BioOne COMPLETE

Neometrypus badius a new species of cricket with an unusual sex determining mechanism (Grylloidea, Eneopteridae, Tafaliscinae, Neometrypini)

Authors: Mesa, A., and Garcia-Novo, P.

Source: Journal of Orthoptera Research, 10(1) : 81-87

Published By: Orthopterists' Society

URL: https://doi.org/10.1665/1082-6467(2001)010[0081:NBANSO]2.0.CO;2

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Neometrypus badius a new species of cricket with an unusual sex determining mechanism (Grylloidea, Eneopteridae, Tafaliscinae, Neometrypini)

A. Mesa and P. García-Novo

Departamento de Biologia, Instituto de Biociencias, UNESP, Campus de Rio Claro. Av. 24A, No. 1515, 13506-900 Rio Claro, SP, Brazil. e-mail: alejomesa@linkway.com.br

Abstract

A new species of the genus *Neometrypus* collected in Cardoso Island in the Atlantic littoral of São Paulo State is described. The species is 2n=14 (male) – 14 (female) with a neoXY-XX sex determining mechanism originated in an X-autosome tandem fusion. Illustrations of the male and female specimens, male meiosis and drawings of the male genitalia sclerites are added.

Key words

Cricket, *Neometrypus*, Tafaliscinae, chromosomes, tandem fusion.

Introduction

The genus *Neometrypus* was erected by Desutter (1988) for a new species of cricket, *Neometrypus amazonus*, collected in the north west corner of the Neotropical region. The description was based on only two male specimens, one from Departamento de Loreto in Peru and the other from the Departamento de Amazonas, Colombia. The female of the species is unknown.

According to Desutter (1988, p 366) the tribes Tafaliscini and Neometrypini (Tafaliscinae) share among others, the following external morphological characters: hind tibia with four internal and five external spines, tympanum absent and ovipositor dorso-ventrally flattened. Species of the second mentioned tribe, that includes the single genus *Neometrypus*, have wings absent and show strongly reduced tegmina or are apterous.

The species here described was collected in salt marsh vegetation (*restinga*) of Cardoso Island in the south of the São Paulo Atlantic littoral and fits very well Desutter's description of the genus *Neometrypus;* but clearly it differs from *N. amazonus* in body color pattern, size and details of the phallic structure.

Several other undescribed species with similar generic characters occur in the Atlantic littoral forest, each one with a distinct color pattern.

The sex determining mechanism found in *N. badius*, originated in a X-A tandem fusion. A similar fusion previously described in three other species of orthopteran insects, one in an eumastacid (White *et al.* 1967) and two in tettigonids (Fernández-Piqueras *et al.* 1981; Warchalowska-Sliwa *et al.* 1998).

The inverted sequence of the reductional/equational first and second meiotic divisions, respectively, owing to the presence of X-A tandem fusions was reported by the above cited authors and is discussed in the present paper.

***Neometrypus badius* n. sp.**

Holotype.— **Male** (specimen Nº 1).

Measurements: femur III length: 10.5; femur III width: 3.4; tibiae III length: 9.0; metatarsum III length: 1.5; prontum length: 4.0; pronotum width: 3.6; distance between external borders of eyes: 3.1; head vertical length: 3.8. Brasil, São Paulo (Município de Cananéia), Cardoso Island, "Interpretative" trail, 13/XII/92 (Fig. 1a); specimen deposited Museum of Zoologia in the São Paulo State University (MZUSP).

Paratypes.— ♀ Nº 2 (Fig. 1b) specimen deposited MZUSP, Nº 5, and three nymphs, 13/XII/92. Nº 8, "Morro das Almas" trail, 14/XII/92. Nº 6 and Nº 7, "Interpretative" trail, 13/III/93.

♂♂: Nº 3 and Nº 4, "Interpretative" trail, 13/XII/92.

All the specimens were collected in the same locality as the holotype by A. Mesa, P. García-Novo and E. Zefa. Adult ♀♀ Nº 5, 8 and 7 and ♂♂ 3 and 4 will be deposited in the Dep. of Biology, UNESP, Rio Claro, Brazil.

Cardoso Island has an area of 151 km^2 and extends between 45º53'48"- 48º05'42"W and 25º18'18"- 25º03'05"S, separated from the continent by the Arapira Channel.

Diagnosis.— Body color, tegmina and karyotype as reported in the description.

Description.— Ambisexual characters: body approximately 20 mm. Tegmina very short, rounded (approximately 2mm from their base to the rear border in males and slightly shorter in females), not touching at the midline. Wings absent. Tibiae III with one or two denticles between spines and 6-8 denticles before spines dorso-proximally.

Females: with dorso-ventrally flattened ovipositor.
Head, thorax, and first two abdominal segments light reddish brown. Remaining abdominal segments very dark brown. Cerci and palps very light yellow. Eyes dark brown, same color at the distal end of the tibial spines, denticles and around tibial spine sockets. Antennae uniformly light yellow along their entire length.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

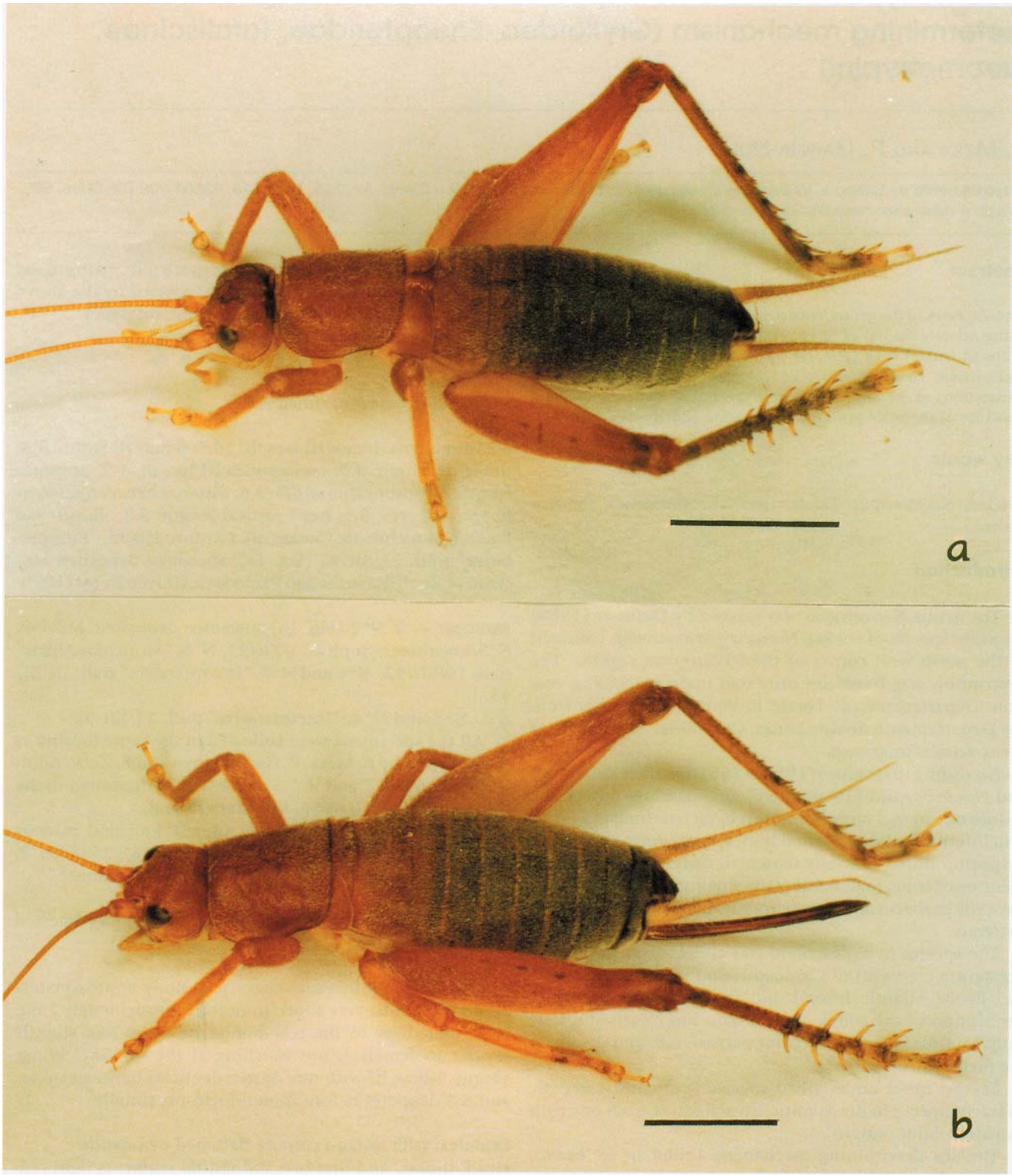


Fig. 1. *Neometrypus badius*. **a** Male holotype. **b.** Female.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

Table 1. Measurements (mm) of *N. badius* and *N. amazonus* specimens.

		FIIIL	TIIIL	PL	PW	OL	DBEBE	HVL
N. badius	♂	10.4-11.2	9.0-9.8	4.0-4.4	3.4-3.6	--	3.10-3.36	3.60-3.80
	♀	10.5-13.1	10.5-11.3	4.5-5.0	3.9-4.5	9.2-9.7	3.52-3.74	4.70-4.80
*N. amazonus**		7.3-7.9	6.2-6.6	2.7-2.8	2.3	--	--	--

FIIIL: femur III length; TIIIL: tibiae III length; PL: pronotum length; PW: pronotum width; OL: ovipositor length; DBEBE: distance between external borders of eyes; HVL: head vertical length.
*from DESUTTER (1988).

Chromosome number (2n = 14) in both sexes with a XY(♂) – XX (♀) sex determinant mechanism.

Male: phallic sclerites - the proximal ectophallic sclerites (PECS) are two parallel bars (Fig. 5d).
The distal ectophallic sclerite (DECS) is a single sclerite that covers the dorsal and lateral faces of the apical phallic region (Fig. 5d) and narrows over its distal third. PECS and DECS are nearly equal in length.
The proximal endophallic sclerite (PENS) is represented by a single sclerite with two forwardly directed parallel projections (Fig. 5e).
The distal endophallic sclerites (DENS) are two parallel sclerites (Fig. 5e).
The stylet (S) is located in the midline of the ventral ectophallic membrane, as a poorly sclerotised elongate plate (Fig. 5e).

Measurements.— Ranges of several body measurements from three ♂♂ and five ♀♀ are given in Table 1.

Etymology.— *Badius* from brown color.

Karyotype.— The chromosome number of the species is 2n=14 in both sexes. The autosomes comprise a long pair, four medium size pairs and one small pair, all of them acrocentrics. The sex chromosomes are of the neoX-neoY type with both chromosomes acrocentric. During first prophase a median size bivalent becomes heterochromatic (see thick arrows in Fig 2a, b, d). The small bivalent is partially heterochromatic, as observed in the same figures (a and b, thin arrows). The sex bivalent shows the primitive X (XL) strongly heterochromatic (Fig. 2a-e) during first prophase stages. The XR segment remains euchromatic (see diakinesis of Fig. 2b) while the Y chromosome becomes heterochromatic from the middle of diplotene to diakinesis (Fig. 2e, i). During pachytene (Fig. 2b), the pairing of XR-Y occurs along most of their lengths (Fig. 2b, c), but from the middle diplotene it is clear that there are no chiasma between the XR and Y as seen in Fig. 2 e, i, h. The sex chromosomes instead seem to be connected by a single chiasma between the small arms as observed in the diakinesis of Fig. 2e and MI of Fig. 2f, g.

During MI the orientation of the centromeres of both X and Y seems to be amphitelic, and the XY bivalent goes through a true equational division during AI (Fig. 2k) and a reductional one at AII (Fig. 2m).

Discussion

According to Desutter (1988) the tribe Neometrypini is comprised of the genus *Neometrypus*, with a single species described (*N. amazonus*), South American species of the genus *Parametrypus* and two new genera, mentioned but not described by her. Within *Parametrypus* only one species (*aculeatus*) is reported from South America (Otte 1994); it was described by Saussure in 1878. The locality for this species is "Le Brèsil, Sierra Giva" which probably means "Serra Geral", an extense territory in the South and South East of Brazil. Saussure's description of *P. aculeatus* indicates that the ovipositor is "grêle" and is not specified to be dorso-ventrally depressed. For this reason the species cannot be included in the subfamily Tafaliscinae.

N. amazonus was described based on two males, one from Peru and the other from Colombia, the female being unknown. Desutter (1988) says that species of the tribe Neometrypini occur in the west of the Amazonian region, the Brazilian state of Rio Grande do Sul, the east coast of Brazil and the surroundings of Buenos Aires (Argentina); she does not mention the origin of this information.

The species *N. amazonus* and *N. badius* differ in several characters. The first, that *N. amazonus* is approximately 80% the size of *N. badius* (see Table 1). Though the phallic structure is basically the same, the species show differences in the proportion of the sclerites. The PECS and DECS are equal in length in *N. badius* while in *N. amazonus* PECS are approximately 80% the length of the DECS. The color of the species is clearly different when the written description of *N. amazonus* is compared. Several species of the genus *Neometrypus* collected by the authors of this paper in the Atlantic forest of the São Paulo State differ from each other in body color, size and karyotypes, but none of them show an X-autosome tandem fusion.

Desutter's diagnosis of the genus *Neometrypus* includes several body color characters. In consequence, each one of the species we collected in São Paulo State, differing among other characters in color pattern, should belong to different genera. We do not agree with this criterion and consider that

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

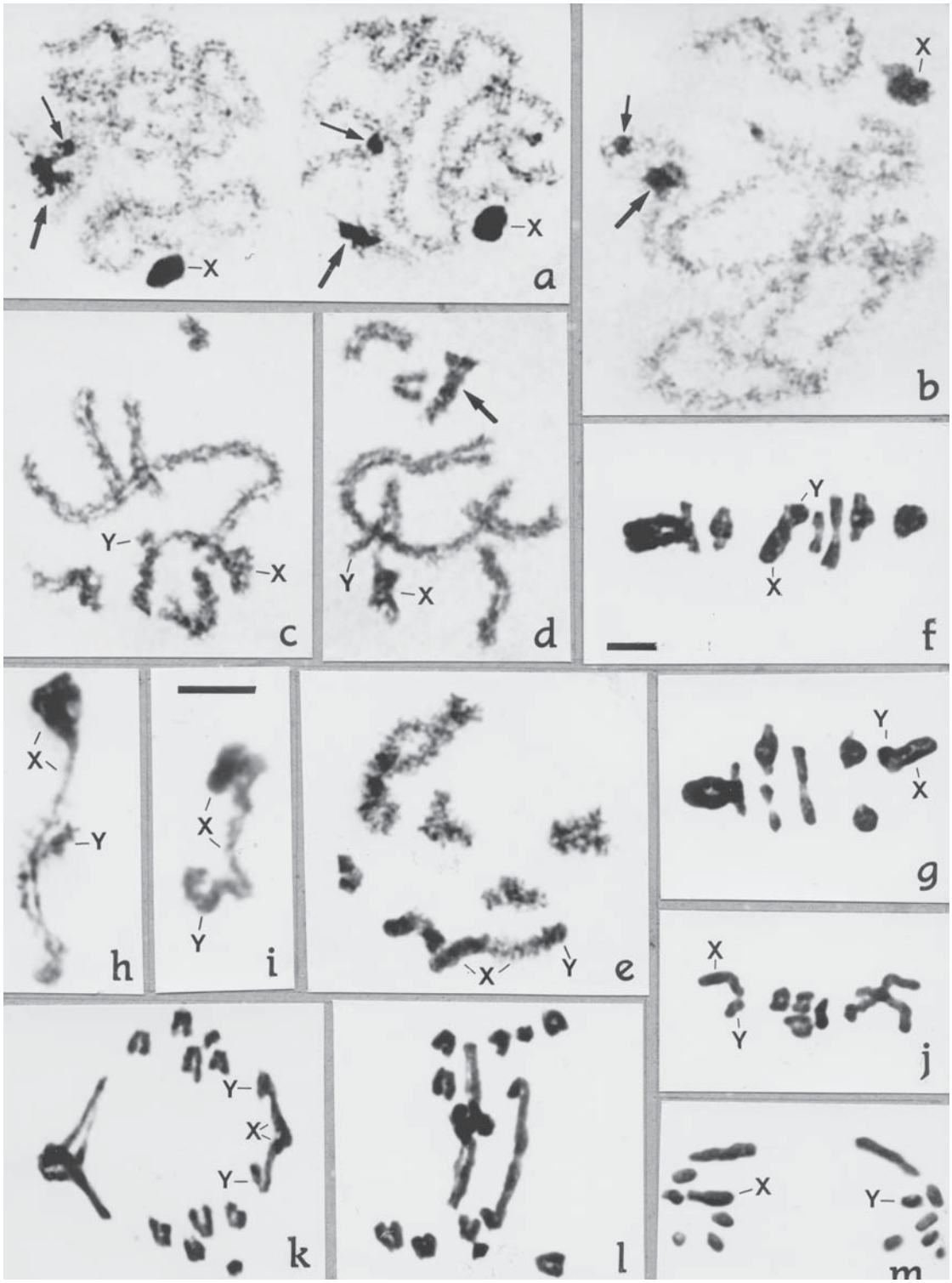


Fig. 2. *N. badius* meiotic chromosomes. **a**, **b**. Pachytenes; **c.** Late pachytene; **d.** Early diplotene; **e.** Diakinesis; **f, g.** First metaphases; **h**, **i.** Neo X-Y pair during early and late diplotene respectively; **j.** Second metaphase; **k**, **l.** First anaphases.; **m.** Second anaphase.
Thick arrows indicate heterochromatic medium-size bivalent. Thin arrows indicate partially heterochromatic small bivalents. Scale bar (10 µm) in Fig. 2i applies to Figs h, i. Scale bar (10 µm) in Fig. 2f applies to Figs a, b, c, d, e, f, g, j, k, l, m.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

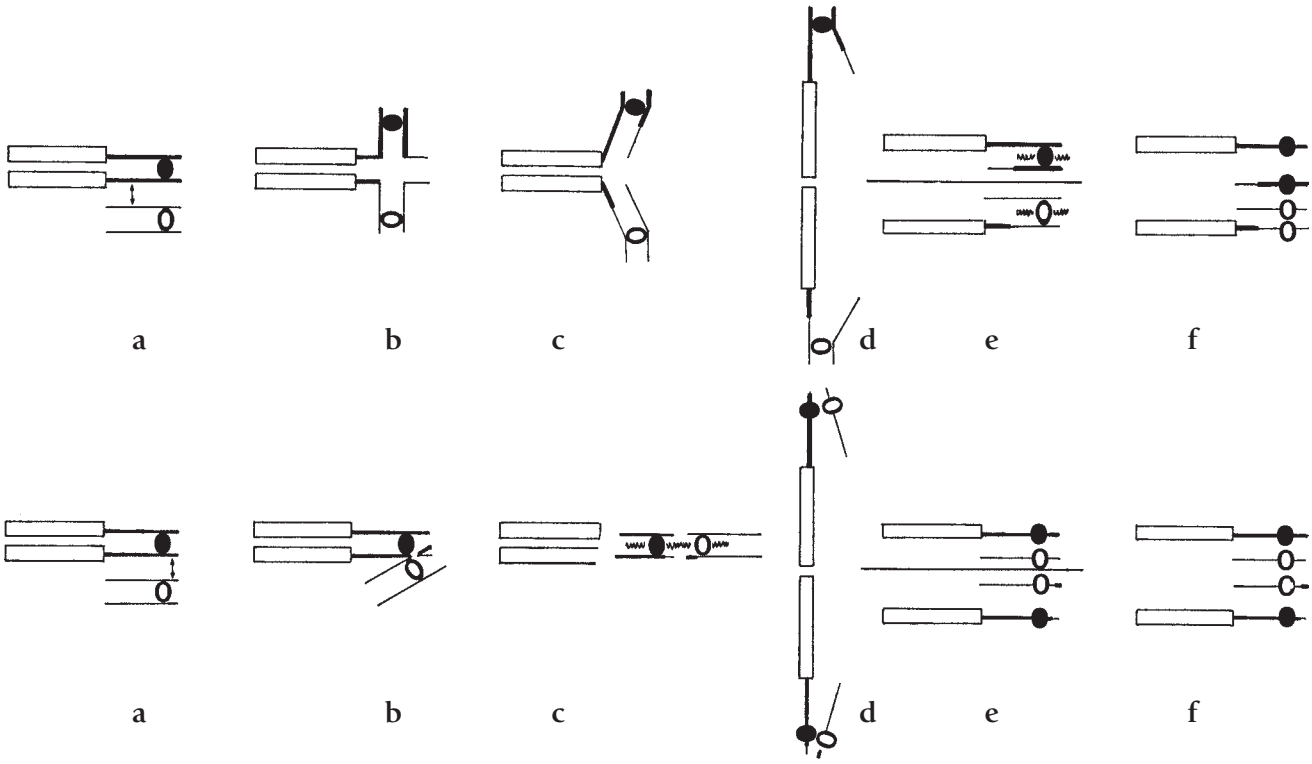


Fig. 3. First row **a** to **f,** meiosis scheme of the three species reported by other authors, with a syntelic orientation of the XY pair during first metaphase and an amphitelic one at MII.
Second row, **a** to **f** meiosis scheme of the species *N. badius* with an amphitelic orientation at first metaphase and chiasma in the small arm. A true reductional division occurs at AII.
For both rows: **a.** Pachytene paired X and Y; **b.** First metaphase; **c.** Early first anaphase; **d.** Late first anaphase; **e.** Two resulting second metaphases; **f.** Gametes.

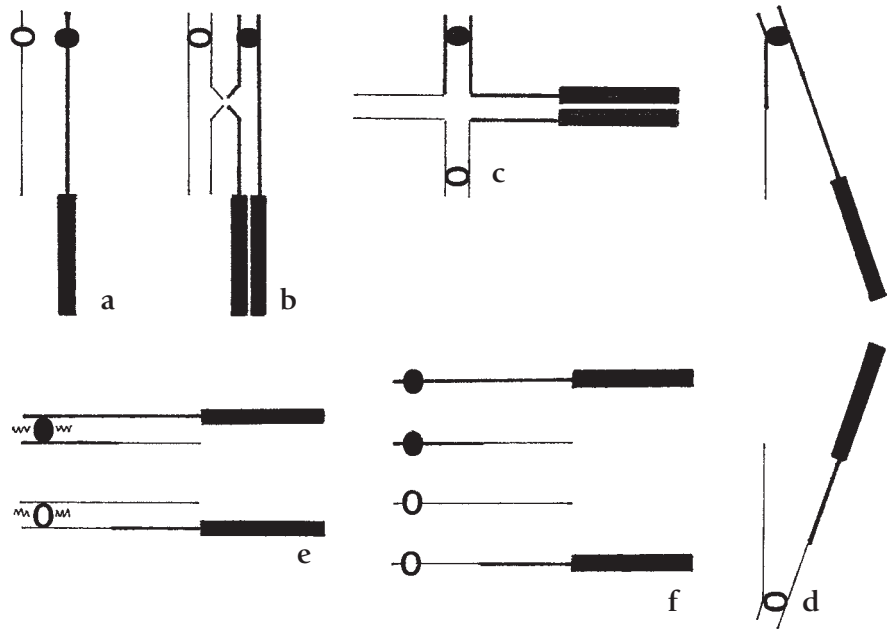


Fig. 4. Meiotic behavior in a generalized small pair of acridid chromosomes heterozygous for a distal heterochromatic segment. **a.** Pachytene; **b.** Crossing-over during pachytene; **c.** First metaphase; **d.** First anaphase; **e.** Two resulting second metaphases; **f.** Resulting four gametes.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

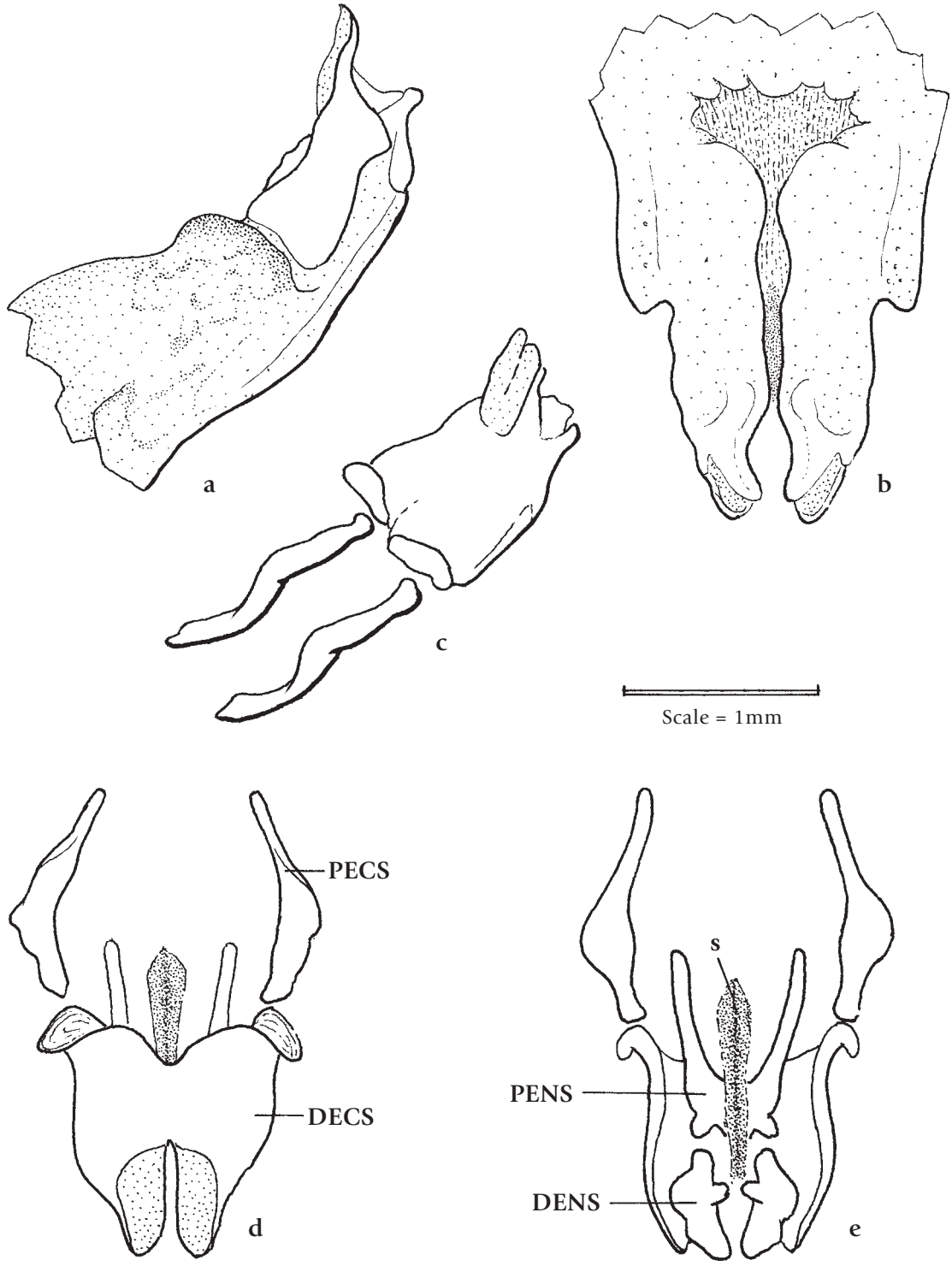


Fig. 5. *N. badius* phallic sclerites. **a.** Lateral view of phallus with its membranes. **b.** *Idem* in ventral view. **c.** Dorsolateral view of phallus without membranes. **d.** *Idem*, dorsal view. **e.** *Idem*, ventral view.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use

in this case body color is only a good specific character within the genus.

The neo-X chromosome of *N. badius* originated in a tandem fusion between the distal region of a medium-size autosome and the proximal region of the primitive X, with the loss of the centromere of this chromosome.

The use of the terms "reductional" and "equational" in reference to the homologous chromosome behavior during the first and second meiotic divisions may be misleading. According to White (1973 Pp. 491-2) both terms are meaningless if applied to whole chromosomes because the terms mean separation of maternal and paternal strands. So only the centromere and segments of chromatids placed between that structure and the first crossing-over are reductional in the first division and equational in the second one. Beyond the first chiasmata maternal and paternal strands may separate reductionally or equationally depending on the number and position of each crossing-over.

In small pairs of acridid chromosomes, the presence of a distal heterochromatic segment is frequently seen (Fig. 4). When in heterozygote condition, two similar chromosomes, both with a short and long chromatid, go to opposite poles during first anaphase, due to the occurrence of a single chiasma in the proximal euchromatic segment. The centromeres divide and separate the unequal chromatids during AII. In this case, the first division is reductional with the centromeres arranged in a syntelic way at MI.

The three species with X-autosome tandem fusion reported, one eumastacid and two tettigonids, are similar to the above mentioned case, having a syntelic arrangment at MI and with a single chiasma taking place between XR and Y (see White *et al.* 1967, Fig. 6b; Fernández-Piqueras *et al.* 1981, Figs 3a ,b and Warchalowska-Sliwa *et al.* 1998, Fig. 1j and this paper first row of Fig. 3).

In the species of cricket here studied the single crossing-over seems to occur in the small arm of X and Y and the structure of the sex bivalent during first metaphase suggests an anphitelic orientation and the splitting of both centromeres to initiate AI, in a true equational first division (see Fig. 3, second row). The second division is then an authentic reductional division.

The presence of a heterochromatic Y chromosome during diakinesis could indicate that the X- tandem fusion in *N. badius* is relatively old. In the three previously published species, the fusion seems to be recent because of the presence of an interstitial chiasma between XR and Y. Moreover, in the case of the eumastacid (White *et al.* 1967, p.45), both XY and X free populations still exist, and the same happens in the tettigonid *Callicrania seoanei* (Fernández-Piqueras *et al.* 1981).

The unusual X-autosome tandem fusion observed in *N. badius* will be a definitive diagnostic character of this species in the event it is absent in *N. amazonus*, but for the present, the karyotype of this species remains unknown.

Acknowledgements

The authors are deeply indebted to Dr. Theodore Cohn who contributed valuable suggestions on the original manuscript. We also want to thank the Florestal Institute (Secretaria de Estado do Meio Ambiente de SP) for authorization to collect in Cardoso Island and Dr. Edson Zefa for his collaboration in the collection of specimens.

Literature Cited

Desutter L. 1988. Structure et évolution du complexe phallique des Gryllidea (Orthoptères) et classification des genres Néotropicaux de Grylloidea. Deuxième Partie. Ann. Soc. Ent. Fr. (N.S.) 24: 343-373.

Fernandez-Piqueras J., Rojo García E., Sentis Castaño C. 1981. A tandem fusion origin of a neoXY sex determining mechanism in the long-horned *Callicrania seoanei* (Bol.). Heredity 47: 397-401.

Otte D. 1994. Orthoptera Species File 1. Pp.120. Crickets (Grylloidea) A systematic catalog.

Sassure H. 1877-78. Mélanges Orthoptérologiques V^{e} et VI^{e} fasc. III, Gryllides (2^{a} partie). Mem. Soc. Phys. Hist. Nat. Geneve, 25:1-352, pl.11-15; 369-702, pl 16-19.

Warchalowska-Sliwa E. 1998. Karyotypes and C-banding patterns of some Phaneropterinae katydids (Orthoptera, Tettigonioidea) with special attention to a post-reductional division of the Neo-X and the Neo-Y sex chromosomes in *Isophya hemiptera*. Folia Biologica (Krakóv) 46: 47-54.

White M. J. D., Blackith R. E., Blackith R. M., Cheney J. 1967. Cytogenetics of the viatica group of Morabinae grasshoppers I. The "costal species". Austr. J. of Zoology 15: 263-302.

White M. J. D. 1973. Animal cytology and evolution. 3rd. Ed. London: Cambridge University Press, 1973. Pp. 961.

Downloaded From: https://complete.bioone.org/journals/Journal-of-Orthoptera-Research on 29 Mar 2024
Terms of Use: https://complete.bioone.org/terms-of-use