

# On some morphological and karyological problems of the generic classification of Landrevinae (Orthoptera, Gryllidae) with descriptions of two new species

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## Abstract

The correlation between morphological and karyological characters in the different genera of Landrevinae are discussed. Difficulties distinguishing the genera *Duolandrevus* and *Repapa* are considered. Two new species, male genitalia of 1 species, karyotypes of 6 species are described for the first time. The new synonymy for one species is established

## Key words

Gryllidae, Landrevinae, taxonomy, karyology, new species

## Introduction

The subfamily Landrevinae was described by Saussure (1878: p. 371) as the legion Landrevites for 2 genera: *Landreva* Sauss. divided into 4 subgenera and *Odontogryllus* Sauss. Later, these subgenera of *Landreva* were all considered as genera, and several new genera were described, but all genera of Landrevinae were included in the tribe Gryllomorphini of the subfamily Gryllinae (Chopard 1967). Then, Gorochov (1982) restored Saussure's Landrevites as a separate subfamily and Otte & Alexander (1983) independently described this group as a new tribe of Gryllinae.

From 1988 to 2000, numerous new genera were described (Gorochov 1988, 1990, 2000; Otte 1988); Otte (1988) included Landrevinae (as a tribe) in the subfamily Pteroplistinae, but Gorochov (1990) disagreed with this opinion, and considered some of the above-mentioned genera as subgenera in the genus *Duolandrevus* Kirby (Gorochov 1996, 2000).

The most recent state of this study is as follows: Landrevinae are probably more related to Eneopterinae and Hemigryllinae than to Pteroplistinae and Phalangopsinae, which are closely related to each other (Gorochov 2001a); the tribe Odontogryllini, described for *Odontogryllus* with 2 other genera, and included in Pteroplistinae sensu Otte (De Mello 1992), is in need of correction of its systematic position (Gorochov 2003); the generic classification within this subfamily and the subgeneric classification of the genus *Duolandrevus* now have many problems.

These problems deserve special discussion. The external morphology of Landrevinae is rather monotonous, but there are numerous cases of parallel reduction or disappearance of wings, stridulatory apparatus, and tympanal organs. On the other hand, the male genitalia of different species are well distinguished, but often don't offer any possibility of generic or subgeneric classification, and we must take single characters (which may be symplesiomorphies or results of convergence) for separation of these superspecific taxa from each other.

Moreover, if we synonymize these taxa with each other, we shall arrive at a few very diverse genera which cannot be separated from each other nor from all other genera of Landrevinae. But many of these taxa are strongly distinguished from each other if we reject numerous intermediate forms from our study.

The way out of this situation is a search of additional characters. The attraction of karyological data seems very perspective for the generic classification of Landrevinae, as the previous study (Warchalowska-Sliwa *et al.* 1997) showed some conformity of structure of karyotype with the generic classification based on genital morphology (3 species of *Duolandrevus* have almost identical karyotypes, but the karyotype of 1 species of *Vasilina* Gor. is well distinguished from them). The new karyological data mainly support this regularity, but some exclusions are possible (one of them will be considered below).

The present study gives cytogenetic information concerning 6 species belonging to 3 genera and 2 subgenera: the genus *Duolandrevus* with the subgenera *Duolandrevus s. str.* and *Bejorama* Otte, the genus *Ectodrelanva* Gor., and possibly the genus *Repapa* Otte. Karyotypic data on these species are now for science.

## Taxonomy

Genus *Duolandrevus* Kirby, 1906

Subgenus *Duolandrevus s. str.*

Gorochov (2000) included in this subgenus 11 species distributed from Malacca to the Philippines and Komodo. At present, such a subgenus seems heterogenous, as some of these species are more similar to the subgenus *Bejorama* in the structure of the male anal plate (see below), and other ones are insufficiently studied or have a very peculiar structure of the epiphallus (*D. saltator* B.-Bien., *D. luzonensis* Otte, *D. balabacus* Otte, *D. gingoogus* Otte, and *D. fruhstorferi* Gor.). Now the nominotypical subgenus probably contains only 2 Javanese species: *D. brachypterus* (Haan) and *D. ?coulonianus* (Sauss.). These two differ from all other congeners in the following combination of characters: male anal plate simple and with rather wide apex (Figs 11 to 13), hind median process of epiphallus distinct and undivided into 2 lateral lobes (Fig. 8).

*Duolandrevus (Duolandrevus) brachypterus* (Haan, 1842)  
= *Duolandrevus karnyi* Otte, 1988, *syn. n.*

Java: 10♂♂, 4♀♀, 20-25 km SE of Bogor, Mts Pangrango, 1000 m, environs of Cemande, 27.XI.-7.XII.1999, A. Gorochov leg. (Zoological Institute, St Petersburg).

Note. The study of these specimens shows that the small differences between the neotype of *D. brachypterus* and the holotype of *D. karnyi* are within the limits of species variability. Descriptions of this species are in Saussure (1877: Figs XXV, 3), Otte (1988: Figs 8B, 20F), and Gorochov (1996: Figs 36, 43, 51-53).

*Duolandrevus (Duolandrevus) ?coulonianus* (Saussure, 1878)  
(Figs 1-3, 8-13)

Java: 3 ♂♂, 1 ♀, 20-25 km SE of Bogor, Mts Pangrango, 1000 m, environs of Cemande, 27.XI-7.XII.1999 (1 male and female collected as nymphs, imago reared respectively III and VI, 2000), A. Gorochov leg. (Zoological Institute, St Petersburg).

Note. This species was described without any mention of its male genitalia. For this reason we give only a preliminary determination of these specimens, as their external morphology is approximately in accordance to Saussure's description.

*Description.*— Species very similar to *D. brachypterus* (male external morphology and female of both species almost identical). Head clearly depressed dorsoventrally, hardly wider than pronotum, with slight longitudinal wrinkles under antennal cavities and rostrum roundly angular (in profile), which is almost as wide as scape; coloration of head and pronotum uniformly dark reddish brown, but with slightly lighter palpi, postclypeus, base of antennae, and with yellowish ocelli. Venation of dorsal part of male tegmina and structure of male metanotum (with hind wings) as in Figs 1, 2; lateral part of male tegmina with 5 to 6 longitudinal and almost straight veins only; dorsal part of female tegmina as in Fig. 3; their lateral part with 4 to 5 slightly arched veins; tegmina attaining, 5<sup>th</sup> 6<sup>th</sup> abdominal tergites in male and middle part of 1<sup>st</sup> abdominal tergite in female; coloration of tegmina dark brown with transparent and semitransparent stridulatory areas in male. Other part of body brown with somewhat lighter legs (but with slightly darker reddish brown distal part of hind femora and dark brown upper surface of hind tibiae between spines) and dorsal part of pterothorax and abdomen (provided with several more or less distinct darkish spots). Male anal plate as in Figs 11-13; male genitalia similar to those of *D. brachypterus*, but epiphallus with different shape of proximal part, long hind median process, and curved apical part of hind lateral processes (Figs 8-10).

*Length (mm).*— Body: ♂ 19 to 20, ♀ 22.5; pronotum: ♂ 3 to 3.2, ♀ 3.6; tegmina: ♂ 8.5 to 9, ♀ 3.5; hind femora: ♂ 11.3 to 12, ♀ 13.7; ovipositor 13.4.

Subgenus *Bejorama* Otte, 1988

Gorochov (2000) included in this subgenus only 2 similar species from Malacca: *D. intermedius* Chop. and *D. firmus* Gor. They are characterized by the specialized distal part of male anal plate (this part more or less narrowing to apex, provided above with longitudinal cavity, bundle of setae on apex, or small apical hook; Figs 17-19, 23-25) and the male genitalia with hind median process of epiphallus divided into 2 lateral lobes (Figs 14, 20) or almost indistinct. Now, it seems more correct to include in *Bejorama* also several additional species from Sumatra and Malacca: *D. modestus* sp. n., *D. improvisus* sp. n., probably *D. soekarandae* Gor., *D. deliensis* Gor., *D. krabi* Gor., *D. aequatorialis* Gor., *D. praestans* Gor., and possibly *D. mostovskyi* Gor.

*Duolandrevus (Bejorama) modestus* Gorochov, sp. n.  
(Figs 4, 5, 14-19)

*Holotype.*— Male, West Sumatra: 20 km E of Sasak, environs of Nat. Park Harau Valley, 600 m, equator, 24-26.XI.1999 (collected as nymph, imago reared XII, 1999), A. Gorochov leg. (Zoological Institute, St Petersburg).

*Description.*— Male similar to that of *D. ?coulonianus*, but distinctly smaller, head somewhat narrower (not wider than pronotum) and slightly less depressed dorsoventrally, pronotum clearly longer (both somewhat transverse), tegmina extending to basal part of 6<sup>th</sup> abdominal tergite with distinctly longer stridulatory vein and clearly larger oval mirror (Fig. 4), metanotal gland and hind wings clearly smaller (Fig. 5), distal part of anal plate with longitudinal dorsal cavity and row of setae along apical edge of this cavity (Figs 17-19), epiphallus of genitalia with different shape of proximal edge and deeply bifurcated hind median process, genital guiding rod long (much longer than above-mentioned process) and with characteristic distal part, mold of spermatophore attachment plate long, apodeme of this mold short (Figs 14-16), and coloration with rather light upper surface of hind tibiae. Female unknown.

*Length (mm).*— Body 17; pronotum 3.1; tegmina 7.8; hind femora 10.2.

*Comparison.*— The new species is well distinguished from all other species of *Bejorama* by the presence of distinct rudiments of hind wings, the shape of its anal plate, and the characteristic structure of the epiphallus and guiding rod in the genitalia.

*Duolandrevus (Bejorama) improvisus* Gorochov, sp. n.  
(Figs 6, 7, 20-25)

*Holotype.*— Male, Sumatra, Jambi: 35 km N of Sungaipenuh, Nat. park Kerinci-Seblat, Mt Kerinci, 1500-2000 m, 18-22.XI.1999 (collected as nymph, imago reared I, 2000), A. Gorochov leg. (Zoological Institute, St. Petersburg).

*Paratype.*— Female, same data as holotype.

*Description.*— Male very similar to that of *D. modestus*, but slightly smaller, pronotum somewhat shorter (shape of its disc almost as in *D. ?coulonianus*); tegmina extending to middle of 5<sup>th</sup> abdominal tergite, stridulatory vein shorter (but relatively longer than in *D. ?coulonianus*), mirror much narrower (but relatively larger than in *D. ?coulonianus*) (Fig. 6); hind wings hardly shorter; metanotal gland with central cavity slightly smaller and with structure of hind edge of this cavity somewhat different (for comparison see Figs 5 and 7); distal part of anal plate narrower and with unwidened apical part of dorsal cavity (Figs 23-25); epiphallus of genitalia with much shorter and less deeply bifurcated hind median process, genital guiding rod shorter and with different shape of distal part, mold of spermatophore attachment plate short and with clearly longer apodeme (Figs 20-22).

Female similar to male, but slightly larger, with somewhat darkened upper part of hind tibiae, very short tegmina extending to base of 1<sup>st</sup> abdominal tergite (their coloration, venation, and shape of lateral part similar to those of *D. ?coulonianus*, but dorsal part much shorter: hind edge of these parts of both tegmina together seem roundly notched, as median part of this "notch" protruding behind hind

pronotal edge by 0.5 mm). Other characters also similar to those of *D. ?coulonianus*.

*Length (mm).*— Body: ♂ 16, ♀ 18; pronotum: ♂ 2.6, ♀ 2.9; tegmina: ♂ 6.5, ♀ 2; hind femora: ♂ 9, ♀ 19; ovipositor 11.5.

*Comparison.*— The distinctions from *D. modestus* are listed above. From all other species of *Bejorama*, *D. improvisus* differs by the same characters as *D. modestus* and the peculiarities of shape of male genital structures.

#### Genus *Repapa* Otte, 1988

In this genus, 5 species were included (Otte 1988; Gorochov 2000, 2001b). Three of them, distributed from Borneo to Palawan [*R. brevipes* (Chop.), *R. sapagaya* Otte, *R. tenompokae* Otte], are very similar to each other in male genital structure. Two other species (*R. sulawesi* Gor. and *?R. paradoxa* Gor.) are similar to each other and to preceding ones in the shape of hind median epiphallic process (long and undivided) only; this character was a single distinct difference between *Repapa* and *Duolandrevus*, but, after the description of male genitalia of *D. ?coulonianus*, the independence of these genera seems questionable. But the latter species has the karyotype almost identical to all other studied congeners of *Duolandrevus*, and one possible species of *Repapa* (*?R. paradoxa*) has the karyotype very different from that of *Duolandrevus* (see chapter "Karyology"). It is possible that *Repapa* differs from *Duolandrevus* mainly in karyotype, but possibly also that *?R. paradoxa* is an aberrant representative of *Duolandrevus*. I cannot exclude that all other species of *Repapa* or part of them belong to *Duolandrevus*. This problem may be decided by future karyological study of the other representatives of *Repapa*.

#### *?Repapa paradoxa* Gorochov, 2001

Note. The material from Thailand used in this study (1 male – holotype and 4 females – paratypes) was sufficiently described by Gorochov (2001b: Figs 1-4).

#### Genus *Ectodreelanva* Gorochov, 2000

This genus is well distinguished from all other genera of Landrevinae in the structure of male genitalia and male metanotal gland. There are also some distinct differences in the karyotype (see below).

#### *Ectodreelanva paramarginalis* Gorochov, 2000

Note. The material from Cambodia used here (1 male – holotype) was sufficiently described by Gorochov (2000: Figs 50, 67).

### Karyology

#### Methods

The testes and ovarioles were excised, incubated in hypotonic solution (0.9% sodium citrate), fixed in ethanol:acetic acid (3:1), and squashed. The squash technique used an air-dried preparation, the C-banding technique (Sumner 1972). Chromosomes were classified according to Levan *et al.* 1964.

### Results

The karyotype of *Duolandrevus* (*Duolandrevus*) *brachypterus* (Sauss.), *D. (D.) ?coulonianus* (Sauss.), *D. (Bejorama) modestus* sp. n., and *D. (B.) improvisus* sp. n. consists of  $2n=19$  (XO) in the male and  $2n=20$  (XX) in the female. All autosomes were acro- or subacrocentric, the metacentric X chromosome was the largest element in size (Fig. 26). Location of C-heterochromatin and NORs of these species were similar. The C-banding pattern was characterized by the presence of a paracentromeric (thin) bands in all autosomes and the X chromosome.

In *?Repapa paradoxa* Gor., the chromosome complement is reduced to  $2n=11$  (XO) in the male. In this case, all chromosomes including the X chromosome being metacentric. Paracentromeric C-bands appears in all autosomes and in the X chromosome (Figs 27, 28). In second pair, variation of the centromeric C-bands (thin/thick) occurred.

The chromosome complement of *Ectodreelanva paramarginalis* Gor.  $2n=21$  (XO) in the male was characterized by presence subacrocentric and acrocentric pairs of autosomes, and the metacentric X chromosome. The paracentromeric C-heterochromatin bands appear in all chromosomes (Fig. 29).

### Discussion

Chromosome number in the Gryllidae ranges from  $2n=11$  to 29 in the male — the most common number being 19 or 21. The sex chromosome mechanism is generally typical XO(♂): XX(♀) type and the X chromosome is metacentric. Crickets have been evaluated for their cytotaxonomical implications and dynamic changes of chromosome number, morphology, as well as sometimes sex chromosome mechanism (Ohmachi 1935, Manna 1979, Hewitt 1979).

Karyological information regarding species which belong to subfamily Landrevinae is not extensive and concerns 10 species belonging to 4 genera (Warchalowska-Sliwa *et al.* 1997; present study). Among these species, the highest chromosome number was found in *Ectodreelanva paramarginalis*  $2n=21$  (XO) in the male, with subacro- or acrocentric autosomes and the metacentric X chromosome. Analysis of chromosome complement, location of C-heterochromatin of 7 species of 3 subgenera of *Duolandrevus* (*Duolandrevus* s. str., *Eulandrevus* Gor., and *Bejorama* Otte), and NORs of 3 species of one subgenus (*Eulandrevus*) (Warchalowska-Sliwa *et al.* 1997, present study) from Vietnam, Sumatra, and Java showed the same karyotype,  $2n=19$  (XO) with acro- or subacrocentric autosomes and metacentric X chromosome, similar C-bands, and NORs location. These species are also similar in morphology and mode of life. The karyotype of *Vasilina vietnamensis* Gor., belonging to another genus, is composed of  $2n=17$  (XO) in the male, with one metacentric pair and the submetacentric X chromosome (Warchalowska-Sliwa *et al.* 1997). On the other hand, the chromosome number of *?Repapa paradoxa* from eastern Thailand, has been reduced to  $2n♂=11$  (XO), thus all chromosomes are metacentric. Clearly Robertsonian fusion is prevalent in this species. Within group, this species is the most advanced in structural evolution of the karyotype.

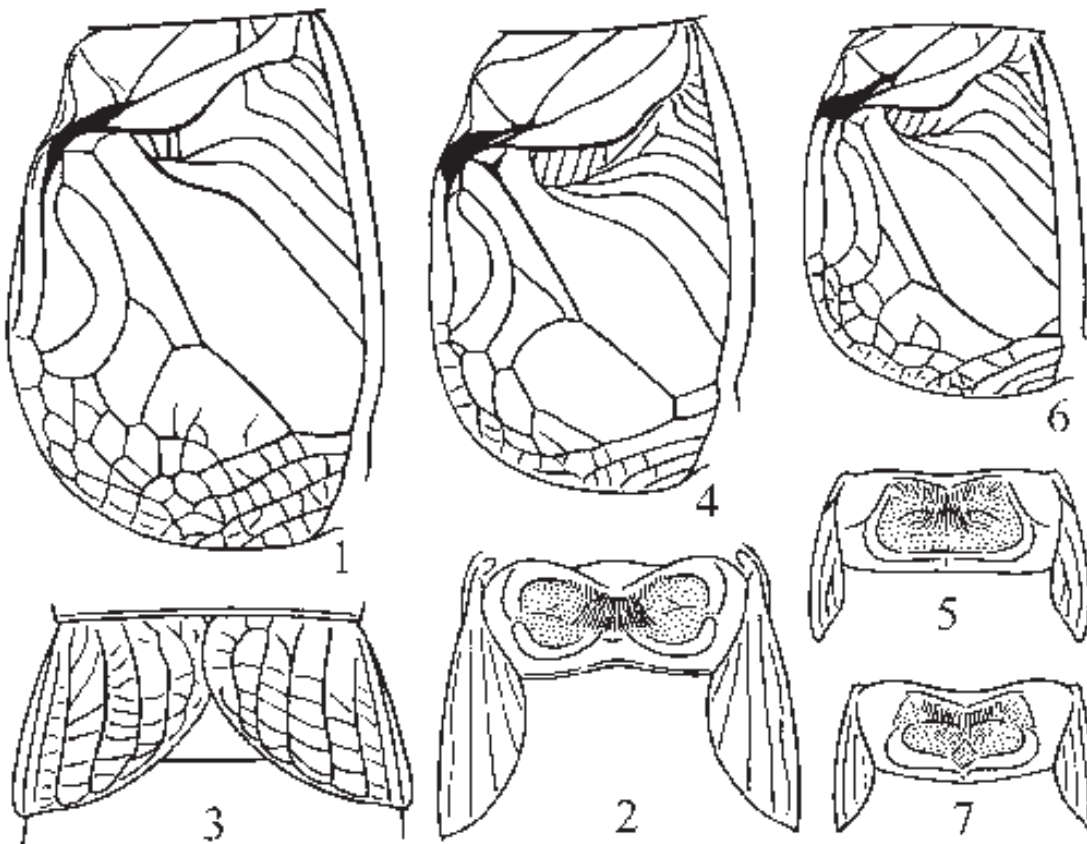
The results, obtained in the cytological analysis of 10 species of 4 genera described earlier and in this paper, indicate the presence of a more intensive karyotype evolution in this subfamily. The origin of different patterns of karyotype in these cases is owing to a complex of translocation. However, discussion about karyotypes and basic/ancestral number of chromosomes in this subfamily is

difficult because of the small amount of data.

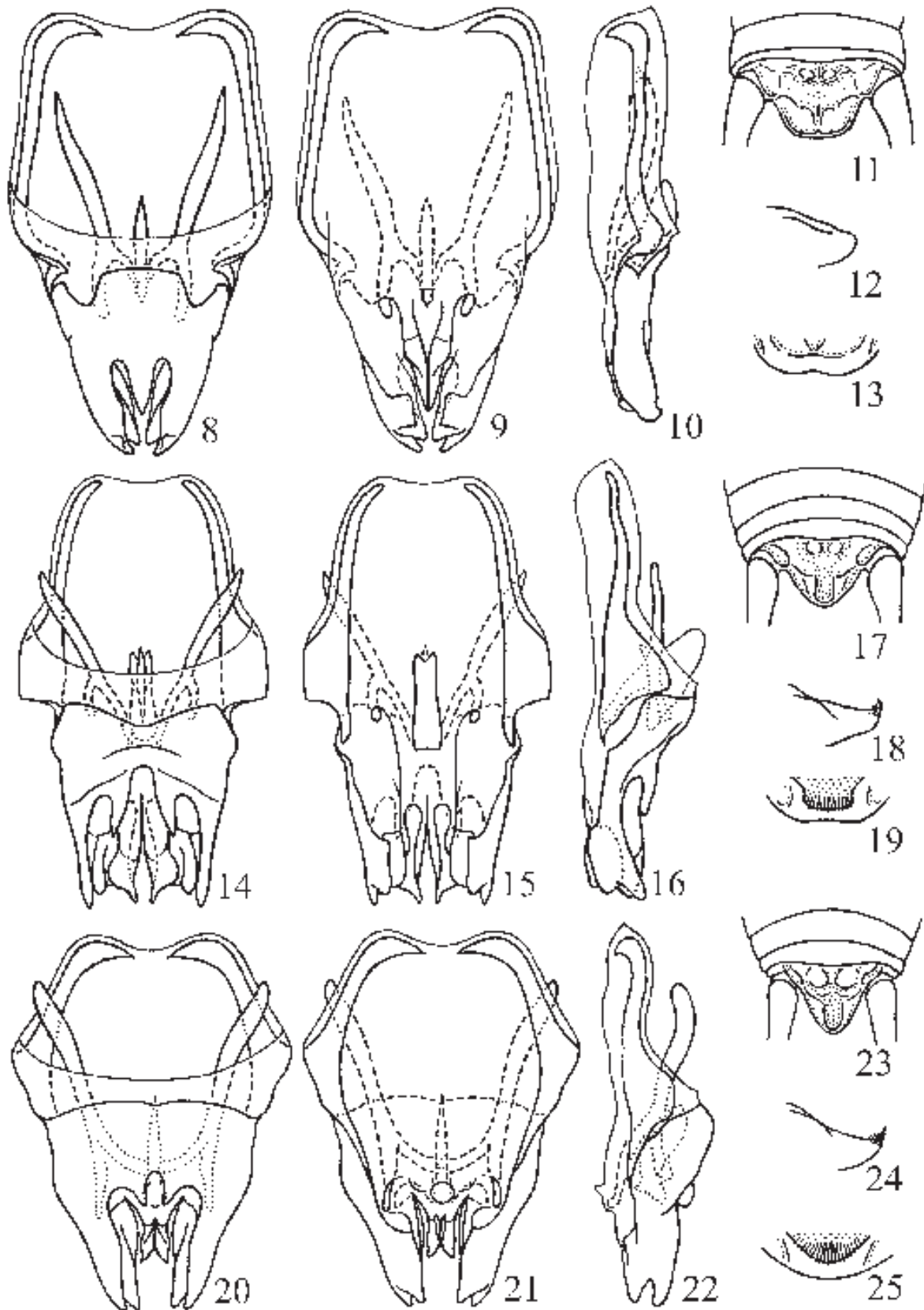
Thus, all the analysed species can be divided into 4 groups according to their karyotype pattern. These groups probably correspond to 4 genera of Landrevinae. Three of these groups (*Duolandrevus*, *Vasilina*, and *Ectodrelanva*) are also well separated morphologically.

## References

- Chopard L. 1967. Gryllides. Orthopterorum Catalogus 10. Uitgeverij Dr. W. Junk's-Gravenhage. 211 p.
- De Mello F.de A.G. 1992. Five new Brazilian crickets and a new tribe for the neotropical members of the subfamily Pteroplistinae (Orthoptera: Gryllidae: Pteroplistinae: Odontogryllini). Transactions, American Entomological Society 118: 147-158.
- Gorochov A.V. 1982. A new subfamily of crickets (Orthoptera, Gryllidae) from Indo-Malayan region. In: Zhivotnyj mir Vietnam [Animals of Vietnam]. Nauka, Moscow: 147-151 [in Russian].
- Gorochov A.V. 1988. New and little known crickets of the subfamilies Landrevinae and Podoscirtinae (Orthoptera, Gryllidae) from Vietnam and some other territories. In: Fauna i ekologiya nasekomykh Vietnam [Fauna and ecologia of the insects from Vietnam]. Nauka, Moscow: 5-21 [in Russian].
- Gorochov A.V. 1990. New and insufficiently studied crickets (Orthoptera, Gryllidae) from Vietnam and some other territories. Proceedings, Zoological Institute, USSR Academy of Sciences 209: 3-28 [in Russian].
- Gorochov A.V. 1996. New and little known crickets from the collection of the Humboldt University and some other collections (Orthoptera: Grylloidea). Part 2. Zoosystematica Rossica 5: 29-90.
- Gorochov A.V. 2000. New and little known Landrevinae (Orthoptera: Gryllidae). Zoosystematica Rossica 8, 1999: 267-280.
- Gorochov A.V. 2001a. Preliminary notes on the history of South American Ensifera (Orthoptera). Acta Geologica Leopoldensia 24 (52/53): 81-86.
- Gorochov A.V. 2001b. A new species of Landrevinae from Thailand (Orthoptera: Gryllidae). Zoosystematica Rossica 10: 36.
- Gorochov A.V. 2003. Review of the subfamily Pteroplistinae (Orthoptera: Gryllidae). In litt.
- Hewitt G.M. 1979. Grasshoppers and Crickets. Animal Cytogenetics 3. Insecta I. Borntraeger, Berlin, Stuttgart. 170 p.
- Levan A., Fredga K., Sanberd A. 1964. Nomenclature for centromeric position on chromosome. Hereditas 52: 201-220.
- Manna G.K. 1979. Chromosome dynamics in Grylloidea. Nucleus 22: 163-174.
- Ohmachi F. 1935. A comparative study of chromosome complements in the Grylloidea in relation to taxonomy. Bulletin, Mie Imperial College 5: 1-48.
- Otte D., Alexander R.D. 1983. The Australian crickets (Orthoptera: Gryllidae). Academy of Natural Sciences of Philadelphia, monograph 22. 477 p.
- Otte D. 1988. Bark crickets of the Western Pacific region (Gryllidae: Pteroplistinae). Proceedings, Academy of Natural Sciences of Philadelphia 140: 281-334.
- Saussure H. 1877. Gryllides. Memoires, Societe de Physique et d'Histoire Naturelle de Geneve 25: 1-341, pls 11-15.
- Saussure H. 1878. Gryllides. Memoires, Societe de Physique et d'Histoire Naturelle de Geneve 25: 369-696, pls 16-19.
- Sumner A.T. 1972. A simple technique for demonstrating centromere heterochromatin. Experimental Cell Research 75: 304-306.
- Warchalowska-Sliwa E., Maryanska-Nadachowska A., Gorochov A.V. 1997. Study of gryllids of the subfamily Landrevinae (Orthoptera: Gryllidae) from Vietnam: karyology and pattern of sperm. Folia biologica (Krakow) 45: 31-34.



Figs 1-7. *Duolandrevus*. 1-3, *D. ?coulonianus* Sauss.; 4, 5, *D. modestus* sp. n.; 6, 7, *D. improvisus* sp. n. Dorsal part of right male tegmen (1, 4, 6); female pterothorax from above (3); male metanotum with hind wings from above (2, 5, 7).



Figs 8-25. *Duolandrevus*, male. 8-13, *D. ?coulonianus* Sauss.; 14-19, *D. modestus* sp. n.; 20-25, *D. improvisus* sp. n. Genitalia from above (8, 14, 20), below (9, 15, 21), and the side (10, 16, 22); anal plate from above (11, 17, 23), and its distal part from the side (12, 18, 24) and behind (13, 19, 25).

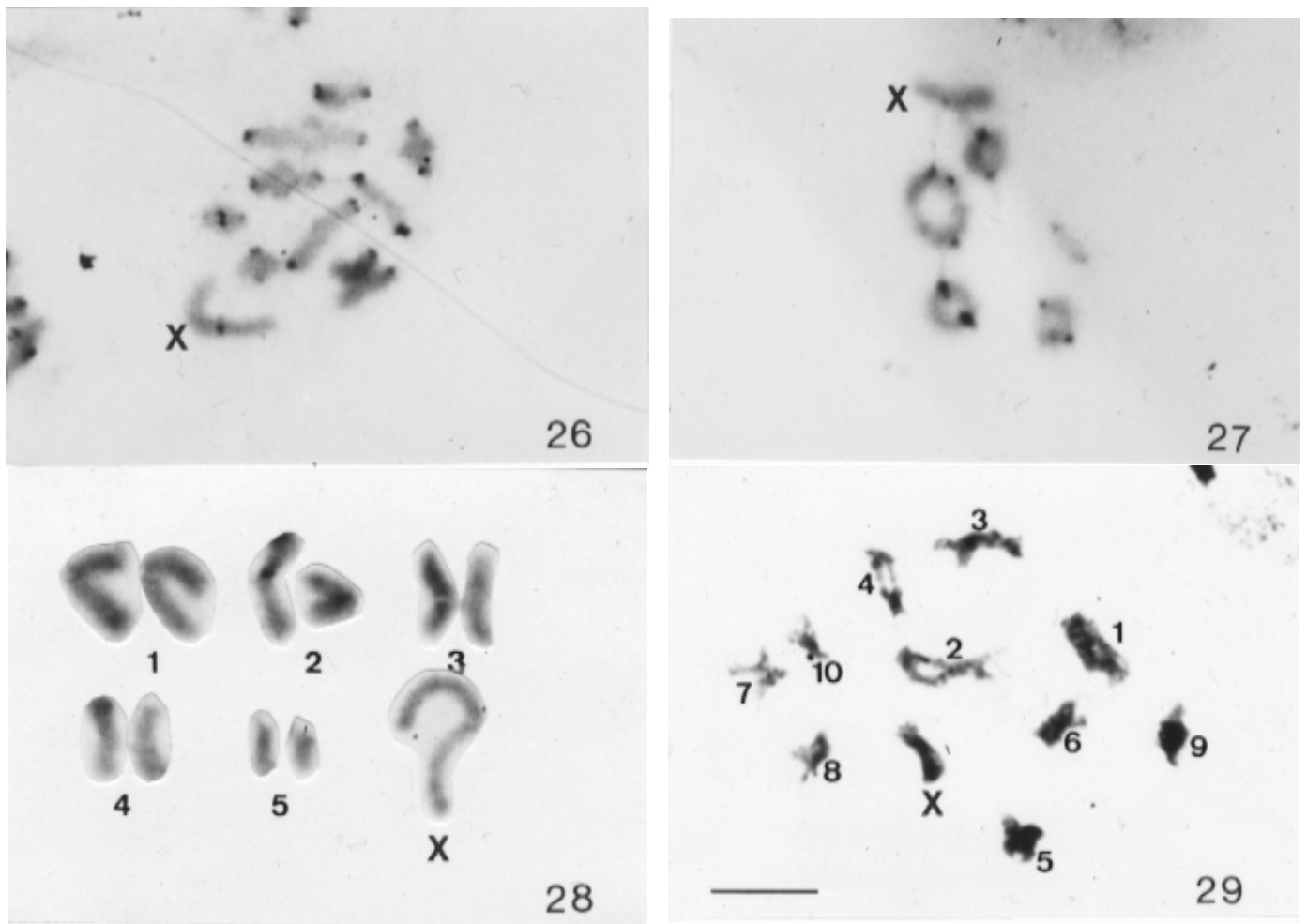


Fig. 26, *Duolandrevus improvisus* sp. n., male diakinesis with C-bands; Figs 27, 28, *Repapa paradoxa* Gor. male: 27, metaphase I; 28, karyotype of mitotic metaphase; Fig. 29, *Ectodrelanva paramarginalis* Gor., male, diakinesis. Bar equals 10  $\mu$ m and applies to Figs 26-29.