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NEOCORDULIA CAMPANA SPEC. NOV., A NEW SPECIES OF DRAGONFLY FROM PANAMA (ANISOPTERA: CORDULIIDAE)

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N. campana sp. n. is described and illstrated from male and female specimens (holotype ♂: Panama, Prov. Panama, Cerro Campana, 18 May 1979; allotype ♀: same data but 14 May 1979; both deposited Florida State Collection of Arthropods [FSCA], Gainesville, Florida), all taken at Cerro Campana, Panama. Distinctive characters of the sp. are compared to those of all other known spp. of *Neocordulia*. Brief notes on ecology and behavior are also provided.

INTRODUCTION

The genus *Neocordulia* is, like most Neotropical Corduliidae, very poorly known. GEIJSKES (1970) reviewed and fully diagnosed the regional genera, including *Neocordulia,* but did not provide species descriptions for the latter. Since the descriptions by SELYS (1871, 1874), only MARTIN (1906) attempted to treat the genus as a whole. Subsequently, species have been described by CALVERT (1909b), RACENIS (1970), and SANTOS (1967a, 1967b).

In 1974 MLM made a brief collecting trip to Cerro Campana, a mountain located a short distance west of the Panama Canal in the Republic of Panama. Among numerous other Odonata species, a male and a female corduliid were collected that proved to belong to an apparently undescribed species of *Neocordulia.* Three additional specimens were collected independently a few days later at the same locality by R. McManaway and given to KWK who deposited them in the FSCA. Several years thereafter, KWK visited the site and obtained several more specimens of both sexes. Together these from the basis for the following description.

The species is named for the beautiful and fascinating site where it was collected. *"Campana"* means *"bell"* in Spanish and refers to the bell-like shape of the mountain as seen from a distance.

TERMINOLOGY AND METHODS

Terminology for the caudal appendages follows SNODGRASS (1954), for the penis BORROR (1942), and for the accessory secondary genitalia TILLYARD (1917). Wing veins are named according to RIEK & KUKALOVA-PECK (1984), as their system is best supported by fossil evidence, but alternative designations following the more familiar Tillyard-Fraser system (TILLYARD & FRASER, 1938-1940) are given in parentheses; the terms costa and subcosta retain their usual meaning.

All measurements are in mm. Those given to 0.5 mm were made with a mm ruler while those given to 0.01 mm were made using a filar micrometer. Illustrations are modified from drawings made with the aid of a Wild® stereo microscope equipped with a camera lucida.

NEOCORDULIA CAMPANA SPEC. NOV.

Figures 1a-b, 2a, 3a-b, 4a

Material — **Holotype:** ♂ (No. 106), Panama, Prov. Panama, Cerro Campana, 8°41'N, 79°55'W, 18 May 1979, coll. by K.W. Knopf; — **Allotype:** ♀ (No. 113), same data as holotype except 14 May 1979; — **Paratypes:** (11 ♂, 6 ♀, all Panama, Prov. Panama, Cerro Campana) 7 ♂ (Nos 101-105, 107, 108), 3 ♀ (Nos 116-118), same data as holotype; 2 ♀ (Nos 114, 115) same data as allotype; 3 ♂ (Nos 109-111), 5 June 1974, coll. by R. McManaway; 1 ♂ (No. 112), 1 ♀ (No. 119), 27 May 1974, coll. by M.L. May.

All specimens are preserved dry in clear plastic envelopes. The holotype, allotype, and paratype Nos 109 and 110 are deposited in the Florida State Collection of Arthropods (FSCA), Gainesville, Florida. Paratypes Nos 101-104 and 114-117 are in the collection of K.W. Knopf, Nos 105, 112, and 119 in the collection of M.L. May, No. 108 in the collection of S.W. Dunkle, Nos 107 and 118 in the U.S. National Museum, and No. 111 in the collection of the International Odonata Research Institute, Gainesville, FL.

DESCRIPTION

Holotype ♂. — Dimensions: total length 55.5; — abdomen including cerci, 41.5; — cerci 2.52; — epiproct 2.25; — forewing 36; — hindwing 35; — pterostigma, fw 2.41, — hw 2.57; — metafemur 6.5.

Head: Labium, maxillae, and mandibles yellow-brown to light orange-brown, maxillae and mandibles dark red-brown at tips; apical incisor tooth of each mandible elongate and bifid. Labrum, clypeus, and frons dark red-brown, without any metallic blue, median stripe about 1/4 width of labrum and ventral margin of clypeus black; vertex nearly black with slight reddish cast. Frons with deep, median fissure dividing anterior surface into pair of flat, eccentric oval or subtriangular facets, the latter distinctly rugose. Vertex smoothly convex. Antennae black, ocelli amber. Entire face covered with moderately dense, dark setae. Compound eyes beige to whitish due to acetone preservation (probably metallic green in life), in contact at midline for 1.25 mm, each with distinct protuberance

along posterior margin. Dorsal occiput very dark brown marginally, paler centrally, strongly convex rearward. Posterior surface of head black or dark brown and shining dorsally and centrally, dark yellow-brown in ventral 1/2, with weak carina just behind dorsolateral margin of eye.

Thorax: Prothorax obscured by head and legs, apparently similar to that paratypes described below. Pterothorax dark brown with slightly reddish cast, and with metallic green reflections on principal sclerites (some faint purplish on mesepisternum), strongest near center of sclerite, absent on sutures and carinae, very weak on mes- and metinfraepisterna. Venter lighter brown, not metallic. Coxae and trochanters concolorous with adjacent thorax, remainder of legs black. Metafemora with numerous, scattered denticles on flexor surface, but with setae few, small, and confined to distal 1/2 of inner surface, except one long, stout, subapical seta (or spur?) on anterolateral surface; metafemora with two rows of stout setae and more numerous small setae as well as denticles, and with short, stout, subapical spine (no large seta) on anterolateral surface; profemora similar to mesofemora but with denticles nearly obsolete and with subapical tuft of slender setae as well as two stout setae on anterolateral surface; tibiae with typical armature. Tibiae all keeled, keels with length relative to respective tibiae as follows: protibiae, 0.35; mesotibiae, 0.078; metatibiae, 0.81. Pterothorax almost entirely clothed with fine, mostly yellow setae, longest near anterior portion of mesepisterna but absent on crescentic area just behind anterior carina of latter.

Wings: Wing membranes hyaline with very faint yellowish tint in anterior 1/2; veins and pterostigmata very dark brown to black. Nodus at 0.54 distance from base to apex of forewings, at 0.40 of hindwings. Antenodal crossveins 12 in forewings, 7 in hindwings, postnodals 10 in forewings, 11 and 14 in hindwings. First postnodal cell between RA (R_1) and RP_1 (R_2) 0.33 distance from nodus to pterostigma. Pterostigmata about 4 times as long as wide. Arculus at or slightly proximal to 2nd antenodal crossvein. Bridge crossveins 2 in forewings, 2 and 3 in hindwings. Forewings with veins RP_{3+4}(R_{4+5}) and MA moderately undulate, with two cell rows for the length of 4 or 5 cells at wing margin and thus slightly but distinctly divergent distally; MA and MP (CuP) nearly parallel for most of their length but slightly divergent near wing margin; trigonal interspace with two cell rows except with three for a length of 3 or 4 cells at wing margin. Trigonal interspace of each hindwing with two cell rows for a distance of 6 cells distal to triangle except with a single through cell adjacent to left triangle. Anal loop extending distad to or just beyond level of basal fork of RP (Rs), consisting of 13 cells on right side, 14 on left; anal field of each hindwing with 3 parallel cell rows as far as toe of anal loop. Anal margin of wing with distinct excavation, anal angle narrowly rounded rather than acute; anal triangle 2-celled; membranule short, grey-brown. Other venational features as described for genus by GEIJSKES (1970).

Abdomen: Segment 1 brown with reddish cast except diffuse black area on

apical 1/2 of dorsum and on posterior carina. Segment 2 brown with reddish cast except dorsum mostly black, margins of black area indistinct; auricles smooth except for shallow, oblique, ventrolateral furrow, also with ventroapical tuft of setae. Segment 3 slightly constricted at about 1/3 its length, dark brownish on ventrobasal area, otherwise black. Remaining segments black with very narrow, tan or reddish brown lines along ventromedial and often on apical or ventroapical margins of tergites. Lateral carinae absent, dorsal carinae present on segments 7-10; supplementary transverse carinae on 2 at about 1/3 length, ending at auricles, on 3 slightly proximal to 1/2 length, on 4-6 at about 2/5 length, and on 7 at 1/4 length; vestigial carina apparent laterally at about 1/6 length of 8. Segments 1, 2 and base of 3 moderately inflated, 6-9 gradually increasing in diameter from anterior to posterior, so abdomen weakly clubbed but not dorsoventrally flattened; segment 10 higher than long, with distinct, narrow, middorsal keel (Fig. 1a-b). Pale setae present, long on dorsum of segments 1 and 2, shorter on lateral surfaces of segment 1 and base of 2, very short and nearly invisible on terga of 3-6 and only slightly more evident on 7-10.

Cerci, epiproct, and associated structures as shown in Figure 1a-b. Cerci somewhat inflated distally and nearly straight, without teeth or other processes or distinct angulations but with obtuse dorsal swelling at 3/4 length, slightly longer than epiproct and a little shorter than abdominal segments 9 and 10 together; very dark brown in color with numerous long, dark setae, especially in apical 1/3.

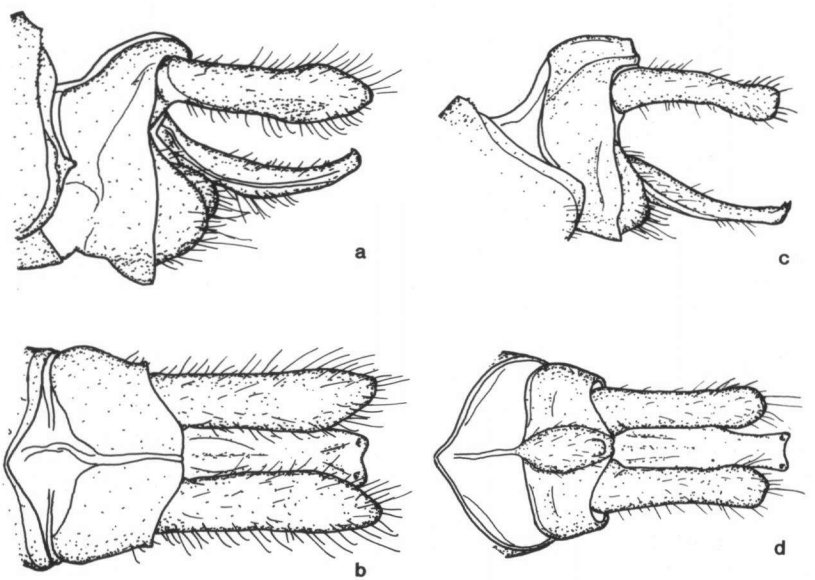

Fig. 1. Male terminalia and tenth abdominal segment: (a) Left lateral view, *N. campana;* — (b) Dorsal view, *N. campana;* — (c) Left lateral view, *N. longipollex;* — (d) Dorsal view, *N. longipollex.*

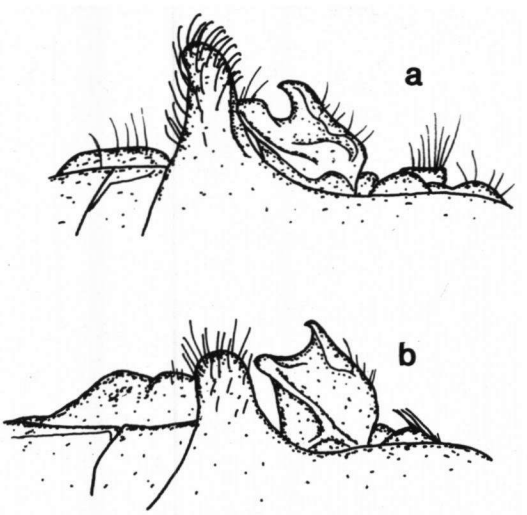

Fig. 2. Male hamules and associated structures, left lateral view, ventral side up, anterior to right: (a) *N. campana;* — (b) *N. longipollex.*

Epiproct curving upward in profile, with small, dorsal tooth at each distal corner, roughly trapezoidal in ventral view, lateral margins convex basally, straight and convergent in distal 1/2, apex distinctly emarginate; numerous long, dark setae, especially on ventrobasal surface.

Hamules and associated structures as shown in Figure 2a. Anterior lamina low but visible in lateral view. Hamule distinctly bifid in lateral view, with dorsal and ventral arms separated by U-shaped cleft, and with small, anterobasal tubercle. Genital lobe extending well beyond hamule, covered with dense, stiff, dark setae, especially at apex, causing latter to appear acute or slightly hooked.

Penis extruded, terminal segment essentially as in Figure 3a. Sclerotized ventral shelf bifid, each branch semi-elliptical in ventral view. Lateral lobes small, subtriangular, membranous. Median process long (base of flagellum far distad of apex of ventral process), gently curved, dark and sclerotized for most of length, terminating in a long, slender, dorsal flagellum that is lightly sclerotized basally, becoming very thin and apparently membranous and flexible distally; large, falcate, membranous projection extending ventroapically from median process at level of base of flagellum. Basal lobe apparently absent.

Allotype ♀. — Dimensions: total length 53; — abdomen including cerci and paraprocts, 40.5; — cerci 1.17; — vulvar lamina 0.29; — forewing 39; — hindwing 38; pterostigmata, fw 2.41, hw 2.60; — metafemur 6.5.

Head and thorax: Nearly identical to male except as noted. Labrum with dark median band less distinct. Eyes steel grey (not acetoned), in contact at midline for 1.14 mm. Pterothorax with metallic green reflections slightly less pronounced. Tibiae without keels. Femora very dark brown, shading gradually to black apically; metafemora with slender, sparse setae full length of internal angle; mesofemora with single, stout, subapical seta, as on metafemora.

Wings: Similar to holotype except as noted. Entire membrane faintly yellow, deeper yellow at base as far as arculus. Nodus at 0.51 distance from base to apex of forewings, at 0.38 of hindwings. Antenodal crossveins 12 in forewings, 6 and 7

in hindwings, postnodals 12 in forewings, 13 in hindwings. Arculus proximal to 2nd antenodal crossvein in all wings. Bridge crossveins 2 in all wings. Trigonal interspace of hindwings without through cells. Anal loop consisting of 14 cells on right side, 15 on left. Anal margin of wing smoothly rounded with very small, grey membranule.

Abdomen: Generally similar to male except for genitalia and form of segment 10; slightly compressed laterally postmortem. Segments 2 and base of 3 moderately swollen. Supplementary transverse carina weakly developed on segment 2, weakly present on segment 8 at about 1/6 segment length. Tergum of segment 10 0.58 mm at dorsal midline, 1.34 mm at ventrolateral margins, with posterior margin mostly concave; sternum of 10 1.69 mm, with sternite extending nearly to apex of paraprocts.

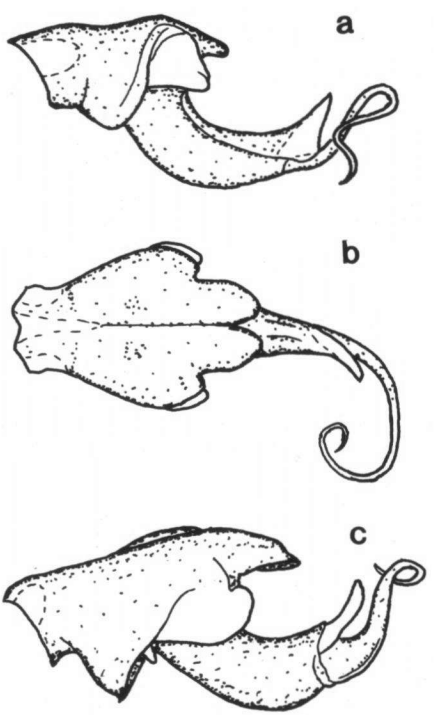

Fig. 3. Terminal segment of penis: (a) Left lateral view, ventral side up, *N. campana;* — (b) Ventral view, *N. campana;* — (c) Left lateral view, *N. longipollex* (ventral branch fully extended).

Cerci black, about as long as segment 9, roughly conical but in dorsal view curving distinctly outward in apical 1/3. Epiproct with distal margin slightly angulate medially, corners rounded, median carina present in basal 2/3; 1.04 mm along midline, extending about 2/3 length of cerci. Paraprocts broadly rounded distally, not quite extending to tips of cerci. Epiproct and paraprocts with dense, stiff, long, dark setae distally. Vulvar lamina 0.20 length of sternum of segment 9, with lobes more or less rounded apically, separated at base by cleft about 1/2 width of each lobe, and with long setae along apical margin; small sclerotized, laterally-directed papillae on sternum of segment 9 just beyond apex of vulvar lamina (Fig. 4a).

VARIATION AMONG PARATYPES

The specimens are, in general, quite uniform. Variation in quantitative characters is indicated in Table I. Slight differences in color appear to be attributable in part to age; based on the more glistening and fragile wings, Nos 112(♂) and 119

Table I

Summary of quantitative characters of *Neocordulia campana* specimens, including holotype and allotype. Continuous values (e.g. length) are given as mean (range), discrete values (e.g. vein counts) as mode (range). — [All lengths are in mm]

Character	Males (N=12)	Females (N=7)
Total length	54.4 (52-56.5)	52.9 (52-54)
Abdomen length	40.7 (39-42.5)	40.0 (38-41)
Cerci length	2.52 (2.26-2.70)	1.23 (1.17-1.29)
Epiproct length	2.27 (2.20-2.37)	1.07 (1.04-1.17)[1]
Vulvar lamina length	—	0.27 (0.21-0.37)
Vulvar lamina[2] ratio	—	0.17 (0.14-0.21)
Eye seam length	1.25 (1.17-1.34)	1.22 (1.14-1.29)
Hind femur length	6.5 (6.3-6.7)	6.6 (6.5-6.8)
Tibial keel ratio,[3]		
protibia	0.42 (0.35-0.52)	—
mesotibia	0.089 (0.072-0.098)	—
metatibia	0.80 (0.76-0.84)	—
Forewing length	35.6 (35-36)	38.6 (38-39)
pt. length[4]	2.24 (2.12-2.41)	2.33 (2.22-2.46)
p.n. space[5]	0.33 (0.30-0.36)	0.34 (0.32-0.36)
nodal ratio[6]	0.53 (0.51-0.54)	0.52 (0.51-0.53)
a.n. crossveins	13 (12-13)	13 (12-14)
p.n. crossveins	10 (10-12)	10 (10-12)
Hindwing length	34.6 (34-35.5)	37.3 (37-38)
width	11.2 (11-11.5)	12 (12)
pt. length[4]	2.37 (2.23-2.57)	2.46 (2.33-2.60)
nodal ratio[6]	0.39 (0.35-0.41)	0.39 (0.38-0.39)
a.n. crossveins	7 (7-8)	7 (6-8)
p.n. crossveins	14 (11-14)	13 (12-15)
anal loop cells	13, 15 (12-17)	15 (14-17)

[1] We consider the small, basally hinged sclerite at the posterodorsal margin of abdominal segment 10, between and slightly above the cerci, to be the epiproct.

[2] Ratio of length of vulvar lamina to length of sternum of abdominal segment 9.

[3] Ratio of length of tibial keel to length of corresponding tibia.

[4] Length of pterostigma, measured along costal margin, including marginal veins.

[5] Ratio of the length of first postnodal space between RA (R_1) and RP_1 (R_2) and the distance from subnodus to posterobasal corner of pterostigma.

[6] Ratio of distance from wing base to nodus to total wing length.

(♀) are probably the least mature specimens. Face may have dark area on labrum rather diffuse and indistinct, vertex red-brown but still darker than frons. Metallic areas of thorax sometimes slightly less extensive than in holotype, absent from mes- and metinfraepisterna.

Wings of males may be entirely hyaline, those of females faintly yellowish at

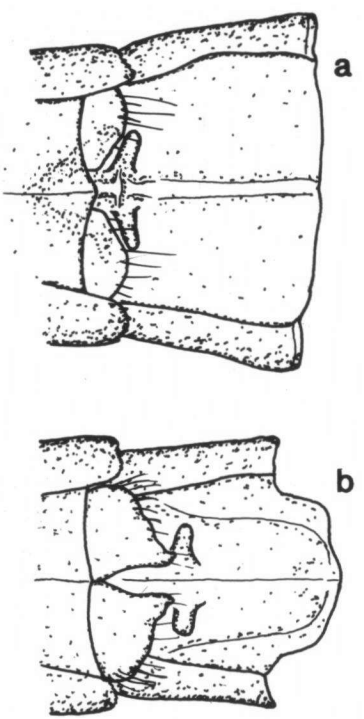

Fig. 4. Vulvar lamina and sternum of ninth abdominal segment of females, ventral view: (a) *N. campana;* — (b) *N. longipollex* (shape of ninth sternite due to postmortem distortion).

least between C and RP and more deeply tinted at least 1/2 distance to arculus. Arculus may be proximal to, even with, or occasionally very slightly distal to second antenodal. Bridge crossveins 2 in forewing except 3 on right side of ♀ No. 116, 2 or 3 in hindwings. In the forewing the space between RP_{3+4} and MA has 2 or 3 cell rows at the wing margin for the length of 4-7 cells, while the trigonal interspace has 3 or 4 rows at the margin for 2-7 cells. In the hindwing the trigonal interspace has two cell rows distad of the triangle for the length of 5-9 cells, except that 6 of 11 males and 2 of 6 females have at least one through cell adjacent to the triangle (♂ No. 103 with through cell each wing, No. 111 with 2 through cells in left wing). Anal field distally with a few columns only 2 cells wide in 3 males, so apex of anal loop may be separated from wing margin by 2 cells.

Anterior lobe of pronotum yellow or yellow-brown, remainder of prothorax brown; shallow, median groove along median lobe of pronotum; posterior lobe of pronotum not erect but somewhat produced rearward, trapezoidal with posterior margin straight or very slightly emarginate. Male No. 101 with epiproct very slightly longer (2.29 mm) than cerci (2.26), No. 107 with two subapical mesofemoral spines on right side. Female No. 119 with epiproct extending almost to tip of cerci.

DISCUSSION

THE SPECIES OF *NEOCORDULIA*

Eight species have heretofore been assigned to *Neocordulia: androgynis* (Selys), *batesi* (Selys), *biancoi* Racenis, *carlochagasi* Santos, *longipollex* Calvert, *luismoojeni* Santos, setifera (Selys), and *volxemi* (Selys) (DAVIES & TOBIN, 1985). We have examined the types of all species except *biancoi, carlochagasi,* and *luismoojeni,* and the original descriptions and illustrations of the latter three are sufficiently detailed to permit an unequivocal diagnosis. The type of *volxemi*

is female; CALVERT (1909a) described the male from specimens in the Museum of Comparative Zoology at Harvard University, which we have not examined. Again, however, the description and drawings permit accurate identification, assuming CALVERT (1909a) correctly associated these males with female *volxemi.* We have not seen females of *batesi* or *setifera;* they were described briefly by MARTIN (1906). The female of *longipollex* is undescribed, but specimens collected in the Caribbean lowlands of central Panama by Drs T.W. Donnelly and E.S. Morton very closely resemble male *longipollex* taken in the same region, and they are distinct from any known congeners. All these species are clearly distinct from campana.

SANTOS (1967a) referred his species *luismoojeni* very doubtfully to *Neocordulia,* and in fact it probably does not belong in that genus; it is radically different from any other species, including *campana,* in having: a single cell row in the forewing trigonal interspace; a yellow, lateral thoracic stripe; a pair of terminal flagellae on the penis; and reduced, unbranched hamules. Males of *campana* may be distinguished from all other species in having the genital lobe much longer than the hamule (Fig. 2a) and from all species except *batesi* and *longipollex* by: the cerci straight in lateral and dorsal view and lacking distinct teeth or angulations (Fig. 1a-b); the sternum of abdominal segment 8 without any sign of a protuberance or tubercle; the hamules clearly bifid in profile (Fig. 2a; in most species the hamular branches are clearly seen only in ventral view). *N. campana* is closest to *batesi* and *longipollex* but has: frons flatter and not metallic blue; cerci straighter and with a distinct, obtuse, dorsal swelling (Fig. 1); abdominal segment 10 with narrow middorsal keel (vs broad prominence; Fig. 1); hamular branches stouter and separated by a comparatively narrow U-shaped cleft (Fig. 2; in *longipollex* the ventral branch can flex relative to the dorsal, as in CALVERT's figure [1909b], but in the extended position the space between is much wider than in *campana*); penis with lateral lobes small and subtriangular, median process, excluding flagellum, extending beyond ventral shelf by 1/2 its length (vs lateral lobes large and rounded, median process extending beyond ventral shelf by distinctly less than 1/2 its length; Fig. 3); mesotibial keels very short (vs about 1/3 the tibial length); mesofemora with short, anteapical spines (stout setae as on metafemora in *longipollex* and in *batesi* type, spines in second *batesi* from Selys collection); RP_{3+4} and MA separated by two or three cell rows for the length of at least 4 cells at the wing margin, so distinctly divergent distally (vs 2 cell rows for 0-2, rarely 3, cells and RP_{3+4} and MA usually parallel or convergent); and usually epiproct shorter than cerci (vs equal or longer; Fig. 1).

Females are less easy to identify. Those of *campana* can be distinguished from: *androgynis* by the black costa (vs yellow), cerci black and outwardly curved (vs pale and straight), tibiae black (vs pale externally) first postnodal cell between RA and RP_1 0.34 distance from nodus to pterostigma (vs 0.46), thorax darker green; from *batesi* by lack of metallic blue on the frons and vertex, by lobes of vulvar

lamina widely separated basally (vs narrowly separated; GEIJSKES, 1970), and probably (by inference from males, see above) by the greater extent of 2 cell rows and consequent divergence between RP_{3+4} and MA near the wing margin; from *biancoi* by lack of metallic reflections on vertex and occiput, cerci black, vulvar lamina only 0.2 length of sternum of segment 9 (vs about 0.3) and with lobes not contiguous at base, and 2 cell rows between RP_{3+4} and MA for a distance of 4 or more cells near the wing margin (vs 1 or 2 doubled cells); from *longipollex* by characters given for *batesi* and by outwardly curved cerci (vs hardly curved) and vulvar lamina only 0.2 length of sternum of segment 9 (vs 0.32-0.41) with the lobes not contiguous at the base and not produced posteromedially to subacute tips (Fig. 4); from *setifera* by the thorax darker green, cerci curved outward, and probably (by interference from males) labrum dark medially, femora very dark brown shading gradually to black (vs medium brown in proximal 3/4, black in apical 1/4), and RP_{3+4} and MA divergent distally and with 2 cell rows for a distance of 4 or more cells near margin of hindwing (vs parallel and with only 1 doubled cell at margin of hindwing); and from *volxemi* by the costa black (vs yellow), pterostigma black and only about 2.5 mm long (vs yellow and 3.2 mm), vulvar lamina 0.2 length of sternum of segment 9 (vs about 0.3) and with lobes widely separated (vs very narrowly separated), and by absence of pale brown dorsal markings on abdominal segments 3-9.

BIOLOGICAL NOTES

Cerro Campana, at 990 m, is considerably higher than the range of hills immediately surrounding it, with the nearest mountain of comparable elevation, Cerro Gaital (Cerro Trinidad) about 20 km west; the nearest peak to the east is Cerro Jefe, about 85 km away. The collecting areas are a little below the summit, in mixed secondary forest and pasture, with several small streams and a boggy pond nearby. Presumably the *Neocordulia* emerged from one of these habitats, although persistent efforts by KWK to collect larvae were unsuccessful. Female No. 116 did later oviposit in the laboratory, and larvae have been reared from those eggs. All specimens of *N. campana* were collected while flying over trails and jeep tracks in light forest. Three females, including the allotype, were captured during overcast, but activity was clearly greater during sunny, warm weather.

RACENIS (1970) reported finding *N. biancoi* at riffles of small rivulets in cloud forest at about 1100 m; these presumably were the sexual rendezvous site, although he did not report matings. Otherwise, the only published reports known to us on any aspects of behavior or ecology of *Neocordulia* are CALVERT's (1909b) remark that the type of *N. longipollex* was taken in flight along a road in forest at about 300 m elevation, and the observations of Dr T.W. Donnelly (reported by MAY, 1979) of *longipollex* feeding at dusk along with *Gynacantha*

and *Triacanthagyna* in clearings on Barro Colorado Island, Panama. Our only personal observation of *longipollex* was of a single male specimen plucked by hand off vegetation by A. Worthington along the Rio Guanche, Prov. Colon, Panama and given to MLM; additional specimens have been taken by Drs T.W. Donnelly and E.S. Morton at the nearby Rio Piedras and Rio Agua Salud. These are all fairly large, rock and gravel-bottomed streams on the Caribbean slope, at no more than 300 m elevation.

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