Odonatologica 7 (1): 15-25 *March 1, 1978*

MALE CHROMOSOME COMPLEMENTS OF SOME FLORIDA DRAGONFLIES, UNITED STATES*

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Received December 30, 1977

The male germ cell complements are for the first time described of the following species: *Argia fumipennis* (Burm.) (n = 14), *Ischnura ramburi* (Sel.) (2n = 27, n = 14; *m*), *Lestes vigilax* Hag. (n = 10), *Calopteryx dimidiata* Burm. (n = 13; *m*), *Aphylla williamsoni* Gloyd (2n = 25, n = 12; *m*), *Gomphus townesi* Gloyd (2n = 23, n = 12; neo-XY), *Celithemis amanda* (Hag.) (n = 13; *m*), *C. ornata* (Ramb.) (n = 13; *m*), *Erythrodiplax connata minuscula* (Ramb.) (n = 13; *m*), *Libellula auripennis* Burm. (n = 13; *m*), and *Perithemis tenera* (Say) (2n = 25, n = 13; *m*). Also included is a note on *Pachydiplax longipennis* (Burm.). The karyotype of the Florida material of this species is characterized by the presence of a minute *m*-pair, as had been recorded in 3 Californian populations, but unlike the material from West Virginia, in which the *m*-elements (bivalent) are (is) lacking (cf. R.W. CRUDEN, 1968. Can. J. Genet. Cytol. 10: 200-214).

INTRODUCTION

Thanks to the excellent organization of the Fourth International Symposium of Odonatology (Gainesville, Florida, USA; August 1-8, 1977; Chairman of the Organizing Committee: Prof. Dr. M.J. Westfall, Jr.) and to the most generous assistance by and cooperation of several colleagues present, we have been able to examine the chromosome complements of a considerable number of Florida odonate species, collected in the wider surroundings of the city of Gainesville and on a post-symposium tour to Northwest Florida. Eleven of these turned out

* Dedicated to our friends, Dr. and Mrs. MINTER J. WESTFALL, Jr., as a token of gratitude for the marvelous hospitality enjoyed in their home during the Fourth International Symposium of Odonatology, Gainesville.

to be new to cytology, hence their complements are briefly recorded here. *Pachydiplax longipennis* is mentioned because of its karyotypic variation.

The species dealt with in the present report are referable to five families, viz: Coenagrionidae: *Argia fumipennis* (Burm.), *Ischnura ramburi* (Sel.), – Lestidae: *Lestes vigilax* Hag., – Calopterygidae: *Calopteryx dimidiata* Burm., Gomphidae: *Aphylla williamsoni* (Gloyd), *Gomphus townesi* Gloyd, – and Libellulidae: *Celithemis amanda* (Hag.), *C. ornata* (Ramb.), *Erythrodiplax connata minuscula* (Ramb.), *Libellula auripennis* Burm., *Pachydiplax longipennis* (Burm.), *Perithemis tenera* (Say).

Temporary acetocarmine slides were made in the Department of Zoology, University of Florida, Gainesville, and in the Field Biological Station, Florida A + M University, Carr Lake, Santa Rosa Co., Northwestern Florida. They were further processed (Feulgen) in Utrecht. Specimens, slides and microfilms are kept in the collection of the Department of Animal Cytogenetics and Cytotaxonomy, University of Utrecht, Utrecht, the Netherlands.

DESCRIPTIONS AND DISCUSSIONS OF THE KARYOTYPES

ARGIA FUMIPENNIS (BURMEISTER, 1839)

Figure 1

Material. – 1 ♂, Blackwater River at Holt, Okaloosa – Santa Rosa Co., NW Florida, 7.VIII.1977. – [11 complements photographed].

A single slide yielded but a few micrographs of inferior quality, most of them hardly analyzable. At primary spermatocyte metaphase there are 14 elements of gradually decreasing magnitude. The X is probably the smallest of the set. If this is so, there are no *m*-chromosomes in this species.

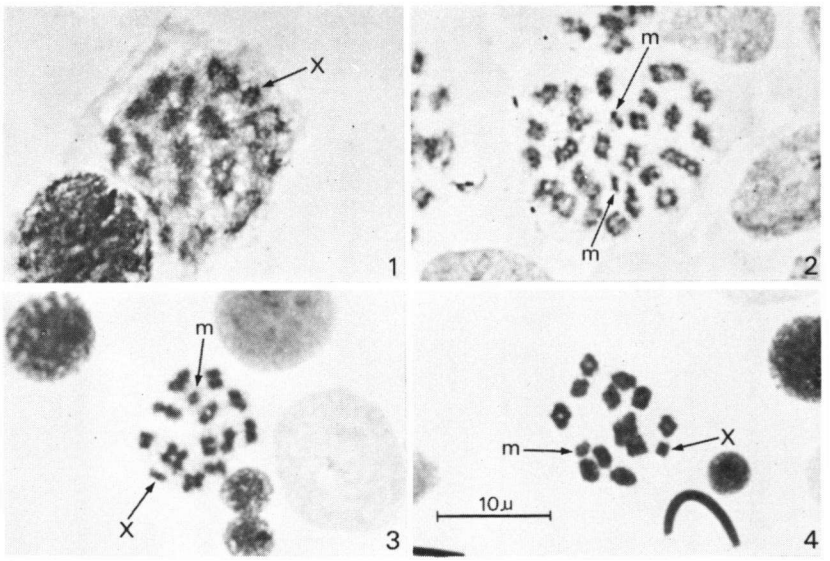
Hardly anything is known on the cytology of this genus, save for the chromosome numbers of four species (n = 14), all lacking the *m*-elements (cf. CRUDEN, 1968; CUMMING, 1964; KIAUTA, 1972b).

ISCHNURA RAMBURI (SELYS, 1850)

Figures 2-4

Material. – 2 ♂, Lake Alice, Gainesville, 9.VIII.1977. – [43 complements photographed].

The chromosome numbers, 2n = 27, n = 14, are the same as in the 11 members of the genus examined so far (KIAUTA, 1975; review and references in KIAUTA, 1972a). One pair (bivalent) is peculiar by its larger size. At spermatogonial metaphase the two *m*-elements are clearly distinct as by far the smallest of the set (Fig. 2). At metaphase I, however, the *m*-bivalent is nearly equal in



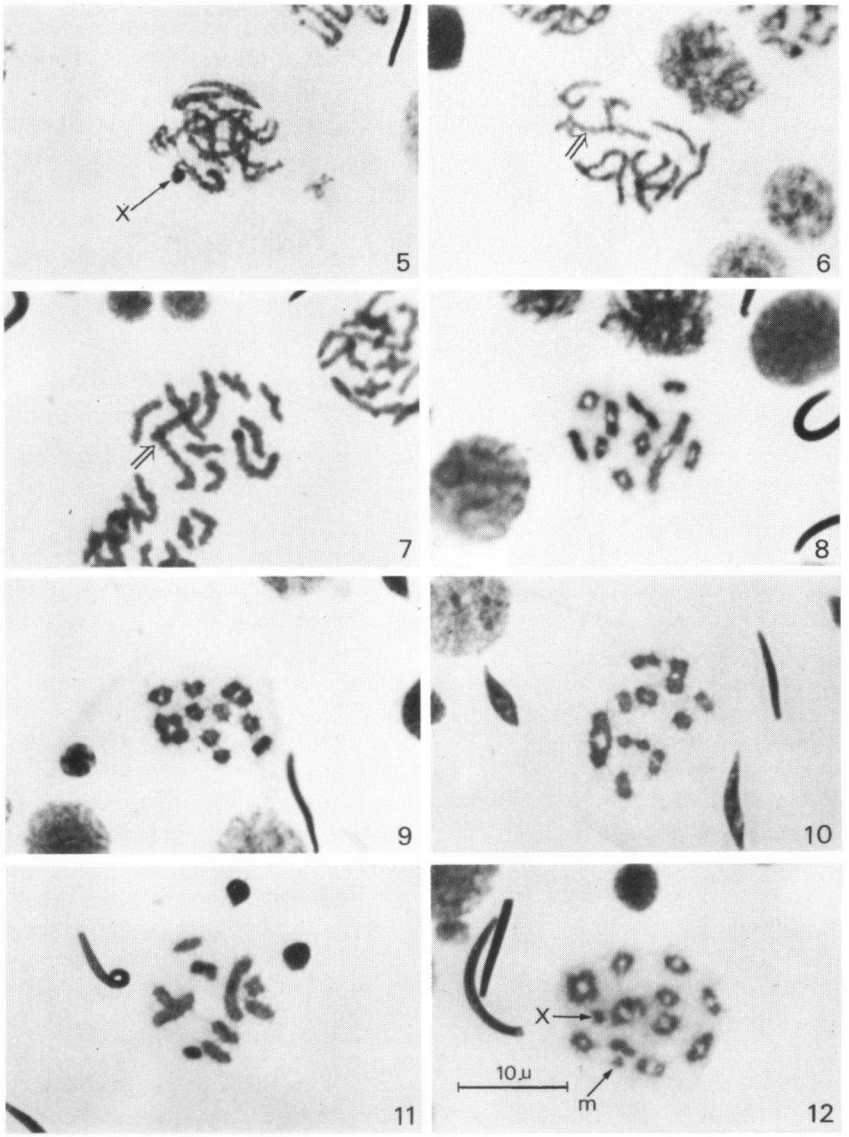
Figs. 1-4. Male germ cell chromosomes of *Argia fumipennis* (Burm.) (Fig. 1), and *Ischnura ramburi* (Sel.) (Figs. 2-4) (Feulgen squash, 1500 X): (1) *A. fumipennis*, late diakinesis; – (2) *I. ramburi*, spermatogonial metaphase, – (3-4) metaphase I.

size to the unpaired X. After *I. senegalensis* (Ramb.) this is the second species of the genus possessing a pair of *m*-chromosomes.

LESTES VIGILAX HAGEN, 1862
Figures 5-11

Material. – 1 ♂, Hatchet Creek, Highway S-225, Alachua Co., 5.VIII.1977. – [65 complements photographed].

This is the first known lestide with a male haploid set of 10 elements (for a review cf. KIAUTA & KIAUTA-BRINK, 1975). At pachytene a small positively heteropycnotic and heterocyclic element seems to be attached to one of the autosomes (Fig. 5). It certainly represents the X-chromosome, though its subsequent destiny is not apparent from our material. At diplotene and diakinesis there are 10 more or less isocyclically spiralized elements, the largest of which looks like a trivalent (Figs. 6-7). The original X can be discerned neither at this nor at metaphase I stage. At the latter, there are two distinctly large bivalents, one of which has a huge size (Figs. 8-11). The other elements are of decreasing magnitude, but it is not clear whether the smallest of these represents the unpaired X. Since anaphase I and II figures are lacking in our material, nothing can be said as to the mode of sex determination in this species.



Figs. 5-12. Male germ cell chromosomes of *Lestes vigilax* Hag. (Figs. 5-11), and *Calopteryx dimidiata* Burm. (Fig. 12) (Feulgen squash, 1500 X): (5) *L. vigilax*, pachytene, – (6-7) diplotene (note the trivalent marked by the arrow, and the absence of any heteropycnotic element or section), – (8-11) late diakinesis – metaphase I; – (12) *C. dimidiata*, metaphase I.

The usual lestide haploid number is 13, often including an extra large element. *Lestes forcipatus* Ramb. is the only other species possessing a reduced number of chromosomes (11), including two extra large elements, but retaining the original XO sex determination (cf. CRUDEN, 1968). In all but one of the fifteen n = 13 species studied, the karyotype is characterized by the presence of an *m*-pair. In the "low-number" species it seems to be lacking; instead, these are characterized by the presence of a second extra large bivalent.

CALOPTERYX DIMIDIATA BURMEISTER, 1838
Figure 12

Material. – 1 ♂, Blackwater River at Holt, Okaloosa – Santa Rosa Co., NW Florida, 7.VIII.1977. – [16 complements photographed].

n = 13, including a distinctly large bivalent. The other primary spermatocyte metaphase elements are gradually decreasing in magnitude, save for a small X and a minute *m*.

APHYLLA WILLIAMSONI (GLOYD, 1936)
Figures 13-25

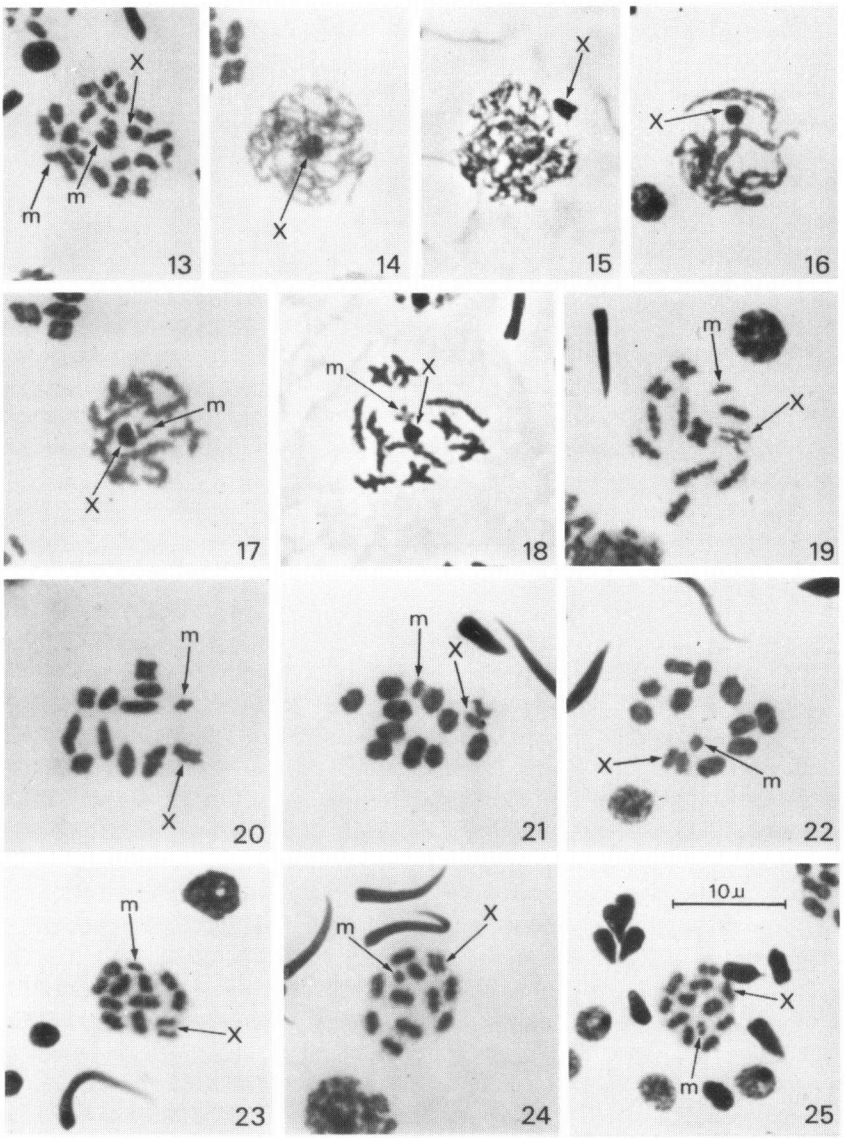
Material. – 1 ♂, Lake Alice, Gainesville, 9.VIII.1977. – [66 complements photographed].

This is the third *Aphylla* species studied cytologically (cf. CUMMING, 1964), and the first for which micrographs became available. The male chromosome numbers are 2n = 23, n = 12. The spermatogonial elements are of gradually decreasing magnitude, save for one slightly larger pair and for the *m*-pair. The sex chromosome is of medium magnitude. During the primary spermatocyte division its behaviour and appearance are greatly peculiar.

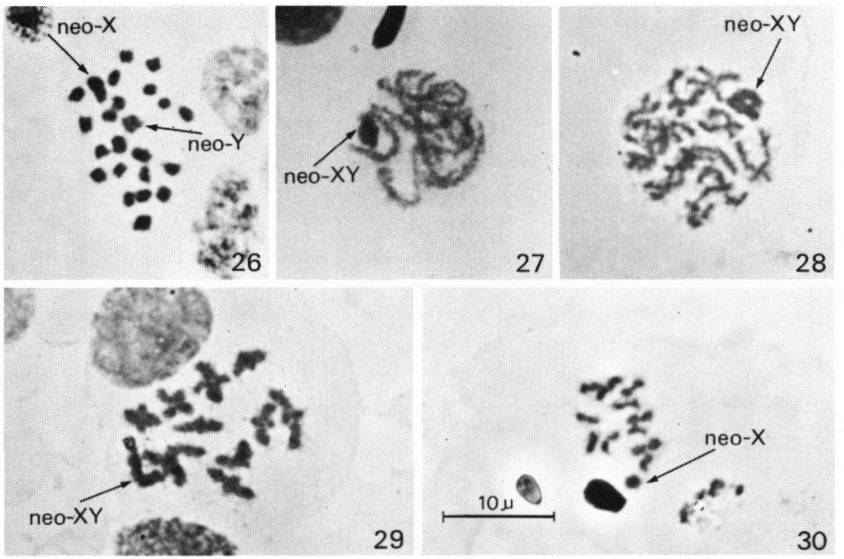
At early prophase stages, from leptotene up to diakinesis (Figs. 14-18), the sex element appears as a positively heteropycnotic body. In most figures of these stages it is not a single oval-shaped body, but its two chromatids are more or less visible (cf. e.g. Figs. 15, 17). At late diakinesis the two chromatids seem to be (optically) separated and they are negatively heteropycnotic (Fig. 19). The X despiralizes in the course of prometaphase simultaneously with the autosomal bivalents, though it is often slightly less stained than the latter, and the chromatids remain separated (Figs. 20-22). The situation remains the same in some (Figs. 23-24), but not all (Fig. 25) figures considered to represent metaphase II.

GOMPHUS TOWNESI GLOYD, 1936
Figures 26-30

Material. – 1 ♂, Blackwater River at Holt, Okaloosa – Santa Rosa Co., NW Florida,



Figs. 13-25. Male germ cell chromosomes of *Aphylla williamsoni* (Gloyd) (Feulgen squash, 1500 X): (13) spermatogonial metaphase, – (14) leptotene, – (15) zygotene, – (16) pachytene, – (17) diplotene, – (18) early diakinesis, – (19) late diakinesis, – (20-22) metaphase I, – (23-25) metaphase II (note the absence of precocious separation of X chromatids in Fig. 25).



Figs. 26-30. Male germ cell chromosomes of *Gomphus townesi* Gloyd (Feulgen squash, 1500 X): (26) spermatogonial metaphase, – (27) pachytene, – (28) diplotene, – (29) diakinesis, – (30) metaphase II.

7.VIII.1977. – [23 complements photographed].

2n = 23, n = 12. At spermatogonial metaphase the sex element is by far the largest of the set. The autosomes exhibit but slight variation in size and the *m*-pair is lacking. Sex determination is of the neo-XY mode.

CELITHEMIS AMANDA (HAGEN, 1861)
Figure 31

Material. – 1 ♂, Juniper Creek, at RT 20, Calhoun Co., 6.VIII.1977. – [20 complements photographed].

n = 13. At primary spermatocyte metaphase the elements are of gradually decreasing magnitude, save for a small *m*, and a minute X. The latter is often weekly stained, hence it is not traceable in all figures.

CELITHEMIS ORNATA (RAMBUR, 1842)
Figures 32-33

Material. – 1 ♂, Juniper Creek, at RT 20, Calhoun Co., 6.VIII.1977. – [35 complements photographed].

n = 13. There is but little size variation in the metaphase I bivalents, save for a small *m*. The latter's volume is approximately equal to that of the X at this stage. The X and *m* appear very small also in a metaphase I figure (drawing) of *C. elisa* (Hag.) published by CRUDEN (1968). It seems, therefore, that the *Celithemis* karyotypes are fairly uniform.

ERYTHRODIPLAX CONNATA MINUSCULA (RAMBUR, 1842)
Figure 34

Material. – 1 ♂, Blackwater River at Holt, Okaloosa – Santa Rosa Co., NW Florida, 7.VIII.1977. – [26 complements photographed].

This is the third infraspecific form of *E. connata* (Burm.) the chromosome complement of which became known. The male haploid number is 13, including a medium-sized X and a slightly smaller *m*. KIAUTA & BOYES (1972) discussed in detail the cytophylogeny of the genus in general and that of BORROR's (1942) section X (= *connata*) in particular. The genus is characterized by a considerable range of chromosome numbers and by a broad variation in recombination indices. On the basis of structural features and geographic distribution they have argued that in *minuscula* no cytological peculiarities could be expected, though its chromosome complement was unknown at that time. It is interesting, therefore, that this speculation is confirmed by the present observations.

LIBELLULA AURIPENNIS BURMEISTER, 1839
Figures 35-36

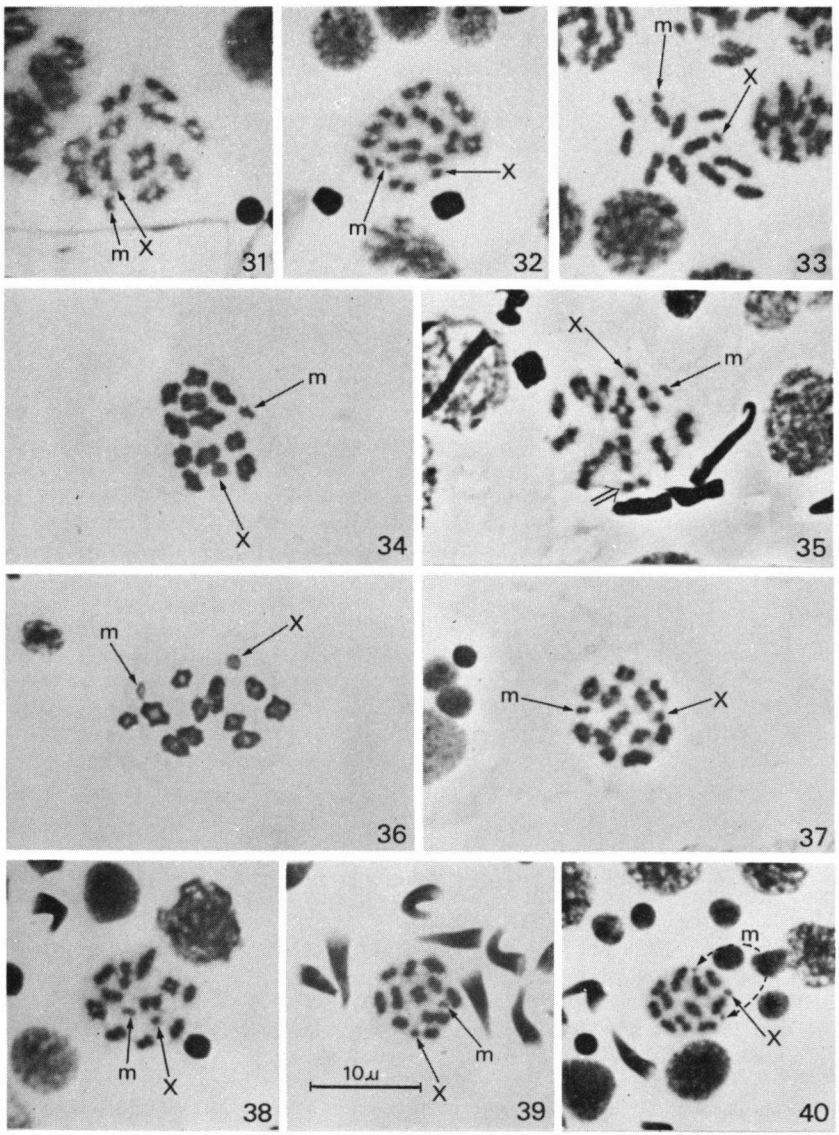
Material. – 1 ♂, Blackwater River at Holt, Okaloosa – Santa Rosa Co., NW Florida, 7.VIII.1977. – [33 complements photographed].

n = 13. At metaphase I there is a distinctly large bivalent. The X is the second smallest at this stage, and approximately twice the size of the *m*-bivalent. The second smallest bivalent tends to segregate precociously in some figures (cf. Fig. 35, arrow).

PACHYDIPLAX LONGIPENNIS (BURMEISTER, 1839)
Figure 37

Material. – 1 ♂, Gainesville, 1.VIII.1977. – [33 complements photographed].

CRUDEN (1968) examined material from three Californian populations, and from one of West Virginian provenience. The male haploid chromosome number is 13, but an *m*-bivalent occurs in the Californian material only (Glenn, Mendocino and Merced counties). In metaphase I figures of the Gainesville specimen the *m* and X are small and nearly equal in size. It seems that the species has two



Figs. 31-40. Male germ cell chromosomes of some Florida Libellulidae (Feulgen squash, 1500 X): (31) *Celithemis amanda* (Hag.), diakinesis; – (32-33) *C. ornata* (Ramb.), metaphase I; – (34) *Erythrodiplax connata minuscula* (Ramb.), metaphase I; – (35-36) *Libellula auripennis* Burm., metaphase I (note precocious segregation of one small bivalent marked by the arrow in Fig. 35); – (37) *Pachydiplax longipennis* (Burm.), metaphase I; – (38-40) *Perithemis tenera* (Say), metaphase I (note the precociously segregated *m* in Fig. 40).

chromosomal races, of which the one with an *m* pair covers a considerable area at least in the southern United States.

PERITHEMIS TENERA (SAY, 1839)
Figures 38-40

Material. – 2 ♂, Lake Alice, Gainesville, 9.VIII.1977. – [54 complements photographed].

2n = 25, n = 13. At metaphase I, one bivalent is distinctly though slightly larger than the others, which are of decreasing magnitude. The *m* and X are minute, and the former often segregates precociously (Fig. 40).

ACKNOWLEDGEMENTS

In the first place our thanks are due to Professor MINTER J. WESTFALL, Jr. and to Mrs. MARGARET WESTFALL (Gainesville, Florida, USA), who made our participation in the Gainesville Symposium a most pleasant experience. The same is true of Mrs. LEONORA K. GLOYD (Ann Arbor, Michigan), Member of Honour of the Symposium.

Dr. T.W. DONNELLY (Binghamton, New York), Mr. S.W. DUNKLE (Fresno, California), Mr. K.W. KNOPF (Gainesville, Florida), and Dr. K.J. TENNESSEN (Florence, Alabama) have been in charge of the collecting trips. It is due to their knowledge of the localities and their fauna that we were able to collect a relatively large number of species within a short time. Nevertheless, some species mentioned in the above account were given to us for examination by the colleagues participating in the trips. Among those who have rendered this and various other kinds of assistance were Mr. R.D. CUYLER (Durham, North Carolina), Dr. A.B.M. MACHADO (Belo Horizonte, Brazil), Dr. D. PAULSON (Seattle, Washington), Dr. R. RUDOLPH (Münster, GFR), Dr. E. SCHMIDT (Flensburg, GFR), and Mr. C.E. WILLIAMS (Marlin, Texas).

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