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OLIGOCLADA ABBREVIATA LIMNOPHILA SSP. NOV., WITH NOTES ON ITS ECOLOGY AND DISTRIBUTION (ANISOPTERA: LIBELLULIDAE)

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The new ssp. (holotype ♂: Santa Bárbara, Minas Gerais, Brazil, 11-1-1987, in coll. A.B. Machado) from SE and NE Brazil is described and compared with the nominal ssp. from the Amazon region. Both occur in lotic ecosystems, but the new ssp. has succeeded in colonizing man-made lakes.

INTRODUCTION

In 1919, RIS described *Oligoclada raineyi* (now *O. abbreviata*) based on nine males collected by Williamson and Rainey in British Guiana and on a single male from the Stockholm Museum, labelled "Espirito Santo". Regarding this male, the author doubted that it came from Espirito Santo, and assumed the specimen was from Surinam. This view was accepted by BORROR (1931) who stated that the species is Amazonian in its distribution.

SANTOS (1946) described as *O. raineyi* a female from Rio de Janeiro, but GEIJSKES (1984) commented that it could hardly be that species since it came from a region where its presence had never been reported. He also stated that the species is known to occur in the Guyanas and northern Brazil.

These considerations show that, although there is agreement regarding the Guyano-Amazonian distribution of *O. abbreviata*, its presence in southeastern Brazil has remained controversial.

During a survey of the odonate fauna of the Reserve of Peti (CEMIG), about 100 km E of Belo Horizonte (MACHADO et al., 1988), we found an *Oligoclada*, initially thought referable to the typical *O. abbreviata* (Rambur, 1842), but here

shown to be sufficiently different to deserve the status of a distinct subspecies. A search among the *Oligoclada* in our collection and in the National Museum, Rio de Janeiro, revealed that the new subspecies occurs in several other localities in SE and NE Brazil. Its morphology and ecological preferences are here described and compared with those of the nominal subspecies.

The name "limnophila" is allusive to the fact that it is frequently found in lakes.

OLIGOCLADA A. ABBREVIATA (RAMBUR, 1842)

Figures 1, 4

Libellula abbreviata RAMBUR, 1842: 119.
Mesothemis abbreviata HAGEN, 1861: 318.
Erythrodiplax abbreviata HAGEN, 1875: 90.
Trithemis abbreviata KIRBY, 1890: 20.
Nec *Oligoclada abbreviata* RIS, 1911: 405-406, figs 253-254 [misidentification]
Oligoclada raineyi RIS, 1919: 1134-1135, figs 650-651; – BORROR, 1931: 34-35, figs 9, 23, 43, 58, 80; – CALVERT, 1948: 76-77, pl. 2 fig. 37.
Oligoclada abbreviata GEIJSKES, 1984: 179-182, figs 1-2, 5-11; – DE MARMELS, 1988: 49; – 1990: 340; – MACHADO et al. 1991: 164.

Material. – (28 ♂, 1 ♀): BRAZIL, State of Amazonas: Taracuá (Uaupés River), 2 ♂, 15-VIII-1964, A. Machado leg. – State of Rondônia: Samuel, (Jamari River), 3 ♂, 11-II-1961, A. Machado & Pereira leg. – State of Roraima: Boa Vista, Estação Ecológia de Maracá (Uraricoera River), 1 ♂, 25-XI-1987, L.F. Reis leg.; – 4 ♂, 3-III-1988, P.A. Machado & C. Valle leg. – State of Pará: Belém, 1 ♂, II-1957, A. Machado & Pereira leg.; – Carajás (Tacaiunas River), 4 ♂, VI-1987, C. Valle leg.; – Itaituba, 5 ♂, XI-1961, B. Ferreira leg.; – Tiriós (Paru de Oeste River and on a stream), 3 ♂, I-1963, A. Machado & Pereira leg.; – Cachoeira Porteira (on streams), 4 ♂, VI-1982, A. Machado leg.; – Tucurui (away from the water), 23-VII-1987, 1 ♂, U. Carvalho leg.; – Altamira, Gradano, (Fresco River), 1 ♀, VIII-1957. – All material in collection A.B. Machado, Belo Horizonte, except the female which belongs to the National Museum, Rio de Janeiro and 4 males from Roraima which belong to the Instituto Nacional de Pesquisas da Amazônia, Manaus.

The male specimens examined, all from the Amazonian region, agree with the descriptions given by RIS (1919), BORROR (1931) and GEIJSKES (1984). The labial black markings, not illustrated by these authors, are shown in Figure 1. In all specimens the median lobe of the labium (ligula) is black. In 91.3% of the specimens, the lateral lobes have a broad black band as wide as, or slightly wider than, the median lobe proximally, narrowing to a point distally (Fig. 1). In two specimens (8.7%) the black band is reduced to a narrow stripe. In 91.3% of the specimens the labial squames are largely black, with yellow areas confined to its lateral third or anterolateral third or fourth. In two specimens (8.7%) the yellow area is larger and occupies the lateral two thirds of the squames. The venational characters are shown in Table I.

The single female examined also corresponded well to the descriptions given by CALVERT (1948) and GEIJSKES (1984).

Table I

Comparison of the venation in *O. a. abbreviata* and *O. a. limnophila*

Character	*a. abbreviata*	*a. limnophila*
Antenodals (FW)	9.5(73.7%); 10.5(21.1%); 8.5(5.3%)	9.5(55%); 10.5(35%); 8.5(10%)
Antenodals (HW)	7(89.5%); 6(5.3%); 8(5.3%)	7(95%); 8(5%)
Postnodals (FW)	8(68.4%); 9(15.8%); 7(15.8%)	8(40%); 9(30%); 7(25%); 10(5%)
Postnodals (HW)	8(47.4%); 9(42.1%); 7(10.5%)	8(55%); 9(30%); 10(10%); 6(5%)
Triangle (FW)	free (47.4%); crossed (52.6%)	free (15%); crossed (85%)
Subtriangle (FW)	3 cell (100%)	3 cell (100%)
Cells bordering triangle in discoidal field (FW)	2(68.4%); 3(31.6%)	2(50%); 3(50%)
Cells bordering triangle in discoidal field (HW)	1(100%)	1(100%)
Cells in Rspl (FW)	6(50%); 5(27.8%); 7(22.2%)	6(60%); 8(20%); 7(15%); 9(5%)
Cells in Rspl (HW)	6(63.4%); 5(31.6%)	6(55%); 7(16.7%); 5(11.1%); 8(11.1%); 9(5.6%)
Cubito-anal cross-veins (FW)	1(100%)	1(95%); 2(5%)
Cubito-anal cross-veins (HW)	1(100%)	1(100%)
Cells in proximal half of anal loop	7(52.6%); 8(31.6%); 6(10.5%); 9(5.3%)	8(45%); 7(35%); 9(15%); 6(5%)
Cells in distal half of anal loop	9(57.9%); 10(36.8%); 8(5.3%)	9(60%); 10(40%)

Measurements (in mm) – MALES: Abdomen 16.2-17.6 (mean 17.0); – forewing 21.7--23.4 (mean 22.5), hindwing 20.4-22.4 (mean 21.4); – pterostigma (in forewing): 1.7-1.9 (mean 1.8). – FEMALE: Abdomen 14.7; – forewing: 23.0, hindwing: 21.9; – pterostigma: 1.9.

OLIGOCLADA ABBREVIATA LIMNOPHILA SSP. NOV.

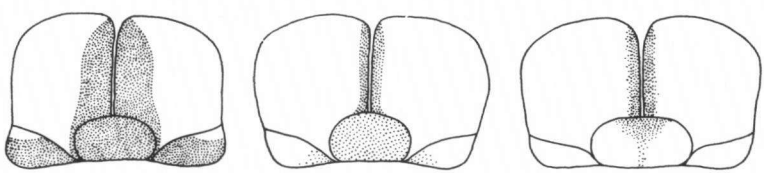
Figures 2-4

Oligoclada raineyi RIS, 1919: 1134 (in part).
Oligoclada rayneyi SANTOS, 1946: 303-305, figs 1, 2.
Oligoclada abbreviata MACHADO et al., 1988: 136.

Material – (33 ♂, 2 ♀): BRAZIL, State of Minas Gerais: Santa Bárbara, Reserve of Peti (on a large reservoir): **Holotype** ♂, 11-I-1987, A., P.A. & E. Machado leg.; – 2 ♂, 29-II-1993, A., P.A. Machado & R.M. Silveira leg.; – 4 ♂, 5-IV-1986, 2 ♂, 13-IX-1986, 1 ♂, 19-X-1986, 1 ♂, 11-I-
-1987, 1 ♂, 21-XI-1987 A., P.A. & E. Machado leg.; – Lagoa Santa (on a small reservoir): 1 ♂, II-1982, A. Machado leg.; – Acucena (on a small reservoir): 2 ♂, II-1952, A. Machado leg.; – Buenópolis: 2 ♂, I-1955, A. Machado & F.A. Almeida, leg.; – Belo Horizonte (Pampulha Reservoir): 1 ♂, I-1981, A. Machado leg. – State of Rio de Janeiro: Rio de Janeiro (Estação Paciência): **Allotype** ♀, 15-V-1941, N. Santos & A. Machado leg.; – Restinga de Marambaia: 4 ♂, 1 ♀, 26-I-1977, N.

Santos leg.; – Rio Claro (Pirai River), 1 ♂, 15-III-1978, N. Santos leg. – State of Espirito Santo: São João de Petrópolis, 2 ♂, 15-V-1967, Paulo Elias leg.; – Colatina (Pancas River), 1 ♂, 13-II-1955, N. Santos leg.; – Santa Tereza, 2 ♂, 16-I-1967, N. Santos leg.; – Barra Seca (Barra Seca River), 1 ♂, VIII-1961, Herbert leg. – State of Bahia: Araci (Itapicuru River), 2 ♂, N. Santos leg. – State of Pernambuco: Cabo, near Recife (Gurjau Reservoir), 1 ♂, 19-II-1963, N. Santos & Andrade-Lima leg. – Holotype and 16 paratypes in collection A.B. Machado; allotype and 15 paratypes in the collection of the Museu Nacional, Rio de Janeiro. Two paratypes in the collection of the Departamento de Zoologia do Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte.

MALE – The color agrees with that of the nominal subspecies except for the frons and the labium. In both subspecies the upper horizontal part of the frons is metallic blue. However, in *O. a. abbreviata* the blue continues anteriorly and



Figs 1-3. Underside labium showing the black markings of: (1) *Oligoclada a. abbreviata*, male from Belem, Pará; – (2) *O. a. limnophila*, holotype male; – (3) *O. a. limnophila*, allotype female.

laterally onto the vertical part, almost reaching the fronto-clipeal suture, whereas in *O. a. limnophila* ssp.n. this part is predominantly yellow. In most *limnophila* specimens there is also a marked reduction of the black areas in the labium as follows (Fig. 2): in the lateral lobes, the black band is reduced to a narrow stripe (69%); in the squames, the black areas are either totally absent (26%) or confined to the medial third of the sclerite (44%). The median lobe is totally black or dark brown but in 21% of the specimens the black area is confined to its anterior part. Most venational characters of *limnophila* (Tab. I) are basically similar to those of *O. a. abbreviata*. However, in the new subspecies the frequency of wings with a free triangle (15%) is significantly smaller than in the nominal subspecies (47.4%). The structural characters of *limnophila*, including the penis, are identical to those of the nominal subspecies, as described and figured by RIS (1919), BORROR (1931) and GEIJSKES (1984). With regard to size, however, the *limnophila* males are significantly larger than those of *abbreviata*.

Measurements (in mm). – Abdomen: 16.4-19.8 (mean 17.3); – forewing: 22.6-25.9 (mean 24.4), hindwing: 21.4-24.5 (mean 23.1); – pterostigma: in forewing: 1.9-2.3 (mean 2.15).

FEMALE – It has already been described by SANTOS (1946) based on one specimen from Estação Paciência (Rio de Janeiro) which we had the opportunity to study. Although basically accurate, Santos's description needs to be complemented with additional information about the labium. In the female from Estação Paciência (**allotype**), the labium is whitish yellow with a black area on the anterior

part of the median lobe and a narrow black stripe, much narrower than the median lobe, along the inner margin of the lateral lobes (Fig. 3). In the **paratype** this stripe is reduced to a dark brown line and there is a brownish area on the anterior part of the median lobe. No structural difference could be found between the *limnophila* and *abbreviata* females. These differ, however, not only in their sizes (*limnophila* being larger), but also in the color of their vertex, frons and labium. In the nominal subspecies the vertex and the upper horizontal part of the frons is dark brown with a shining metallic blue, whereas in *limnophila* the vertex is orange yellow and the metallic blue on the frons is either absent or confined to its posterior half. In the nominal subspecies the labium median lobe is black and the black stripe along the inner margin of the lateral lobes has about the same width as the median lobe. In *limnophila* the median lobe is perdominantly yellow, the black stripe on the lateral lobe is much narrower than the median lobe (Fig. 3), or reduced to a brown line.

Measurements (in mm). – Abdomen: 15.5-16 (mean 15.7); – forewing: 24-24.8 (mean 24.4), hindwing: 22.4-23 (mean 22.7); – pterostigma: 2.1-2.2 (mean 2.15).

ECOLOGICAL OBSERVATIONS

During several collecting trips to the Amazon region, we observed and collected specimens of *O. a. abbreviata* in small and medium-size forest streams as well as in the marginal forest vegetation of large rivers such as the Uaupés, Jamari and Uraricoera, but never in lentic environments. The subspecies was not represented in a fairly large collection of Odonata made recently in the Tucurui Reservoir (Pará), in spite of the fact that it is situated within the subspecies range. These data indicate that *O. a. abbreviata* is rheophilic and possibly confined to forested lotic ecosystems. Quite a different situation was observed with *O. a. limnophila* which has been found in forested and non-forested rivers and streams as well as in small to large man-made lakes. We had the opportunity to study it in the large reservoir of the Peti hydroelectric dam, near Belo Horizonte, during visits carried out every two months from April 1986 to August 1988. The subspecies was absent during the cooler months of May to August, reappeared in September, and attained its peak in October and November. The spatial situation of the insects on the reservoir depended on the level of the water, which is regulated by the dam gates and varies considerably (about 5 m) during the year. In September and early October, the level is maintained high and the water reaches the marginal vegetation, where the *Oligoclada* males are seen flying or alighting on leaves overhanging the water. In order to prevent flooding, the water level is lowered during the rainy season (October to March), exposing large stretches of shore. The males are then found on the stretch of land between the water and the marginal vegetation where they frequently perch either on mud or on the dry ground. Significantly, most specimens collected in this situation were found to

have dry mud attached to their tarsal claws. The only other dragonfly seen on the exposed shores of this reservoir was *Erythemis peruviana* which, unlike *O. a. limnophila*, spends most of the time in flight.

When perched on the ground, the *Oligoclada* males either maintain the abdomen and the wings in the same plane – a position similar to that observed when they alight on leaves – or the abdomen is raised to an almost vertical position, usually directed towards the sun (obelisk position). No specimen was seen assuming this position on leaves but it was frequently observed on the dry ground, during the hottest hours of the day.

DISCUSSION

The two subspecies of *O. abbreviata* do not differ only in size, venation and head coloration, but also in their ecological features. *O. a. abbreviata* has so far been recorded only in forested rivers and streams, whereas *O. a. limnophila* occurs both in non-forested rivers and streams and also in small to large reservoirs. Indeed, the subspecies seems to be well adapted to cope with the large differences in water level that frequently occur in these reservoirs, shifting its perching sites from the marginal vegetation to the ground, depending on the water level.

The "obelisk position" assumed by males of *O. a. limnophila* on the ground has been reported for several dragonflies, but never for *Oligoclada*, and it is generally believed this behaviour has a thermoregulatory function (review in DELL'ANNA & UTZERI, 1990). By raising their abdomen in the warmest part of the day, they diminish the body surface exposed directly to the sun, thus protecting themselves against overheating. This is especially important when the insect is perched on the dry ground and receives the additional heat that irradiates from it.

As pointed out by BORROR (1931), the oligocladas are stream dwellers, usually found along small streams, in woods or in clearings. Indeed, of the 16 species and subspecies of the genus whose habitats have been described, only *O. nemesis*, *O. heliophila* and now *O. abbreviata limnophila* have been found to occur in lentic environments. The latter seems to have a preference for man-made lakes, as it has never been found in natural lakes, in spite of the fact that some lakes (such as Lake Don Helvecio and Lagoa Santa, Minas Gerais), have been intensely surveyed. It is reasonable to assume that rivers and streams were the original habitat of *O. a. limnophila*, which adapted itself to reservoirs when the opportunity was offered by the construction of a large number of impoundments in southeastern and northeastern Brazil during the last century. In their study on the effect of river impoundments on Odonata, VOSHELL & SIMMONS (1978) provided several examples of species that were present in the river prior to the impoundment and were succesful in colonizing the subsequent man-made reservoir. From the standpoint of conservation, the ability of *limnophila* to colo-

nize reservoirs will enable it to survive in certain areas of southeastern Brazil where hydroelectric impoundments are changing large rivers into a succession of large artificial lakes.

The geographic distribution of the two subspecies (Fig. 4) deserves some consideration. *O. a. abbreviata* is distributed in the Amazon Forest whereas the range of *O. a. limnophila* corresponds to the region formerly occupied by the mid and northern parts of the Atlantic Forest. This forest has been reduced to about 8% of its original area, transformed mainly into agricultural and pasture land. An apparent exception was the discovery of *limnophila* on the Itapecuru River, a seasonally dry river that runs through a semidesert Caatinga region of northeastern Bahia. This finding is coherent with recent historical and biogeographic studies (COIMBRA-FILHO et al., 1991) which revealed that in the 16th century the Itapecuru River was perennial and its valley covered by Atlantic Forest, which was devastated for cattle ranching in the early days of the colonization of Brazil.

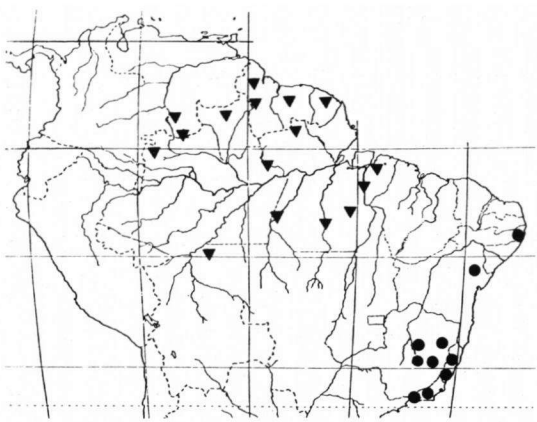


Fig. 4. The distribution of *O. a. abbreviata* (▼) and *O. a. limnophila* (●).

Assuming that the centre of *Oligoclada* dispersion is in the Amazon region, which contains 60% of the known species of the genus, *O. abbreviata* would have reached the Atlantic Forest through a rain forest connection known to have existed in northeastern Brazil in the Late Tertiary (BIGARELLA & ANDRADE-LIMA, 1982). Indeed it is known that the Amazon and the Atlantic forests share several species, or closely related species, of plants and animals (BIGARELLA & ANDRADE-LIMA, 1982) among which we could quote the libellulid *Uracis imbuta*.

From the standpoint of its conservation, it is worth mentioning that *O. a. limnophila* is successful in maintaining its populations even after deforestation, a fact that enabled its survival in the now largely devasted areas of the Atlantic Forest. Thus, we have an example of a polytypic odonate species in which one subspecies from the Amazon region maintained its original lotic habitat in the forest, whereas the other, from the Atlantic Forest, was able to change its ecological requirements to cope with such recent anthropogenic actions as deforestation and river impoundments.

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