesting because their evolution is often intimately joined to that of their host-plants and it might be clarified a measure of concordance between plant and insect (Hodkinson 1989).

Apart from important collections carried out in Costa Rica by J. Longino and the southern Brazilian Parana Forest and Atlantic Forest, the knowledge of *Procryptocerus* is meager. Intensified collections are necessary everywhere. Finding nests and their associated plants are important to recognize patterns biology and patterns of distribution. Although most species have been collected in lower elevations from below 1300 m, neither low nor high elevations from over 1700 can be considered the richest habitats for *Procryptocerus* spp. It has been emphasized that for different biotas every montane forest in the neotropics is substantially different from all others (Kelly et al. 1994).

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Appendix 3.1. Matrix between Morrone's (2006) provinces and present (1) or absent (0) of *Procryptocerus* spp. in those provinces.

	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	2	2	2	2	2	2	3		
Sca	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
FS02	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Bel	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Imp	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
FS03	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Pic	0	0	1	1	0	1	1	1	0	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1
Att	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	
Bat	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Cor	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Ela	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Kem	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Nal	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
Hyl	0	0	1	0	0	1	1	0	0	1	0	0	1	1	0	0	1	1	0	1	1	1	1	1	0	0	1	1	1	1	
FS29	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Vir	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
FS04	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

FS06	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Car	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Fer	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
FS07	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
FS12	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
FS01	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
FS08	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Hir	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0
Spi	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Gra	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0
FS20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS28	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS33	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS39	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS30	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Bal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Ele	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0

FS35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
FS36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Con	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
FS15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
FS14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
FS18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Reg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
FS19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Goe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Lei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Sch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
FS16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
FS17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
FS21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
FS22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
FS34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Adl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Cla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Mon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Sea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Con	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Gib	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Vic	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Appendix 3.2. Distribution of *Procryptocerus* spp. by countries.

SPECIES		PROVENCE	BELIZE	MEXICO	GUATEMALA	HONDURAS	EL SALVADOR	NICARAGUA	COSTA RICA	PANAMA	COLOMBIA	TOBAGO	VENEZUELA	GUYANA	SURINAM	FRENCH GUA.	ECUADOR	PERU	BRASIL	BOLIVIA	PARAGUAY	ARGENTINA
1	<i>P. adlerzi</i>	Par, Atl.For.																	BR A			
2	<i>P. attenuatus</i>								COS	PAN	CO L			GU Y		SUR	GUF U	EC PER	BR A	BO L		
3	<i>P. balzani</i>																	PER		BO L		
4	<i>P. batesi</i>								COS	PAN	CO L											
5	<i>P. belti</i>		BEL	MEX		HON		NIC	COS	PAN	CO L						EC U					
6	<i>P. carbonarius</i>										CO L											
7	<i>P. clathratus</i>																		BR A			
8	<i>P. convergens</i>																		BR A			
9	<i>P. convexus</i>																		BR			

22	<i>P. lenkoi</i>								BR A
23	<i>P. lepidus</i>								BR BO A L
24	<i>P. marginatus</i>				CO L				BR A
25	<i>P. mayri</i>		COS		CO L	VEN		EC U	BR PERA
26	<i>P. montanus</i>								BR A
27	<i>P. nalini</i>		COS						PER
28	<i>P. paleatus</i>	MEX			CO PAN L				
29	<i>P. pictipes</i>		COS	PAN	CO L	TRI	GU VENY	EC U	BR BO PERA L
30	<i>P. regularis</i>				CO L	TRI			BR A PA R ARG
31	<i>P. rudis</i>				CO L				
32	<i>P. sampaioi</i>								BR A
33	<i>P. scabriusculus</i>	BEL MEX GUAHONELS	COS		CO L	VEN			BR A

34	<i>P. schmalzi</i>								BR A
35	<i>P. schimitii</i>					VEN			BR A
36	<i>P. seabrai</i>								BR A
37	<i>P. spiniperdus</i>			CO L	TRI	GU Y		EC U	BR PERA
38	<i>P. subpilosus</i>				TRI	GU Y		EC U	BR PERA
39	<i>P. sulcatus</i>								BR A
40	<i>P. tortuguero</i>		COS	CO L					
41	<i>P. victoris</i>								BR A
42	<i>P. virgatus</i>			CO L				EC U	PER
43	FS01			CO L					
44	FS02		COS						
45	FS03		COS						
46	FS04			CO					

			L		
47	FS06		CO L		
48	FS07		CO L		
49	FS08		CO L		
50	FS012	COS	CO L	EC U	
51	FS014				BR A
52	FS015				BR A
53	FS016				BR A
54	FS017				BR A
55	FS018				BR A
56	FS019				BR A
57	FS020			EC U	

58	FS021				BR A
59	FS022				BR A
60	FS028				EC U
61	FS029		PAN	VEN	
62	FS030			VEN	
63	FS031				EC U
64	FS033		CO L		
65	FS034				BR A
66	FS035				BO L
67	FS036				BO L
68	FS037				PER
69	FS039				EC U

Vita

Francisco J. Serna-C.

Biological Sciences

Francisco Serna earned his Bachelor of Agronomy Engineering from Universidad Nacional de Colombia (UNAL) in 1994. He received his Master of Science degree in Entomology in 1999 from Universidad Nacional de Colombia. In 2005 he joined the doctoral program in Biological Sciences at The University of Texas at El Paso (UTEP).

Francisco Serna has been the recipient of numerous honors and awards such as the Meritorious Master Thesis, the UNAL Research Groups Award in 2000, the Colciencias-Laspau-UNAL Scholarship for doctoral studies, and the Dodson Fellowship from UTEP.

While pursuing his degree, Dr. Serna worked as an Assistant Instructor for the Biology department at UTEP. His research includes with insect biodiversity, morphology and taxonomy. He has published five papers since his enrollment at UTEP in 2005, and a total of 31 papers during his career.

Dr. Serna's dissertation entitled, "Revision of the ant genus *Procryptocerus* (Hymenoptera: Formicidae: Myrmicinae: Cephalotini)" was supervised by Dr. William P. Mackay.

After graduation, Dr. Serna will return to Colombia where he is a faculty member (associate professor) at UNAL, Bogotá, and the leader of the Grupo Sistemática de Insectos Agronomía (SIA), which includes some other members from the Biology department at UTEP as well. Dr. Serna is also the founder and curator of the Museo Entomológico Universidad Nacional Agronomía Bogotá (UNAB).

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This dissertation was typed by Dr. Francisco Serna.