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Source: Journal of Orthoptera Research, 11(2) : 175-183

Published By: Orthopterists' Society

URL: [https://doi.org/10.1665/1082-6467\(2002\)011\[0175:NANGOB\]2.0.CO;2](https://doi.org/10.1665/1082-6467(2002)011[0175:NANGOB]2.0.CO;2)

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# *Novadrymadusa*, a new genus of bushcricket with a new species and notes on related genera (Orthoptera: Tettigoniidae)

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## Abstract

A new genus, *Novadrymadusa*, and a new species, *N. karabagi*, are described. A new combination, *N. kurda* (Uvarov), is established. Together with a key to species in the new genus there is a short account of its geographical distribution and that of related genera.

## Key words

Endemism, Anatolia, Iran, biogeography, Turkey

## Introduction

*Paradrymadusa kurda* was described by Uvarov (1929), on the basis of a single male from northern Iran (Khane village, Lahid-zhan valley). Later, Ramme (1939) placed this species in the genus *Scotodrymadusa* (also described by him). However, Ramme (1939) gave no reasons for this transfer and until now, the female of this species has never been described.

In the present work we report on the interesting materials collected by Dr. S. Salman in eastern Anatolia; it was noticed that this material and *S. kurda* have some common characteristics. We have also determined that these taxa should be placed in another genus. Ramme probably included *P. kurda* in *Scotodrymadusa* because of the shape of the cercus in males: the female of this species was unknown to him. However, the epiproct of our material and of *S. kurda* have a peculiar shape, and a morphology different from that seen in the genus *Scotodrymadusa*. Another important diagnostic characteristic is the shape of ovipositor which is downcurved in our specimens.

Our Anatolian material is described as a new species, and together with *S. kurda* placed in a new genus. Also given in this paper is a key to species belonging to the new genus. We have not actually examined any specimens of *S. kurda*: characteristics used in the key to this species are based on Uvarov (1929). The shape of the titillator is a very important taxonomic characteristic for many bushcrickets. But since Uvarov didn't use this character, it couldn't be used by us. A comparison of collected materials with *S. kurda*, revealed the presence of a new species in Turkey.

## Materials and Methods

Material was examined in the Hacettepe University Biological Museum (HUBM) in Ankara. Dry museum specimens were rehydrated, dissected and cleared in 8% KOH. The external morphology of the genitalia was studied under a stereomicroscope and figures drawn with the aid of a camera lucida. Stridulatory files were studied

using a scanning electron microscope (SEM). Color descriptions are based upon dry materials. All size measurements are expressed in mm. Body length is the distance from the most anterior part of the head (usually the fastigium verticis) to the posterior extremity of the abdomen proper, i.e., excluding all terminalia. Pronotal length was measured in the dorsal midline. Tegmina length was measured from the rear margin of the pronotum to tegmen tip as viewed laterally. Hind femora were measured in lateral view, excluding trochanters. The ovipositor was measured as a straight line between its tip and the posterior extremity of the subgenital plate.

Holotype and paratypes are deposited in the collection of the HUBM.

## *Novadrymadusa* gen. n. (Figs 1-8)

*Type species*.— *Novadrymadusa karabagi* sp. n.

*Distribution*.— Eastern Turkey and northern Iran.

*Etymology*.— [Gr.]: *nova*, new; *drimos*, bushes, shrubs; *ado*, sing.

**Male**: Fastigium of vertex (Figs 1A, 2) as wide as first antennal segment or slightly wider. In dorsal view, pronotum moderately smooth, its posterior margin clearly convex (Fig. 1A,B). Prosternum with two spines. Tegmina as long as pronotum. Cercus (Figs 1A, 3A,B) short, thick, dorsoventrally flattened, with strong subapical mesad branch. Last tergite fused with epiproct (Fig. 3B); lateral lobes of tergite with or without long appendages. Epiproct (Figs 1A, 3B) prolonged, surpassing lateral appendages of last tergite; in posterior view, apex of epiproct transverse (Fig. 4). Subgenital plate with styli (Fig. 5). Apical arms of titillators flattened, barely thinner than basal arms (Fig. 6).

**Female**: Vertex and pronotum as in male, but tegmina shorter than pronotum, dorsally overlapping (Figs 1D, 7). Seventh sternite (Fig. 8A, B) with distinct tubercle. Subgenital plate (Fig. 8A) large, with deep excision posteriorly. Ovipositor slender, regularly downcurved (Fig. 1C).

*Differential diagnosis*.— Stolyarov revised the genus *Phytodrymadusa* Ramme in 1994. In his work, the genus is divided into 3 genera and the position of some species changed. Stolyarov especially used the proportion of fastigium verticis to the first antennal segment, shape of the pronotum, structure of the male anal tergite, titillator

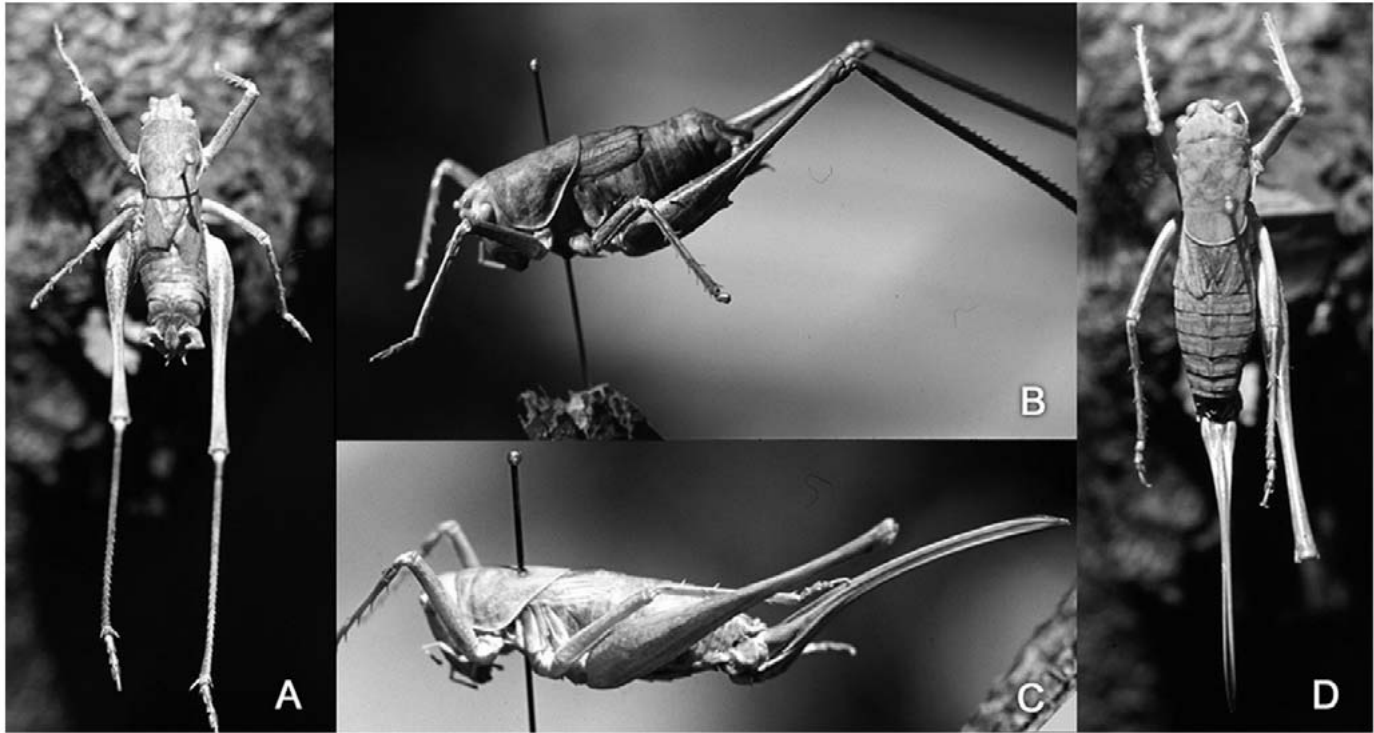


Fig. 1. *N. karabagi* sp. n.: A, B, male; C, D, Female.

and male cercus, female tegmina and length of the ovipositor, in establishing his new genera. When the materials we had on hand were compared regarding the characters used by Stolyarov, we found they had some different morphologies.

Separation of *Novadrymadusa* from related genera is based on pronotal shape (Figs 1, 7, 9-11), the specific structure of the male epiproct and male cerci, the structure of the appendages of the male cerci (Figs 3A, B4, 12-16) and on the long female tegmina and a female 7<sup>th</sup> sternite with a distinct tubercle (Fig. 8A, B). The male epiproct of the new genus is elongate, and, especially in its distal part, strongly V-shaped, depressed dorsally and laterally. This structure can be easily recognised by the naked eye. But male epiprocts of related genera share a plate-shaped structure. Morphological characters differentiating between the new genus and related genera are discussed below.

*Novadrymadusa* is more closely related to the genera *Phytodrymadusa* Ramme, *Leptodusa* Stolyarov, *Mixodusa* Stolyarov and *Delodusa* Stolyarov than to *Paradrymadusa* Herman, *Pezodrymadusa* Karaba, *Anadrymadusa* Karaba, *Drymadusa* and *Scotodrymadusa* Ramme. Diagnostic features separating these 7 genera are given in Table 1.

The new genus, being related to *Scotodrymadusa*, shares resemblances in pronotum (Figs 7, 11), tegmina and male cerci, but differs in that *Scotodrymadusa* has a distinctive basal sclerite portion of its titillators (Figs 6, 17) and an upcurved ovipositor. And in addition, except for *Scotodrymadusa ozkani* Erman & Salman, it has longer and pointed lateral lobes of the last tergite in males.

Separation of *Novadrymadusa* from *Phytodrymadusa* (Figs 10, 14, 18-19) is based on structural differences in the pronotum, and the male last tergite, an elongate and distinctive male epiproct, the absence of a distinct spine on the male cercus, the narrowed apical part of the titillator, and the 7<sup>th</sup> sternite of the female bearing a tubercle. *Novadrymadusa* has long tegmina and a slightly longer ovipositor.

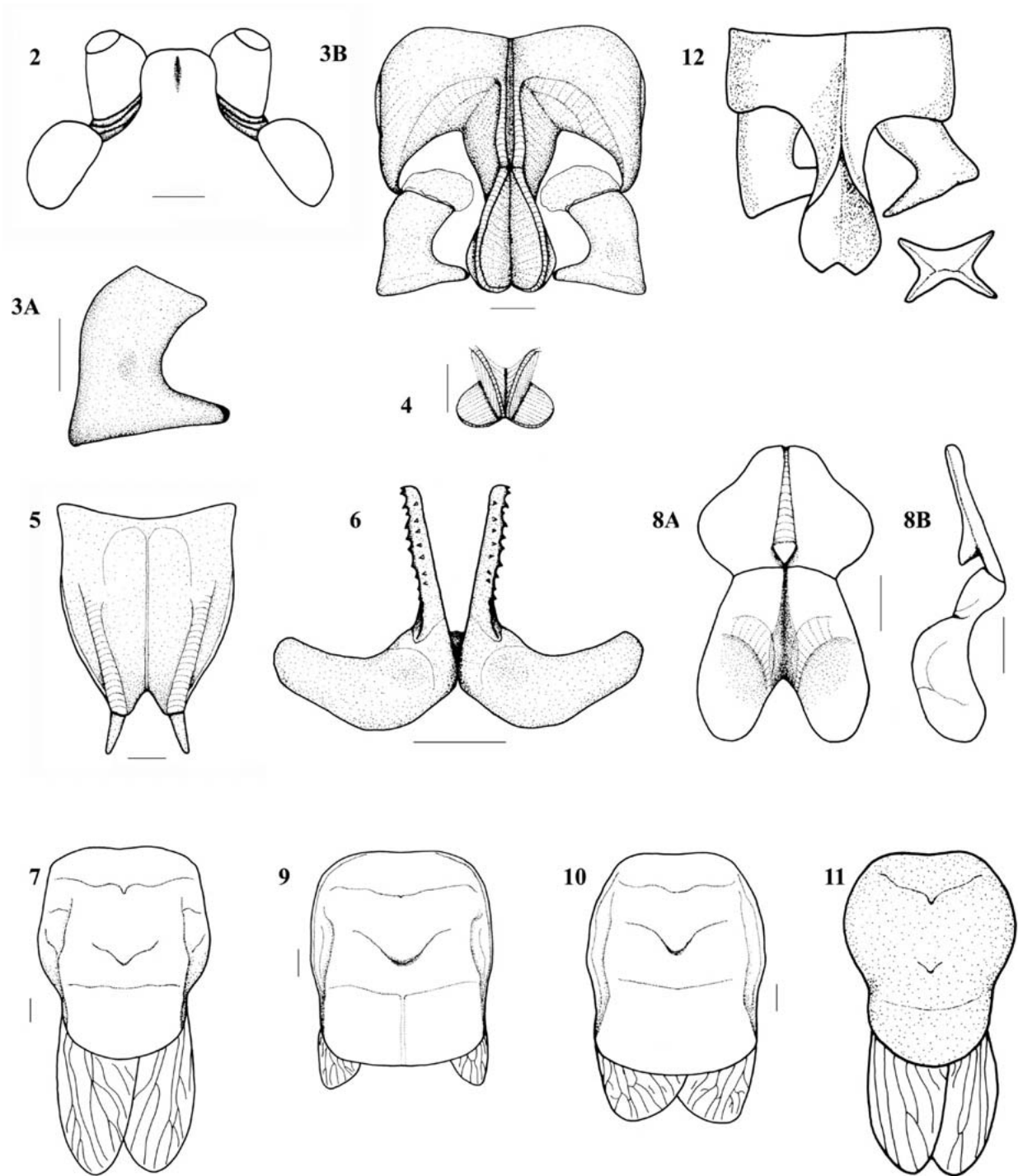
*Leptodusa* can be distinguished from the new genus by the following characters (Figs 9, 20-21): fastigium of vertex narrower than first antennal segment, male cerci short and robust, structure of male last tergite and epiproct, apical part of titillator bent sideways apically, female tegmina short, not overlapping dorsally.

Among other genera, *Novadrymadusa* is very closely related to *Mixodusa* (Figs 15, 22) in the shape of the titillator and the possession of a tubercle on the female 7<sup>th</sup> sternite, but the genera differ in the shape of the male's last tergite and epiproct and the shape of the male cerci. Also, in *Mixodusa*, tegmina and ovipositor are shorter than in *Novadrymadusa* [for example, ovipositor length of *Mixodusa siazovi*: 23 mm (Uvarov 1929: 638)].

The monotypic genus *Delodusa* (Figs 16, 23) differs from the new genus in having a narrower fastigium verticis; it differs also in the shape of the male epiproct, distinctive male cerci, shape of the titillator and in the shorter tegmina of the female.

Except for *Scotodrymadusa*, *Novadrymadusa* and related genera typically have a downcurved ovipositor. Among the genera, *Paradrymadusa* can be easily distinguished from the new genus in having a dark band between its eyes. Similarly, this important character is shared with other related genera *Anadrymadusa*, *Pezodrymadusa* and *Drymadusa*. *Novadrymadusa* clearly differs from species of the other genera in having a slender body, shorter tegmina, distinctive male last tergite and epiproct, longer ovipositor, and in lacking a dark band between its eyes. *Pezodrymadusa* shares some similarities with *Novadrymadusa*: both are brachypterous and have a downcurved ovipositor; but it differs in the punctuation of its pronotum and tegmina, its shorter and more robust ovipositor and in the distinctive last tergite and epiproct of the male. *Novadrymadusa* can be easily distinguished from the latter 3 genera by its being without a dark band between the eyes.

More taxonomic and faunistic data about these genera are available in Uvarov (1929, 1934), Ramme (1939, 1951), Tarbin-



**Figs 2-12.** (Scale bars: 1 mm) *Novadrymadusa karabagi* — 2. Male fastigium of vertex, dorsal view; 3A. Male left cercus; 3B. Male last tergite, epiproct and cerci, dorsal view; 4. Male apex of epiproct, posterior view; 5. Male subgenital plate, ventral view; 6. Titillator, dorsal view; 7. Female pronotum and tegmina, dorsal view; 8. Female 7th sternite and subgenital plate, A ventral view, B lateral view. *Leptodusa harzi* — 9. Female pronotum and tegmina, dorsal view; *Phytodrymadusa hakkarica* — 10. Female pronotum and tegmina, dorsal view; *Scotodrymadusa amani* — 11. Female pronotum and tegmina, dorsal view (from Ramme 1951); *Novadrymadusa kurda* — 12. Male last tergite, epiproct and cerci, dorsal view (from Uvarov 1929).

skii (1940), Karabag (1952, 1956, 1958, 1961, 1975), Bei-Bienko (1958), Harz (1969), Demirsoy (1975), Salman (1978), Stolyarov (1983, 1994), Willemse (1984), Çıplak *et al.* (1996) and Naskrecki and Ünal (1995). Checklists of European and Turkish species are found in Heller *et al.* (1998) and Çıplak *et al.* (2002). All species of these genera are listed in Otte & Naskrecki (1997).

#### Key to species of *Novadrymadusa* gen. n.

1. Tegmina of male >10 mm; lateral lobes of male anal tergite well developed, apical parts of lateral lobes distinctly narrowed (Fig. 3B); epiproct not extending beyond apex of male cercus (Fig. 3B); inner branch of male cercus with widely based black blunt tooth (Fig. 3A, B) . . . . . *N. karabagi* sp. n.  
— Tegmina of male 8 mm or shorter; anal tergite of male without distinct lateral lobes or slightly produced (Fig. 12); epiproct long, extending beyond cercus apex (Fig. 12); inner branch of male cercus without tooth . . . . . *N. kurda* (Uvarov) comb. n.

#### *Novadrymadusa kurda* (Uvarov 1929) comb. n. (Fig. 12)

*Paradrymadusa kurda* Uvarov 1929: 636.

*Scotodrymadusa kurda* (Uvarov 1929); Ramme 1939: 81, 85.

**Female:** Unknown.

**Discussion.**— Last tergite, epiproct and cerci as in Fig. 12 [illustrated by Uvarov (1929)]. The male of this species may be easily distinguished from *N. karabagi* sp. n. by its shorter tegmina, the shape of the last tergite, by its having an epiproct extending beyond the apex of the cerci, and by the absence of a tooth on the inner branch of the cercus.

**Distribution.**— Known only from the type locality in northern Iran.

#### *Novadrymadusa karabagi* sp. n. (Figs 1-8, 25-26A,B)

**Male (Holotype):** Fastigium of vertex slightly wider than first antennal segment, with very shallow dorsal sulcus (Fig. 2). Pronotum almost cylindrical, but more or less flattened in posterior half, without median and lateral carinae; first sulcus distinct in prozona; typical second sulcus distinct behind middle of pronotum; posterior margin of pronotum convex, not straight; in lateral view, dorsally straight (Fig. 1B).

Tegmina as long as pronotum, extending to end of third tergite. Stridulatory file of male (with *ca* 120 teeth) (Figs 25, 26A, B) not reaching right margin of tegmen; shortest distance from most proximal to most distal tooth, 1.9 mm, with undulating surface, spacing widest in midregion of file (Fig. 26B); proximal and distal part of file gradually narrowed.

Dorsal surface of fore tibia with 3 spines on posterior margin, 4 spines on anterior margin; fore femora with 2 spines ventrally. Ventral surface of fore and midtibia with 6 spines on both anterior and posterior margin. Midfemora with 3 spines ventrally. Hind femora long, slightly shorter than three times pronotal length, with brown band on ventral and lateral surface near apex; ventral surface of hind femora with 4-8 spines on outer margin, 4-6 spines

on inner margin. Plantulae of hind tarsi < half as long as first tarsal segment.

Last tergite (Fig. 3B) moderately large, fused with epiproct, with long lateral lobes gradually tapering; epiproct of characteristic shape (Fig. 3B), long, almost reaching cercus apex, with deep groove longitudinally and laterally, widened at apex. Cercus (Fig. 3A,B) short and robust, slightly dorsoventrally flattened, proximally slightly curved, with strong, large inner branch at apex, this branch with a black, blunt tooth apically.

Titillator (Fig. 6) slender, its basal arms widened, flattened and regularly upcurved; apical arms flattened, more or less straight, with small but strong teeth on inner surface.

Subgenital plate (Fig. 5) with styli; having short and acute-angular median excision, with distinct lateral and median carinae distad ventrally.

General coloration light greenish-brown; face uniformly creamy; antennae dirty yellowish; upper surface of fastigium of vertex, occiput and pronotum greenish-brown. Tegmina (especially anal veins) reddish-brown (in some specimens lighter). Upper surface of abdomen yellowish-brown; last tergite reddish-brown in middle part.

**Female:** Fastigium of vertex wider than first antennal segment. Pronotum (Figs 1D, 7) cylindrical, without lateral and median carinae; first and typical sulci distinct; posterior edge of pronotum convex, not straight. Tegmina (Figs 1D, 7) shorter than pronotum, extending to end of second tergite, dorsally overlapping, not scale-like. Cercus short, conical. Seventh sternite with distinct pointed carina on posterior part (Fig. 8A, B). Subgenital plate longer than wide, posteriorly widened, with deep excision (Fig. 8A). Ovipositor long, but slightly shorter than hind femur; downcurved, not straight (Fig. 1C). Gonangulum swollen, ventral part wider than dorsal side. Coloration as in male.

This new species shares its interesting male epiproct with *N. kurda* (Uvarov), but differs from the latter species in having longer tegmina, and well developed lateral processes of the anal tergite. The male inner branch of the cercus has a black tooth, reaching the epiproct apex in *N. karabagi*; but the male cercus of *N. kurda* is without a tooth and does not attain the epiproct apex.

**Measurements.**— (mm) Length of body: male, 30-32; female, 29; length of pronotum: male, 10.3-11; female, 9; length of tegmina: male 10-11; female, 7; length of hind femur: male, 28-29; female, 29.5; length of ovipositor: 28.

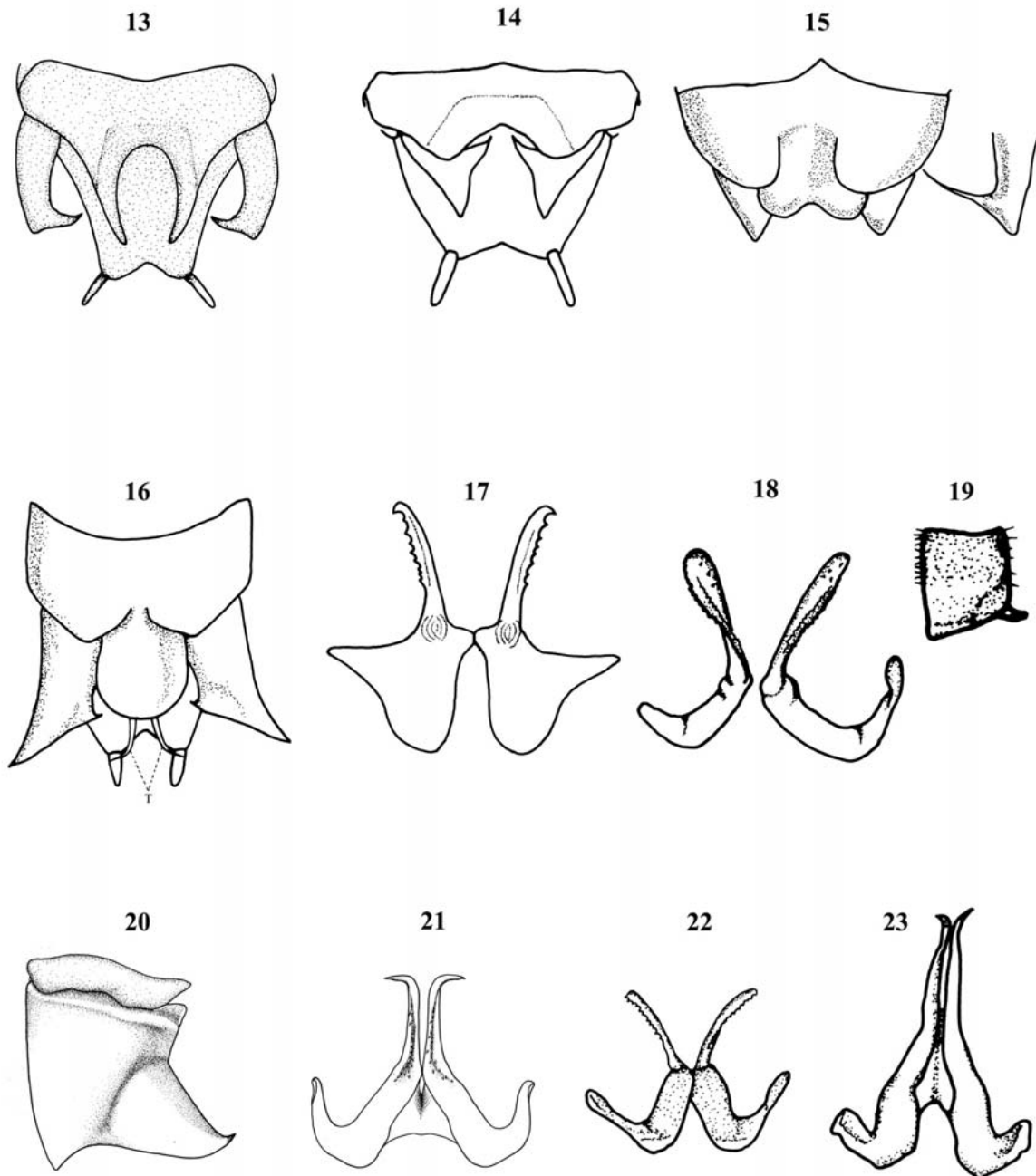
**Material examined.**—Holotype, ♂, TURKEY: Hakkari- Semdinli-Derecik road, 10.0 km, 21.07.1979, (leg. S. Salman). Paratypes, 2♂, 1♀ (same data as holotype).

**Distribution.**— Known only from the type-locality in Semdinli, Hakkari province, eastern Anatolia.

**Etymology.**— Named after Prof. Dr. Tevfik Karabag for his extensive contributions to the orthopteran fauna of Turkey.

#### Biogeography of the new genus and related genera (Fig. 24)

Fig. 24 shows *Novadrymadusa* and related genera to be essentially Palearctic. The Palearctic region has been divided into 7 zoogeographical subregions (Uvarov 1921, Sergeev 1993). These



**Figs 13-23.** *Scotodrymadusa anatolica* — 13. Male last tergite, cerci and subgenital plate, dorsal view (from Ramme 1951); *Phytodrymadusa hakkarica* — 14. Male last tergite, cerci and subgenital plate, dorsal view (from Karabag, 1956); *Mixodusa siazovi* — 15. Male last tergite, epiproct and cerci (from Uvarov 1929); *Delodusa humeralis* — 16. Male last tergite, epiproct, cerci and subgenital plate (T: titillator), dorsal view (from Uvarov 1929); *Scotodrymadusa ozkani* — 17. Titillator, dorsal view (from Erman & Salman 1990); *Phytodrymadusa variicercis* — 18. Titillator, dorsal view; 19. Male left cercus (from Stolyarov 1994); *Leptodusa harzi* — 20. Male left cercus; 21. Titillator, dorsal view (from Karabag 1975); *M. siazovi* — 22. Titillator dorsal view; *Delodusa humeralis* — 23. Titillator, dorsal view (from Stolyarov 1994).

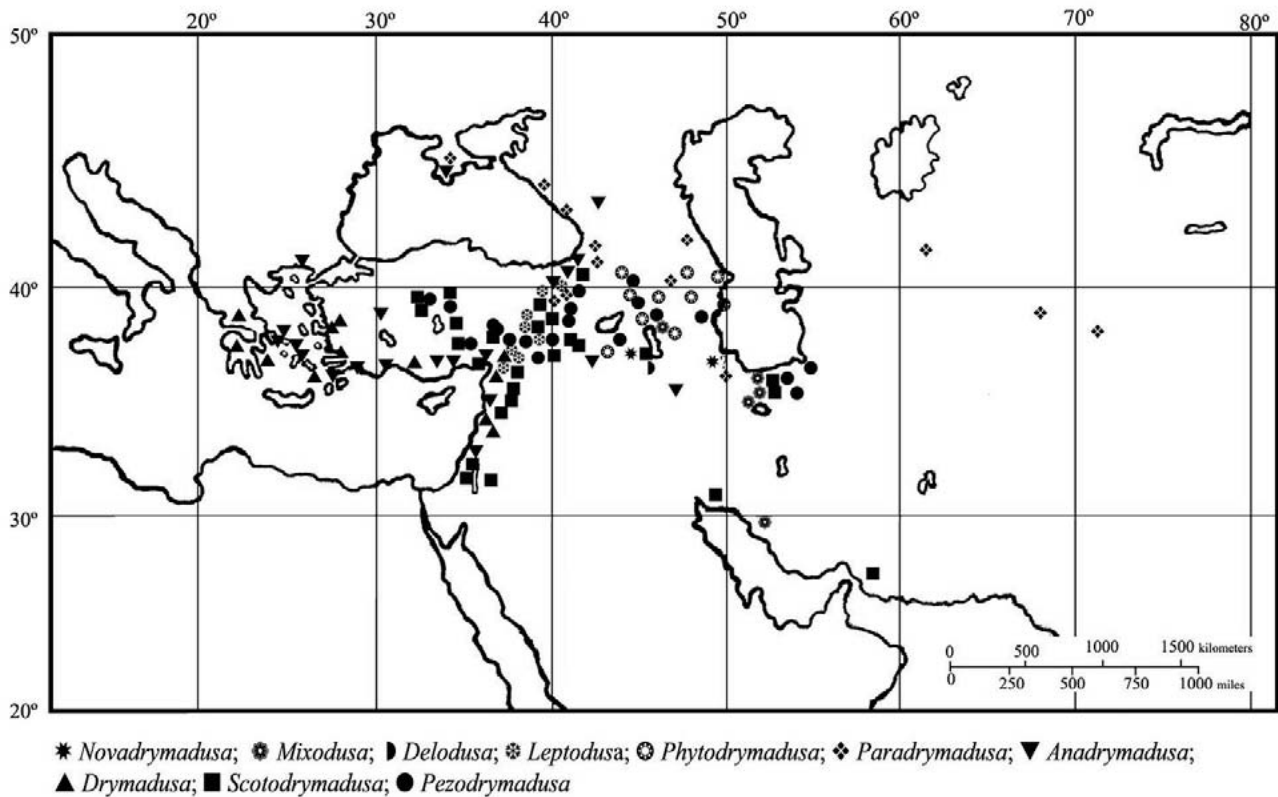


Fig. 24. Known distribution of *Novadrymadusa* and some related genera.

subregions have been divided into even smaller areas (Sergeev 1993). Study of the taxonomic composition and faunistic relationships of orthopteran fauna are very important. But we have little information about the biology and environmental requirements of the remaining genera.

The bushcrickets of this new genus and its related genera are mainly species of the East Mediterranean and West Saharan-Gobian subregions of the Palearctic Region. In the area studied, they are mainly associated with eastern Anatolia and Transcaucasia — northern Iran. The eastward distribution of the genera in Anatolia is restricted by a series of mountain ranges, forming the Anatolian Diagonal (Çiplak *et al.*, 1993). The majority of them are micropterous, and so they have very localized distributions (*e.g.*, *Delodusa*, *Leptodusa* and *Novadrymadusa*) due to limited dispersal ability. Localized distributions are especially characteristic for species on high mountains (*e.g.*, *Pezodrymadusa* spp.) and in vegetation-rich valleys (*e.g.*, *Novadrymadusa* spp.). Species are mainly associated with low bushlands, forest, dry and wet shrub-grasslands of forest openings and forest steppe vegetation.

*Novadrymadusa*, as presently known, is confined to the mountains and high valleys of eastern Anatolia and northern Iran. Its distribution is disjunct from that of *Phytodrymadusa*, *Leptodusa* and *Drymadusa*. *N. karabagi* is known from Semdinli, Hakkari province, eastern Turkey. The most easterly species of the genus, *N. kurda*, also has a more restricted range. As presently known, it is found in the Lahidzhan valley of northern Iran.

The genus *Mixodusa* is endemic to Iran. Its eastern populations are isolated in the Elburz mountains, north of Tehran province. A southern arm of the genus reaches Abadeh in southern Iran. A northern population of the genus is found in northwestern Iran, near Urmiye lake.

Another endemic genus of Iran, *Delodusa* is a monotypic genus. *D. humeralis* is known only from Ushnu, near to and southwest of Urmiye lake.

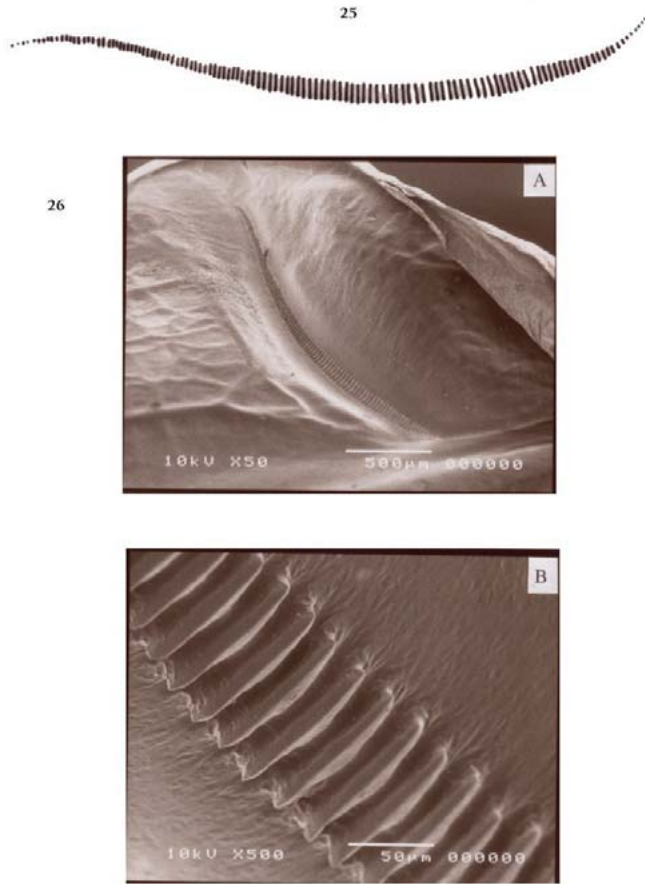
The genus *Leptodusa* Stolyarov 1994 is composed of 3 species. All are endemic to Anatolia. They occur on the Anatolian Diagonal and at some adjoining altitudes.

The genus *Phytodrymadusa* is distributed in eastern Anatolia (Hakkari) and Transcaucasia (Armenia, Daghestan, Azerbaijan and northwestern Iran). Its species occur much further north than *Novadrymadusa*, *Mixodusa* and *Delodusa*.

Most of the species of the genus *Paradrymadusa* are known from the Saharan-Gobian subregion. Three species of the genus occur in Turkey. They are found in northeastern and eastern Turkey. The western and southern distributions of the species are restricted by the Anatolian Diagonal and East Taurus mountains respectively. Other species of the genus are distributed in southern Crimea, Russia, Azerbaijan, Daghestan, Georgia, northern Iran, Tajikistan and Uzbekistan. (Distribution in the Ussurian region is not shown on the map.)

*Anadrymadusa* is as widely distributed as *Paradrymadusa*, but reaches much further west than other related genera, excluding *Drymadusa*. Their species occur in South Crimea, Caucasus, Iran, Turkey, Israel, Greece and the Greek Islands. Mediterranean species of the genus are mainly associated with maquis vegetation. Seven species are distributed in Turkey.

The genus *Drymadusa* occurs in the Mediterranean zones of Syria, Turkey and Greece. Three species are known from Turkey. All species of the genus are confined to the East Mediterranean subregion. The distribution of species of *Pezodrymadusa* appears to be limited to mountain ranges. They occur in Transcaucasia, Turkey and northern Iran.



**Figs 25, 26.** *Novadrymadusa karabagi* sp. n. male. 25. Dorsal view SEM of file; 26. A: File, B: SEM close-up of file tooth.

Endemism of the Anatolian species of *Pezodrymadusa* is high: 12 species are found in Turkey — in central Anatolia, the eastern part of the Taurus and the western and eastern part of east Anatolia. The northern distribution of the genus is also related to the mountain ranges in the western part of the Saharan-Gobian subregion.

*Scotodrymadusa* includes mainly East-Mediterranean species. But some species of the genus occur in the central and southeastern part of Iran. Species distributed in Anatolia are found in southern and central Anatolia, the eastern part of the Taurus mountains, and east and northeastern Anatolia. Seven species occur in Turkey. All of them are endemic to Anatolia. The East Mediterranean species of Turkey are associated with forest and bushlands. Levant species are associated with Mediterranean forest and the Irano-Turanian steppes in Israel (Ayal, Broza and Pener 1999).

### Acknowledgements

The authors would like to thank Prof. Dr. Zekiye Suludere at the Department of Zoology, Gazi University, Ankara, for the scanning electron micrographs.

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**Table 1.** Principal distinguishing features of *Novadrymadusa*, *Phytodrymadusa*, *Mixodusa*, *Leptodusa*, *Scotodrymadusa*, *Paradrymadusa* and *Delodusa*.

Genera/Diagnostic features	<i>Novadrymadusa</i>	<i>Phytodrymadusa</i>	<i>Mixodusa</i>
fastigium of vertex basally (Figs 1A, 2)	as wide as 1 <sup>st</sup> antennal segment or slightly wider	wider than 1 <sup>st</sup> antennal segment	wider than 1 <sup>st</sup> antennal segment
with dark band between eyes	no	no	no
metazona of pronotum (Figs 7, 9-11)	slightly narrowed, rounded	broadly rounded, hind margin convex	rounded-truncate
male supra-anal plate (Figs 1, 3B, 12, 13-16)	prolonged, much longer than anal tergite, in posterior view cross-shaped	short, same length as lateral lobes of last tergite or shorter, dorso-ventrally flattened (except <i>Ph. variicercis</i> ), in posterior view straight	slightly prolonged, dorso-ventrally flattened
male last tergite (Figs 1, 3B, 12, 15-16)	lateral lobes short or prolonged with blunt apex	lateral lobes short	lateral lobes relatively long and broadly rounded
male cercus (Figs 1, 3A, B, 12-16, 19-20)	with stout appendage on apex of cercus	with distinct spine	with distinct spine
titillator (Figs 6, 17-18, 21-23)	apical arms thinner than basal arms, without distinct pointed apex, but narrowed	apical arms more strongly flattened than basal arms, relatively enlarged at apex	generally resembles <i>Novadrymadusa</i> , but basal arms longer and thinner
female tegmina (Figs 1C, D, 7, 9-10)	short, slightly shorter than pronotal length (~ 0.8 times as long as pronotum), overlapping dorsally	shorter or as long as half length of the pronotum, overlapping dorsally	short, about 0.33 times as long as pronotum overlapping dorsally
female 7 <sup>th</sup> sternite (Fig. 8A, B)	with an acute conical projection	straight	with an acute conical projection
ovipositor downcurved or upcurved (Fig. 1D)	downcurved	downcurved	downcurved

<i>Leptodusa</i>	<i>Scotodrymadusa</i>	<i>Paradrymadusa</i>	<i>Delodusa</i>
as wide as 1 <sup>st</sup> antennal segment or narrower	wider than 1 <sup>st</sup> antennal segment or 2 times wider	as wide as 1 <sup>st</sup> antennal segment or slightly wider	narrower than 1 <sup>st</sup> antennal segment
no	no	yes	no
hind margin relatively straight	broadly rounded	relatively straight	hind margin very broadly rounded-truncate
short, as length as lateral lobes of last tergite or shorter, dorso-ventrally flattened	small, sometimes longer than lateral lobes of the last tergite, dorso-ventrally flattened	small, dorso-ventrally flattened	longer than lateral lobes of the last tergite, dorso-ventrally flattened
lateral lobes relatively long with blunt apex	lateral lobes very long and pointed apically or sometimes with blunt apex ( <i>S. ozkani</i> )	without lateral lobes or with very short rounded lobes	without distinct lateral lobes, relatively truncated
with a very stout appendage and with a pointed apex	with a stout appendage on apex of the cercus	relatively long cercus with a stout appendage near apex, apex of cerci almost pointed	short, thick; apex acutely triangular; inner angle with a short, very acute spinule
apical arms gradually pointed, bent sideways at apex	basal arms short, distally widened, triangular	basal arms moderately long and strongly curled	as Fig. 23
very short, scale-like laterally	short, longer than half length of pronotum, overlapping dorsally	very short, shorter than half length of pronotum, scale like laterally	short, 1/3 times as long as pronotum, overlapping dorsally
straight	straight	straight	straight
downcurved	upcurved	downcurved	slightly downcurved