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# THE KARYOTYPES OF SOME ANISOPTERA FROM SURINAM

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The male germ cell chromosome complements are described and illustrated of the following 25 spp. from the surroundings of Paramaribo, Surinam, 16 of which (asterisked) have not been previously examined cytologically: Gomphidae: *Phyllogomphoides undulatus* (Needham)* (n=12, *m*), *Zonophora calippus* Sel.* (n=12, *m*); — Aeshnidae: *Anax concolor* Brauer* (n=14, *m*), *Coryphaeschna viriditas* Calv.* (2n=23; n=13, XO; n=14, *m*); — Libellulidae: *Anatya guttata* (Erichs.)* (n=13), *Diastatops pullata* (Burm.)* (n=12, *m*), *Dythemis williamsoni* Ris* (2n=22, neo-XY; n=11, neo-XY; n=12, neo-XY; n=13, *m*, XO), *Erythemis credula* (Hag.)* (n=13, *m*), *E. haematogastra* (Burm.)* (n=13), *E. peruviana* (Ramb.)* (n=13), *Erythrodiplax b. basalis* (Kirby) (n=13, no *m* in the Surinam specimen, but it occurs in material from Bolivia and Brazil), *E. connata fusca* (Ramb.) (n=13, *m*), *E. paraguayensis* (Foerst.) (n=13, *m*, but n=12, without *m* from Bolivia), *E. umbrata* (L.) (n=13, *m*), *E. unimaculata* (de Geer) (n=13, *m* uncertain), *Lepthemis vesiculosa* (Fabr.) (n=13), *Micrathyria eximia* Kirby* (n=13, *m*), *Oligoclada amphinome* Ris* (n=13, *m*), *Orthemis aequilibris* Calv.* (2n=12, n=6, neo-XY), *O. ferruginea* (Fabr.) (2n=25, 2*m*, XO; 2n=23, *m*, XO; n=12, *m*, XO; n=11, *m*, neo-XY; n=10, neo-XY), *Rhodopygia geijskesi* Belle* (n=13, *m*), *Tramea binotata* (Ramb.) (n=13, *m*), *Uracis imbuta* (Burm.) (n=13, *m*), *Zenithoptera americana* (L.)* (n=13, *m*), and *Z. fasciata* (L.)* (n=13, *m*). — It is argued that the genus *Dythemis*, viewed as a whole, appears cytologically peculiar within the subfamily, and that the evidence on the cytogenetic features of *O. ferruginea* is in good agreement with its general morphological variation and unusually wide geographic range.

## INTRODUCTION

While on military duty in Paramaribo, Surinam (formerly Dutch Guiana) (March 1, 1973 - February 28, 1974), Mr. Jacques Jean Belle of Velp, the Netherlands, kindly sent through the Royal Dutch Airlines (KLM) a number of parcels containing living dragonfly specimens, collected in the savannah

ponds at Zanderij, the Paramaribo International Airport, some 50 km south of the city. In this way I was able to prepare the chromosome preparations within 48 hours (at most) after the moment of collection. This material has been supplemented by a small but interesting collection of living specimens brought from Paramaribo by Dr. D.C. Geijskes of the Leyden Museum of Natural History, upon his return from a vacation in September 1973. The collection includes 25 species, referable to 17 genera of Gomphidae (2), Aeshnidae (2), and Libellulidae (13), among which no less than 16, pertaining to 13 genera of the three families are cytological novelties, viz. *Phyllogomphoides undulatus* (Needham), *Zonophora calippus* Sel., *Anax concolor* Brauer, *Coryphaeschna viriditas* Calv., *Anatya guttata* (Erichs.), *Diastatops pullata* (Burm.), *Dythemis williamsoni* Ris, *Erythemis credula* (Hag.), *E. haematogastra* (Burm.), *E. peruviana* (Ramb.), *Micrathyria eximia* Kirby, *Oligoclada amphinome* Ris, *Orthemis aequilibris* Calv., *Rhodopygia geijskesi* Belle, *Zenithoptera americana* (L.) and *Z. fasciata* (L.). No members of the genera *Phyllogomphoides*, *Zonophora* and *Anatya* have been previously studied cytologically.

Most of the species dealt with here are but little more than new items in a catalogue of odonate chromosome cytotaxonomy, and are brought here on record with this purpose only.

Of some more interest is the evidence on *Dythemis williamsoni* which, coupled with the available record on other taxa of the genus, points to cytologically peculiar features of the genus as a whole.

Of particular interest is the fresh evidence on the cytotaxonomic and cytogenetic features of *Orthemis ferruginea*. This species is noted for its exceptional geographic range, which is probably still expanding. The pronounced variation in the recombination index seems in general agreement both with this circumstance and with the remarkable morphological variation, though neither of these features shows a clear geographic gradient.

## DESCRIPTIONS AND DISCUSSIONS OF THE KARYOTYPES

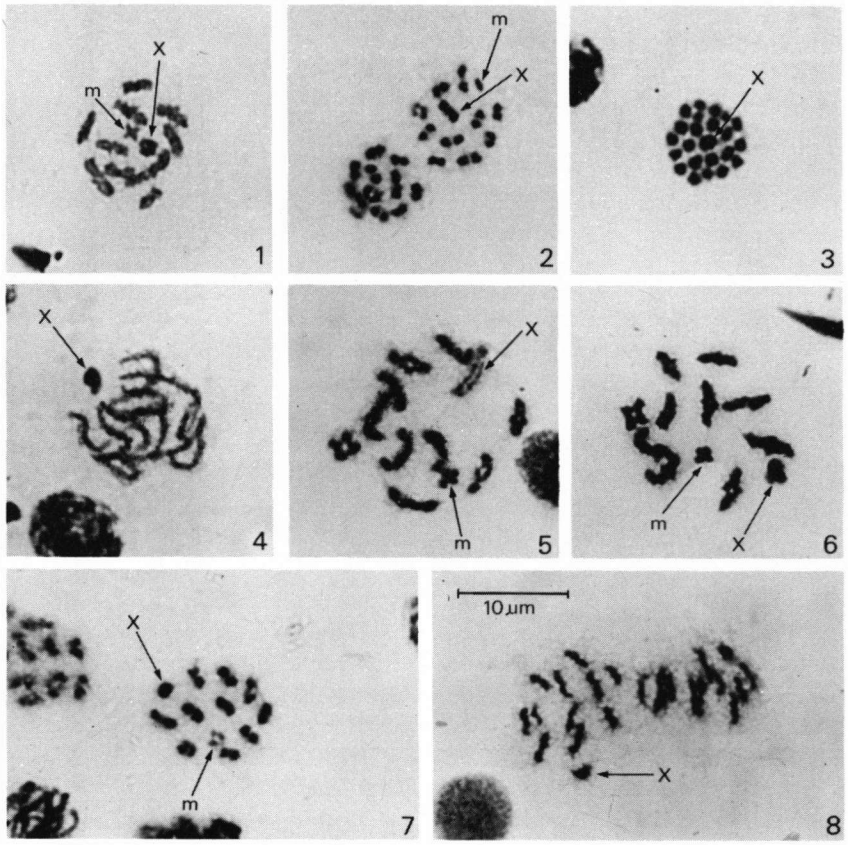
### Gomphidae

#### *PHYLLOGOMPHOIDES UNDULATUS* (NEEDHAM, 1944)

Figures 1-2

Material. — 1♂, Sabakoekreek, Zanderij, Paramaribo, Sept. 5, 1973. — [74 complements photographed].

n = 12. The metaphase I elements are of gradually decreasing magnitude, save for one distinctly large bivalent and a considerably large *m*. The rather voluminous, unpaired X has about the size of the smaller bivalents (Fig. 1),




Figs. 1-8. Male germ cell chromosomes of *Phyllogomphoides undulatus* (Needham) (Figs. 1-2) and *Zonophora calippus* Sel. (Figs. 3-8) (Feulgen squash, 1500 X): (1) early metaphase I; — (2) metaphase II; — (3) spermatogonial metaphase; — (4) pachytene; — (5) late diakinesis (note the isocycly of the sex element); — (6) early metaphase I; — (7) metaphase II; — (8) anaphase II.

while it is the smallest of the set in the secondary spermatocyte metaphase (Fig. 2).

This is the first cytologically examined member of the genus.

### *ZONOPHORA CALIPPUS* SELYS, 1869
Figures 3-8

Material. — 3 ♂, Zanderij, Paramaribo, Dec. 3, 1973. — [519 complements photographed].

2n = 23, n = 12. The spermatogonial metaphase is characterized by the occurrence of an unpaired, distinctly large element (Fig. 3), considered to

represent the sex chromosome. The *m*-pair is rather large, hence indistinguishable at this stage.

In the pachytene bouquet the X is positively heteropycnotic (Fig. 4), but it is isocyclic at diakinetic stages (Fig. 5), similarly to the situation encountered in *Aphylla williamsoni* (Gloyd) (KIAUTA & VAN BRINK, 1978). At early metaphase I it becomes positively heteropycnotic again, and is second in size to the *m*-bivalent only (Fig. 6). While at metaphase I the autosomal bivalents are, save for *m*, of gradually decreasing magnitude, only little size variation occurs at metaphase II, at which stage the X is among the medium-sized elements (Fig. 7). At anaphase/telophase II it precedes the dividing autosomes in the usual way (Fig. 8).

This is the first cytologically examined member of the genus.

## Aeshnidae

### *ANAX CONCOLOR* BRAUER, 1865

Figures 9-10

Material. — 1 ♂, Zanderij, Paramaribo, Dec. 3, 1973. — [104 complements photographed].

n = 14. The primary spermatocyte karyotype is peculiar by the considerable size variation of the elements, viz. one bivalent is conspicuously large, the *m*-bivalent is extremely minute, and the unpaired X is but slightly larger than the *m* (Fig. 10).

The despiralization of the diakinetic elements is not simultaneous (Fig. 9).

The species has not been previously examined cytologically, and deviates, in the above features, from all other known members of the genus. (For references cf. KIAUTA, 1972, 1975).

### *CORYPHAESCHNA VIRIDITAS* CALVERT, 1952

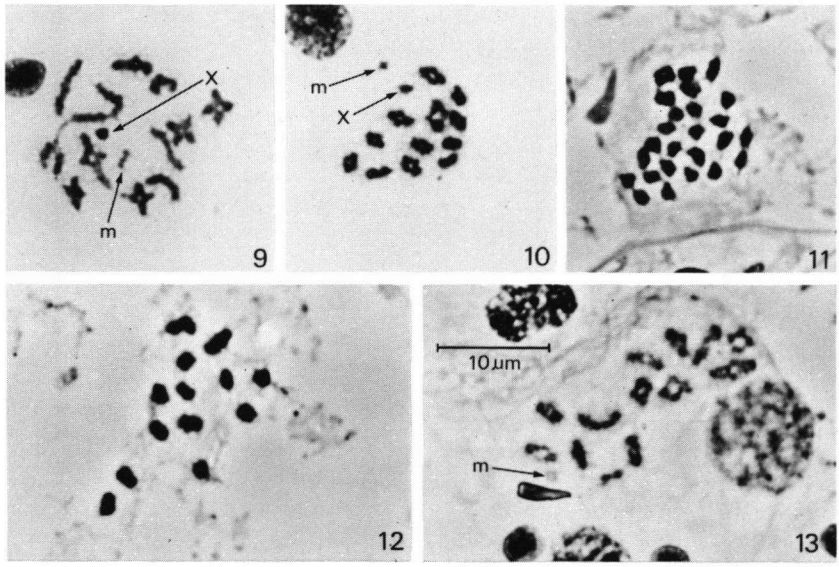
Figures 11-13

Material. — 1 ♂, Pontjibrug, Zanderij, Paramaribo, July 23, 1973. — [115 complements photographed].

2n = 23, n = 13, 14. The spermatogonial metaphase elements are almost uniform in size and shape, the *m*-chromosomes are lacking, and the X cannot be distinguished from the autosomes (Fig. 11). A similar situation prevails in the n = 13 complements at metaphase I (Fig. 12). In some metaphase I figures, however, a very tiny, weakly stained additional element of apparent bivalent structure occurs (*m*) (Fig. 13). The small X is the second smallest at this stage.

The species has not been previously studied cytologically. In *C. adnexa* (Hag.) (CUMMING, 1964) and *C. l. luteipennis* (Burm.) (FERREIRA et al., 1979) 27 and 14 elements occur at spermatogonial and primary spermatocyte

metaphase respectively. At variance with our species, the metaphase I karyotype of *C. luteipennis* is characterized by a considerable size range of the elements, including the *m*, but no evidence is available on the karyotype morphology of *C. adnexa*, though in the latter too an *m*-pair is present.




Figs. 9-13. Male germ cell chromosomes of *Anax concolor* Brauer (Figs. 9-10) and *Coryphaeschna viriditas* Calv. (Figs. 11-13) (Feulgen squash, 1500 X): (9) late diakinesis; — (10) early metaphase I; — (11) spermatogonial metaphase; — (12) metaphase I of the n = 13 complement; — (13) early metaphase I of the n = 14 complement (note the additional, minute *m*-bivalent).

## Libellulidae

### *ANATYA GUTTATA* (ERICHSON, 1848)
Figure 14

Material. — 1♂, Zanderij, Paramaribo, Dec. 3, 1973. — [7 complements photographed].

n = 13. The metaphase I elements are of gradually decreasing magnitude, there is no *m*, and the X is the smallest of the set.

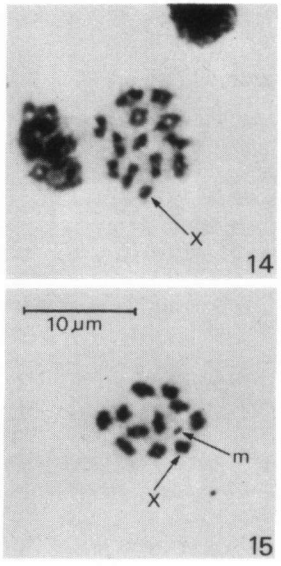
The species is new to cytology.

### *DIASTATOPS PULLATA* (BURMEISTER, 1839)
Figure 15

Material. — 2♂, Zanderij, Paramaribo, July 28 and Dec. 3, 1973. — [156 complements photographed].

n = 12. There is hardly any size gradation on the metaphase I elements, save for an extremely minute *m*. The sex element is not recognizable.

This is the third member of the genus studied cytologically. In the Bolivian *D. intensa* Montg. and *D. obscura* (Fabr.) there are 13 elements in the haploid set, including the *m*-bivalent (CUMMING, 1964). In view of the lack of any major size gradation of the elements, the origin of the reduced chromosome number in our species cannot be discerned.




Figs. 14-15. Early primary spermatocyte metaphase of (14) *Anatya guttata* (Erichs.); — (15) *Diastatops pullata* (Burm.) (Feulgen squash, 1500 X).

*DYTHEMIS WILLIAMSONI* RIS, 1916
Figures 16-24

Material. — 2♂, Zanderij, Paramaribo, Sept. 5 and Dec. 3, 1973. — [637 complements photographed].

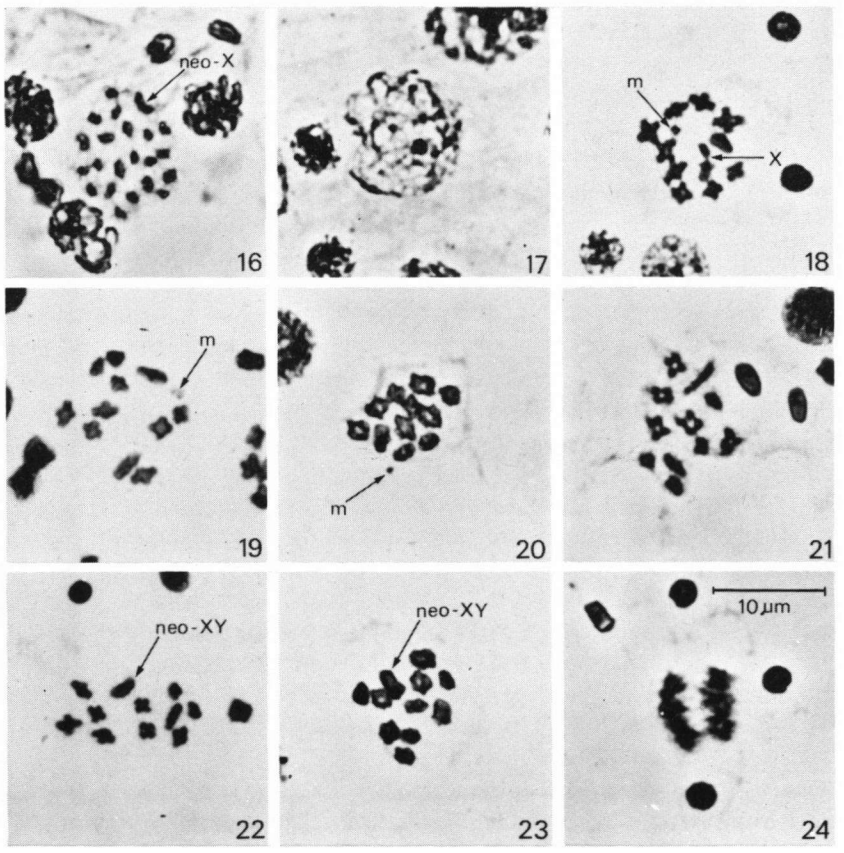
2n = 22, n = 11, 12, 13. Among the 22 spermatogonial elements, one is somewhat larger than the others. Since it is unpaired, it presumably represents the compound neo-sex element (Fig. 16).

At pachytene, there occurs a positively heteropycnotic body, corresponding to the sex-element (Fig. 17). At metaphase I, there are usually 11 or 12, occasionally 13 elements. In the n = 11 complements the *m*-bivalent is lacking (Figs. 21-23), and the neo-sex element is probably one of the largest of the set. In the n = 12 set (Figs. 19-20) and in the few n = 13 cells there is a minute *m*-bivalent. In the latter complements the small X is the second smallest of the set (Fig. 18).

In our figures of the lateral view of anaphase II the sex element is dividing simultaneously with the autosomes (Fig. 24), hence its compound nature is apparent (cf. KIAUTA, 1969).

Cytologically, the genus appears rather peculiar. So far five species have been examined. The haploid number of 13 was reported in *D. fugax* Hag. (CRUDEN, 1968), *rufinervis* (Burm.) (CUMMING, 1964) and *velox* Hag. (CUMMING, 1964, sub *multipunctata*; KIAUTA & BOYES, 1972), whereas in *D. cannacrioides* Calv. from Bolivia, CUMMING (1964) recorded 12 elements, including an *m*, and FERREIRA et al. (1979) counted 11 elements, without *m*, in the Brazilian material. *D. williamsoni* is the first species with a haploid chromosome number ranging from 11 to 13, but it should be stressed that in view of the minute size of *m* and X the two can be easily overlooked in preparations and micrographs, if only little material is available.

The few spermatogonial figures in our series, all originating from the same individual and lacking the *m*-pair, tentatively suggest that three fusions must have taken place in the original karyotype, including one involving the original *m*, viz. the two *m*-elements are fused with two autosomes, and the X with either one of these or with another autosome. Due to the small size of *m*, the increase of size of the neo-element(s) is not noticeable, whereas the neo-sex chromosome is clearly larger than the others. The original X, as apparent from the pachytene figures, must have been of medium size.




Figs. 16-24. Male germ cell chromosomes of *Dythemis williamsoni* Ris (Feulgen squash, 1500 X): (16) spermatogonial metaphase (note the large neo-X); — (17) pachytene; — (18) early metaphase I of the n = 13 complement; — (19-20) early metaphase I of the n = 12 complement (note the presence of the minute *m*-bivalent and the lack of X); — (21-23) various metaphase I stages of the n = 11 complement, lacking the *m* and the X; — (24) anaphase II, probably pertaining to the n = 12 or n = 11 complement; all elements segregating simultaneously.

*ERYTHEMIS CREDULA* (HAGEN, 1861)
Figures 25-26

Material. — 1 ♂, Zanderij, Paramaribo, Sept. 5, 1973. — [162 complements photographed].

n = 13. The metaphase I elements are of gradually decreasing magnitude, save for small X and *m* which are of similar size.

The species is new to cytology.

*ERYTHEMIS HAEMATOGASTRA* (BURMEISTER, 1839)
Figure 27

Material. — 1 ♂, Borro-Borro, Paramaribo, Jan. 14, 1974. — [2 complements photographed].

n = 13. There is probably no *m*, and at metaphase I the X is the smallest of the set. The species is new to cytology.

*ERYTHEMIS PERUVIANA* (RAMBUR, 1842)
Figures 28-29

Material. — 1 ♂, Zanderij, Paramaribo, Oct. 15, 1973. — [31 complements photographed].

2n = 25, n = 13. At metaphase I, X is the smallest of the set, whereas the autosome bivalents are nearly uniform in size. The *m*-chromosomes are lacking.

So far four other members of the genus have been studied cytologically (CUMMING, 1964; CRUDEN, 1968), all having the same chromosome number, but the *m*-chromosomes are appearing only in two of them.

*ERYTHRODIPLAX BASALIS BASALIS* (KIRBY, 1897)
Figure 30

Material. — 1 ♂, Zanderij, Paramaribo, Sept. 5, 1973. — [40 complements photographed].

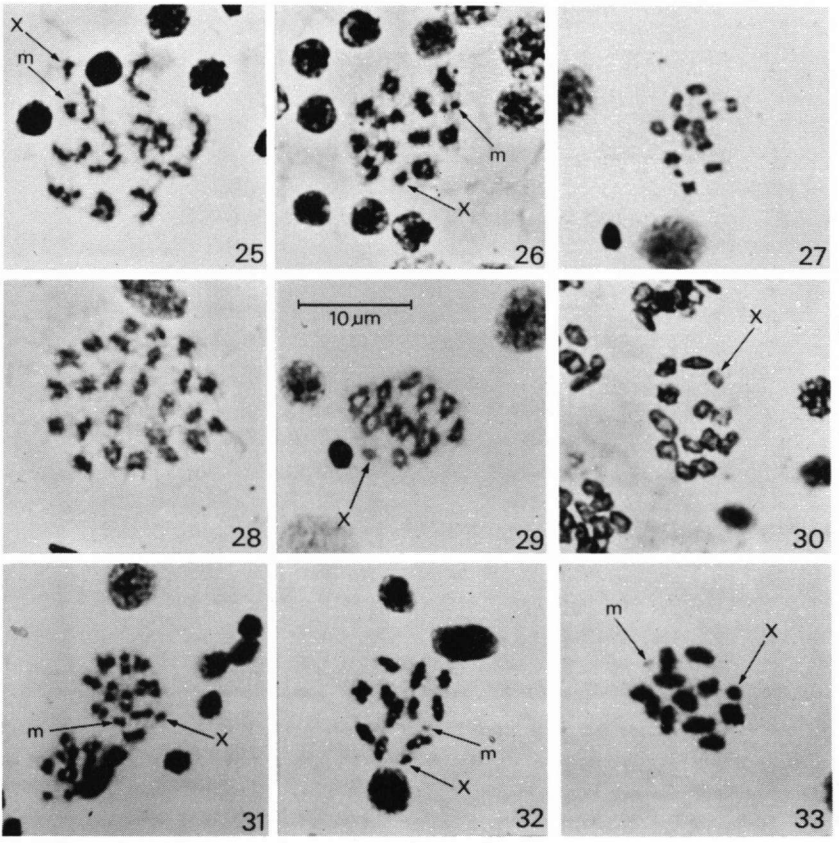
n = 13. No *m* is present in the Surinam specimen, like there was none reported for material from Bolivia (CUMMING, 1964). On the other hand, an *m*-bivalent of approximately the same size as X appears in the metaphase I figures of a specimen from Cruzeiro do Sul, Acre, Brazil (FERREIRA et al., 1979). In view of the well-known geographic variation in the male abdominal and wing coloration it is interesting that karyotypic variation is also one of the features of this form. Before we can conclude from this to a possible correlation beween the two, however, longer series of cytologically examined material would have to be available.

*ERYTHRODIPLAX CONNATA FUSCA* (RAMBUR, 1842)
Figure 31

Material. — 1 ♂, Zanderij, Paramaribo, Dec. 3, 1973. — [31 complements photographed].

n = 13. At metaphase II the *m*-bivalent is slightly larger than the X.

A pair of distinct *m*-chromosomes was reported also for two different populations from Saõ Paulo, Brazil (FERREIRA et al., 1979), whereas the *m*-elements are lacking in the Bolivian and Guatemalan material studied by




Figs. 25-33. Male germ cell chromosomes of (25-26) *Erythemis credula* (Hag.), late diakinesis and early metaphase I, respectively; — (27) *E. haematogastra* (Burm.), early metaphase I; — (28-29) *E. peruviana* (Ramb.), metaphase I (note the extremely tiny, hardly visible *m*-bivalent); — (30) *Erythrodiplax b. basalis* (Kirby), metaphase I; — (31) *E. connata fusca* (Ramb.), metaphase II; — (32-33) *E. paraguayensis* (Foerst.), spermatogonial metaphase and early metaphase I, respectively. (Feulgen squash, 1500 X).

CUMMING (1964) and CRUDEN (1968), respectively. The *m*-chromosomes also occur in *E. c. connata* (Burm.) from Chile (KIAUTA & BOYES, 1972) and in *E. c. minuscula* (Ramb.) from Florida, USA (KIAUTA & VAN BRINK, 1978). This situation is in good agreement with Kiauta & Boyes's theory on the infraspeciation and on the age of the phyletic lines of the *connata* "Artenkreis".

*ERYTHRODIPLAX PARAGUAYENSIS* (FOERSTER, 1904)
Figures 32-33

Material. — 1 ♂, Zanderij, Paramaribo, Sept. 5, 1973. — [10 complements photographed].

n = 13. At metaphase I there are 12 elements of gradually decreasing magnitude, the smallest of which is probably the X. The extremely minute and pale *m* is not easily detectable in all figures. This might be the reason that only 12 elements were reported by CUMMING (1964) from Bolivia, though a secondary origin of the *m* in our population could also be tentatively assumed on phylogenetic grounds (cf. KIAUTA & BOYES, 1972).

*ERYTHRODIPLAX UMBRATA* (LINNAEUS, 1758)
Figures 34-35

Material. — 5 ♂, Zanderij, Paramaribo, July 29 - Dec. 13, 1973. — [172 complements photographed].

2n = 25, n = 13. The spermatogonial and spermatocyte I elements (bivalents) seem to show more gradation in size than is the case in the specimen brought on record from Brazil (FERREIRA et al., 1979). The biggest autosome pair (bivalent) is large enough to be easily discerned at all stages. In spermatogonial metaphase the *m*-pair is by far the smallest of the set, and the unpaired X is not recognizable (Fig. 34). At metaphase I, the X and *m*-bivalent are similar in size; in some figures the X is the smallest of the set, in others the *m* (Fig. 35).

*ERYTHRODIPLAX UNIMACULATA* (DE GEER, 1773)
Figure 36

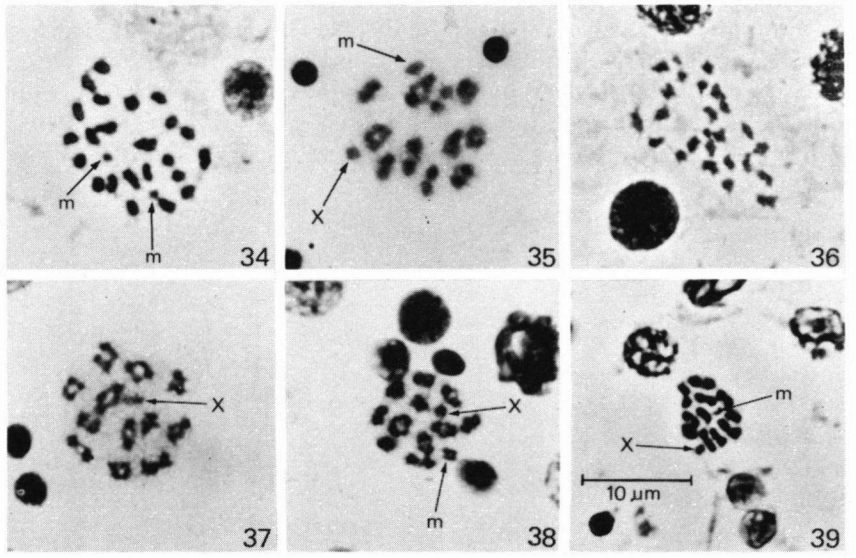
Material. — 1 ♂, Zanderij, Paramaribo, Oct. 15, 1973. — [22 complements photographed].

2n = 25. Only spermatogonial nuclei are present in our material, and the quality of the micrographs is inadequate for any further consideration. The occurrence of the *m* cannot be ascertained, but the latter has been reported for Bolivian material (CUMMING, 1964).

*LEPTHEMIS VESICULOSA* (FABRICIUS, 1775)
Figure 37

Material. — 2♂, Zanderij, Paramaribo, Sept. 5 and Oct. 15, 1973. — [76 complements photographed].

n = 13. The metaphase I complement is identic to that from Bolivia (CUMMING, 1964) and Brazil (FERREIRA et al., 1979). The X is the smallest of the set, and the *m*-bivalent is lacking.




Figs. 34-39. Male germ cell chromosomes of (34-35) *Erythrodiplax umbrata* (L.), spermatogonial metaphase and early metaphase I, respectively; — (36) *E. unimaculata* (de Geer), spermatogonial metaphase; — (37) *Lepthemis vesiculosa* (Fabr.), early metaphase I; — (38) *Micrathyria eximia* Kirby, early metaphase I; — (39) *Oligoclada amphinome* Ris, metaphase II. (Feulgen squash, 1500 X).

*MICRATHYRIA EXIMIA* KIRBY, 1897
Figure 38

Material. — 1♂, Zanderij, Paramaribo, Dec. 3, 1973. — [43 complements photographed].

n = 13. The metaphase I elements are of gradually decreasing magnitude, but the largest of them is recognizable in all figures. The smallest element at this stage is the unpaired X. In some figures the *m* is hardly discernable from the other autosome bivalents, and is but slightly superior in size to the X.

CUMMING (1964) recorded 11 elements in the male haploid set of a

species referred to as "*M.* cf. *eximia* Kirby" from Bolivia.

*OLIGOCLADA AMPHINOME* RIS, 1916
Figure 39

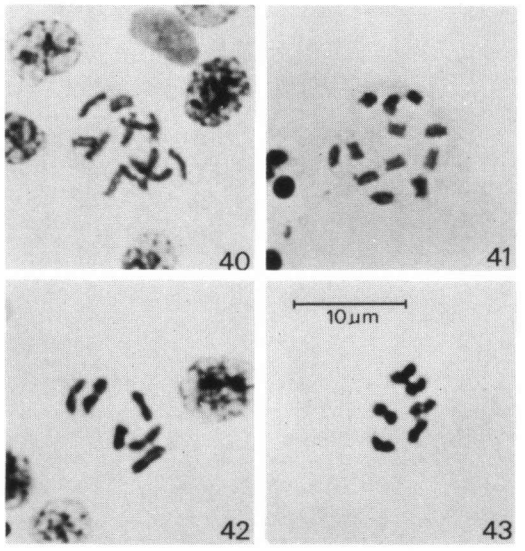
Material. — 1♂, Zanderij, Paramaribo, July 29, 1973. — [3 complements photographed].

n = 13. The three micrographs available all represent polar views of metaphase II, hence little can be said on the karyotypic morphology, save for the presence of an *m*-pair.

In *O. monosticha* Borror, studied by FERREIRA et al., (1979) 23 and 12 elements occur in spermatogonial and primary spermatocyte metaphase, respectively, a pair (bivalent) of which is exceptionally large. The *m*-pair in this species is minute, and so it appears in *O. amphinome*. Structurally the two species are not closely allied (cf. BORROR, 1931).

*ORTHEMIS AEQUILIBRIS*
CALVERT, 1909
Figures 40-43

Material. — 1♂, Borro-Borro, Paramaribo, Jan. 14, 1974. — [89 complements photographed].




Figs. 40-43. *Orthemis aequilibris* Calv. (Feulgen squash, 1500 X): (40-41) spermatogonial prometaphase and metaphase, respectively; — (42-43) primary spermatocyte metaphase.

2n = 12, n = 6. Spermatogonial metaphase elements do not show much gradation in size (Fig. 41), save for one pair which is distinctly shorter at prometaphase (Fig. 40). The same lack of size gradation appears in the metaphase I figures (Figs. 42-43). Neither the univalents nor the bivalents are noticeably large. At spermatogonial metaphase they do not show any structure, while a kind of constriction is apparent in all 6 spermatocyte-I bivalents. The sex element is, without doubt, compound, but it cannot be identified. No chromosome, at any stage, has any peculiar heteropycnotic sections, pointing to the original X. Some of the prophase nuclei, however, do show, though rather unconvincingly, two, instead of one heteropycnotic spot.

This is the fifth member of the genus examined cytologically. The male haploid chromosome numbers range between 3 and 12 (3, 4, 5, 12), the latter being considered the generic type number. No species has been previously known with the haploid number of 6. The low-n complements have neo-XY sex determination, and originate in fusion of the elements of the primary, n = 12, set (cf. KIAUTA & BOYES, 1972; FERREIRA et al., 1979).

### *ORTHEMIS FERRUGINEA* (FABRICIUS, 1775)
Figures 44-49

Material. — 5♂, Zanderij, Paramaribo, Sept. 5, 1973 - Jan. 14, 1974. The material includes one specimen pertaining to the smaller, blue type, while the other are all referable to the larger, pruinose form. — [108 complements photographed].

2n = 25, 23; n = 12, 11, 10. This variety of chromosome numbers has been found in the pruinose specimens, while the single blue individual contained only spermatocyte divisions with 12 elements. The *m*-chromosomes occur in both spermatogonial sets and in the n = 12 and n = 11 complements.

In spermatogonial metaphase the usual number is 23, including a minute *m*-pair. The largest pair is easily recognizable, but not so the unpaired sex element (Fig. 44). In a considerable percentage of micrographs of this stage (exceeding 20%) there is an extra pair of minute *m*-elements, bringing the diploid chromosome number of the male up to 25 (Fig. 45). This is the first case of the occurrence of two pairs of *m*-elements in odonate spermatogonial metaphase and the first 2n = 25 karyotype in *Orthemis*.

The spermatogonial set of 25 elements would be expected to produce 12 bivalents and an unpaired sex chromosome in the primary spermatocyte. This, however, does not seem to be the case. the spermatocytes usually contain 12 elements,the smallest of which are apparently the *m*-bivalent and the X. The remaining bivalents are gradually decreasing in magnitude, save for one that is distinctly larger than the others (Fig. 47). The additional *m*-pair in the spermatocyte I does not reappear as an extra *m*-bivalent. Judging from the pachytene figures, the second smallest element of the n = 12 metaphase I almost certainly corresponds to the unpaired X (Fig. 46).

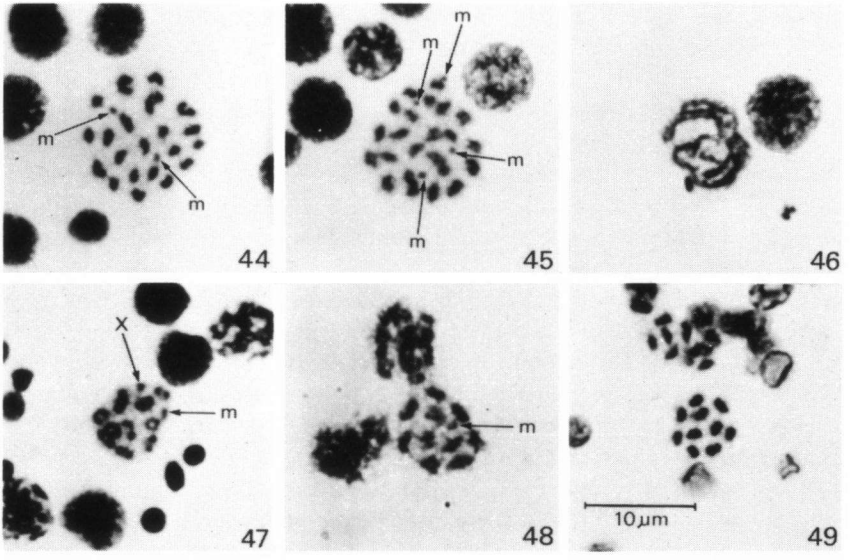
In some 20% of metaphase I micrographs 11 elements are counted, including the *m*. In polar views of this stage all seem to have a bivalent structure, pointing to the compound nature of the sex element (Fig. 48). The "normal" spermatogonial set, corresponding to the haploid number of 11, would be expected to have 21 elements. Such complements, however, were not seen in our material. It is likely, therefore, that, next to the original X, two autosome pairs are also involved in a secondary fusion, though this could not be demonstrated on the basis of our material.

In about 5% of our metaphase I micrographs there occur only 10 chromosomes, almost equal in size; the *m*-bivalent is lacking, and all elements

appear to have a bivalent structure in polar views (Fig. 49). The neo-sex element is not recognizable morphologically. The corresponding diploid sets of 19 elements are lacking.

The mode of sex determination is also subject to variation. The XO system occurs in the 2n = 25 karyotypes and in the n = 12 sets; very likely also in the 2n = 23 complements, though in the latter, due to the minuteness of the additional *m*-pair, the place of the secondary fusion or, more likely; fragmentation cannot be ascertained. The n = 11 sets have almost certainly the neo-XY mode, and the n = 10 karyotypes very definitely. CUMMING (1964) reported, from Bolivia, 2n = 10, n = 5 male complements, with the neo-XY sex determination.

In the Surinam material a single chiasma occurs per bivalent without exception and regardless of the chromosome number, hence the recombination index of the low-n karyotypes is low. This is at variance with the case reported from Brazil by FERREIRA et al. (1979), where the chiasma frequency in the n = 12 complements (the only ones encountered) was significantly higher, but it is in agreement with observations recorded by KIAUTA & BOYES (1972) from Peru. Since no n = 13 spermatocyte complements, corresponding to the 2n = 25 spermatogonial sets, were




Figs. 44-49. Male germ cell chromosomes of *Orthemis ferruginea* (Fabr.) (Feulgen squash, 1500 X): (44) spermatogonial metaphase of the usual, 2n = 23, complement; — (45) the same, of the 2n = 25 complement (note the occurrence of two *m*-chromosome pairs); — (46) pachytene; — (47) metaphase I, n = 12 complement (note one large element, presumably the neo-XY); — (48) metaphase I, n = 11 complement; — (49) metaphase I, n = 10 complement.

encountered in our material, it is doubtful whether or not the extra *m*-pair is stable. If so, this would increase significantly the spectrum of the recombination index of the species.

The question now arises whether the 25 or the 23 karyotype should be considered as the primary karyotype of the species. The subject has been discussed by KIAUTA & BOYES (1972), who arrived at the conclusion that it is most likely that the latter and not the former chromosome number represents the original complement of the genus. This has been supported both by the distribution of the chromosome numbers in the hitherto examined species, and by the karyotype morphology. The available evidence suggests that the increase of the chromosome number in our material is of secondary origin, due to an instable fragmentation of a pair of the primary, 2n = 23, karyotype.

*O. ferruginea* is by far the most wide-spread member of the genus. It is peculiar by its considerable morphological variation, which is not geographically restricted. This circumstance, at present, makes it impossible to point out any structurally distinct geographically defined infraspecific forms. The species seems to be still expanding its range; the instability of its karyotype, particularly the pronounced variation in recombination indices, causing variation in genetic fitness and flexibility, might well be related to this feature.

### *RHODOPYGIA GEIJSKESI* BELLE, 1964
Figure 50

Material. — 1 ♂, Zanderij, Paramaribo, Dec. 3, 1973. [30 complements photographed].

n = 13. The metaphase I elements slightly vary in size, save for small *m* and X, of which the latter is the smallest of the set at this stage.

After *R. cardinalis* (Erichson) (CUMMING, 1964), this is the second member of the genus the chromosome complement of which has been examined.

### *TRAMEA BINOTATA* (RAMBUR, 1842)
Figure 51

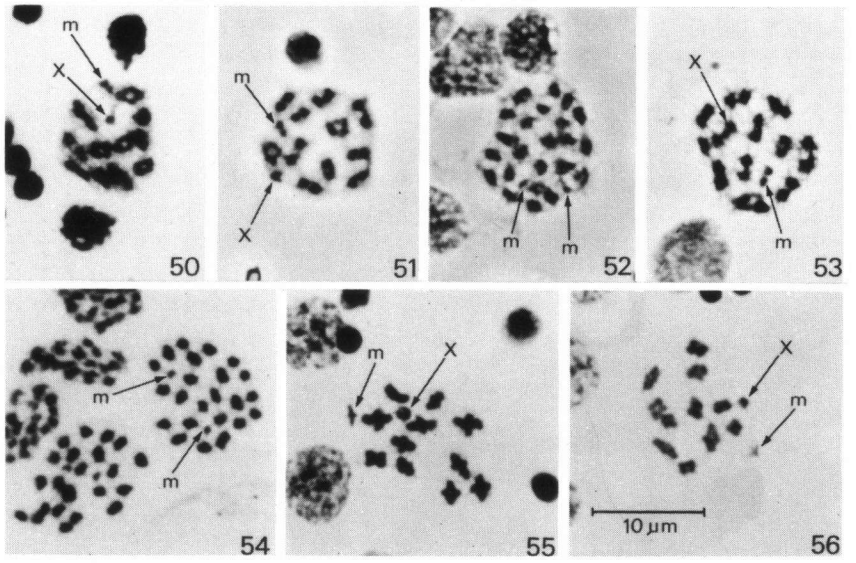
Material. — 1 ♂, Zanderij, Paramaribo, Sept. 5, 1973. — [128 complements photographed].

n = 13. The autosome bivalents are of gradually decreasing magnitude, including the *m*. The latter is similar or slightly smaller than X, hence the karyotype does not deviate from that described from Brazil (FERREIRA et al., 1979).

*URACIS IMBUTA* (BURMEISTER, 1839)
Figures 52-53

Material. — 3♂, Paramaribo, Sept. 6, 1973. — [107 complements photographed].

2n = 25, n = 13. Contrary to the situation in a specimen from Acre, Brazil (FERREIRA et al., 1979), there are two distinctly large bivalents at metaphase I (Fig. 53), but these are not recognizable in our spermatogonial micrographs (Fig. 52). The *m* bivalent is the smallest, and the X is the second smallest in the metaphase I complement.




Figs. 50-56. Male germ cell chromosomes of (50) *Rhodopygia geijskesi* Belle, early metaphase I; — (51) *Tramea binotata* (Ramb.), early metaphase I; — (52-53) *Uracis imbuta* (Burm.), spermatogonial metaphase and metaphase I, respectively; — (54-55) *Zenithoptera americana* (L.), spermatogonial metaphase and early metaphase I, respectively; — (56) *Z. fasciata* (L.), metaphase I. (Feulgen squash, 1500 X).

*ZENITHOPTERA AMERICANA* (LINNAEUS, 1758)
Figures 54-55

Material. — 1♂, Zanderij, Paramaribo, Dec. 3, 1973. — [163 complements photographed].

2n = 25, n = 13. The spermatogonial elements are fairly uniform in size (Fig. 54) and so are the metaphase I bivalents (Fig. 55), save for the minute *m*-pair (bivalent) and the X which is the second smallest at metaphase I.

The species is new to cytology.

*ZENITHOPTERA FASCIATA* (LINNAEUS, 1758)
Figure 56

Material. – 2♂, Paramaribo, Jan 4-14, 1974. – [52 complements photographed].

n = 13. The karyotypic morphology is identic to that of the preceding species. The two species, however, differ from *Z. lanei* Santos, in which the largest bivalent is discernable, and the X is equal in size to the second smallest bivalent (FERREIRA et al., 1979).

The species is new to cytology.

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