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MALE GERM CELL CHROMOSOMES OF THIRTY-TWO BRAZILIAN DRAGONFLIES

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The male germ cell chromosome complements are described and illustrated of the following spp. from the states of Acre and São Paulo, 19 of which (asterisked) have not been previously examined cytologically: Coenagrionidae: *Acanthagrion gracile minarum* Sel.* (n = 14), *Enallagma cheliferum* (Sel.)* (n = 14, *m*; the first known case of the occurrence of *m* in an n = 14 Enallagma complement), *Oxyagrion terminale* Sel.* (n = 14), *Telebasis carmesina* Sel.* (n = 14); — Hetaerinidae: *Hetaerina rosea* Sel. (from Rio Claro n = 13; from Pirassununga n = 14, *m*); — Gomphidae: *Aphylla theodorina* (Nav.)* (n = 12, *m*); — Aeshnidae: *Coryphaeschna l. luteipennis* (Burm.)* (n = 13, *m*), *Gynacantha interioris* Wllms.* (2n ♂ = 26, n = 13, *m*, neo-XY); — Libellulidae: *Brachymesia furcata* (Hag.)* (n = 13, *m*), *Dythemis cannacrioides* Calv. (n = 11), *D. multipunctata* Kirby* (n = 13, *m*), *Erythrodiplax attenuata* (Kirby)* (n = 13, *m*?), *E. b. basalis* (Kirby) (n = 13, *m*; no *m* in Bolivian material recorded by CUMMING, 1964, PhD Thesis, Univ. Texas, No. 64-11,789), *E. connata fusca* (Ramb.) (n = 13, *m*; no *m* in Bolivian and Guatemalan populations recorded resp. by CUMMING, 1964, cf. above, and CRUDEN, 1968, Can. J. Genet. Cytol. 10: 200-214), *E. latimaculata* Ris* (n = 13, *m*), *E. media* Borror (2n ♂ = 22, n = 11, *m*, XO), *E. umbrata* (L.) (n = 13, *m*), *Lepthemis vesiculosa* (Fabr.) (n = 13), *Miathyria marcella* (Sel.) (n = 13, *m*), *Micrathyria artemis* Ris* (n = 13, *m*), *M. hesperis* Ris* (n = 13, *m*), *Oligoclada monosticha* Borror* (n = 12, *m*), *Orthemis cultriformis* Calv. (n = 12, *m*), *O. ferruginea* (Fabr.) (n = 12, *m*), *Pantala flavescens* (Fabr.) (n = 13, *m*), *Perithemis lais* (Perty) (n = 9, XO), *P. mooma* Kirby (n = 13, *m*), *Tholymis citrina* Hag.* (n = 13, *m*), *Tramea binotata* (Ramb.)* (n = 13, *m*), *Uracis imbuta* (Burm.)* (n = 13, *m*), *U. ovipositrix Calv.** (n = 13, *m*), *Zenithoptera lanei* Santos* (n = 13, *m*).

INTRODUCTION

This is the first report in what we hope to be a series on the cytotaxonomy of Brazilian dragonflies. It includes the karyotypic descriptions of 32 species, referable to 22 genera of five families. The following 19 have not been previously studied cytologically: *Acanthagrion gracile minarum* Sel., *Enallagma cheliferum* (Sel.), *Oxyagrion terminale* Sel., *Telebasis carmesina* Sel., *Aphylla theodorina* (Nav.), *Coryphaeschna l. luteipennis* (Burm.), *Gynacantha interioris* Wllms., *Brachymesia furcata* (Hag.), *Dythemis multipunctata* Kirby, *Erythrodiplax attenuata* (Kirby), *E. latimaculata* Ris, *Micrathyria artemis* Ris, *M. hesperis* Ris, *Oligoclada monosticha* Borror, *Tholymis citrina* Hag., *Tramea binotata* (Ramb.), *Uracis imbuta* (Burm.), *U. ovipositrix* Calv. and *Zenithoptera lanei* Santos. Of most of the other species dealt with here only the chromosome numbers, without karyotypic descriptions and illustrations had so far been published.

Although the cytotaxonomic conditions of well over 100 neotropical taxa have so far been brought on record (CUMMING, 1964; CRUDEN, 1968; KIAUTA, 1970, 1972a, 1972c; KIAUTA & BOYES, 1972), this represents only an insignificant fraction of the rich dragonfly fauna of this region.

The material dealt with in this paper has been collected and the slides photographed by the first and the third authors, who also provided a provisional draft of the karyotypic descriptions. The latter were completed and annotated by the second author.

Most of the material has been identified by Dr. A.B.M. Machado (Belo Horizonte), some critical taxa by Dr. J. Belle (Velp) and Dr. D.C. Geijskes (Leyden). Most of the plesiotypes are in the collection of the second author.

For fixing and staining the lacto-acetic-orcein squash method was used, and the slides were photographed with a Zeiss photomicroscope (2250 X). In cases where the photographs were unsatisfactory, drawings were made with the aid of a camera lucida (3000 X). The negatives and slides are deposited with the first author.

DESCRIPTIONS AND DISCUSSIONS OF THE KARYOTYPES

Coenagrionidae

ACANTHAGRION GRACILE MINARUM SELYS, 1876

Figure 1

Material. — 2♂, Wenzel Lake, Rio Claro, São Paulo, Sept. 1972. (The reference specimens identified by Dr. D.C. Geijskes, Leyden, The Netherlands).

2 n = 27, n = 14. At primary spermatocyte metaphase the bivalents are of gradually decreasing magnitude, an *m*-bivalent is lacking, and the sex element is the smallest of the set.

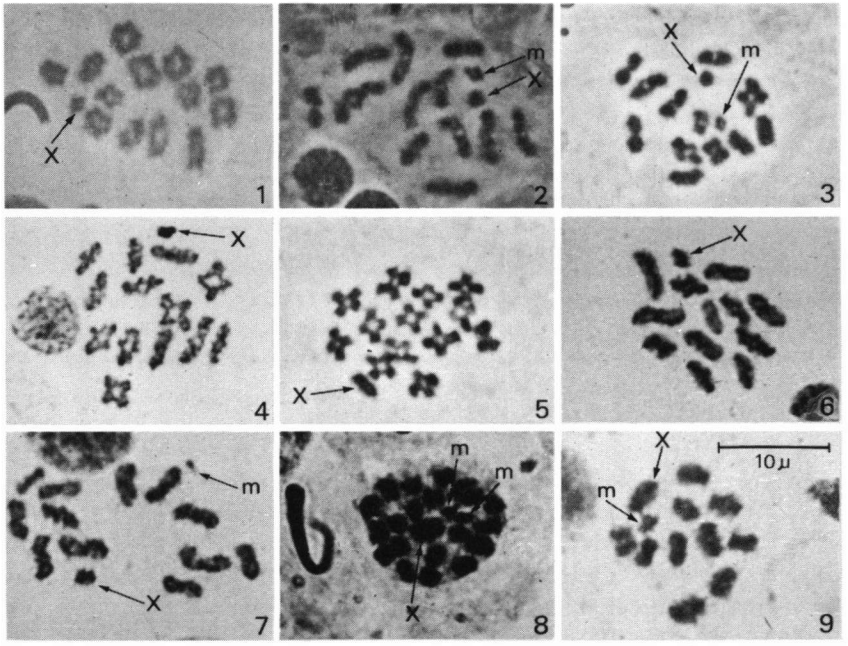
CUMMING (1964) recorded the chromosome numbers of the Bolivian *A. ascendens* Calv. and *A. chacoense* Calv. In both of these *m*-chromosomes are present, but no figures have been published of the karyotypes.

ENALLAGMA CHELIFERUM (SELYS, 1875)
Figures 2-3

Material. — 3♂, Rio Claro, São Paulo, Febr. 1972.

2 n = 27, n = 14. The elements (bivalents) are of gradually decreasing magnitude, save for a small *m*-pair (bivalent). The largest autosome pair (bivalent) can also be discerned in all figures. At primary spermatocyte metaphase the round-shaped X is but slightly smaller than the *m*-bivalent.

So far seven other members of the genus have been studied cytologically



Figs. 1-9. Primary spermatocyte chromosomes of some Brazilian Zygoptera (Figs. 1-7) and male germ cell complement of *Aphylla* (Figs. 8-9) (Lacto-acetic-orcein squash, 1500 X): (1) *Acanthagrion gracile minarum* Sel., late diakinesis; — (2-3) *Enallagma cheliferum* (Sel.), early metaphase I; — (4) *Oxyagrion terminale* Sel., late diakinesis; — (5) *Telebasis carmesina* Calv., diakinesis; — (6-7) *Hetaerina rosea* Sel., metaphase I (Fig. 6: Rio Claro, n = 13, — Fig. 7: Pirassununga, n = 14, including an additional small element); — (8-9) *Aphylla theodorina* Navas, spermatogonial metaphase (Fig. 8) and metaphase I (Fig. 9).

(cf. KIAUTA, 1972b). This is the only species in which an *m*-pair has hitherto been recorded.

OXYAGRION TERMINALE SELYS, 1876
Figure 4

Material. — 1♂, Forestry Department, Rio Claro, São Paulo, Febr. 1973.

2 n = 27, n = 14. This is the first member of the genus studied cytologically. The primary spermatocyte bivalents are similar in size. There are no *m*-chromosomes and the sex element is by far the smallest of the set. It is distinctly heteropycnotic at this stage.

TELEBASIS CARMESINA CALVERT, 1909
Figure 5

Material. — 2♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 27, n = 14. The bivalents are rather uniform in size and show a very synchronous kinetic behaviour at diakinesis. At primary spermatocyte stages the unpaired, large X can be easily discerned. No evidence has been published so far on the chromosome cytology of any other member of the genus.

Hetaerinidae

HETAERINA ROSEA SELYS, 1853
Figures 6-7

Material. — 3♂, Rio Claro, São Paulo, Oct. 1971; — 2♂, Emas Falls, Pirassununga, São Paulo, Nov. 1973.

The chromosome numbers and the karyotype morphology are different in the two populations, viz. 2 n = 25, n = 13 in the Rio Claro material, and 2 n = 27, n = 14 in the Pirassununga specimens. A minute *m*-bivalent occurs in primary spermatocyte metaphase of the latter only. A relatively large X has a similar size in both populations; its volume is approximately half that of the smallest "normal" autosome bivalent.

In the male haploid set of the Bolivian material of this species, brought on record by CUMMING (1964), there are also 14 elements, including an *m*-bivalent. KIAUTA (1969) has suggested that the increase of the chromosome number may be due to fragmentation. Due to the minute size of the additional element, its origin cannot be demonstrated with certainty. In a number of other genera, where the extra element is distinctly larger and/or its behaviour

can be traced, this kind of fragmentation has indeed been cytologically evidenced.

So far the chromosome conditions of seven members of the genus have become known. In all other species 13 elements only occur in the haploid set. Save for *H. sanguinea* Sel. and (perhaps) *H. vulnerata* (Sel.) an *m*-pair is present in all of them. (For the latter species cf. KIAUTA, 1970). *H. rosea* is the first member of the family in which karyotypically distinct populations have been brought on record.

Gomphidae

APHYLLA THEODORINA (NAVAS, 1933)
Figures 8-9

Material. — 1♂, Forestry Department, Rio Claro, São Paulo, March 22, 1973. (The identification of the reference specimen checked by Dr. J. Belle, Velp, The Netherlands). The specimen is unusually small.

2 n = 23, n = 12. There is but little size graduation in both the spermatogonial and primary spermatocyte metaphase elements, save for a huge X chromosome and for a rather large *m*-pair (bivalent). The former is by far the largest of the set at all stages.

This is the fourth *Aphylla* species studied cytologically, though a detailed description of the karyotype and an accurate account of the meiotic chromosome behaviour are available for *A. williamsoni* (Gloyd) only (KIAUTA & VAN BRINK, 1978). In the latter species the sex element is of a medium magnitude and isocyclic during spermatocyte meiosis. It is unfortunate that its behaviour could not be traced in our material.

Aeshnidae

CORYPHAESCHNA LUTEIPENNIS LUTEIPENNIS (BURMEISTER, 1839)
Figure 22

Material. — 2♂, Cruzeiro do Sul, Acre, Sept. 1972.

Only a few micrographs of poor quality are available in our material. It seems there are 27 elements at spermatogonial metaphase, while 13 bivalents and a rather small X occur in primary spermatocytes. The bivalents show a considerable size range at this stage. Two are relatively large, eight are of medium magnitude, two are small, and there is an *m*-bivalent of approximately half the volume of X.

The same chromosome number, including an *m*-bivalent, occurs also in *C.*

adnexa (Hag.), but no details on the karyotype morphology of this species have been published (cf. CUMMING, 1964).

GYNACANTHA INTERIORIS WILLIAMSON, 1923
Figures 10-14

Material. — 2 ♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n (♂) = 26, n = 13; neo-XY. There are clearly 26 elements in spermatogonial metaphase. The largest of these is the neo-sex chromosome, the X region of which is negatively heteropycnotic. A pair of minute, weakly stained *m*-elements are also present.

At pachytene the section of the neo-sex element that corresponds to the original X is heteropycnotic and it is distinctly separated from the autosomal portion by a secondary constriction. At late diakinesis there are 12 autosomal elements of various sizes and showing a wide range in the degree of despiralization. The autosomal part of the neo-XY is clearly distinct. Compared to the widely separated chromatids of the X portion, it is heterocyclic. It is apparent that the Y is one of the medium-sized elements.

The neo-XY mode of sex determination has been reported (either as a permanent or as a temporary condition) in a number of aeshnide species, and it is always coupled with a decrease of the chromosome number. The latter, however, may evolve occasionally also without the involvement of the sex element (for references cf. KIAUTA, 1972b).

Gynacantha japonica Bart. is the only other member of the genus so far examined. It has a "normal", n = 14 complement, with the usual XO sex determination (OMURA, 1957).

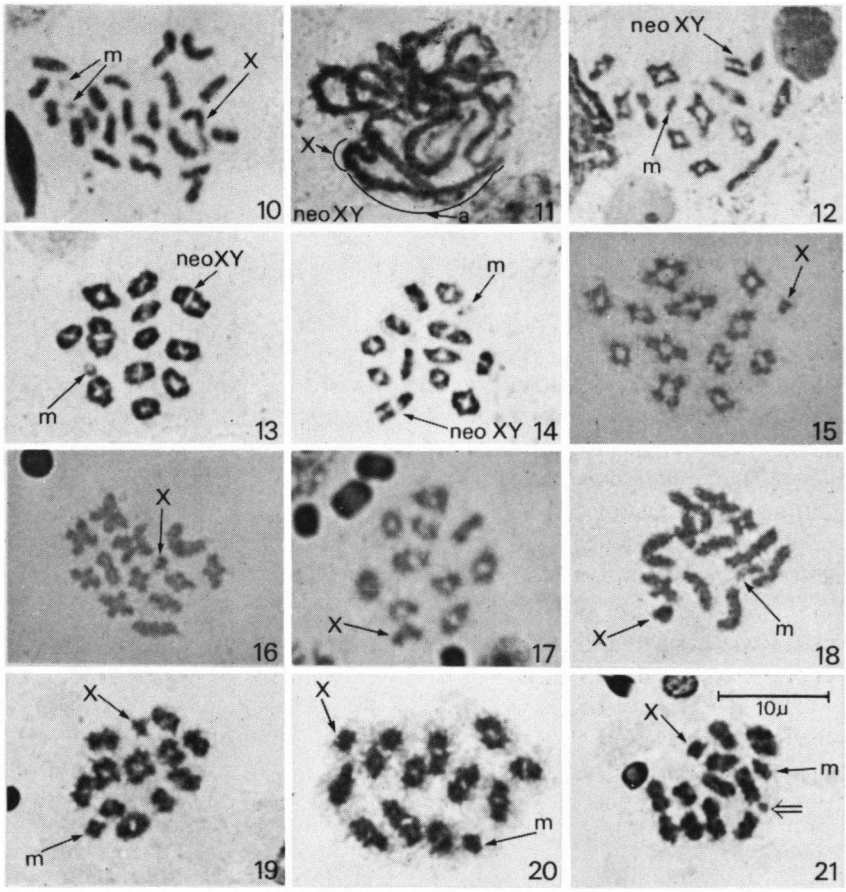
Libellulidae

BRACHYMESIA FURCATA (HAGEN, 1861)
Figures 15-16

Material. — 1 ♂, Cruzeiro do Sul, Acre, Sept., 1972.

2 n = 25, n = 13. The primary spermatocyte karyotype is characterized by a small X and by the lack of an *m*-bivalent. The bivalents are of gradually decreasing magnitude.

This is the first member of the genus the karyotype of which has become known.



Figs. 10-21. Male germ cell chromosomes of *Gynacantha* (Figs. 10-14) and primary spermatocyte complements of some Libellulidae (Figs. 15-21) (Lacto-acetic-orcein squash, 1500 X): (10-14) *Gynacantha interioris* Wllms., spermatogonial metaphase (Fig. 10), pachytene (Fig. 11), late diakinesis (Figs. 12-14); — (15-16) *Brachymesia furcata* (Hag.), late diakinesis; — (17) *Dythemis cannacrioides* Calv., early metaphase I; — (18-21) *D. multipunctata* Kirby, late diakinesis to metaphase I; an additional small element, occurring in some cells, is indicated by an arrow in Fig. 21.

DYTHEMIS CANNACRIOIDES CALVERT, 1906
Figure 17

Material. — 1♂, Emas Falls, Pirassununga, São Paulo, Nov. 1972.

2 n = 21, n = 11. The primary spermatocyte elements are more or less

uniform in size, including the X chromosome. There are no *m*-elements in this species.

CUMMING (1964) examined the species from Bolivia and reported the male haploid number as 12, including an *m*-bivalent. Since no figures of this material have ever been published, it is considered better to refrain from any speculations concerning chromosomal polymorphism.

DYTHEMIS MULTIPUNCTATA KIRBY, 1894
Figures 18-21

Material. — 1♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. Save for a distinctly large bivalent, and for the *m*-bivalent and the X, the primary spermatocyte metaphase elements are slightly decreasing in magnitude. The *m* and X are nearly uniform in size at this stage. In some metaphase I figures, there appears an additional minute element of unknown provenience and unclear structure.

This is the fifth cytologically examined species of the genus. Save for *D. cannacrioides*, all of them have 13 elements in the haploid set (cf. KIAUTA, 1972b).

ERYTHRODIPLAX ATTENUATA (KIRBY, 1889)
Figure 23

Material. — 4♂, Cruzeiro do Sul, Acre, Sept. 8, 1972.

2 n = 25, n = 13. The primary spermatocyte elements are gradually decreasing in magnitude. Two bivalents are distinctly smaller than the others, but it is questionable whether or not the smallest of them could be regarded as an *m*-bivalent. The sex chromosome is the smallest of the set at this stage.

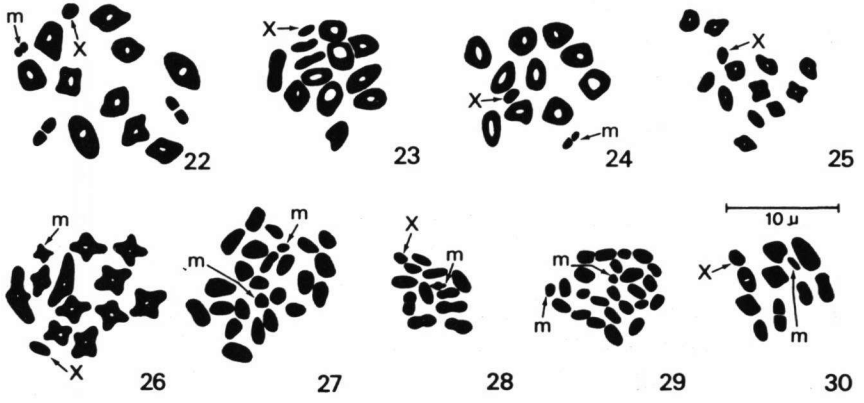
This is one of the three members of BORROR's (1942) Group 2, Attenuata, which is considered to be closely related to his groups Longitudinalis and Unimaculata. No species of the former has been studied cytologically, while the karyotypes of three Unimaculata-members are known (KIAUTA & BOYES, 1972). *E. berenice* (Dru.) from North Carolina, USA, is the only one of them lacking the *m*-bivalent (cf. CRUDEN, 1968). In material of the same species from Grand Forks, North Dakota, USA, HUNG (1971) recorded 14 elements, including an *m*-bivalent, but his taxonomic identification has been questioned by BICK, BICK & HORNUFF (1977).

ERYTHRODIPLAX BASALIS BASALIS (KIRBY, 1897)
Figure 24

Material. — 1♂, Cruzeiro do Sul, Acre, Sept. 8, 1972.

2 n = 25, n = 13. The same chromosome number has been reported by CUMMING (1964) from Bolivia, but there were no *m*-elements in his material, whereas a small *m*-bivalent, of approximately equal size as the X, is present in our specimen.

Along with the situation in *E. connata fusca* (cf. below), this is the second case of *m*-chromosome polymorphism recorded in the genus (KIAUTA & BOYES, 1972). Aside from its infraspeciation, *E. b. basalis* is known for geographic variation in its abdominal coloration and in the size of the basal spot in the wing of males (BORROR, 1942). It would be interesting, therefore, to examine if the variation in the karyotype is peculiar to different geographic populations.



Figs. 22-30. Male germ cell chromosomes of *Coryphaeschna* (Fig. 22) and some Libellulidae (Figs. 23-30) (Lacto-acetic-orcein squash, camera lucida drawings, 1500 X): (22) *Coryphaeschna l. luteipennis* (Burm.), early metaphase I; — (23) *Erythrodiplax attenuata* (Kirby), early metaphase I; — (24) *E. b. basalis* (Kirby), early metaphase I; — (25) *Lepthemis vesiculosa* (Fabr.), metaphase I; — (26) *Tholymis citrina* Hag., early metaphase I; — (27-28) *Tramea binotata* (Ramb.), spermatogonial metaphase (Fig. 27) and metaphase I (Fig. 28); — (29-30) *Zenithoptera lanei* Santos, spermatogonial metaphase (Fig. 29) and metaphase I (Fig. 30).

ERYTHRODIPLAX CONNATA FUSCA (RAMBUR, 1842)
Figures 31-32

Material. — 3♂, Rio Claro, São Paulo, Nov. 13, 1971; — 2♂, Emas Falls, Pirassununga, São Paulo, Jan. 15, 1974.

2 n = 25, n = 13. In the two São Paulo populations there is a pair of distinct *m*-elements; at metaphase I the *m*-bivalent is approximately equal in size to X. In the Bolivian and Guatemalan material, studied respectively by CUMMING (1964) and CRUDEN (1968), *m*-chromosomes are lacking, whereas they are present in *E. c. connata* (Burm.) from Chile (KIAUTA & BOYES, 1972) and in *E. c. minuscula* (Ramb.) from Florida, USA (KIAUTA & VAN BRINK, 1978).

On the basis of the distributional patterns, structural characters and the available cytological evidence KIAUTA & BOYES (1972) have suggested that *fusca* is probably the oldest form of the *connata* "Artenkreis". It occupies the centre of the species range, in the Atlantic drainage of South America, Central America and Mexico, while *connata* and *minuscula* occur on the periphery. It is greatly interesting that the *m*-chromosomes occur in both peripheral subspecies and in the more or less peripherally situated southern populations (São Paulo) of *fusca*, whereas they are apparently lacking in *fusca* material originating from the central portions of the range of the latter. This evidence is certainly in agreement with Kiauta & Boyes's theory of the infraspeciation and radiation from the *fusca* stock.

ERYTHRODIPLAX LATIMACULATA RIS, 1911
Figures 33-34

Material. — 2 ♂, Cruzeiro do Sul, Acre, Sept. 8, 1972.

2 n = 25, n = 13. The X and *m*-bivalent are similar in size, while the other metaphase I elements are of gradually decreasing magnitude.

This is the first member of BORROR's (1942) rather uncertain Famula group studied cytologically. In view of the rather standard karyotype and of the fact that the group consists of two species only, it does not seem likely that the chromosome morphology could ever contribute to the clarification of its phylogenetic affinities.

ERYTHRODIPLAX MEDIA BORROR, 1942
Figures 35-37

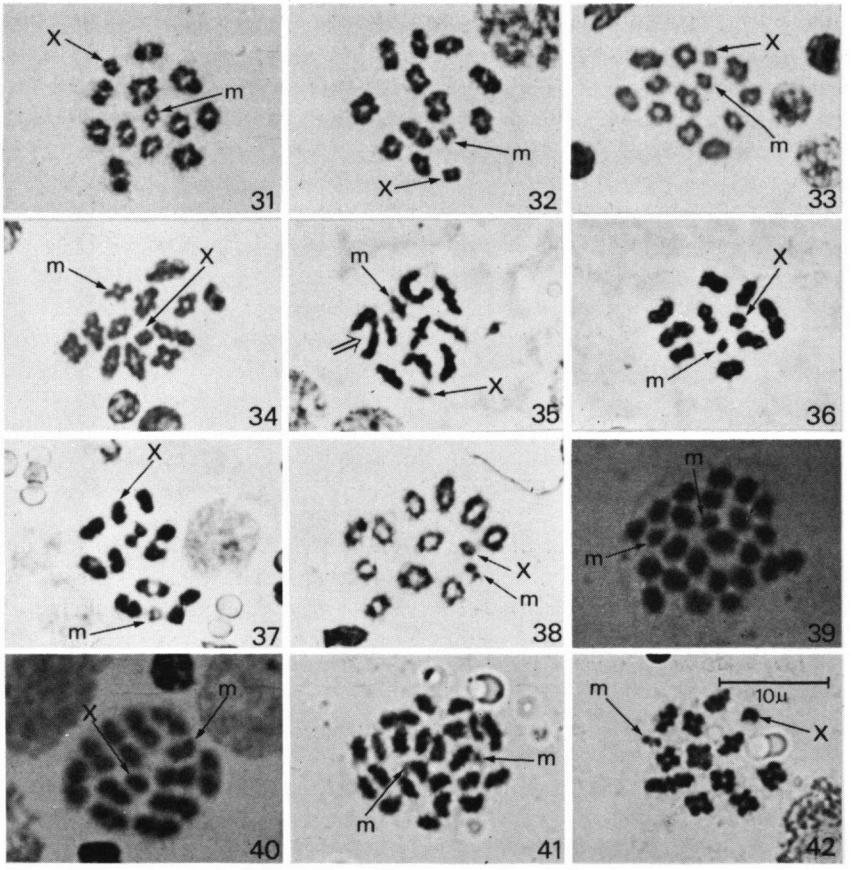
Material. — 3 ♂, Forestry Department, Rio Claro, São Paulo, Jan., 1972.

2 n (♂) = 22, n = 11, XO. The karyotype is identic to that recorded by CUMMING (1964, Bolivia) and KIAUTA & BOYES (1972, São Paulo, Brazil), and is characterized by the presence of an extra large bivalent at metaphase I.

ERYTHRODIPLAX UMBRATA (LINNAEUS, 1758)
Figure 38

Material. — 1♂, Cruzeiro do Sul, Acre, Sept. 8, 1972.

2 n = 25, n = 13. There is but little variation in the size of the metaphase I bivalents, save for a minute *m*, of about the same magnitude as X at this stage.



Figs. 31-42. Male germ cell chromosomes of some Libellulidae (Lacto-acetic-orcein squash, 1500 X): (31-32) *Erythrodiplax connata fusca* (Ramb.), early metaphase I; — (33-34) *E. latimaculata* Ris, early metaphase I; — (35-37) *E. media* Borror, various metaphase I stages (the extra large bivalent is marked by an arrow in Fig. 35); — (38) *E. umbrata* (L.), late diakinesis; — (39-40) *Miathyria marcella* (Sel.), spermatogonial metaphase (Fig. 39) and metaphase (Fig. 40); — (41-42) *Micrathyria artemis* Ris, spermatogonial metaphase (Fig. 41) and metaphase I (Fig. 42).

The karyotype morphology of this species has so far not been described, but the chromosome numbers reported by CUMMING (1964, Bolivia) and CRUDEN (1968, Dominica) are the same. The *m*-chromosomes are present in all populations studied.

LEPTHEMIS VESICULOSA (FABRICIUS, 1775)
Figure 25

Material. — 2 ♂, Rio Claro, São Paulo, Febr. 10, 1971.

2 n = 25, n = 13. The primary spermatocyte metaphase elements are of gradually decreasing magnitude, X is the smallest of the set, and there are no *m*-chromosomes. The same chromosome number and the absence of the *m* were recorded by CUMMING (1964) from Bolivia.

MIATHYRIA MARCELLA (SELYS, 1857)
Figures 39-40

Material. — 2 ♂, Rio Claro, São Paulo, Febr. 1971.

2 n = 25, n = 13. The spermatogonial metaphase elements are nearly uniform in size, save for a slightly smaller *m*-pair. The sex chromosome is not recognizable at this stage. At metaphase I the *m*-bivalent is larger than the unpaired X. The *m*-bivalent and the same chromosome number were reported by CUMMING (1964) from Bolivia.

MICRATHYRIA ARTEMIS RIS, 1911
Figures 41-42

Material. — 1 ♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. At spermatogonial metaphase one large and an *m*-pair can be distinguished. At metaphase I the X is the second smallest of the set.

MICRATHYRIA HESPERIS RIS, 1911
Figures 43-44

Material. — 2 ♂, Rio Claro, São Paulo, Jan. 8, 1971.

2 n = 25, n = 13. The primary spermatocyte set is similar to that of the preceding species, but no bivalent is distinctly large.

The two *Micrathyria* species dealt with here, bring the number of cytologically examined members of the genus up to 11. The chromosome

numbers of the other nine have been published by CUMMING (1964, without illustrations and descriptions) and by KIAUTA & BOYES (1972). The type number of the genus is 13, but 12 elements occur in two species and 11 in one. Except in the n = 11 and one of the n = 12 species, *m*-chromosomes are present in all of them. Nothing could be said either on the origin of the low-n karyotypes or on the mode of sex determination in these.

OLIGOCLADA MONOSTICHA BORROR, 1931
Figure 45

Material. — 2 ♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 23, n = 12. This is the first member of the genus studied cytologically. The metaphase I set is peculiar by the presence of a huge bivalent, which is certainly due to a fusion of two elements of the primary karyotype. The *m*-bivalent is minute and the X is the second smallest of the set at this stage. It is considerably larger than the *m*-bivalent, but has hardly a quarter of the volume of the smallest "normal" bivalent.

ORTHEMIS CULTRIFORMIS CALVERT, 1895
Figures 46-47

Material. — 3 ♂, Cruzeiro do Sul, Acre, Sept., 1972.

2 n = 23, n = 12. At diakinesis some bivalents show two chiasmata. One of the metaphase I elements is considerably larger than the others. Among the remaining, two are large, the others are medium-sized, and the *m* is minute. The sex element is the second smallest of the set.

CUMMING (1964) described and illustrated Bolivian material, but did not make any reference to the increased chiasma frequency.

ORTHEMIS FERRUGINEA (FABRICIUS, 1775)
Figure 48

Material. — 2 ♂, Rio Claro, São Paulo, March 1972.

2 n = 23, n = 12. At diakinesis two chiasmata occur in at least eight bivalents. Four of the latter are distinct by their larger size, one being larger than the others. The X and *m* are small and of similar size, the former segregates precociously at metaphase I.

The cytology of various populations of this widely spread species has been reviewed by KIAUTA & BOYES (1972).

PANTALA FLAVESCENS (FABRICIUS, 1798)
Figure 49

Material. — 1♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. The cytology of this nearly cosmopolitan species has been studied on material from Hawaii, India, Nepal, Madagascar, Bolivia (cf. KIAUTA, 1975) and from southern Africa (VAN BRINK & KIAUTA, 1977). It seems that the relative size of the *m* is peculiar on the geographic population level. In our specimen the *m*-bivalent is small (but not minute), slightly smaller than the X. The largest and the second smallest bivalent are also readily distinguishable at metaphase I. In some of the Old World populations, notably so in Nepal, the *m*-bivalent is extremely minute, while the other autosomes, save for the largest bivalent, are graded in size.

PERITHEMIS LAIS (PERTY, 1834)
Figures 50-51

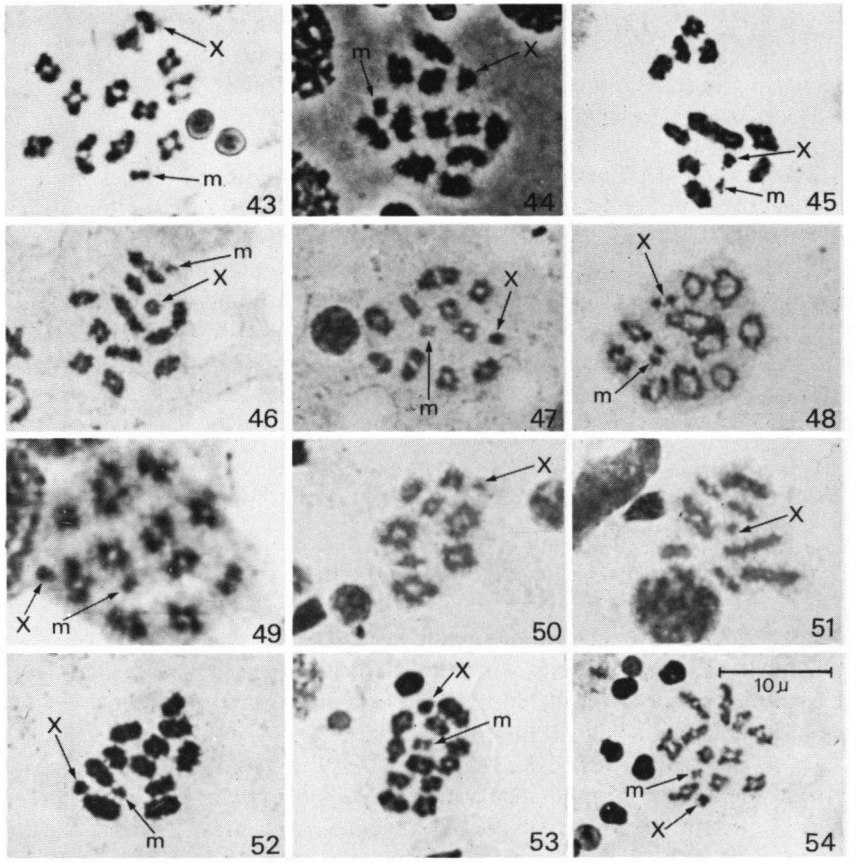
Material. — 3♂, Emas Falls, Pirassununga, São Paulo, Nov. 1973.

2 n = 17, n = 9. The spermatocyte I karyotype consists of four large and four medium sized bivalents; the unpaired X is minute. There is hardly any size gradation among the elements of the same class, while the large bivalents are at least twice as big as the medium ones.

In the Bolivian material described and illustrated by CUMMING (1964) "five bivalents occur [in the polar view of metaphase I] which are much larger than the other three. The smallest [of them] may represent what was the largest pair of the original karyotype. The other four, still larger, bivalents seem to contain chromosomes which were derived from the fusion of two chromosomes of the original karyotype". This is certainly a very acceptable explanation of the origin of the karyotype of this species. Since, however, there are only four large and four medium sized bivalents in our material, and there is no size gradation within the two classes, no extra large pair (bivalent) occurred in the primary karyotype of the Brazilian population. More material would have to be examined in order to ascertain whether or not the size polymorphism is peculiar for different geographic populations.

PERITHEMIS MOOMA KIRBY, 1889
Figure 52

Material. — 2♂, Rio Claro, São Paulo, Sept. 1973; — 2♂, Emas Falls, Pirassununga, São Paulo, Jan. 1974.



Figs. 43-54. Male germ cell chromosomes of some Libellulidae (Lacto-acetic-orcein squash, 1500 X): (43-44) *Micrathyria hesperis* Ris, late diakinesis (Fig. 43) and early metaphase I (Fig. 44); — (45) *Oligoclada monosticha* Borror, early metaphase I; — (46-47) *Orthemis cultriformis* Calv., early metaphase I; — (48) *O. ferruginea* (Fabr.), late diakinesis; — (49) *Pantala flavescens* (Fabr.), late diakinesis; — (50-51) *Perithemis lais* (Perty), late diakinesis; — (52) *P. mooma* Kirby, metaphase I; — (53) *Uracis imbuta* (Burm.), early metaphase I (note the large bivalent); — (54) *U. ovipositrix* Calv., late diakinesis.

2 n = 25, n = 13. The *m*-bivalent is considerably smaller than X at metaphase I. In other respects the karyotype is identic to that described by CUMMING (1964) from Bolivia.

THOLYMIS CITRINA HAGEN, 1867
Figure 26

Material. — 2♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. This is the first cytologically examined member of the genus. Save for an *m*-bivalent, the metaphase I bivalents are gradually decreasing in magnitude, and X is the smallest of the set.

TRAMEA BINOTATA (RAMBUR, 1842)
Figures 27-28

Material. — 2♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. The karyotype is essentially similar to that of the seven other species of the genus studied cytologically (cf. KIAUTA, 1972b, sub *Trapezostigma*). The spermatogonial elements are of gradually decreasing size, the smallest is the *m*-pair. At metaphase I the X is the second smallest of the set.

URACIS IMBUTA (BURMEISTER, 1839)
Figure 53

Material. — 2♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. The characteristic feature of the primary spermatocyte metaphase is a large bivalent. All other elements are of gradually decreasing magnitude at this stage, including X and the *m*-bivalent. The former is the second smallest of the set.

URACIS OVIPOSITRIX CALVERT, 1909
Figure 54

Material. — 1♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. This and the preceding species are the first members of the genus so far examined. The metaphase I karyotypes are similar, but all elements of *ovipositrix* appear smaller than in *imbuta*, and the size variation among them is considerably more pronounced. This applies to the *m*-bivalent and X as well. On the other hand, a distinctly large bivalent, as occurring in *imbuta*, is lacking in this species.

ZENITHOPTERA LANEI SANTOS, 1941
Figures 29-30

Material. — 3♂, Cruzeiro do Sul, Acre, Sept. 1972.

2 n = 25, n = 13. At spermatogonial metaphase the largest and the smallest

(*m*)pairs are recognizable. At metaphase I the *m*-bivalent is minute, while X is equal in size to the second smallest bivalent. This is the first member of the genus examined cytologically.

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