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Carajathemis simone, new genus and species from Brazil (Odonata: Libellulidae).

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ABSTRACT

Carajathemis simone n. gen., n.sp. from the state of Pará, Brazil, is described and illustrated based on 22 specimens collected in a "canga" (laterite) lake within the forest at the Flona de Carajás, Parauapebas Municipality. The new libellulid genus fits in the subfamily *Sympetrinae* and the male keys out to *Erythemis* in Garrison et al. (2006). The new taxon has a combination of characters that makes it different from all genera of *Sympetrinae* including *Erythemis*. The species is remarkable by its large size, pleural striping and especially by the complex and strongly dimorphic leg armature. It seems to be restricted to shallow, rainfall-dependent, iron-rich lakes.

Key words: taxonomy, morphology, dragonflies, legs.

INTRODUCTION

Libellulidae is the largest family of Anisoptera with 1,012 known species in 143 genera (Kalkman et al. 2008). Kirby (1889) described 56% of the genera and laid the basis for the generic taxonomy of the family. Since then the number of genera continually increased until the end of the decade of 1950 when 90% of the presently accepted genera had been described. From then on, the erection of new libellulid genera occurred sporadically and only four genera have been erected in the Neotropical region in the last 65 years: *Nothodiplax*, *Elasmothemis*, *Garrisonia* and *Orionothemis*, respectively described by Belle (1984), Westfall (1988), Penalva and Costa (2007) and Fleck et al. (2009). Among the Odonata material that I received from Carajás, state of Pará, called my attention a very large and laterally striped libellulid collected in a "canga" (laterite) lake within the forest, clearly an undescribed genus and species. These new taxa are now described and illustrated, with special emphasis on its remarkably complex leg armature.

The finding of such a conspicuous and undescribed dragonfly nowadays shows how meager is our knowledge regarding Brazil's biodiversity, especially in the Amazon region.

Being very common in the lake from where they were collected and considerably visible due to its large size, *C. simone* seems to be especially suitable for ecological and behavioral studies, relatively scarce in dragonflies of the Amazon forest.

MATERIALS AND METHODS

Twenty males and two females collected in a small "canga" lake (laterite) in the Carajás forest were studied. Two specimens were acetoned and the remainder killed in potassium cyanate jars.

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All specimens are at the present in the A. B. M. Machado collection, and will be transferred to the collection of the Departamento de Zoologia, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte. Drawings were made with the aid of a camera lucida. For the scanning electron microscope study legs were mounted in aluminum stubs, sputtered with gold and examined in a Quanta 200 FEG, SEM. Abdomen length includes appendages; venation and color terminology follows respectivelly Tillyard and Fraser (1938), Kornerup and Wanscher (1967). Abbreviations: FW: forewings; HW: hind wings; S: abdominal segment(s).

TAXONOMY

Carajathemis gen. nov.

Type species. *Carajathemis simone* sp. nov.

Etymology. Named in reference to the Serra dos Carajás, a mountain chain in the Amazon forest of the state of Pará from which the type species has been collected.

Generic characterization. Large species (♂ HW, 42.1, Abd 38.2) with the pterothorax marked with alternating pale and dark stripes (Fig. 5). Compound eyes dorsally barely touching each other. Frons rounded with a slight medial furrow. Posterior lobe of prothorax erect, narrowed at the base (Figs. 3, 4) bearing a fringe of long hairs. Legs (Figs. 14-29) provided with a complex and strongly dimorphic armature; males with protibiae (Fig. 15, 27), pro and metafemora (Figs. 16, 18, 29) with hairs on dorsal surfaces; mesofemora of males with regularly spaced large modified spines closely-set in a row (Figs. 17, 26); distal 1/3 of male metafemora with three long and strong spines; females without dense hairy areas (Figs. 19-21) except on protibiae (Fig. 14). Venation (Fig. 6): last antenodal in FW incomplete; in HW complete. Ax in FW 17 (20%), 18 (60%), 19 (20%), in HW 13 (40%) 14 (40%), 15 (20%); Px in FW 13 (10%), 14 (60%), 15 (30%), in HW 15 (10%), 16 (70%), 17 (20%); triangles crossed (95%), subtriangle with 3 (90%) or 4 (10%) cells; arculus between Ax1 and Ax2, nearer to the Ax2; costal side of triangle in FW straight, 1/3 as long as proximal side; one bridge crossveins; nodus approximately in the middle of the wings; sectors of arculus arising by a fairly long common stalk; RP2 not undulate; Rsp1 and Msp1 well developed; radial and medial planates with two rows of cells for a distance of 3-6 cells, proximal side of triangle in HW coinciding with the arculus; discoidal field strongly widened distally in FW and HW; one CuA crossvein; anal loop well developed, foot-shaped, closed posteriorly and not extending to wing margin; MP in HW arising at anal angle of triangle. Female with sides of S8 not dilated and vulvar lamina not vertical (Fig. 12) occupying the anterior 1/4 of S9 (Fig. 13). Penis (Figs. 9a, 9b) with a pair of strongly esclerotized ventral process, in lateral view looking like a bird head (Fig. 9a).

Carajathemis simone sp. nov.

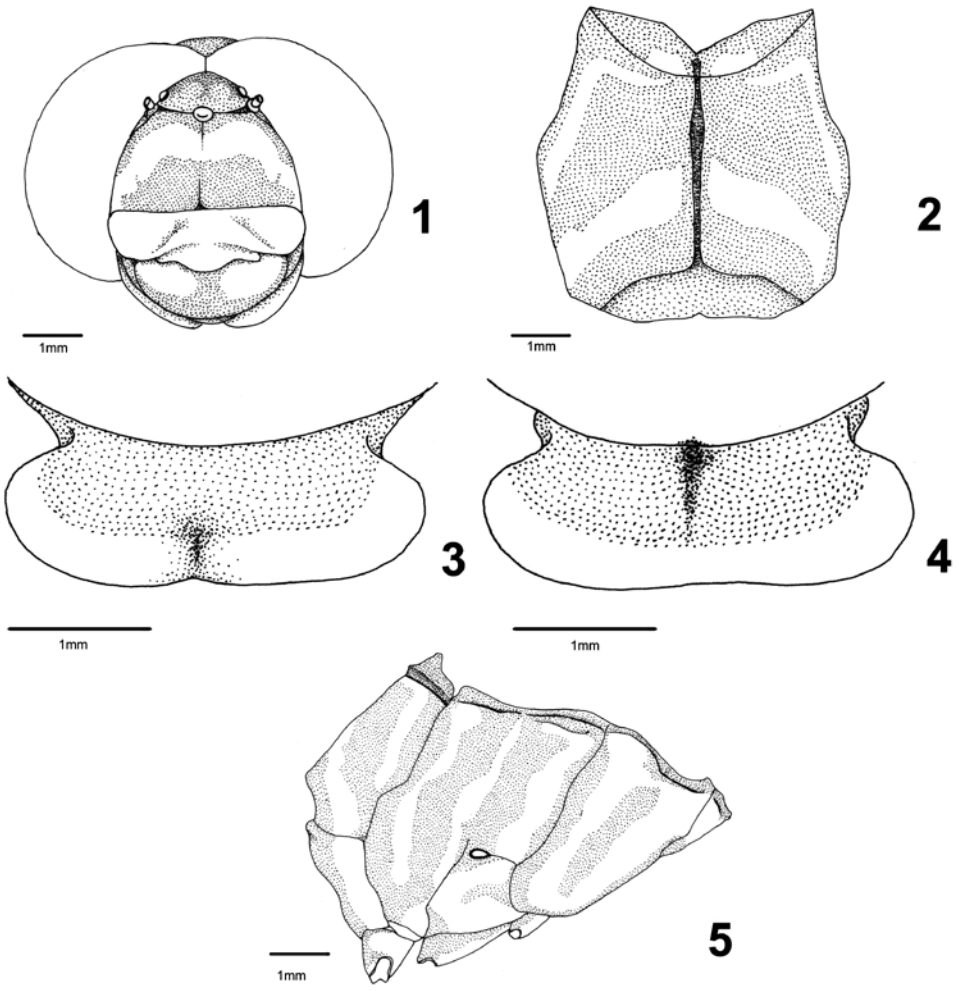
Type specimens: Brazil, Pará, Parauapebas, Floresta Nacional (Flona) de Carajás, (6° 03'S, 50° 03' W). Holotype male and Allotype female 12-XI-1994. Male paratypes: 3, 3-XI-1994; 3, 12-XI-1994; 5, 17-XI-1994; 3, 23-XI-1994; 3, 2-XII-1994; 1, 15-XII-1994; 1 female paratype 12-XI-1994, all Haroldo Lapertosa Junior and Simone Soares dos Santos leg.

Total 20 ♂ 2 ♀. All in A. B. M. Machado collection, Belo Horizonte, to be transferred to the collection of the Departamento de Zoologia, ICB, UFMG.

Etymology. - I dedicate this species to the biologist Simone Soares dos Santos who, together with her husband Haroldo Lapertosa Junior, collected the material of this outstanding species.

Description

Male (**Holotype**). - Color description based on the living holotype.



Figs. 1-5 - *Carajathemis simone* n. gen., n. sp. male holotype, head in frontal view **(1)** pterothorax in fronto-dorsal view **(2)**, hind prothoracic lobe in fronto-dorsal view **(4)** pterothorax in lateral view **(5)**. Female allotype hind prothoracic lobe in fronto-dorsal view **(3)**.

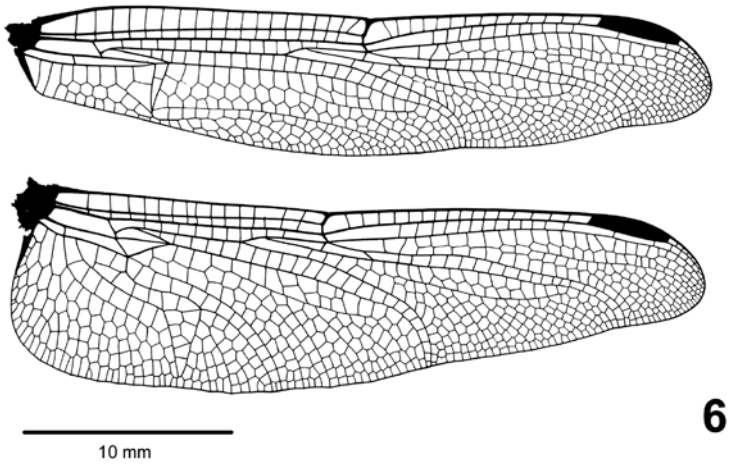
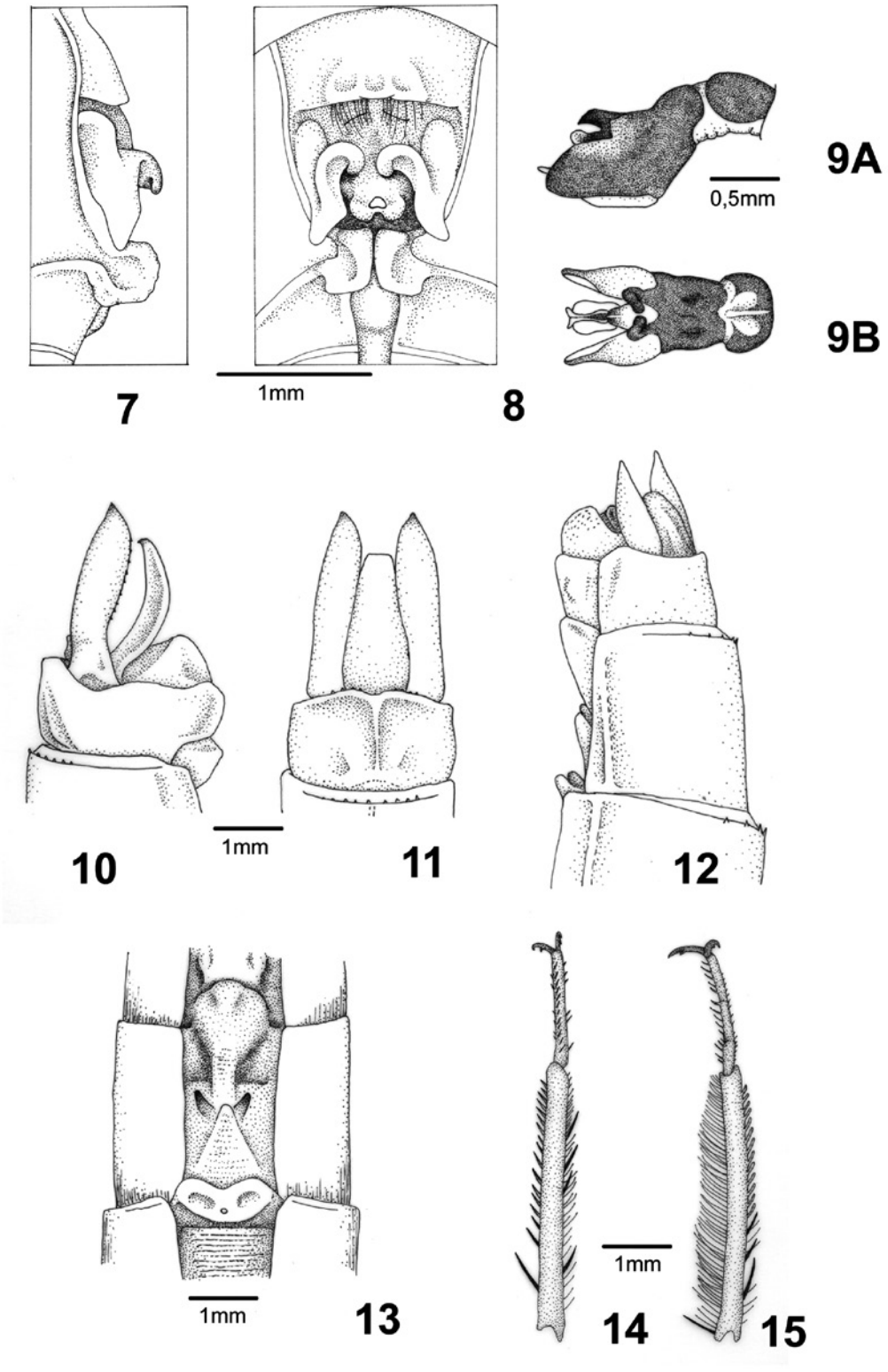
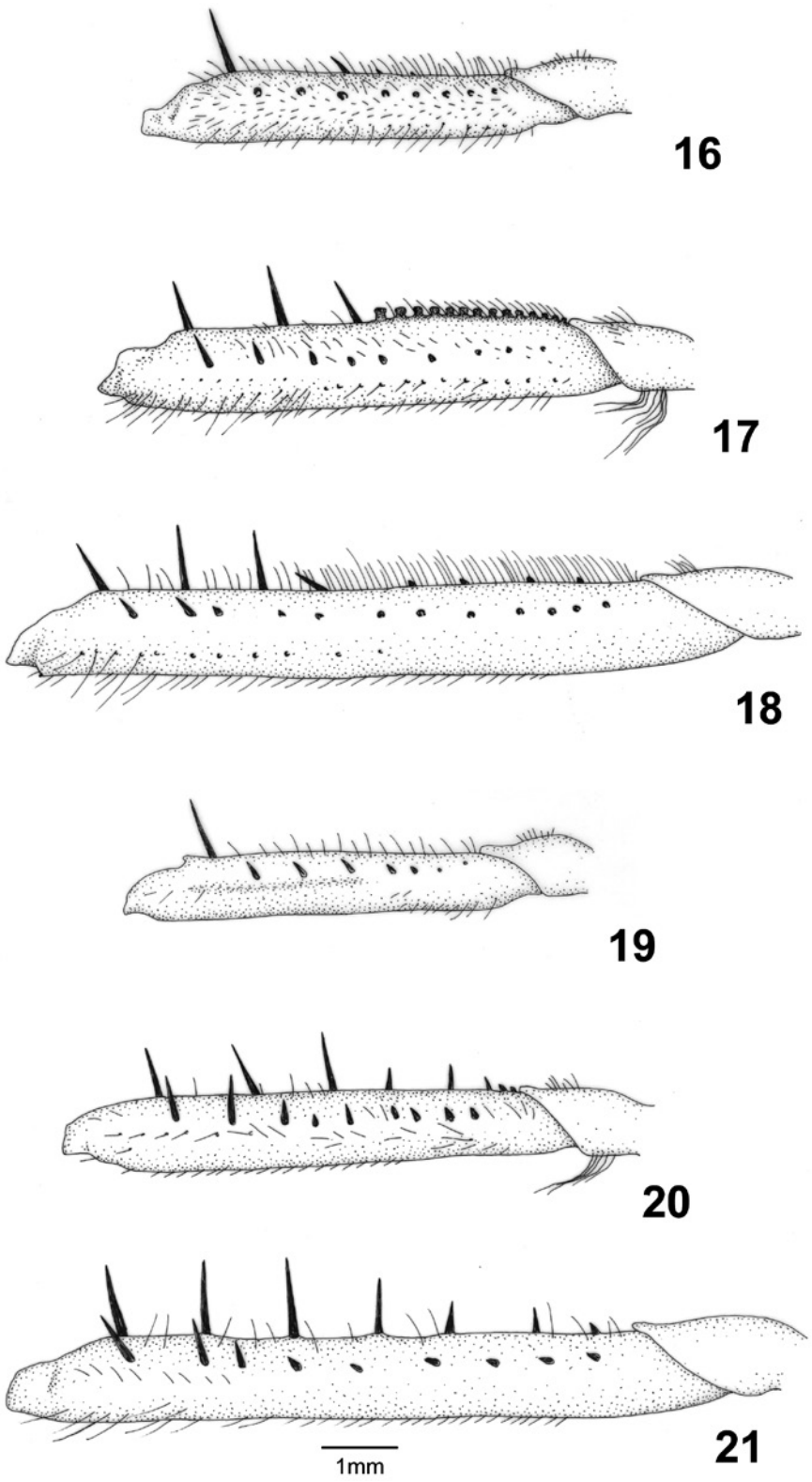


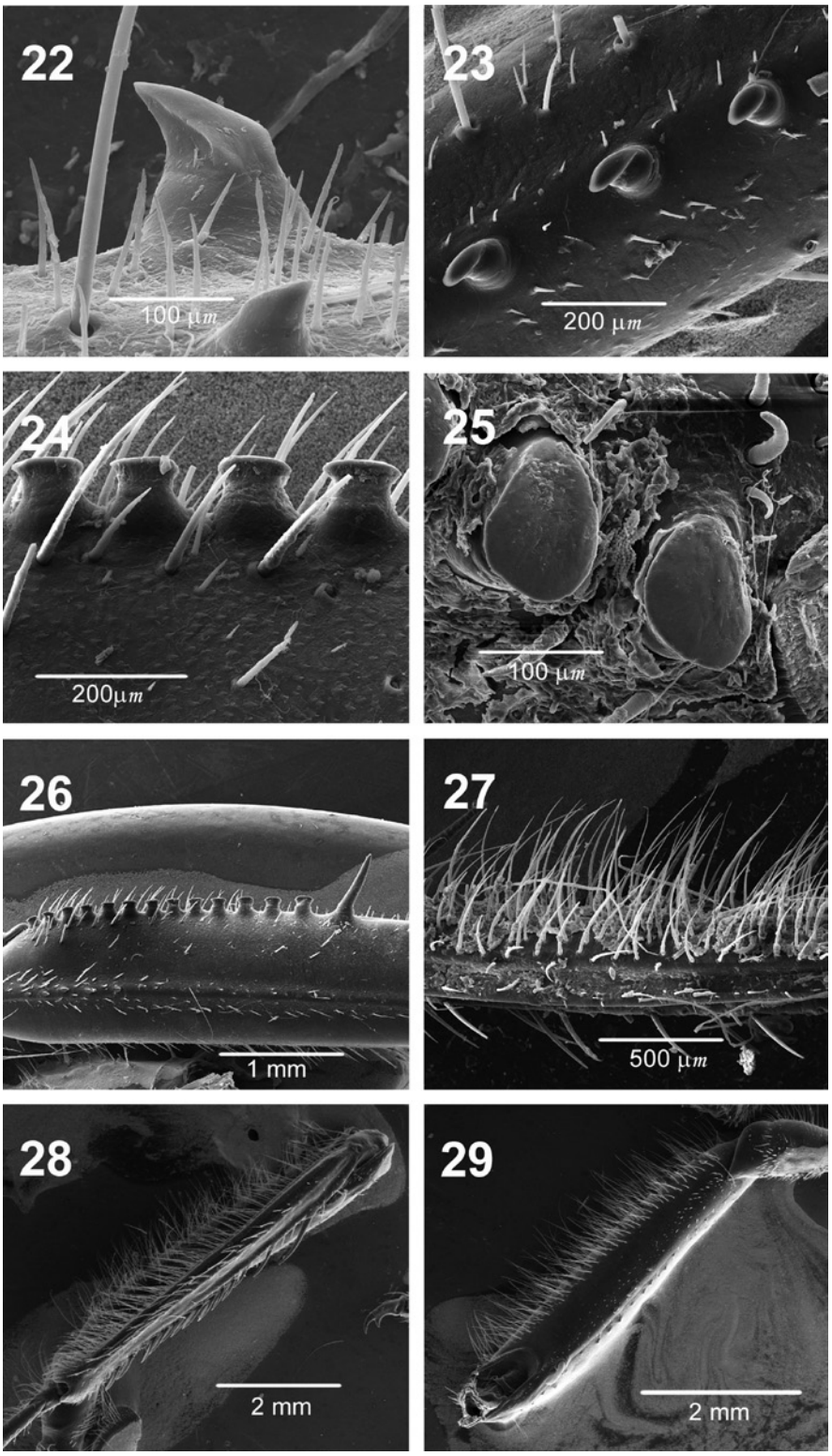
Fig. 6 - *Carajathemis simone* n. gen., n. sp. male paratype, wings.



Figs. 7-15 - *Carajathemis simone*, male holotype. Genitalia of S2 in lateral **(7)** and ventral **(8)** views, penis in lateral **(9a)** and ventral **(9b)** views; anal appendages in lateral **(10)** and dorsal **(11)** views. Female allotype, abdominal segments 9-10 in lateral view **(12)** segment 9 in ventral **(13)**, protibia and tarsus internal view **(14)**, male holotype, protibia and tarsus in internal view **(15)**.



Figs. 16-21 - *Carajathemis simone* n. gen., n. sp. male holotype, internal view of pro **(16)** meso **(17)** and meta **(18)** femora. Female allotype, internal view of pro **(19)**, meso **(20)** and meta **(21)** femora.



Figs. 22-29 - *Macrothemis imitans imitans* large modified spine in metafemur of male in lateral **(22)** and top **(23)** views. *Carajathemis simone* n. gen., n. sp. male paratype, large modified spines in mesofemur in lateral **(24)** and top **(25)** views. Row of large modified spines of mesofemur in lateral view **(26)**. Protibia **(27)**, protibia flexed against profemur **(28)**, metafemur **(29)**.

Head (Fig. 1) - Labium with median lobe black, lateral lobes greenish yellow with a narrow black stripe along inner margins. Labrum black with two large yellow lateral spots. Ante and postclypeus grayish green. Frons rounded with a distinct median furrow, its anterior part black, its dorsal part with a transverse grayish green band followed posteriorly by another black area up to the limits of vertex and eye. Vertex black, apex with two small rounded tubercles. Antennae dark brown, occiput yellowish brown, greenish yellow posteriorly. Eyes light green turning yellowish below, orbits greenish yellow.

Thorax. - Prothorax dark brown with two lateral spots and the rim of posterior lobe greenish yellow. Pterothorax black with a slight metallic copper luster and seven grayish green long stripes (Figs. 2, 5) turning into greenish yellow ventrally, disposed as follows (Fig. 5): 1. obliquely crossing the lower half of mesepisternum and continuing to the posterior part of mesinfraepisternum; (Fig. 2, 5) 2. near the upper half of humeral suture and antealar ridge; 3. occupying the upper 3/4 of anterior part of mesepimeron; (Fig. 5); 4. occupying almost the whole length of posterior part of mesepimeron connected inferiorly with a rounded spot that occupies the antero-posterior part of sclerite; (Fig. 5) 5. occupying the whole length of metepisternum and continuing to metinfraepisternum at which point it is connected with a large oblong yellowish spot situated at inferior part of this sclerite (Fig. 5). 6 and 7 connected at their upper and lower parts, occuping almost all metepimeron. Antealar sinus with a small grayish green spot; tergal area of mesonotum copper metallic with three grayish green spots; postnotum and metanotum black with copper metallic luster and grayish green spots. Legs black except for fore legs in which coxae and medial part of femora are yellowish. Wings hyaline. A small brownish yellow spot at base of HW occupying five cells of anal area and reaching about half distance from base to cubito-anal crossvein. Pterostigma yellowish brown. Venation): as described for the genus.

Abdomen – Segment S1 greenish yellow with anterior half of dorsum dark brown; S2 greenish yellow, antero-dorsally brown; postero-dorsal parts of S3 to S7 black with pale blue pruinescence. A greenish yellow area at anterior and lower parts of S3, continuing into anterior part of S4. Posterior half of S7 dark gray with poorly defined reddish areas; S8-9 and dorsal part of S10 orange red, lateral part reddish-orange. Ventral tergum of S3-10 black with pale blue pruinescence. Epiproct dark brown.

Structural characters. – Abdomen in dorsal view with S1-2 moderately dilated, S3 slightly constricted, S4-9 about the same width, S10 slightly narrower. In lateral view moderately dilated ventrally on S1-3, about same width of S4-10. Hind prothoracic lobe (Fig. 4) with hind margin slightly concave upright, constricted at the base bearing a fringe of long black hairs. Protibiae (Fig. 27), pro and metafemora covered with hairs on their dorsal surfaces (Figs. 16, 18, 29). Metafemora with 3 long and strong spines on its distal 1/3 (Fig. 18) followed by a medium size oblique spine and four very small distally directed spines on its proximal 2/3. Mesofemora with a single row of regularly spaced large modified spines (Figs. 17, 26) whose base has the shape of a trunk of cone (Fig. 24) and the top, in lateral view, is dish shaped (Fig. 24) and the distal surface is plane (Fig. 25). In medial view they appear as a subtriangular pointed structure (Fig. 22). Genitalia of abdominal S2 (Figs. 7-8): hamule bifid with internal branch hook-shaped, external subtriangular, larger than internal one (Figs. 7-8); genital lobe about same height as hamule, constricted at base, round with borders elevated, delimitating a large external concavity (Figs. 7-8); penis with a pair of strongly esclerotized ventral processes (Figs. 9a, 9b) in lateral view, looking like a bird head (Fig. 9a). Cerci (Figs. 10-11) with ventral surface provided with 20-21 teeth, only lateral ones arranged in a row (Fig. 10). Epiproct reaching to level of the distalmost tooth (Fig. 10).

Measurements (mm). - Holotype. Total length 56.4, abdomen 40.0; hind wing 43.4.

Female (**Allotype**) Head - color pattern same as in male holotype (Fig. 1), but pale colors are yellowish orange, whereas in male holotype they are grayish green.

Thorax - Pleural color pattern as in the male (Fig. 5) but pale colors are brownish orange whereas in male holotype they are green; black legs except at internal surfaces of profemora orange yellow. Venation: similar to male's.

Abdomen - S1 brownish orange, dorsally black, S2 brownish orange with a dorso-posterior black area; S3 black with two brownish orange areas adjacent two mid-dorsal carina; S4-S8 black with two brownish orange stripes adjacent to dorsal and lateral carinae; S9-S10 and epiproct black; cerci brown. The color of female paratype similar to that of allotype.

Structural characters - Abdomen in dorsal view with S1-S2 moderately dilated, S3-S10 about same width;

Prothoracic hind lobe with hind margin bearing a slight incision (Fig. 3), upright with a fringe of long hairs, constricted at the base. Legs (Fig. 19-21) without dense hairy areas except at the protibiae, (Fig. 14) and, to a lesser extent, at the profemora (Fig. 19). Mesofemora without large modified spines. Spines of metafemora decreasing in size towards base (Fig. 21). Vulvar lamina about 1/4 length of S9 (Fig. 13), not projected ventrally (Fig. 12-13). Epiproct well-developed (Fig. 12).

Measurements (mm). - Allotype. Total length 57.5, abdomen 38.6, HW 44.4.

VARIATIONS IN MALE PARATYPES

Measurements (n = 10). Total length 53.7 – 59.0 (average 55.9); abdomen 36.7 – 40.6 (average 38.2) HW 40.2 – 44.1 (average 42.1)

Thorax - All male paratypes have seven longitudinal, pale, pterothoracic stripes as holotype. The posterior mesepimeral stripe is not connected with anterior rounded spot in 80%, of the paratypes. The mesepisternal stripe is not connected with the oblong spot at the inferior part of the metinfrapisternum in 66%. Pale color of stripes grayish yellow (39.1%), grayish orange (22.2%) reddish (22.2%) and reddish yellow (16.5%). Wings hyaline (53%) or slightly suffused with yellow (47%). Metafemora without oblique medium size spine after the third long spine (63%).

Abdomen ventral part of terga black, on S2-S6 with whitish pruinescence in most of specimens and poorly defined small reddish orange stripes. Color variability observed only in dorsolateral part of the tergum. S1 and anterior part of S2 greenish or brownish yellow in most specimens. Considerable color variability observed in S3-S10 allowing the distinction of 5 color patterns: brownish orange (30%); brownish orange with S8-S10 brownish red (5%); reddish orange (5%); red (10%); black with S8-S10 red (50%).

The most common reason for color changes in odonates is aging (Corbet 2004), usually associated with sexual maturation as demonstrated by Mc Vey (1985) in *Erythemis simplicicollis* Say (1840). In *C. simone* the appearance of black color on abdomen S3-S7 is associated with the appearance and increase in pruinescence in the black areas. Especially in libelulids, pruinescence is indicative of sexual maturation (Corbet 2004), which leads to the conclusion that the specimens with abdomen black with S8-S10 red are sexually mature and comprise 50% of the population at the canga lake at the time of capture.

DISCUSSION

Carajathemis belongs to subfamily *Sympetrinae* as defined by Davies and Tobin (1985) and in group VI of Ris (1909). Within this subfamily it has a unique position being easily distinguished from the other genera of the subfamily by its large size, peculiar thoracic color pattern, penis structure, and especially by its complex leg armature. *Carajathemis simone* sp. nov. is among the largest Neotropical Libellulids.

By its large size and striped thoracic color pattern, it superficially resembles some of the African and Oriental species of Zygonychynae. The distal third of metafemora of male *Carajathemis* is provided with three long and strong spines a disposition so far regarded as unique for the genus Erythemis (Garrison et al. 2006). In *Carajathemis*, however, this feature occurs only in the male. Thus, in the key of Garrison et al. (2006) the male *Carajathemis* keys out to *Erythemis* whereas the female fits none of the couplets used in this key for females. *Carajathemis* differs from *Erythemis* by venation, penis structure, and leg armature. The radial and median planates have two rows of cells in *Carajathemis* and a single row in *Erythemis*. The presence in the distal segment of the penis of a pair of strongly esclerotized ventral process directed anteriorly is a character so far found only in the Brachydiplacinae *Edonis*, a genus otherwise very different from *Carajathemis*.

Carajathemis shares with *Garrisonia* a pronounced and dimorphic femoral spination, but differs from it by the presence in femora of dense hairy areas and large modified spines. In addition, *Carajathemis* has radial and median planates with two rows of cells and bifid hamulus (single branched in *Garrisonia*). The complex leg armature of *Carajathemis* has two components that deserve special considerations: large modified spines and hairy areas. The large modified spines that occurs on the mesofemora of male *Carajathemis*, in Neotropical genera also occurs on the legs of *Brechmorhoga*, *Macrothemis* and *Scapanea*, but on the metafemora. In such genera, however, these modified spines are more complex as its top (Fig. 23) has an oblong structure in which one extremity projects beyond the border of the base and is proximately directed (Fig. 23). These modified spines, which have been used as a generic taxonomic character (Garrison et al. 2006) had never been studied with SCM. The presence of extensive hairy areas in the legs is a remarkable character of *Carajathemis*. Ris (1909) and Montgomery (1940) reported that the femora of the oriental Sympetrinae *Deielia phaon* are provided with long hairs. A study of the legs in this species revealed that the hairs are arranged in a single row on each femur and, therefore, are very different from the extensive hairy areas found in the femora and protibiae of male *Carajathemis*. In Libellulidae such areas occur only in the African Brachydiplacinae genus *Porpax*, in which they were first reported by Ris (1911). In his review of this genus Dijkstra (2006) described and illustrated hairy areas similar to those of *Carajathemis* in *P. risi* Pinhey, 1958, *P. garambensis* Pinhey, 1966 and *P. asperipes* Karsch, 1896. In these species however, hairy areas occur only in the metafemora of males and females (Dijkstra 2006), whereas in *Carajathemis* they occur in all femora of males, profemora of females and protibiae of both sexes. The above consideration leads to the conclusion that the leg armature of *Carajathemis* has a combination of characters that makes it unique in libellulids and raises the question of its function. It is difficult to ascribe a function to the large modified spines of *Carajathemis*, as well as those of *Macrothemis*, *Brechmorhoga* and *Scapanea*. Concerning to the hairy areas of *Carajathemis*, there is morphological evidence that they might be related to prey capture. It is well known that dragonflies capture their prey in flight. Although some use the mouthparts alone to capture small preys, large preys are brought to the mouth by the legs (Corbet 2004). It is therefore significant that only the protibiae has hairy areas in both sexes and, in females, only the profemora has such areas. Thus, only the fore legs are able to grab preys with the femora and tibiae provided with hairy areas. The large number of long hairs in these areas increases the contact area between the fore legs and the prey and allows the capture of larger preys, which is especially important in a very large libellulidae such as *Carajathemis simone*.

Carajathemis simone was very common in a small lake situated at an altitude of 672 m in a clearing of the Carajás forest especially in November. The Odonata fauna of this lake was

constituted by 10 species of Anisoptera and only three of Zygoptera, being worth mentioning the very large and rare libellulid *Orthemis regalis* Ris, 1909 that was also common there. The lake has 70% of its margin surrounded by forest and 30% by an open area of "canga" (laterite). It has no tributaries and is rainfall dependent. In the rainy season its longest dimension is around 40 m. In the dry season, from May to October, the water level is reduced by about 85%, the lake almost disappears and the adults of *C. simone* are no longer seen. The lake has no floating macrophytes, its water is transparent allowing to see the bottom with benthonic algae. Although data about the chemical composition of the water in this lake is not available, chemical analysis of a analogous water system in Morro do Ferro (Iron Mountain) in Poços de Caldas, Minas Gerais state, revealed high concentration Fe^{2+} that precipitates to form red deposits of iron hydroxide (Pivetta 1983). A major collecting effort by Simone Soares, Haroldo Lapertosa, Nelson Ferreira Jr., Celio Valle and myself covering large areas of Carajás forest, failed to find adults of *C. simone*, out of the aforementioned iron-rich lake. Further studies of the behavior and ecological adaptation of *C. simone* to this unusual environment would be welcome.

RESUMO

Carajathemis simone n. gen., n. sp. do estado do Pará, Brasil, é descrita e ilustrada com base em 22 espécimes coletados em uma lagoa de canga (laterita) dentro da Floresta Nacional de Carajás, Município de Parauapebas. O novo gênero de libelulídeos enquadra-se na subfamília *Sympetrinae* e o macho na chave de Garrison et al. (2006) enquadra-se no gênero *Erythemis*. O novo gênero tem uma combinação de caracteres que o torna diferente de todos os gêneros de *Sympetrinae*, inclusive *Erythemis*. A espécie é notável por seu grande tamanho, pelas faixas pleurais e especialmente pela complexa e dimórfica armadura das pernas. A espécie parece restrita a lagos rasos dependentes de chuva e ricos em ferro.

Palavras-chave: taxonomia, morfologia, libélulas, pernas.

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