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New species of *Necaxacris* Roberts, 1939 (Orthoptera: Acrididae) from northeastern Mexico

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Abstract

The genus *Necaxacris* Roberts, 1939 (Acrididae: Melanoplinae) is endemic to Mexico. Two species were previously known for this genus: *N. micans* (Hebard, 1932) and a species collected by Roberts in 1936, mentioned *in litteris* by Descamps (1975) as *N. moctezumae* Roberts, 1975, but never formally described. We here describe and assign the name of *N. tamazunchale* n. sp. for this taxon and describe three additional new species: *N. azura* n. sp., *N. afurculae* n. sp. and *N. davidi* n. sp. A revision, description and illustration of diagnostic characters to identify the species that make up the genus are provided for the first time. Information on distribution and habitat of the species treated is also provided herein.

Key words

Mexico, biodiversity, melanoplinae, new species

Introduction

Mexico is characterized by an exceptional diversity of fauna and flora and a great number of endemisms; CONABIO (2008) pointed out that Mexico occupies third place among the 20 countries with major biodiversity. At least five new genera and more than 55 new species of Melanoplinae (Orthoptera: Acrididae) from México have been described in the last five years (Otte 2007; Fontana *et al.* 2007, 2011; Buzzetti *et al.* 2010; Barrientos *et al.* 2010, 2011). The origin and evolution of this great diversity (not only for the Orthoptera, but for other insect groups) can be explained by geologic history, climatic change, ecological factors, dispersion and *in situ* speciation (Halffter 1976, 1987; Brooks & McLennan 2001; Morrone & Marquez 2001; Morrone 2009, 2010; Barrientos *et al.* 2011).

All *Necaxacris* species treated in this paper inhabit the Huasteca region in northeastern Mexico. The Huasteca encompasses two Biogeographic Provinces — the Gulf Coastal Plain (GCP) and the Eastern Sierra Madre (ESM) mountain range — and embraces part of six states: southern Tamaulipas, eastern San Luis Potosí, the north portion of Veracruz, the Sierra Gorda of Querétaro (northern third portion of the state), the northeastern portion of Hidalgo and the north of Puebla. This vast area of land derives its name from the Huastec Indians that descended from the Mayas and occupied here 6000-4000 years ago (INFDM 2005, Velasco 2006, Martínez *et al.* 2007, Algara-Siller *et al.* 2009).

The Huasteca is physically and culturally very rich; it is home to an exceptional number of ecosystems and biological abundance, and at least five ethnic groups inhabit the area. The region is centered in the drainage basin of the Pánuco River, inland from the city of Tampico, Tamaulipas. It has the highest concentration of rivers and floodplains in the country. At least 10 Natural Protected Areas have been established in the Huasteca to protect and preserve ecological diversity and natural resources. Among the most prominent is the Sierra Gorda Biosphere Reserve (SGBR) in northern Querétaro (400,000 ha, including the Sierra Gorda Natural Protected Area of Guanajuato), and el Cielo BR in southern Tamaulipas (144,000 ha). The SGBR is the most ecodiverse: it possesses 10 of the 11 ecosystems known for Mexico (Velasco 2006, Quiroz-Moreno & Romero-Sánchez 2006, Martínez *et al.* 2007).

The elevation gradient varies abruptly from sea level to 2200 m (*i.e.*, El Cielo BR) and continues up to 3100 m above sea level (*i.e.*, Sierra Gorda Querétaro BR-Cerro de la Pingüica-Pinal de Amoles). The climate of the region depends on altitude and the fact that the mountains form a natural barrier against the prominent source of moisture, the Gulf of Mexico. The east side of the mountains receives significantly more rainfall than the west, as the altitude extracts moisture from the clouds. Tropical forests and rainforests are found in the east, while the west is dominated by desert and semidesert conditions. The coldest temperatures occur between December and January, with high temperatures from April to August. Temperatures vary widely depending on altitude.

Overall, the lowlands with tropical deciduous and tropical semideciduous forests have a semiwarm humid climate with rains from May to October; the mean annual temperature is 23-24°C and total annual rainfall reaches 1852 mm.

The midelevation cloud forest has a temperate humid climate with a mean annual temperature of 14-20°C and a mean annual rainfall of 2527 mm. Mist is always present, with relative humidity over 90%, and the wettest months are May to October. Highlands are variously covered with oak, pine and mixed oak-pine forests or chaparral and have a generally temperate subhumid climate, with a cool summer. The annual temperature averages 16°C and the annual rainfall is 889 mm. In the western portion of the region, the desert scrublands have a semiwarm dry climate, with summer rains; the mean annual temperature is 22°C and annual rainfall 505 mm (Puig & Bracho 1987, Contreras 1991, Pineda-Martínez *et al.* 2007, Algara-Siller *et al.* 2009).

The dominant soils are lithosols and rendzinas less than 40 cm deep. In the bottom of valleys and ravines and on gentle slopes, luvisols, acrisols, vertisols, phaeozems, regosols and cambisols have developed. On these soils slash and burn agriculture and grasslands are found. Aridisols have developed in the driest inland portion of the region (Bracho & Sosa 1987, Contreras 1991, Ortega-Gutiérrez *et al.* 2000).

The entire area is extremely rugged, with high steep mountains, lush deep canyons, extensive valleys, and many formations caused by the erosion of limestone, especially caverns and pit caves known locally as *sótanos*. The ruggedness of the terrain and the wide variation in rainfall and elevation create microenvironments which favor speciation, diversity and endemisms. The orientation of the ESM,

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running from the NE to SE, and the fact that it merges in the south with the Trans-Mexican Volcanic Belt connecting it to the Sierra Madre Occidental, has allowed these ecoregions to share species that have evolved to better fit their unique surroundings (Ortega-Gutiérrez *et al.* 2000, Morrone & Espinosa 2002, Velasco 2006, Quiroz-Moreno & Romero-Sánchez 2006, Martínez *et al.* 2007).

Extensive field work was performed in northeastern Mexico from 2000 to 2011. A total of 161 specimens of *Necaxacris* spp. were collected in the Huasteca region and in the northern portion of the ESM. This genus has been poorly known and, apart from the original description (Hebard 1932), there was no additional or recent information available.

The name *Necaxacris* was assigned by Roberts in 1939 for the genus *Necaxa* erected by Hebard in 1932; the generic name given by Hebard was already occupied by *Necaxa* Baker, 1930 (Mollusca), and a new name was therefore necessary. Two species of *Necaxacris* were known: *N. micans* (Hebard, 1932) and a species collected by Roberts in 1936, but never formally described or published [mentioned *in litt.* by Descamps (1975)]. The present paper aims to review the genus *Necaxacris* Roberts; the species of *Necaxacris* collected and mentioned by Roberts, 1936 and cited in Descamps (1975) is named and described here as *N. tamazunchale* n. sp., and three additional new species are described. Diagnostic characters to separate the five (so far) species of the genus are illustrated and provided.

Materials and methods

Specimens were collected using a sweep net or by hand. Morphological characters, original descriptions (Hebard 1932, Roberts 1939, Descamps 1975) and the Orthoptera Species File Online (Eades *et al.* 2011) were used to identify specimens. Measurements and laboratory images were taken with a Motic Stereomicroscope, Model 43-FBGG-C, 3.0 mp. Dorsal view measurements: body length (measured from the vertex to the apex of the flexed and parallel-aligned to body hind femora) and pronotum length; lateral view: hind femora and tegmina length. All measurements were taken at 10×. Male cerci and supra-anal plate drawings were made using a Motic stereomicroscope model K-400L equipped with a drawing device SP10.0102K; drawings were made at 50×, then reduced 50%.

Internal genitalia dissection was performed by relaxing specimens in hot water for 1 h. After relaxation the male is positioned on a sheet of pinning surface, and the phallus slipped back using insect pins with the tip bent at a right angle. The phallic complex is placed for ~10 min in a 10% KOH solution to clear and remove the membranes and muscles. The membranes and muscles are then completely removed with insect pins with the tip bent, and the epiphallus separated from the phallic complex. The mass is then washed with cold water. Phallic structures were mounted on cardboard and photographed. This procedure varies according to different authors (Hubbell 1932, Cohn & Cantrall 1974).

Habitat.— Photographs of habitat were taken and samples of grasses and host plants collected during field trips; dichotomous keys were used for determination following Rzedowski & Rzedowski (2005) and Rzedowski (2006). Coordinates and altitude measurements were taken using a Garmin-GPS48 (12-channel).

Depositories.—University of Michigan Museum of Zoology (UMMZ): ♂ holotypes and ♀ allotypes. Instituto de Biología-Universidad Nacional Autónoma de Mexico (IB-UNAM): 1 ♂ and 1 ♀ paratypes. L. Barrientos-Lozano collection-Instituto Tecnológico de Cd. Victoria, Tamaulipas, Mexico. (L. Barrientos-Lozano-ITCV): all other ♂ and ♀ paratypes.

Results

Genus *Necaxacris* Roberts, 1939
(Figs 1-33, 35-38)

Synonym *Necax*a Hebard, 1932.

Hebard M. 1932: 290; Roberts, H.R. 1939: 160. Note: new name for *Necaxa* Hebard, *Necaxacris*; Otte, D. 1995: 399, *Necaxacris*; Yin, X. C., J. Shi & Z. Yin. 1996: 435, *Necaxacris*

Type species.— *Necaxacris micans* (Hebard, 1932), by monotypy.

Redescription.—Medium to small size, body slender; males: 14-16 mm; females: 15-20 mm (Tables 1, 2). Females are larger and heavier than males, fusiform. Alive the general body color is green-brown or bluish-green, dorsally brown or shining dark blue (Figs 35-37). Antennae in males are light to dark brown, slightly more slender than caudal femora. The eyes are rather large, widely separated and

Table 1. *Necaxacris* spp., males' measurements (mm).

Species	Body length			Pronotum length			Tegmina length			Hind femora length		
	x̄	Range	SD	x̄	Range	SD	x̄	Range	SD	x̄	Range	SD
N. micans	15	N.A.	N.A.	2.3	N.A.	N.A.	2.3	N.A.	N.A.	8.1	N.A.	N.A.
N. tamazunchale n. sp.	16	N.A.	N.A.	2.5	N.A.	N.A.	2.1	N.A.	N.A.	8.5	N.A.	N.A.
N. azura n. sp.	16	15.0-17.0	0.83	2.5	2.4-2.7	0.16	2.3	2.0-3.0	0.39	8.9	8.5-9.2	0.29
N. afurculae n.sp.	14	13.0-15.0	0.89	2.3	2.2-2.5	0.11	2.5	2.1-3.0	0.32	7.5	7.0-7.9	0.38
N. davidi n. sp.	14	13.0-15.0	0.83	2.5	2.3-2.6	0.15	2.6	2.4-2.9	0.19	7.4	7.1-8.0	0.35

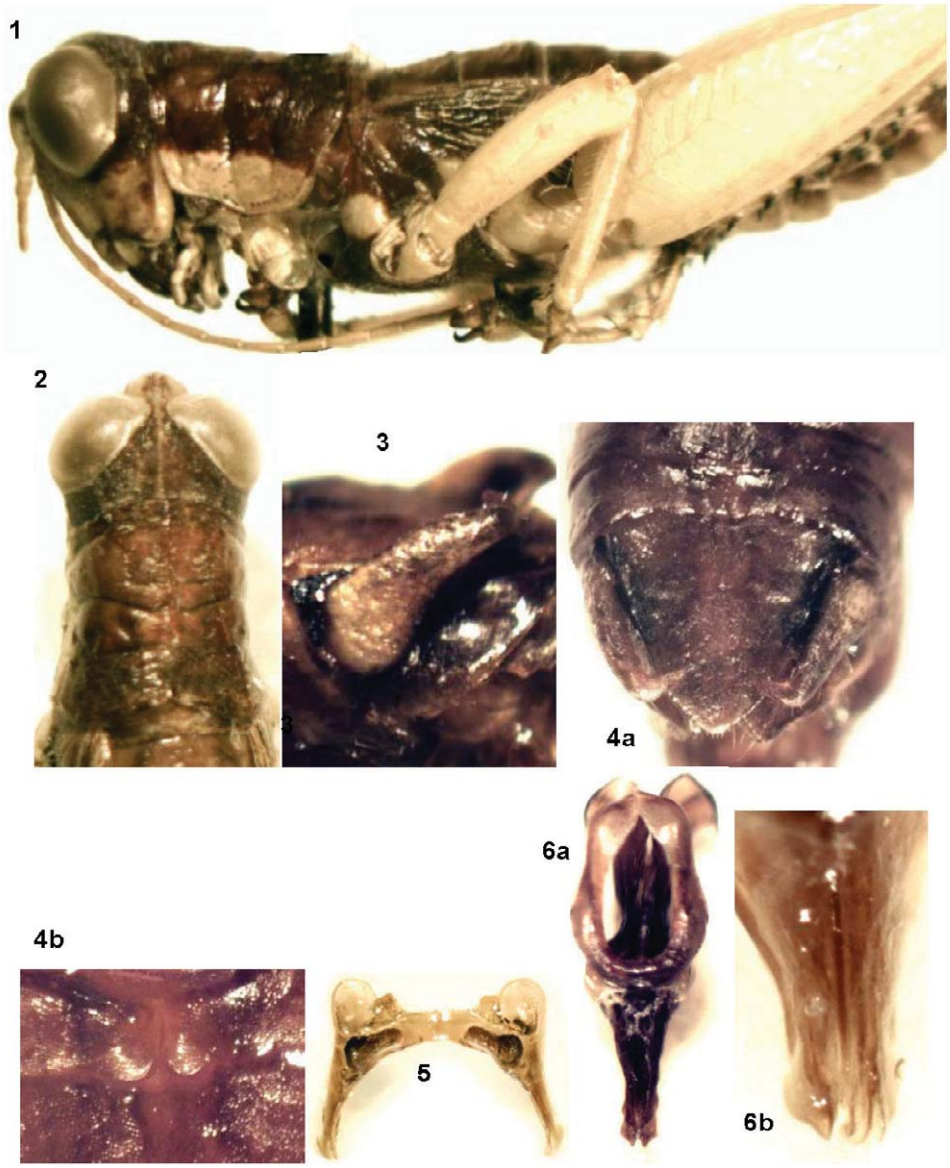
N.A.= Not Available

Table 2. *Necaxacris* spp., females' measurements (mm).

Species	Body length			Pronotum length			Tegmina length			Hind femora length		
	x̄	Range	SD	x̄	Range	SD	x̄	Range	SD	x̄	Range	SD
N. micans	18	N.A.	N.A.	2.9	N.A.	N.A.	2.3	N.A.	N.A.	9.8	N.A.	N.A.
N. tamazunchale n. sp.	20	N.A.	N.A.	3.5	N.A.	N.A.	3.2	N.A.	N.A.	11	N.A.	N.A.
N. azura n. sp.	19	18.0-22.0	2.08	3.1	3.0-3.3	0.1	2.8	2.1-3.6	0.76	10.6	9.9-11.8	0.86
N. afurculae n. sp.	16	15.0-17.0	0.83	2.9	2.7-3.0	0.13	3	2.5-3.3	0.38	8.8	8.4-9.3	0.37
N. davidi n. sp.	15	14.0-16.0	1.54	2.8	2.5-3.0	0.26	2.8	2.3-3.2	0.36	8.4	7.6-9.2	0.8

N.A.= Not Available

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Figs 1-6. *Necaxacris micans*. Male head, pronotum, thorax in left lateral view (1) and head and pronotum in dorsal view (2); left cercus in lateral view (3); distal segments of male abdomen in dorsal view (4a); furculae (4b); epiphallus in dorsal view (5); phallic complex without epiphallus in dorsal view (6a); distal portion of aedeagus valves in closer dorsal view (6b).

moderately prominent; fastigium projecting forward conspicuously in dorsal view (Figs 2, 8, 14, 20, 26, 38). Pronotum widening gently posteriorly, median carina prominent or moderately prominent, prozona over twice as long as metazona; posterior margin of disk notched and distinctly emarginated in males, slightly so in females; a brown, green or very dark postocular band on sides of head extending onto sides of pronotum; a faint to well-indicated cream stripe extending from the back of eyes throughout the pronotum and sides of abdomen; tegmina represented by very small, narrow pads, reaching or slightly surpassing the second abdominal segment; fore and medium femora and tibiae green; caudal femur green with black knees; caudal tibiae bluish-green to dark blue. Apex of male abdomen thickening gradually in ventral view; enlarged ventral section formed by the subgenital plate and the large preceding sternite, the former with lateral dorsal portion convex, projecting and also provided with a very large subapical tubercle. The supra-anal plate is subtriangular, furculae represented by two small, broad projections. Male cerci broad basally, with apices directed inwards at a right angle (Fig. 31). Ovipositor's ventral valves with sharp distal extremities broadly or moderately curved (Fig. 33).

Epiphallus (Figs 5, 11, 17, 23, 29, 32[1A-E, 2A-E]): ancorae well developed, but smaller than the anterior process, basally broad and robust; anterior process well developed, about two or three times wider than ancorae width; lophi subrectangular, medium size; short moderately broad bridge, lower margin straight or in some species with a gentle hump in the middle; posterior process well developed, projecting and diverging downwards.

Internal valves of aedeagus (Figs 6, 12, 18, 24, 30, 32[3A-E, 4A-E, 5A-E]): dorsal valves elongated, moderately broad and stout, caudally expanded, curved downwards and inwards; ventral valves elongated, basally broad, tapering gradually and curving downwards and inwards. Species may be easily separated from other genera of Melanoplinae based on male's cerci, genitalic characters and external morphology.

Closest genus.— Specimens of the genus *Necaxacris* may be mistaken at first sight for *Phaedrotettix* Scudder, 1897. However, *Phaedrotettix* spp. possess a pronotal disk widening backwards, a feeble median pronotal carina, linear wings, and the males' cerci and supra-anal plate are of variable shape and size, whereas in *Necaxacris* spp. the pronotal disk is not conspicuously widened, the median pronotal carina is prominent, the wings are ovate, the supra-anal plate is triangular and the cerci of males are broad basally, with apices directed inwards at a right angle.

Necaxacris micans (Hebard, 1932)
(Figs 1-6, 31, 32[1A, 2A, 3A, 4A, 5A], 33, 34, 38)

Hebard M. 1932: 291. *Necaxa micans.*
Roberts, H.R. 1939: 160. *Necaxacris micans.*

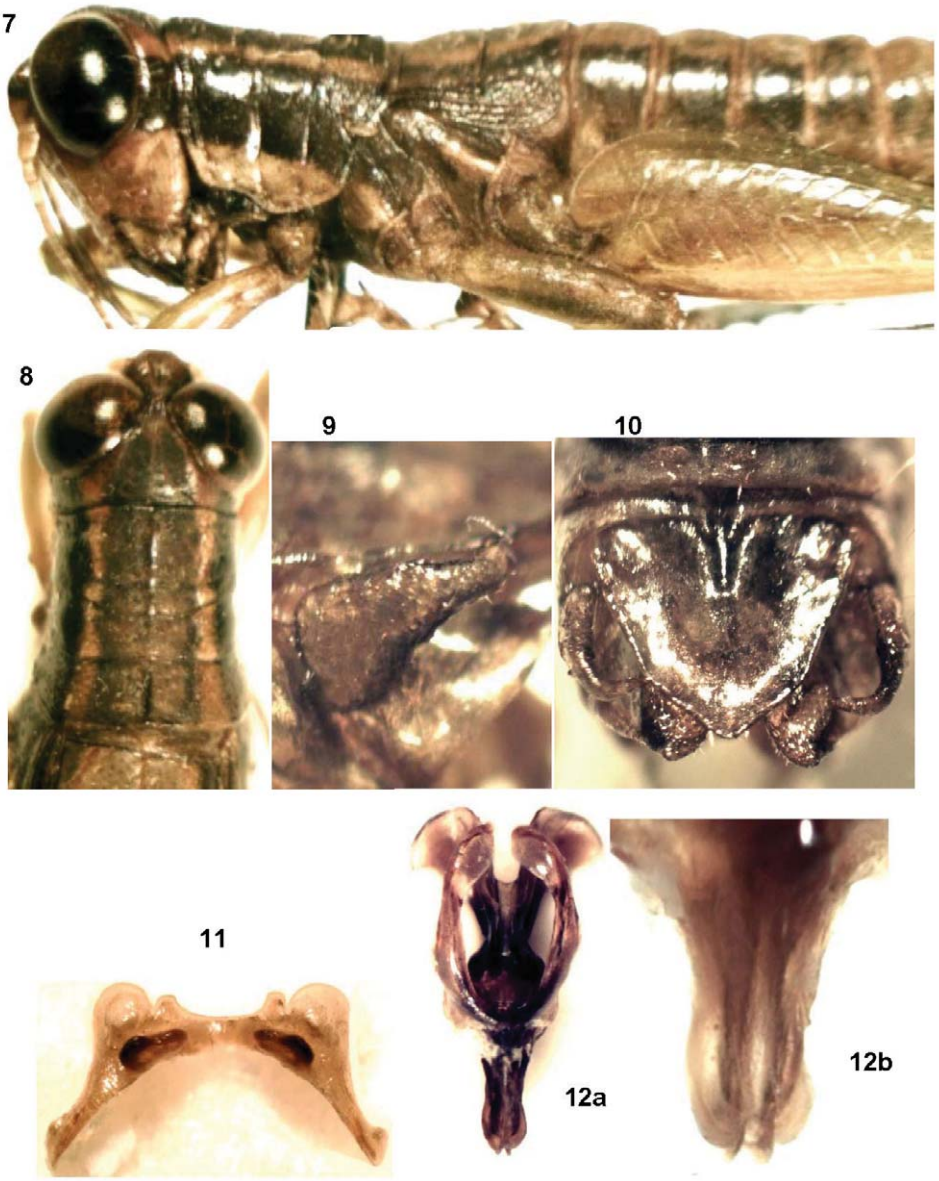
Type locality.—Northern America, Mexico Central, Puebla, Necaxa.

Type.—Holotype male, ANSP-USA.

Material examined.—Puebla: 2♂ and 3♀, Villa Juárez, 2180m, lat 19°03′08.36″N, long 98°13′36.75″W, 09.X.1947, Wagner H.O., coll. UMMZ.

Diagnosis.— Differing from congeneric species by the more elongated, vertically compressed cerci, broadly incurved and decurved,

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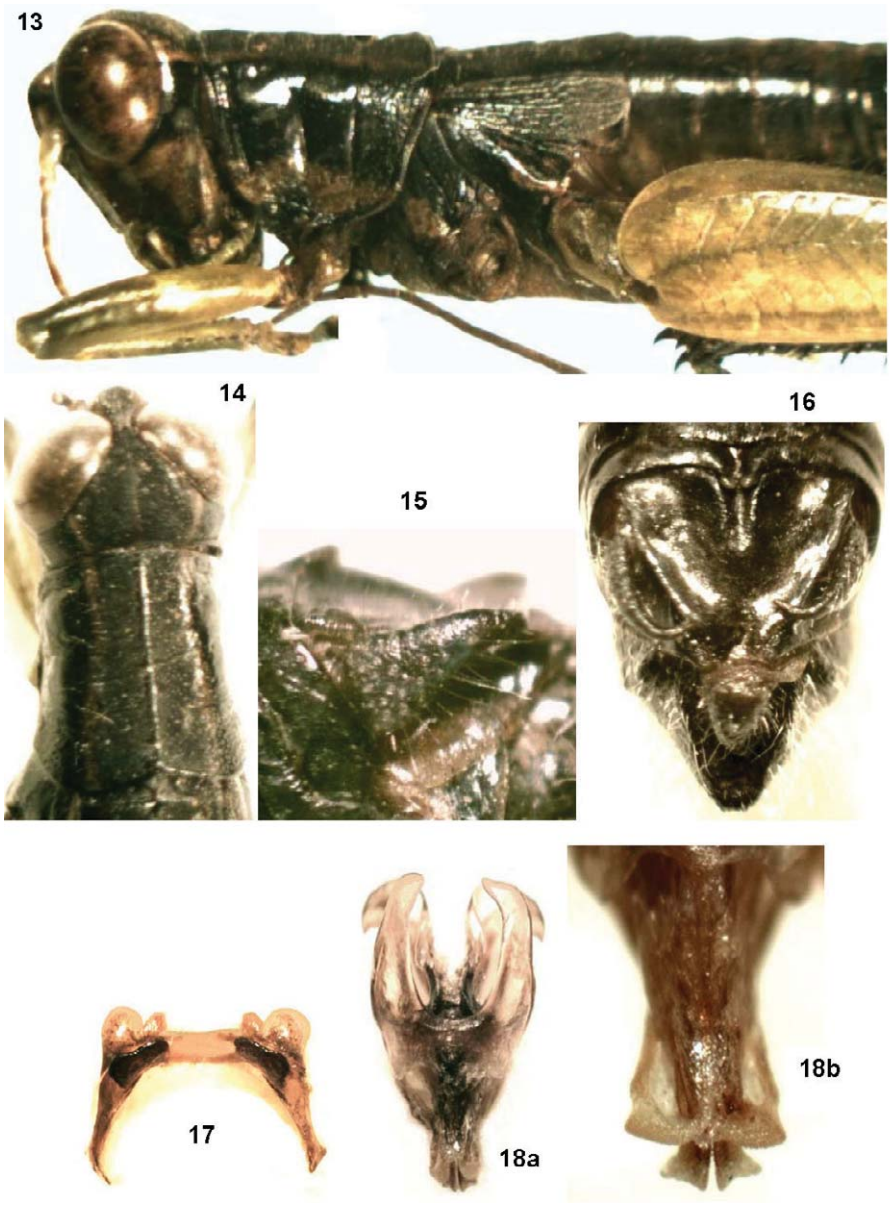
Figs 7-12. *Necaxacris tamazunchale* n. sp. Male head, pronotum, thorax in left lateral view (7) and head and pronotum in dorsal view (8); left cercus in lateral view (9); distal segments of male abdomen in dorsal view (10); epiphallus in dorsal view (11); phallic complex without epiphallus in dorsal view (12a); distal portion of aedeagus valves in closer dorsal view (12b).

tapering very gradually, with apical quarter suddenly bent inwards at a right angle to shaft and tapering to its rounded apex (Figs 3, 4a, 31). The supra-anal plate (Figs 4a, 31) is triangular, surface with a broad shallow, mediolongitudinal sulcus in proximal portion only, furculae (Figs 4a, 4b) represented by two small projections broader than tall. Epiphallus (Figs 5, 32[1A, 2A]): ancorae stout, not exceeding the anterior process, anterior process well developed, medium size compared to congeneric species; lophi subrectangular, prominent; apodemes of cingulum (Figs 6a, 32[3A, 4A]) basally stout, tapering towards mid portion, cephalic portion expanded and concave, pointed apex. Internal valves of aedeagus (Figs 6a, b, 32[3A, 4A, 5A]): dorsal valve of aedeagus elongated, apex in dorsal view moderately expanded; ventral valve of aedeagus broad basally, tapering, and curving inwards distally in lateral view.

Redescription of males.—Body surface shining and rather hirsute. Eyes large and moderately prominent, interocular space fairly wide. Fastigium moderately declevent, moderately impressed, projecting beyond lateral ocelli. Frontal costa prominent, gently expanding between the antennae, flat with scattered impressed punctae from median ocellus to clypeus and shallowly concave between the lateral carina; a dark spot below median ocellus and above antennae (Fig. 38). Pronotum with disk defined from lateral lobes by gentle lateral carinae which are straight and very slightly divergent caudad; median-longitudinal carina, cut by three delicate but distinct transverse sulci; caudal margin of disk broadly convex on each side, thus forming a median broadly obtuse-angulated emargination. Tegminal pads slender, considerably surpassing second abdominal tergite; length three times greater than width, gradually expanding to their rounded apices; venation prominent, longitudinal, fairly regular. Cephalic and median femora thickened and feebly bowed. The caudal femur is of medium size, caudal tibiae with nine spines on each margin. Caudal metatarsus nearly three times as long as second joint, the latter somewhat longer than broad; ultimate caudal tarsal joint with shaft almost as long as combined length of the two preceding joints. Arolium large. Supra-anal plate (Figs 4a, b, 31) triangular, surface with a broad and shallow medio-longitudinal sulcus in proximal portion only; lateral margins convergent, very faintly convex, then very faintly concave, then straight and more strongly convergent to the rounded apex; furculae represented by two very small, adjacent, transversely rounded enlargements of the caudal margin of the tergites, each over twice as broad as long. Cerci with shaft vertically compressed, broadly incurved and decurved, tapering very gradually, with apical quarter suddenly bent inwards at a right angle to shaft and tapering to its rounded apex. Internal valves of aedeagus (Figs 6a, b, 32[3A, 4A, 5A]): dorsal valve of aedeagus elongated, curving, apex moderately expanded in dorsal view; ventral valve of aedeagus broad basally, tapering and curving inwards distally in lateral view. The subgenital plate possesses an apical tubercle seen in ventral view.

Redescription of females.— The eyes are less prominent and the interocular space wider than in males. Antennae decidedly shorter, a dark subrectangular spot is located below the lateral ocelli and above the antennae (frontal view). Posterior margin of pronotal disk shows very slight lateral convexity and median middle emargination. Face and genae buffy suffused with brown. Antennae light brown becoming paler and greenish proximad. The lower portions of pronotal lateral lobes, a large area on lower portion

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Figs 13-18. *Necaxacris azura* n. sp. Male head, pronotum, thorax in left lateral view (13) and head and pronotum in dorsal view (14); left cercus in lateral view (15); distal segments of male abdomen in dorsal view (16); epiphallus in dorsal view (17); phallic complex without epiphallus in dorsal view (18a); distal portion of aedeagus' valves in closer dorsal view (18b).

of episternum 2, and distal portion of episternum 3 are whitish. Occiput and postocular portions of genae, pronotum (except lower portions of lateral lobes), tegmina and all other portions of body shining blackish-brown (except whitish markings on episterna described above and last two sternites of females which are greenish); tegminal pads do not surpass the second abdominal tergite. Femora yellowish green, caudal femora with apices blackish brown and exposed surface slightly darkened, leaving a subapical paler annulus. Caudal tibiae are glaucous with a brief portion of bases and apices blackish. Caudal tarsi are blackish-brown with metatarsus and last joint to near apex yellowish-green. Ovipositor valves: ventral valves shorter and stouter, tip considerably less produced than congeneric species; margins not toothed, apical fans broadly curved (Fig. 33).

Measurements.—(mm) **Males:** body length from vertex to end of femur 3: 15.0. Pronotum length: 2.3. Tegmina length: 2.3. Caudal femur length: 8.1. **Females:** body length: 18.0. Pronotum length: 2.9. Tegmina length: 2.3. Caudal femur length: 9.8.

Distribution.—This species has been collected in Puebla, Mexico at two localities: Necaxa, 1400 m and Villa Juárez, 925 and 2180 m (Table 3, Fig. 34).

Habitat.—The localities where *N. micans* has been collected are situated at the Sierra Norte de Puebla (SNP): this mountain is located between lat 19°45′ and 20°50′ N, long 97°10′ and 98°17′ W. The elevational gradient for this area varies from 100 to 2300 m, characterized by a warm to semiwarm humid climate in the lowlands and temperate humid climate in the highlands. Main corresponding vegetation types are tropical evergreen forest, mesophyll montane forest, oak forest, pine forest and oak-pine forest, with extensive ecocline zones between the contiguous types of vegetation (Martínez *et al.* 2007). *N. micans* lives on the grassy vegetation of mountainsides; common host plants are *Lysiloma* sp., (Fabaceae), *Acacia* sp., (Fabaceae) and *Pluchea* sp., (Asteraceae).

Necaxacris tamazunchale n. sp.
(Figs 7-12, 31, 32[1B, 2B, 3B, 4B, 5B], 33, 34, 38)

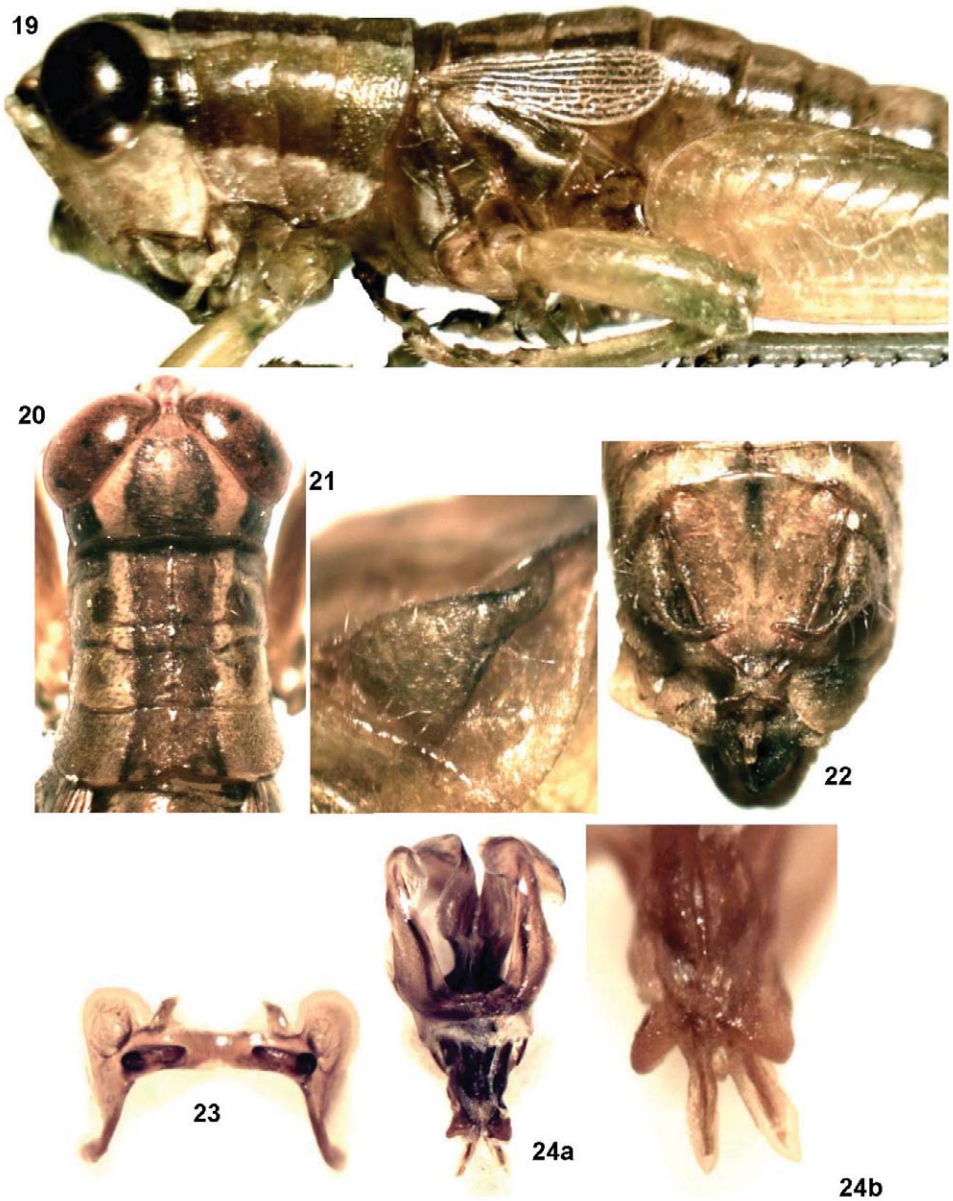
N. moctezumae Roberts in Descamps, 1975: 69 *nomen nudum.*
Descamps M. 1975. 31-32: 69. Note: "*Necaxacris moctezumae* Roberts *in litt*."
Otte D. 1995: 399. Note: *in litt*. Roberts, unfinished manuscript *Necaxacris moctezumae.*
Barrientos-Lozano L., Medina R.F & Rocha-Sánchez A.Y. 2009.48. *Necaxacris moctezumae.*

Type locality.—Northern America, Mexico, Mexico Northeast, San Luis Potosí, Tamazunchale.

Type material.— (material examined). Holotype ♂ and allotype ♀, Mexico, San Luis Potosí, Tamazunchale, 136 m, lat 21°15′15.35″ N, long 98°47′16.74″W, 22.VIII.1954, Young F. N., coll. UMMZ.
Paratypes: San Luis Potosí: 1♀, Tamazunchale, 136 m, lat 21°15′15.35″ N, long 98°47′16.74″ W, 22.VIII.1954, Young F.N., coll. UMMZ; 1 ♂ and 2 ♀, prior to Tamazunchale, 140 m, lat 21°16′ N, long 98°48′W, 20.IX.2009, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV.

Diagnosis.— This species is most similar to *N. davidi* n. sp. However, it may be easily distinguished by the stouter male cerci (Figs 9, 10, 31 *vs* 27, 28, 31) these basally broader, tapering abruptly about mid portion, with apical quarter bent inwards at a more produced

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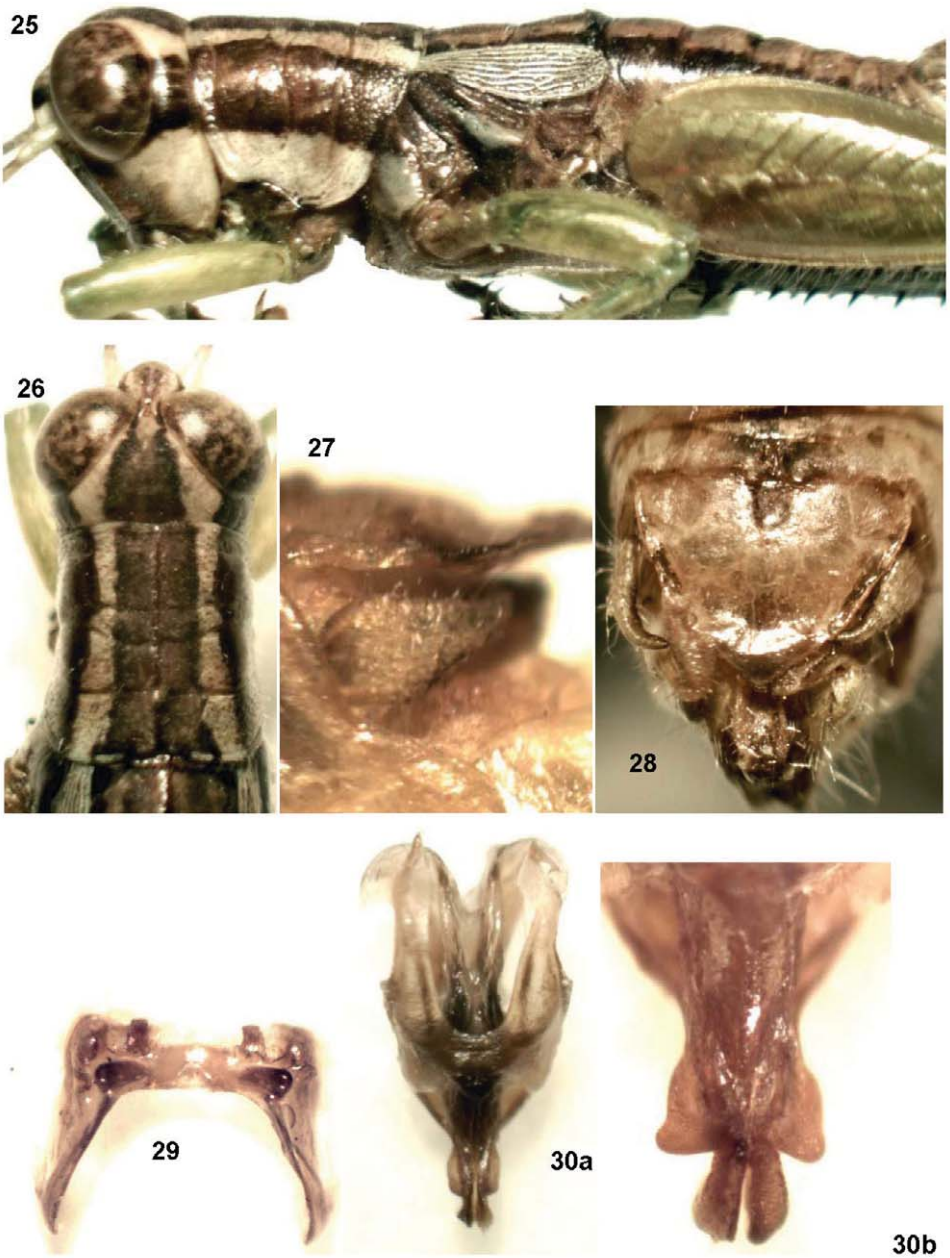
Figs 19-24. *Necaxacris afurculae* n. sp. Male head, pronotum, thorax in left lateral view (19) and head and pronotum in dorsal view (20); left cercus in lateral view (21); distal segments of male abdomen in dorsal view (22); epiphallus in dorsal view (23); phallic complex without epiphallus in dorsal view (24a); distal portion of aedeagus valves in closer dorsal view (24b).

right angle than *N. davidi* n. sp. The supra-anal plate (Figs 10, 31 *vs* 28, 31) and furculae differ as follows: in *N. tamazunchale* n. sp., the supra-anal plate is subpentagonal, surface with a broad deep median sulcus in proximal third only; furculae represented by two small digitiform projections. In *N. davidi* n. sp., the supra-anal plate is triangular, the median sulcus is broader shorter and not very deep; furculae represented by two broader and smaller projections. Internal genitalia: *N. tamazunchale* n. sp. (Figs 11, 12a, b, 32[1B, 2B, 3B, 4B, 5B]) possesses an epiphallus with a more broadly developed anterior process and the posterior process is shorter; apodemes of cingulum with expanded, converging concave apices. These characters are not so in *N. davidi* n. sp. (Figs 29, 30a, b, 32[1E, 2E, 3E, 4E, 5E]). Internal valves of aedeagus in *N. tamazunchale* n. sp., are shorter, stockier and less produced distally than in *N. davidi* n. sp.

Description of males.—General body color green (alive), surface shiny and hairy. Eyes are large and slightly prominent, interocular space wide. Fastigium moderately declevent, slightly swollen, impressed, projecting beyond lateral ocelli. Frontal costa moderately prominent, slightly expanding between antennae, flat with scattered impressed punctae from lateral ocelli to clypeus and shallowly concave between the lateral carina; a large sub-rectangular spot above the antennae and below lateral ocelli (Fig. 38). A cream colored stripe extends from the back of eyes throughout pronotum and on sides of abdomen till 5th abdominal segment; a dark brown postocular band on sides of head extends onto sides of pronotum and abdomen. Pronotum with disk defined from lateral lobes by feeble lateral carinae which are straight and very slightly divergent caudad; mediolongitudinal carina prominent, cut by three distinct transverse sulci; caudal margin of disk broadly convex on each side, thus forming a median broadly obtuse-angulated emargination. Tegminal pads slender, not surpassing second abdominal tergite, length about three times greater than width, gradually expanding to their rounded apices; venation white, prominent, longitudinal, fairly regular. The cephalic and median femora thickened, caudal femora with black knees and tibiae bluish-green. The supra-anal plate (Figs 10, 31) is subpentagonal, surface with a broad deep medium sulcus in proximal portion only; furculae represented by two small digitiform projections. Cerci broad basally, tapering abruptly about mid portion, then incurved and decurved, tapering very gradually, with apical third bent inwards at a right angle to shaft and tapering to its rounded apex. Epiphallus (Figs 11, 32[1B, 2B]): ancorae stout, not exceeding the anterior process; anterior process well developed, posterior process short and diverging greatly compared with congeneric species; lophi subrectangular and prominent. Apodemes of cingulum (Figs 12a, 32[3B, 4B]) with distal cephalic portion expanded, concave and converging. Internal valves of aedeagus (Figs 12a, b, 32[3B, 4B, 5B]): dorsal valve of aedeagus elongated, distally expanded and curving inwards in dorsal view; ventral valve more elongated than dorsal valve, basally broad, tapering gradually, curving inwards in lateral view.

Description of females.—Eyes less prominent and interocular space wider than in males; antennae decidedly shorter, a dark subrectangular spot below the ocelli and above the antennae (frontal view). Pronotum shows lateral convexity and very faint medium emargination. Face and genae buff suffused with brown. Antennae light

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Figs 25-30. *Necaxacris davidi* n. sp. Male head, pronotum, thorax in left lateral view (25) and head and pronotum in dorsal view (26); left cercus in lateral view (27); distal segments of male abdomen in dorsal view (28); epiphallus in dorsal view (29); phallic complex without epiphallus in dorsal view (30a); distal portion of aedeagus' valves in closer dorsal view (30b).

brown becoming paler and greenish proximad. Lower portions of pronotal lateral lobes, a large area on lower portion of episternum 2, and distal portion of episternum 3 are whitish. Occiput and postocular portions of genae, pronotum (except lower portions of lateral lobes), tegmina and all other portions of body shiny and blackish-brown (except whitish markings on episterna described above). Tegminal pads not surpassing the second abdominal tergite. Cephalic and medium femora yellowish-green, the caudal femora with apices blackish-brown and exposed surface slightly darkened, leaving a sub-apical paler annulus. Caudal tibiae are glaucous, with a brief portion of bases and apices blackish. Ovipositor valves as shown in Fig. 33.

Measurements.—(mm). **Males:** body length from vertex to end of femur 3:16.0. Pronotum length: 2.5. Tegmina length: 2.1. Caudal femur length: 8.5. **Females:** body length: 20.0. Pronotum length: 3.5. Tegmina length: 3.2. Caudal femur length: 11.0.

Distribution.—This species is known only from the type locality, 136-140 m (Table 3; Fig. 34).

Habitat.— Tamazunchale is located in the heart of the Huasteca Potosina in northeastern Mexico. It is distinguished by its warm subhumid climate, with rains in both summer and winter. The average annual temperature is 23-24° and the annual precipitation varies between 2500 to 2600 mm. Soils are limestone karst with numerous underground rivers, turquoise-hued surface rivers, feeding springs, world-renowned caves and waterfalls. The dominant vegetation is tropical evergreen forest and low deciduous forest (Rzedowski 1963, 2006). *N. tamazunchale* n. sp. is found on patches of grassy vegetation along roadsides and in humid green open areas, mainly on *Phoebe* sp., (Fabaceae), *Pseudogynoxys* sp., (Asteraceae), *Dioscorrea composita* (Dioscorreaceae).

Etymology.—Species named after type locality, Tamazunchale; this word derives from "temazolcali", a Huastec Indian word meaning "place where the governor woman lives." It is well known that in past times, Huastec localities had female governors.

Necaxacris azura n. sp.

(Figs 13-18, 31, 32[1C, 2C, 3C, 4C, 5C], 33, 34, 35, 38, 39)

Type material.—(Material examined). Holotype ♂ and allotype ♀. Mexico, San Luis Potosí, Xilitla, by the Edward James Castle, 277 m. lat 21°23'46.9"N, long 98°59'52.2"W, 20.IX.2009, Barrientos-Lozano L. & Rocha-Sánchez A.Y.

Paratypes.—San Luis Potosí: 2 ♂ and 3 ♀, 20 mi. WNW Antiguo Morelos, Salto del Agua, 520 m, 26-27.VIII.1955, Cohn T.J., coll. UMMZ; 6 ♂ and 2 ♀, 7 mi., by rd SW El Naranjo, 671 m. lat 22°30'19.23"N, long 99°22'57.6"W, 22.VIII.1959, Cohn T.J. & Cantrall I.J., coll. UMMZ; 8 ♂ and 11 ♀, 1.5 mi., E of church by Chupaderos, 4.7 mi., W El Naranjo, 670 m, 07.VII.1964, Cohn T.J., coll. UMMZ; 8 ♂ and 17 ♀, Xilitla, by the Edward James Castle, 277 m, lat 21°23'46.9"N, long 98°59'52.2"W, 20.IX.2009, Barrientos-Lozano L. & Rocha-

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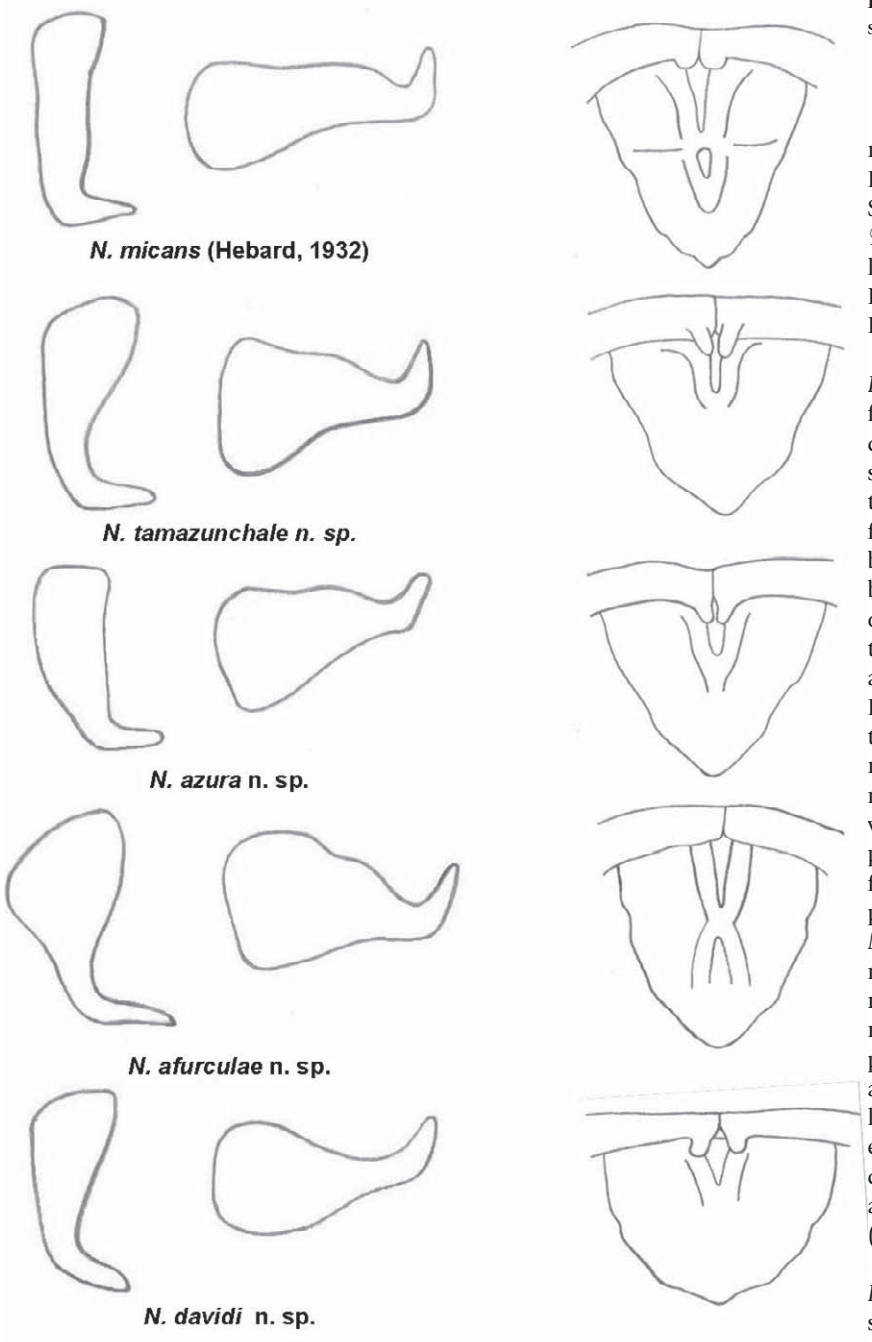


Fig. 31. *Necaxacris* spp., male cerci and supra-anal plates, species as indicated.

Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 6 ♂ and 8 ♀, same locality, 28.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll L. Barrientos-Lozano-ITCV; 5 ♀, between El Naranjo and Ciudad del Maíz, Km 157, 509 m, lat 22°31.446′N, long 99°23.019′W, 20.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1 ♀, Taninul, 1079 m, lat 22°29.272′N, long 99°43.905′W, 28.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll L. Barrientos-Lozano-ITCV. **Veracruz:** 1 ♂ and 1 ♀, Benito Juárez, 269 m, lat 20°51.736′N, long 98°10.940′W, 30.X.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV. **Hidalgo:** 1 ♀, Atlapexco, 451 m, lat 20°58.371′N, long 98°19.130′W, 30.X.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 3 ♂ and 4 ♀, prior to Chapulhuacán, Km 246, 821 m, lat 21°11.000′N, long 98°53.975′W, 31.X.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1 ♀, Puerto del Zopilote, 1052 m, lat 21°09.137′N, long 98°56.335′W, 31.X.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV.

Diagnosis.— At first sight this species may be confused with *N. micans*. However, the general color differs from *N. micans* and from other congeneric species: males are shiny blue; face, occiput, pronotum, and abdomen are intense blue (alive; Fig. 35); females are slightly less colorful, their general color being dark brown with a dark blue-black postocular band extending onto sides of pronotum and sides of abdomen; the lower margin of pronotal lobes, the lower portion of episternum 2, and the distal area of episternum 3 are white (alive, Fig. 35). Both sexes possess green femora and intense blue tibiae, the caudal femora with a black apex. The males' cerci (Figs 15, 16, 31 *vs* 3, 4a, 31) are more robust and slightly shorter than in *N. micans*; the vertical portion is basally broader. The supra-anal plate (Figs 16, 31 *vs* 4a, b, 31) and furculae differ as follows: in *N. azura* n. sp., the supra-anal plate is triangular but shorter and wider than in *N. micans*; furculae are represented by two small rounded projections, slightly longer than broad, not so in *N. micans*. Internal genitalia of *N. azura* n. sp. (Figs 17, 18a, b, 32[1C, 2C, 3C, 4C, 5C]) presents a stouter epiphallus (more developed anterior and posterior processes and less prominent lophi); apodemes of cingulum with cephalic apex expanded and converging, more elongated and distally expanded internal valves of aedeagus and a very large covering sheath; not so in *N. micans* (Figs 5, 6a, b, 32[1A, 2A, 3A, 4A, 5A]).

Description of males (alive).—General body color shiny blue, hairy; face, occiput, pronotum and abdomen intense dark blue. The eyes are large and moderately prominent, interocular space wide. Fastigium slightly declevent, moderately impressed, projecting beyond lateral ocelli; lateral ocelli considerably larger in comparison to congeneric species. Frontal costa expanding between the antennae, decidedly converging below medium ocellus, flat with scattered impressed punctae from fastigium to medium ocellus and slightly convex between lateral carina; a dark subquadrate spot above antennae (Fig. 38). A delicate white stripe extends from the back of eyes throughout pronotum continuing onto abdomen; on second abdominal tergite edges becoming convergent, then parallel till 5th-6th tergite. A black postocular band develops on sides of head extending onto sides of pronotum and abdomen. The pronotum medio-longitudinal carina is prominent, cut by three transverse sulci; caudal margin of disk broadly convex on each side, thus forming a median broadly obtuse-angulated emargination. Tegminal pads slender, not surpassing

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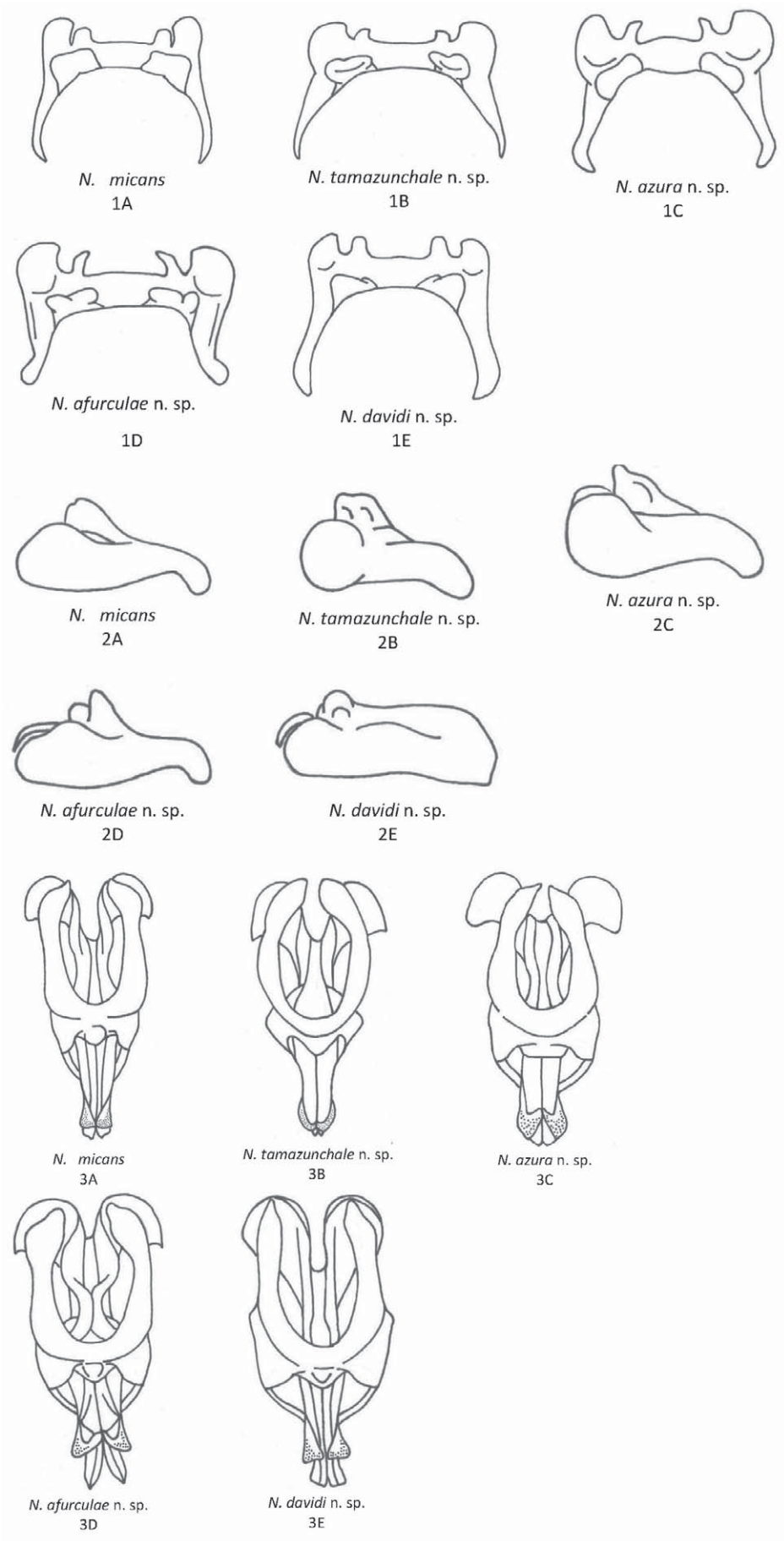


Fig. 32. *Necaxacris* spp. male internal genitalia. 1A-E epiphallus in dorsal view, 2A-E epiphallus in lateral view, 3A-E phallic complex without epiphallus-dorsal view. Fig continued next page.

the second abdominal tergite, length about three times greater than width, gradually expanding to their rounded apices; venation white, prominent, longitudinal, fairly regular. The cephalic and median femora thickened, caudal femora with black knees and tibiae intense blue. The supra-anal plate (Figs 16, 31) is triangular, surface with a broad, deep, median sulcus in proximal portion only; furculae represented by two small rounded projections slightly longer than broad. Cerci basally broad, tapering, with apical quarter bent inwards at a right angle, then tapering again to its rounded apex. Epiphallus (Figs 17, 32[1C, 2C]): ancorae small and stout, not exceeding the anterior process; anterior process well developed, lophi subrectangular and moderately prominent. Apodemes of cingulum (Figs 18a, 32[3C, 4C]) stout, tapering beyond midlength; cephalic extremity expanded and concave, converging with a pointed apex. Internal valves of aedeagus (Figs 18a, b, 32[3C, 4C, 5C]): dorsal valve of aedeagus with half basal portion very broad, tapering abruptly, then elongated with slightly expanded and inwardly curving apex, dorsal view; ventral valve distally very expanded, subtriangular and curving inward in lateral view.

Description of females (alive).—Eyes less prominent and interocular space wider than in males. A dark subtriangular spot below the ocelli and above the antennae in frontal view. Pronotum's caudal margin emarginated, showing gently lateral convexity and median emargination; median carina prominent. A white stripe extends from the back of eyes through pronotum, continuing onto abdomen, on second abdominal tergite becoming convergent, then parallel till 8th tergite. Face and genae buff suffused with whitish, brown and blue. Antennae light brown becoming paler and greenish proximad. Lower portions of pronotal lateral lobes, a large area on lower portion of episternum 2 and distal portion of episternum 3 are whitish. Occiput and postocular portions of genae, pronotum (except lower portions of lateral lobes), tegmina and all other portions of body are shiny and blackish, dark brown or bluish (except whitish markings on episterna described above). Cephalic and medium femora green, the caudal femora with apices blackish-brown

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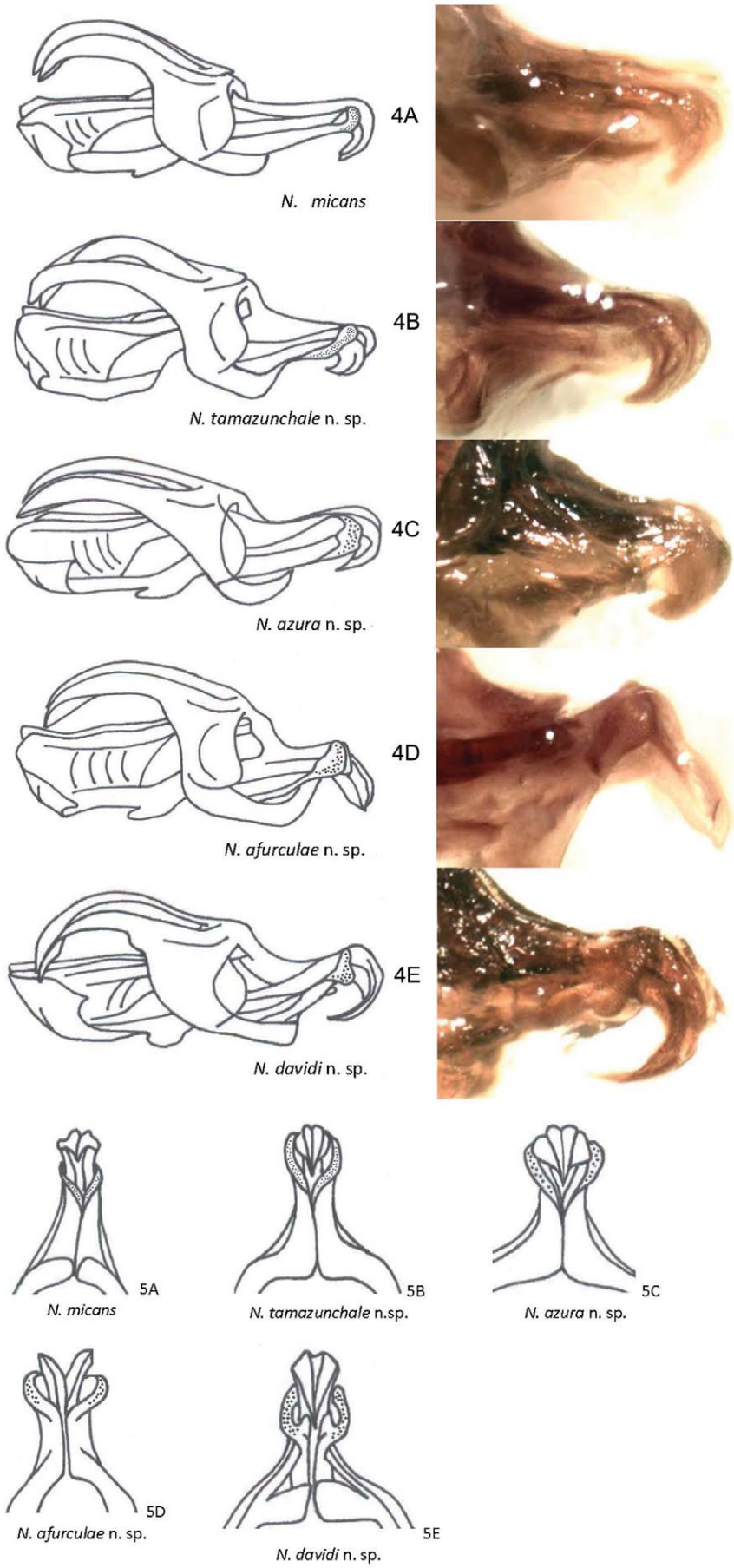


Fig. 32. (continued) *Necaxacris* spp., male internal genitalia. 4A-E, phallic complex without epiphallus, lateral view. 5A-E distal portion of aedeagus' valves, ventral view. Species as indicated.

and exposed surface slightly darkened, leaving a subapical paler annulus. Caudal tibiae with a brief basal and distal portion blackish, otherwise is intense blue. Ovipositor valves as shown in Fig. 33.

Measurements.— (mm) **Males:** body length from vertex to end of femur 3: 16.0 (15.0-17.0). Pronotum length: 2.5 (2.4-2.7). Tegmina length: 2.3 (2.0-3.0). Caudal femur length: 8.9 (8.5-9.2). **Females:** body length: 19.0 (18.0-22.0). Pronotum length: 3.1 (3.0-3.3). Tegmina length: 2.8 (2.1-3.6). Caudal femur length: 10.6 (9.9-11.8).

Distribution.— This species presents a wider distribution range than *N. micans* and *N. tamazunchale* n. sp. It has been collected in the states of San Luis Potosí, Veracruz and Hidalgo in northeastern Mexico (Fig. 34). The elevation gradient varies from 269 to 1079 m (Table 3).

Habitat.—(Fig. 39) Localities where *N. azura* n. sp. has been collected in the Huasteca Region, Xilitla and surroundings, unquestionably present an optimal condition of humidity: the annual precipitation is > 2600 mm, and mist occurs throughout the year. The average relative humidity is estimated to exceed 90%. The area is characterized by its semiwarm humid climate, with yearlong rainfall and an average annual temperature of 20-21 °C. The topography is very hilly; soils are limestone karst with abundant water sources. The dominant vegetation is tropical evergreen forest and low deciduous forest. *N. azura* n. sp. inhabits very humid areas on patches of grassy lush vegetation. Main host plants are members of the Asteraceae family, such as *Heliomeris obscura*, *Calyptocarpus* sp., *Eupatorium* sp., though it has also been collected on *Sphaeralcea angustifolia* (Malvaceae) and *Gomphrena globosa* (Amaranthaceae).

Etymology.—"Azura" refers to the intense blue general body color of living males and females.

Necaxacris afurculae n. sp.
(Figs 19-24, 31, 32[1D, 2D, 3D, 4D, 5D], 33, 34, 36, 38])

Type material.—(Material examined). **Mexico, Tamaulipas.** Holotype ♂ and allotype ♀, Hwy. 70, Villa de Casas- Soto La Marina, km 74, 466 m, lat 23 °34.316'N, long 98 °30.917'W, 13.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV

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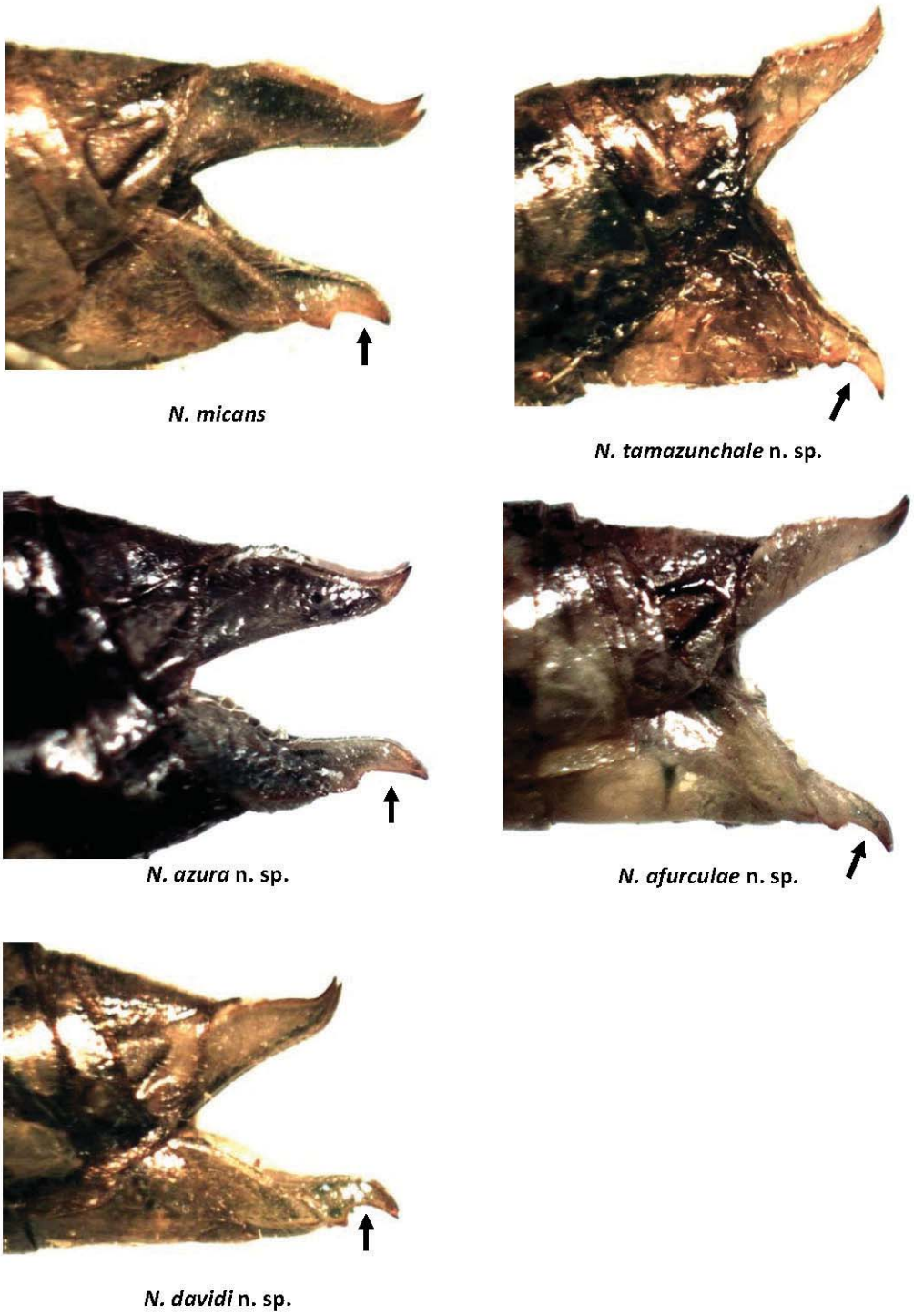


Fig. 33. *Necaxacris* spp. female valves; species as indicated.

Paratype.—Tamaulipas: 1 ♂, Nuevo Morelos, 400 m, 21.VII.1954, Cohn T.J., coll. UMMZ; 1 ♀, 21 mi. SW Padilla, 209 m, lat 23°52′06.00″N, long 99°05′58.98″W, 05.X.1958, Cohn T.J., coll. UMMZ; 1 ♀, 8 mi. SW Ciudad Victoria, 500 m, lat 23°42′04.64″N, long 99°12′55.43″W, 15.VIII.1959, Cohn T.J., coll. UMMZ; 2 ♀, Victoria, La Libertad Canyon, 361 m, lat 23°46.630 N, long 99°13.029 W, 29.VII.2009, Barrientos-Lozano L., Ramírez-Núñez J.B., coll. L. Barrientos-Lozano-ITCV; 2♀, Hwy. 101, between Ciudad Victoria and San Antonio, 1066 m, lat 23°37.167′N, long 99°16.689′W, 27.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV. 2♂, Gómez Farías, El Mirador, 530 m, lat 23°03.432′N, long 99°10.389′W, 23.X.2009, Barrientos-Lozano L., Méndez-Gómez B.R., Montelongo-Ruiz G., Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 6♂ and 11♀, Hwy. 70, Villa de Casas-Soto La Marina, km 74, 466 m, lat. 23°34.316′N, long. 98°30.917′W, 13.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1♂ and 2♀, between Nuevo Morelos and El Naranjo, km 174, 366 m, lat. 22°31.680′N, long. 99°16.044′W, 20.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R., Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV. **San Luis Potosí**: 1♂ and 1♀, El Salto-near El Naranjo, 477 m, lat 22°21′44.93″N, long 99°15′57.66″W, 03.IX.1948, Cohn T.J., coll. UMMZ; 1♂, El Pujal, 96 m, lat 21°57′31.04″N, long 98°59′38.16″W, 12.VI.1948, Cohn T.J., coll. UMMZ; 1♀, San José, 170.6 mi. Antiguo Morelos, 290 m, lat 22°24′42.98″N, long.99°03′24.07″W, 20.VI.1948, Hubbell T.H., coll. UMMZ; 1♂ and 5♀, 29 mi. NW Ciudad Valles, on Hwy. 85, near Buena Vista, 1476 m, lat 22°12′55.27″N, long 99°27′49.31″W, 19.VIII.1954, Cohn T.J., coll. UMMZ; 3♂ and 4♀, 18 mi. S Antiguo Morelos, 213 m, lat 22°19′26.02″N, long 99°01 45.98″W, 14.VIII.1959, Cohn T.J., coll. UMMZ; 1 ♀, Hwy. 85, km 27, Laguna del Mante, between Ciudad Mante and Ciudad Valles, 289 m, lat 22°13′16.6″N, long 98°59′58.7″W, 20.IX.2009, Barrientos-Lozano L. & Rocha-Sánchez A.Y., coll L. Barrientos-Lozano-ITCV. **Hidalgo**: 6♂ and 2♀, Hwy. 85, Chapulhuacán, Km 254, between Tamazunchale and Ixmiquilpan, 540 m, lat 21°13′17.7″N, long 98°53′52.6″W, 15.IX.2009, Barrientos-Lozano L. & Ramírez-Núñez J.B., coll. L. Barrientos-Lozano-ITCV. **Veracruz:** 1♂, Benito Juárez, 269 m, lat 20°51.736′N, long 98°10.940′W, 30.X.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1♂, 35 mi. NE Tempoal, 30 m, lat 21°58′15.09″N, long 98°16′46.72″W, 11.X. 1958, Cohn T.J., coll. UMMZ; 2 ♂, Lomas del Dorado, 410 m, lat 20°48.937′N, long 98°8.391′W, 30.X.2010, Barrientos-Lozano L., Méndez-Gómez B.R.

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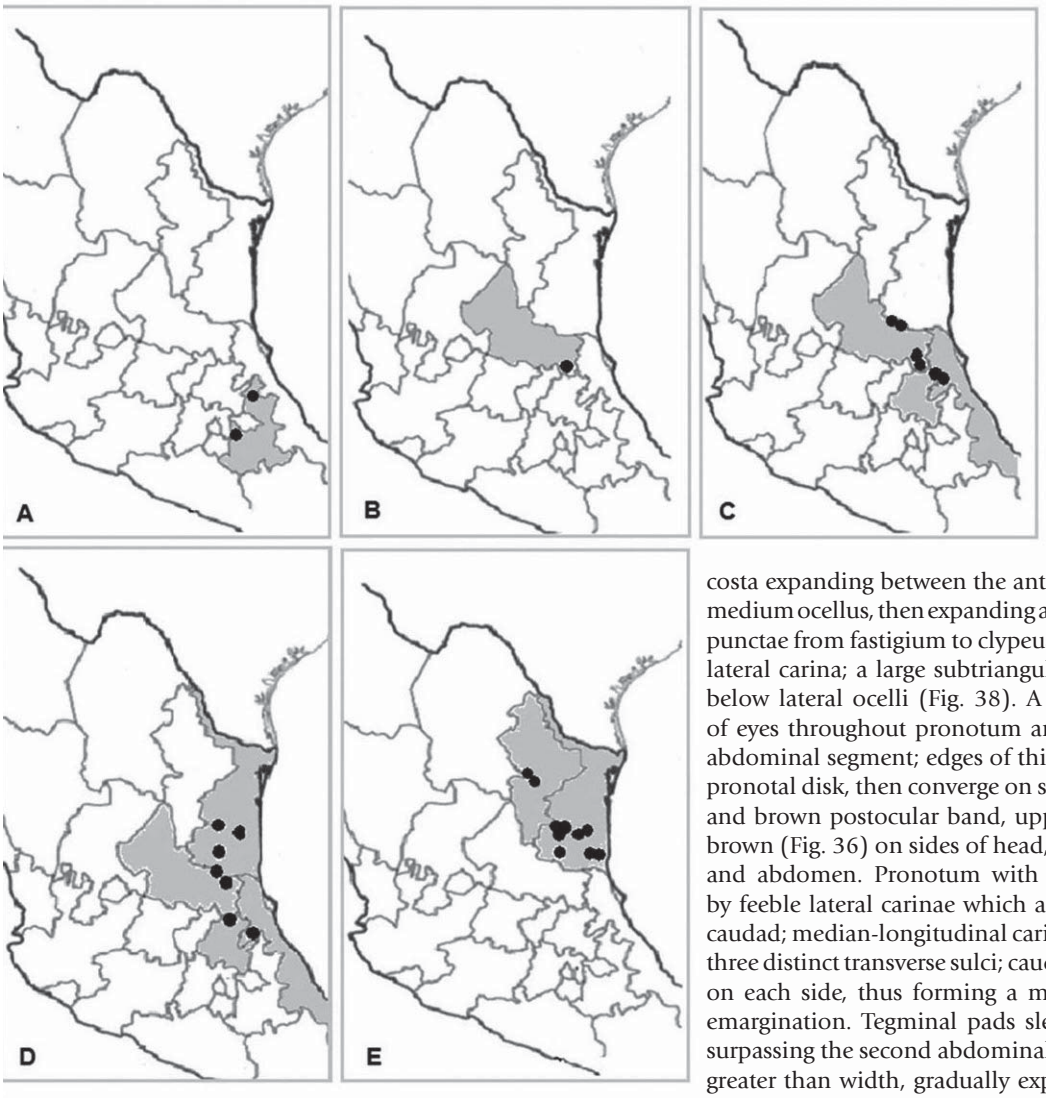


Fig. 34. Distribution of *Necaxacris* spp. A. *N. micans*; B. *N. tamazunchale* n. sp.; C. *N. azura* n. sp.; D. *N. afurculae* n. sp.; E. *N. davidi* n. sp.

& Rocha-Sánchez A.Y., coll L. Barrientos-Lozano-ITCV.

Diagnosis.—This species is most similar to *N. davidi* n. sp. However, it may be easily distinguished by the cerci of the males (Figs 21, 22, 31 *vs* 27, 28, 31). *N afurculae* n. sp. presents cerci basally broader and distally more elongated than *N. davidi* n. sp. The supra-anal plate (Figs 22, 31 *vs* 28, 31) and furculae differ as follows: in *N. afurculae* n. sp. the supra-anal plate is triangular and more elongated, surface with a shallow median sulcus extending beyond midlength, furculae absent; whereas in *N. davidi* n. sp. the supra-anal plate is triangular but basally wider, median sulcus proximad, very broad and moderately deep, furculae represented by two small, rounded projections. Internal genitalia of *N. afurculae* n. sp. (Figs 23, 24a, b, 31, 32[1D, 2D, 3D, 4D, 5D]) are characterized by a stouter epiphallus (anterior process more widely developed, posterior process shorter), apodemes of cingulum cephalically more expanded and converging, internal valves of aedeagus shorter and distally less expanded (lateral view) than in *N. davidi* n. sp., (Figs 29, 30a, b, 31, 32[1E, 2E, 3E, 4E, 5E]); sheath of aedeagus is larger and of different shape (Figs 24a, b, 32[3D, 4D], *vs* 30a, b, 32[3E, 4E]).

Description of males.—The general body color is green and brown (alive) (Fig. 36), surface shiny and hairy. Eyes large and prominent, interocular space narrow compared to congeneric males (Fig. 20). Fastigium moderately declivent, moderately impressed. Frontal costa expanding between the antennae, slightly converging below medium ocellus, then expanding again, flat with scattered impressed punctae from fastigium to clypeus and slightly convex between the lateral carina; a large subtriangular spot above the antennae and below lateral ocelli (Fig. 38). A cream stripe extends from back of eyes throughout pronotum and abdomen, appreciably till 5th abdominal segment; edges of this cream stripe tend to diverge on pronotal disk, then converge on second abdominal tergite. A green and brown postocular band, upper portion green, lower portion brown (Fig. 36) on sides of head, extends onto sides of pronotum and abdomen. Pronotum with disk defined from lateral lobes by feeble lateral carinae which are straight and slightly divergent caudad; median-longitudinal carina moderately prominent, cut by three distinct transverse sulci; caudal margin of disk broadly convex on each side, thus forming a median broadly obtuse-angulated emargination. Tegminal pads slender, not surpassing or slightly surpassing the second abdominal tergite, length about three times greater than width, gradually expanding to their rounded apices; venation white, prominent, longitudinal, fairly regular. Cephalic and median femora thickened, caudal femora with black knees, caudal tibiae basally yellowish-green, remaining portion bluish-green. The supra-anal plate (Figs 22, 31) is triangular, surface with a long, shallow median sulcus extending beyond midlength; furculae absent. Cerci very broad basally, tapering abruptly at about the third quarter, incurved and decurved, then tapering gradually, with apical quarter bent inwards at right angle to shaft and tapering to its rounded apex. Epiphallus (Figs 23, 32[1D, 2D]): ancorae stout, not exceeding anterior process, anterior process wide and well developed; lophi subrectangular and prominent; posterior process stout and short compared to congeneric species; apodemes of cingulum (Figs 24, 32[3D, 4D]) basally stout, tapering beyond midlength, cephalic portion expanded, concave, converging with a round apex. Internal valves of aedeagus (Figs 24a, b, 32[3D, 4D, 5D]): dorsal valve of aedeagus elongated, bending downwards beyond midlength, distally pointed; ventral valve elongated, bending downwards beyond midlength, distally pointed in dorsal and lateral view; aedeagus sheath as shown in Figs 24b, 32[3D, 4D].

Description of females (alive).—The general body color is green and brown (Fig. 36), eyes less prominent and interocular space wider than in males, antennae yellowish-brown, becoming paler and greenish proximad, caudal segments very dark or blackish, also a couple of darker segments about mid portion. A dark subcircular

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Fig. 35. *Necaxacris azura* n. sp., female (above) and male (below). For color version, see Plate I.

spot located below lateral ocelli and above the antennae (frontal view). Pronotum, with caudal margin emarginate, shows moderate lateral convexity and median emargination. Face and genae buff suffused with white and green. Lower portions of pronotal lateral lobes, a small area on lower portion of mesoepisternum 2, and half lower portion of metaepisternum-3 are whitish. Postocular portion of genae with a stripe, dark brown on the lower portion and dark green on the upper portion; this band continues and

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Fig. 36. *Necaxacris afurculae* n. sp., female (above) and male (below). For color version, see Plate I.

widens on pronotal lobes where it is almost entirely green, except for the lower portion where there is a delicate brownish line. Occiput, dorsum of pronotum, and abdominal tergites brown, with a darker brown stripe on sides of abdomen; abdominal sternites light green. Tegmina brown with whitish veins, not surpassing the second abdominal tergite. Femora light green, the caudal femora with black apices and exposed surface slightly darkened, leaving a sub-apical paler annulus. Caudal tibiae are bluish-green, with a brief basal yellowish area (greenish alive). Caudal tarsi are bluish-green. Ovipositor valves as shown in Fig. 33.

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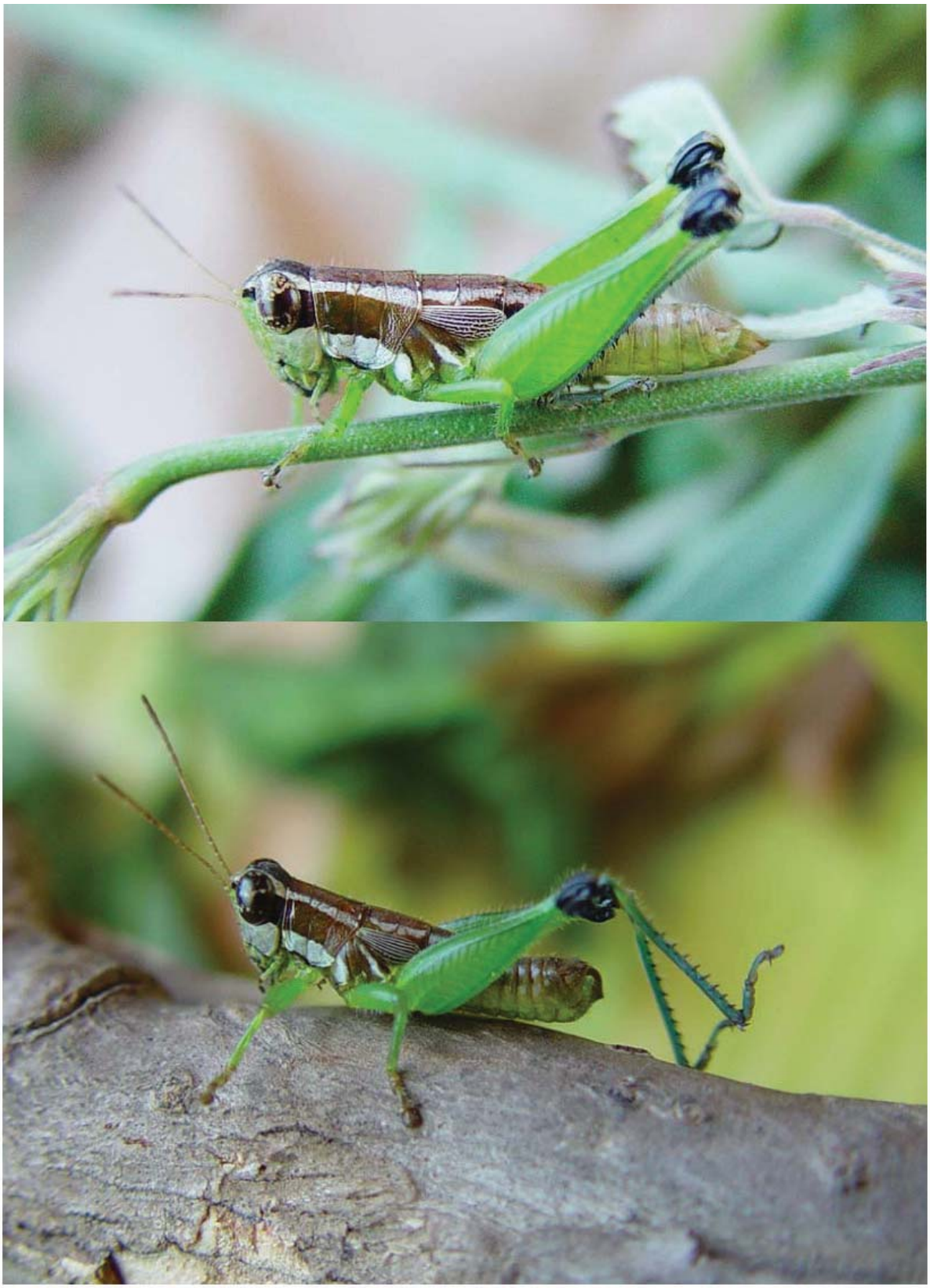


Fig. 37. *Necaxacris davidi* n. sp., female (above) and male (below). For color version, see Plate I.

Measurements.— (mm) **Males:** body length from vertex to end of femur 3: 14.0 (13.0-15.0). Pronotum length: 2.3 (2.2-2.5). Tegmina length: 2.5 (2.1-3.0). Caudal femur length: 7.5 (7.0-7.9). **Females:** Body length: 16.0 (15.0-17.0). Pronotum length: 2.9 (2.7-3.0). Tegmina length: 3.0 (2.5-3.3). Caudal femur length: 8.8 (8.4-9.3).

Distribution.—Tamaulipas, San Luis Potosí, Veracruz, Hidalgo, from sea level (30 m) to 1500 m (Table 3, Fig. 34).

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Habitat.—Collection sites are located at the Huasteca Region in northeastern Mexico. Climate in the distribution area varies according to altitude and relief — overall the following characteristics may apply: warm subhumid and semiwarm humid in the lowlands, temperate humid in higher elevations. Dominant vegetation types are deciduous low forest and tropical evergreen forest in lowlands; oak forest above 1000 m. Average annual temperature varies from 24-25°C in the lowlands to 16-20°C at higher elevations with oak and mixed oak-pine forest. Annual rainfall ranges from 1800-2000 mm to 800-1500 mm, following the elevation gradient from lowlands to transition lands where *N. afurculae* n. sp. is found (Rzedowski 1963, 2006; Algara-Siller *et al.* 2009). At low elevations *N. afurculae* n. sp. is easily found on grasses, intermountain valleys, canyons, mountainsides, and in the medium highlands on patches of grassy vegetation. Main host plants are as follows: *Pteridium* sp., (Dennstaedtiaceae), *Tetramerium* sp., (Acanthaceae), *Iresine* sp., (Amaranthaceae), *Asclepias curassavica* (Asclepiadaceae), *Heliotropium* sp., (Boraginaceae), *Chenopodium* sp., (Chenopodiaceae), *Cnidoscolus* sp., (Euphorbiaceae), *Eupatorium* sp., (Asteraceae).

Etymology.—"Afurculae" refers to the fact that this species does not have a furcula.

Necaxacris davidi n. sp.
(Figs 25-30, 31, 32[1E, 2E, 3E, 4E, 5E], 33, 34, 37, 38)

Type material.—(Material examined). **Mexico, Tamaulipas.** Holotype ♂ and allotype ♀, Hwy. 70, Ciudad Victoria-Soto La Marina, Ej. El Sabinito, km 97, 306 m, lat 23°37.663' N, long 98°22.123' W, 13.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y.

Paratypes.—***Tamaulipas*****:** 1 ♀, Jaumave, Balcón del Chihue, 1590 m, lat 23°36'7.50''N, long 99°15'32.0''W, 12.X.2001, Barrientos-Lozano & Guerrero-Garza, J.M., coll. L. Barrientos-Lozano-ITCV; 2♀, Gómez Farías, El Cielo Biosphere Reserve (BR), between Gómez Farías and Ejido (Ej.) Altacima, 1318 m, lat 23°03'7.01"N, long 99°12'3.47''W, 19.VIII.2003, Zárate-Torres, J.F., coll. L. Barrientos-Lozano-ITCV; 1♀, Ciudad Victoria, rd. Interejidal, 22.X.2003, Zárate-Torres J.F., coll. L. Barrientos-Lozano-ITCV; 1♂ and 1♀, Victoria, Cañón de Calamaco, 180 m, lat 23°43'00''N, long 99°17'00''W, 22.VII.2004, Barrientos-Lozano L., coll. L. Barrientos-Lozano-ITCV; 1♂ and 5♀, same locality, 23.IX.2005, Barrientos-Lozano L. & Torres-Acosta R.I., coll. L. Barrientos-Lozano-ITCV; 1♀, same locality, 12.X.2005, Barrientos-Lozano L. & Torres-Acosta R.I., coll. L. Barrientos-Lozano-ITCV; 3♂ and 7♀, same locality, 16.X.2005, Torres-Acosta R.I., coll. L. Barrientos-Lozano-ITCV; 5♂ and 2♀, same locality, 08.VII.2007, Barrientos-Lozano L., coll. L. Barrientos-Lozano-ITCV; 1 ♀, Hwy. 101 Ciudad Victoria-Jaumave, 10 km SW from Ciudad Victoria, 589 m, lat 23°40'001''N, long 99°11'69.4''W, 22.VII.2004, Barrientos-Lozano L. & Torres-Acosta R.I., coll. L. Barrientos-Lozano-ITCV; 2♂ and 1♀, Cañón de la Libertad, 361 m, lat 23°40.630'N, long 99°13.029'W, VIII.2004, Lumbreras-Cepeda S. L., coll. L. Barrientos-Lozano-ITCV; 1♂ and 1♀, Ciudad Victoria, La Bandera Ecological Park, 820 m, lat 23°45'38.06"N, long 99°11'39.06"W, 14.VIII.2004, Torres-Acosta R.I., coll. L. Barrientos-Lozano-ITCV; 1♂ and 1♀, Llera de Canales, 14 km south from Ej. El Ébano, 348 m, lat 23°45'16.6''N, long 99°00'6.6''W, 08.IX.2005, Torres-Acosta R.I., coll. L. Barrientos-Lozano-ITCV; 1♀, Cañón de la Peregrina, 200 m, lat 23°45'00''N, long 99°15'00''W, 30.IX.2005, Barrientos-Lozano L., coll. L. Barrientos-Lozano-ITCV; 1♀, Gómez Farías, 400 m, lat 23°2.808'N, long 99°9.308'W, 12.VII.2007, Barrientos-Lozano L., coll. L. Barrientos-Lozano-ITCV; 2♀, Nuevo Centro de Población (NCP) Altas Cumbres, low lands, 926 m, lat 23°36.332'N, Long 99°13.179'W, 31.VII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1♂, HWY. 101, Ciudad Victoria-Jaumave, Ej. El Huizachal, 852 m, lat 23°35.284'N, long 99°13.467'W, 31.VII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 2♂ and 5♀, Hwy. 70, Villa de Casas-Soto La Marina, km 74, 466 m, lat 23°34.316'N, long 98°30.917'W, 13.VII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 2♂ and 3♀, Hwy. 70, Ciudad Victoria-Soto La Marina, Ej. El Sabinito, km 97, 306 m, lat 23°37.663'N, long 98°22.123'W, 13.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1 ♂, Hwy. 180, Soto la Marina–Aldama, km 113, 312 m, lat 23°37.666'N, long 98°22.1263'W, 13.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 4♂ and 3♀, Aldama, 9 km prior to Cenote El Zacatón, 214 m, lat 22°59.177›N, long 98°09.351'W, 13.VIII.2010, Barrientos-Lozano L., Méndez-Gómez B.R. & Rocha-Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV; 1♂, Hwy. 180, Aldama-Tampico, San Esteban, 154 m, lat 22°56.525'N, long 97°59.656'W, 29.X.2010, Barrientos Lozano L., Méndez Gómez B.R. and Rocha Sánchez A.Y., coll. L. Barrientos-Lozano-ITCV. **Nuevo León:** 3♂ and 10♀, 10 mi. NW from Montemorelos, 610 m, lat 25°06'55.21''N, long 99°58'48.36''W, 29.IX.1958, Cohn T.J., coll. UMMZ; 1♂, Vitro Parque el Manzano, 1513 m, lat 25°22.017'N, long 100°11.879'W, 10.III.2001, Barrientos-Lozano L. & Guerrero-Garza J.M., coll L. Barrientos-Lozano-ITCV.

Diagnosis.—In general appearance and body color pattern, this species is most similar to *N. afurculae* n. sp. It may be separated by the males cerci (Figs 27, 28, 31 *vs* 21, 22, 31): *N davidi* n. sp., presents a less robust and slightly shorter cercus than *N. afurculae* n. sp. The supra-anal plate (Figs 28, 31 *vs* 22, 31) and furculae differ as follows: in *N davidi* n. sp. the supra-anal plate is triangular, widening basally, median sulcus proximad, very broad and moderately deep, furculae represented by two small, rounded projections; whereas in *N. afurculae* n. sp. the supra-anal plate is triangular but more elongated, surface with a shallow median sulcus extending beyond midlength, furculae absent. Internal genitalia of *N. davidi* n. sp., (Figs 29, 30a, b, 32[1E, 2E, 3E, 4E, 5E] *vs* 23, 24a, b, 32[1D, 2D, 3D, 4D, 5D]) present a more elongated epiphallus, with stockier ancorae and narrower anterior process, more prominent lophi and a more elongated posterior process; the apodemes of cingulum are less robust and cephalically not very expanded or converging; the internal valves of the aedeagus are more elongate, apically expanded and more produced.

Description of males.—The general body color is green and brown (alive) (Fig. 37), surface shiny and hairy. The eyes are large and slightly prominent, interocular space wide. Fastigium moderately declivent, impressed, projecting beyond the ocelli. This species presents a large subrectangular spot above the antennae and below the lateral ocelli. The frontal costa expands between the antennae, slightly converging below medium ocellus, flat with scattered impressed punctae from fastigium to clypeus and slightly convex between the lateral carina; antennae yellowish-brown with distal segments darker (Fig. 38). A cream stripe extends from the back of eyes throughout pronotum and abdomen; the stripe margins tend to diverge caudally on pronotal disk and converge on second abdominal segment. A dark brown postocular band on sides of head extends onto sides of pronotum, plates of second and third pleura, and abdomen sides. Pronotum's

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N. micans



N. tamazunchale n. sp.



N. azura n. sp.



N. afurculae n. sp.



N. davidi n. sp.

Fig. 38. *Necaxacris* spp., male face in frontal view.

carina media prominent, cut by three distinct transverse sulci, caudal margin of disk moderately convex on each side, thus forming a median broadly obtuse-angulated emargination. Tegminal pads slender, surpassing slightly the second abdominal tergite, length about three times greater than width, gradually expanding to their rounded apices. Venation white, prominent, longitudinal, fairly regular. The cephalic and median femora thickened, caudal femora with black knees, caudal tibiae bluish-green, basally yellowish-green. The supra-anal plate (Figs 28, 31) is triangular, widening basally, surface with a broad, moderately deep, medium sulcus in proximal portion only; furculae represented by two small digitiform projections. Cerci moderately broad basally, tapering gradually, then incurved and decurved, with apical quarter bent inwards at a right angle to shaft and tapering to its rounded apex. Epiphallus (Figs 29, 32[1E, 2E]): ancorae stout, not exceeding the anterior process, anterior process not very wide, posterior process elongated; lophi subrectangular and prominent; apodemes of cingulum (Figs 30a, 32[3E, 4E]) tapering about midlength, cephalic portion moderately expanded, with a pointed apex. Internal valves of aedeagus (Figs 30a, b, 32[3E, 4E, 5E]): dorsal valve of aedeagus elongated, distally expanded and curving downwards and inwards, in dorsal and lateral view; ventral valves shorter than dorsal valves, basally broad, tapering gradually, moderately expanded and curving inwards distally in lateral view.

Description of females (alive).—The general body color green and brown (Fig. 37). Eyes less prominent and interocular space wider than in males, antennae yellowish-brown, becoming paler and greenish proximad, caudal segments darker or blackish, also darker segments intercalated with light segment along the antennae (Fig. 37); a dark subquadrate spot below the lateral ocelli and above the antennae, frontal view. Pronotum presents the caudal margin emarginated, showing moderate lateral convexity and median emargination; median sulcus prominent proximad, then weak, becoming prominent again caudally. Face and genae buff suffused with white and green. Lower portion of pronotal lateral lobes, lower portion of episternum 2, and distal portion of episternum 3 are white. Postocular portions of genae with a dark brown stripe: this continues and widens gently on pronotal lobes and plates of pleura two and three. Occiput dark-brown, dorsum of pronotum and abdominal tergites light brown, and the abdominal sternites light green. Tegmina brown with whitish veins, surpassing slightly the second abdominal tergite. Femora light green, the caudal femora with black apices and exposed surface slightly darkened, leaving a subapical paler annulus. The caudal tibiae are bluish-green with a brief area on bases and apices blackish. Caudal tarsi are bluish-green. Ovipositor valves as shown in Fig. 33.

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Fig. 39. *Necaxacris azura* n. sp., habitat (below). Female (above).

Measurements.—(mm) **Males:** body length from vertex to end of femur 3: 14.0 (13.0-15.0). Pronotum length: 2.5 (2.3-2.6). Tegmina length: 2.6 (2.4-2.9). Caudal femur length: 7.4 (7.1-8.0). **Females:** body length: 15.0 (14.0-16.0). Pronotum length: 2.8 (2.5-3.0). Tegmina length: 2.8 (2.3-3.2). Caudal femur length: 8.4 (7.6-9.2).

Distribution.—Tamaulipas and Nuevo León, Mexico; 150 a 1600 m (Table 3, Fig. 34).

Habitat.—*N. davidi* n. sp. is typical of the mountains of Tamaulipas and Nuevo León. It is found on grasses in valleys, canyons, moun-

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Table 3. *Necaxacris* spp., elevation range (m above sea level).

N. micans	*N. tamazunchale n. sp.*	*N. azura n. sp.*	*N. afurculae n. sp.*	*N. davidi n. sp.*
925	136	269	30	154
1400	140	277	96	180
2180		451	153	200
		509	162	214
		520	209	306
		670	213	312
		671	269	348
		821	270	361
		1052	361	400
		1079	289	466
			290	589
			366	610
			400	820
			410	852
			466	926
			477	1318
			500	1513
			520	1590
			530	
			540	
			1066	
			1476	

tainsides and open grassy patches at higher elevations. Dominant types of vegetation along its range, from south Tamaulipas northwards to Nuevo León, are as follows: low deciduous forest, tropical evergreen forest, matorral, thorny shrub, oak forest. Attending the same pattern of distribution, the climate varies from warm subhumid to temperate subhumid (Rzedowski 2006). *N. davidi* n. sp. lives on grasses or seedlings such as *Phoebe* sp., *Bursera simaruba*, *Pithecellobium* sp., *Acacia* sp., (Fabaceae), *Pseudogynoxys* sp. (Asteraceae), *Helianthus annuus* (Asteraceae), *Atriples canesens* (Amaranthaceae), *Bouteloua hirsute* (Poaceae), *Saccharum officinarum* (Poaceae).

Etymology.—Species named after Eng. David Zepeda-Sánchez, present Director of the Instituto Tecnológico de Ciudad Victoria. David Zepeda-Sánchez has given unprecedented support to the Technological Institute Postgraduate program and its research activities: a very enthusiastic and keen person.

Discussion

The genus *Necaxacris* was erected as monotypic by Hebard (1932). An additional species collected by Roberts in 1936 was never formally described or published, but was mentioned by Descamps (1975). Following the ICZN (1999, arts. 12.1 and 13.1) we have described and named this taxon as *N. tamazunchale* n. sp. In redescribing the genus and assigning new taxa we considered the characters provided by Hebard (1932) and additional new characters such as the males' internal genitalia, the females' valves, and distribution range.

The genus is typical of semiwarm and humid and temperate subhumid climate and is usually found on patches of lush vegetation in very humid environments. This was also pointed out by Hebard (1932) and Descamps (1975). *N. micans* seems to inhabit the highest elevation, 2180 m above sea level, and seems restricted to the mountainsides of northeastern and central Puebla; *N. tamazunchale* n. sp., is apparently restricted to the lowlands of Tamazunchale in San Luis Potosí, *ca* 140 m, while *N. azura* n. sp., has extended its distribution to warm/humid and temperate/subhumid areas of La Huasteca in eastern San Luis Potosí, North of Veracruz and northeastern Hidalgo at 250 to 1100 m. *N. afurculae* n. sp. seems a more generalist species, inhabiting canyons, mountainsides and open low forest areas in Tamaulipas, San Luis Potosí and Veracruz from sea level to 1500 m. *N. davidi* n. sp. is the only one that extends its distribution northwards into the Eastern Sierra Madre mountain range, reaching the tropical semi-deciduous forest and oak forest near Monterrey, Nuevo León. This species may represent the northern extreme of the genus' distribution range, while *N. micans* in Necaxa and Villa Juárez, Puebla, possibly occupies the southern extreme of the distribution range.

All *Necaxacris* species inhabit the Huasteca region in northeastern Mexico. The Huasteca embodies two Biogeographic Provinces: the Gulf Coastal Plain (GCP) and the Eastern Sierra Madre (ESM) mountain range. The ESM mountain range arose as a result of the upward folding of Cretaceous deposits and resulted in a region of abrupt topography, with valleys, deep canyons and ravines that allow the persistence of a unique and diverse community of plants and animals. The ruggedness of the terrain, the wide variation in rainfall and elevation, the presence of a great variety of plants and soils of different origin, create microenvironments which favor speciation, diversity and endemisms, as indicated by different authors (Halffter 1976, 1987; CONABIO 2008; Morrone 2009, 2010).

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