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REDESCRIPTION OF *CENTRUROIDES KOESTERI* KRAEPELIN (SCORPIONIDA, BUTHIDAE)

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ABSTRACT

The scorpion *Centruroides koesteri* Kraepelin from Costa Rica, previously known only from one female, is redescribed and illustrated. Additional specimens of both sexes come from Provincia de Guanacaste. This species appears to be endemic to northwestern Costa Rica's tropical semi-evergreen and deciduous forest, and to be rather strictly arboreal in habits. Its closest relative is considered to be *Centruroides margaritatus* (Gervais), and differential characters between these, and other related species, are given.

INTRODUCTION

The buthid scorpion *Centruroides koesteri* was described by Kraepelin (1911) from one adult female collected in Costa Rica. Meise (1934) treated all the species of the genus *Centruroides* Marx as members of the genus *Rhopalurus* Thorell, recognized only four polytypic species, and considered *C. koesteri* as a subspecies of *Rhopalurus testaceus* [= *Centruroides testaceus* (Geer)]. Viquez (1935) failed to mention *C. koesteri* in his work on the scorpions of Costa Rica, and was apparently unaware of the publications by Kraepelin (1911) and Meise (1934). Finally, Stahnke and Calos (1977) did not include *C. koesteri* in their key to the species of *Centruroides*, nor did they consider it a valid subspecies as Meise (1934) had, listing it as a junior synonym of *Rhopalurus testaceous* (sic, = *Centruroides testaceus* ?).

I have recently examined the holotype of *Centruroides koesteri* Kraepelin, and found that it is a valid species. the study of various collections, as well as personal collecting, have produced 18 additional specimens of *C. koesteri*, providing valuable taxonomic information on this hitherto poorly known species.

Centruroides koesteri Kraepelin
Figs. 1-6

Centruroides kösteri Kraepelin 1911:70; Meise 1934:26.
Centruroides koesteri, Kraepelin 1911:72; Mello-Leitão 1945:255.
Rhopalurus testaceus kösteri, Meise 1934:29, 32.
Rhopalurus testaceous (sic), Stahnke and Calos 1977:119 [nec *Centruroides testaceus* (Geer)].

Type data.—Holotype female, adult, from Costa Rica, 10 June 1905 (H. Köster). Deposited in the Zoologisches Institut und Zoologisches Museum, Hamburg Universität, Germany.

Distribution.—Known only from Provincia de Guanacaste, Costa Rica.

Diagnosis.—Medium sized, adults about 65-75 mm in total length. Yellowish brown with diffuse dark-brown tinging on carapace, post-tergites, and metasomal carinae; mesosomal pretergites with moderately dense, uniform, dark-brown bands submedially. Tergites 1-6 monocarinate, tergite 7 pentacarinate. Basal piece of pectines in female without median depression. Pectinal tooth count 22-25 in females, 22-26 in males, predominantly 23-24 in both sexes. Metasomal segments I-II decacarinate, III with lateral inframedian keels present on distal one-half to one-third, vestigial and sparsely granulose; IV octocarinate; all metasomal keels moderately strong, with distinct large granules. Segment V with lateral regions bulging distally, carinae moderately strong and granulose. Pedipalp chela with granulose carinae, manus lighter than fingers, dentate margins of fingers with eight oblique rows of granules.

Description.—Measurements of two females, including holotype, and two males appear in Table 1.

Prosoma—Carapace (Fig. 1) yellowish brown; median eyes, lateral eyes, anterior margin, and lateral margins with dense, uniform dark brown tinging; interocular triangle moderately tinged (appearing medium brown), with distinct dark-brown to black maculae underlying large granules; posterior submedian regions with very diffuse, sparse blackish tinge throughout, and with distinct dark-brown maculae under granules. Interocular triangle of carapace, including anterior margin, densely and coarsely granulose; other carapacial regions moderately granulose. Superciliary carinae moderate to strong, vestigially granulose to subgranulose; other carapacial carinae (Fig. 1) weak to vestigial, subgranulose to moderately granulose. Venter yellow, sparsely setose. Sternum subtriangular with moderately deep, anteriorly directed Y-shaped longitudinal furrow.

Mesosoma—Tergites light yellow-brown. Pretergites shagreened; submedially with dense, uniformly tinged dark brown bands. Post-tergites moderately granulose, lateral margins and submedian areas of posterior margin with sparse to moderate brown to black tinge. Tergal median longitudinal keels weak to moderately strong, bearing medium to large granules; submedian transverse carinae weak, with a few large granules each underlain by dark-brown to black maculae. Post-tergite 7 pentacarinate: median, submedian and lateral carinae strong, granulose, maculated. Venter light yellow-brown, sparsely setose. Genital operculi without median longitudinal membranous connection; genital papillae whitish and small in males, absent in females. Basal piece of pectines wider than long, without median depression. Pectinal tooth counts 22-26, predominantly 23-24 in both sexes (in holotype female 23-23, not 22-23 as indicated by Kraepelin, 1911). Sternite 7 with submedian and lateral carinae moderately strong, granulose; median and submedian intercarinal areas smooth, lateral intercarinal areas with dense, small and medium granules.

Metasoma—Yellowish brown dorsally, slightly tinged on lateral and ventral intercarinal areas (appearing medium brown ventrally), with dark brown to black maculations under carinal granules; sparsely setose. Segments I-IV with dorsolateral, lateral supramedian, ventrolateral, and ventral submedian carinae strong, with large, distinct granules. Lateral inframedian carinae on I strong, complete, with large granules; on II weak to moderate, complete, with well-spaced small granules; on III present on distal one-third to one-half, vestigial, with well-spaced small granules; on IV obsolete. Intercarinal areas on I-IV

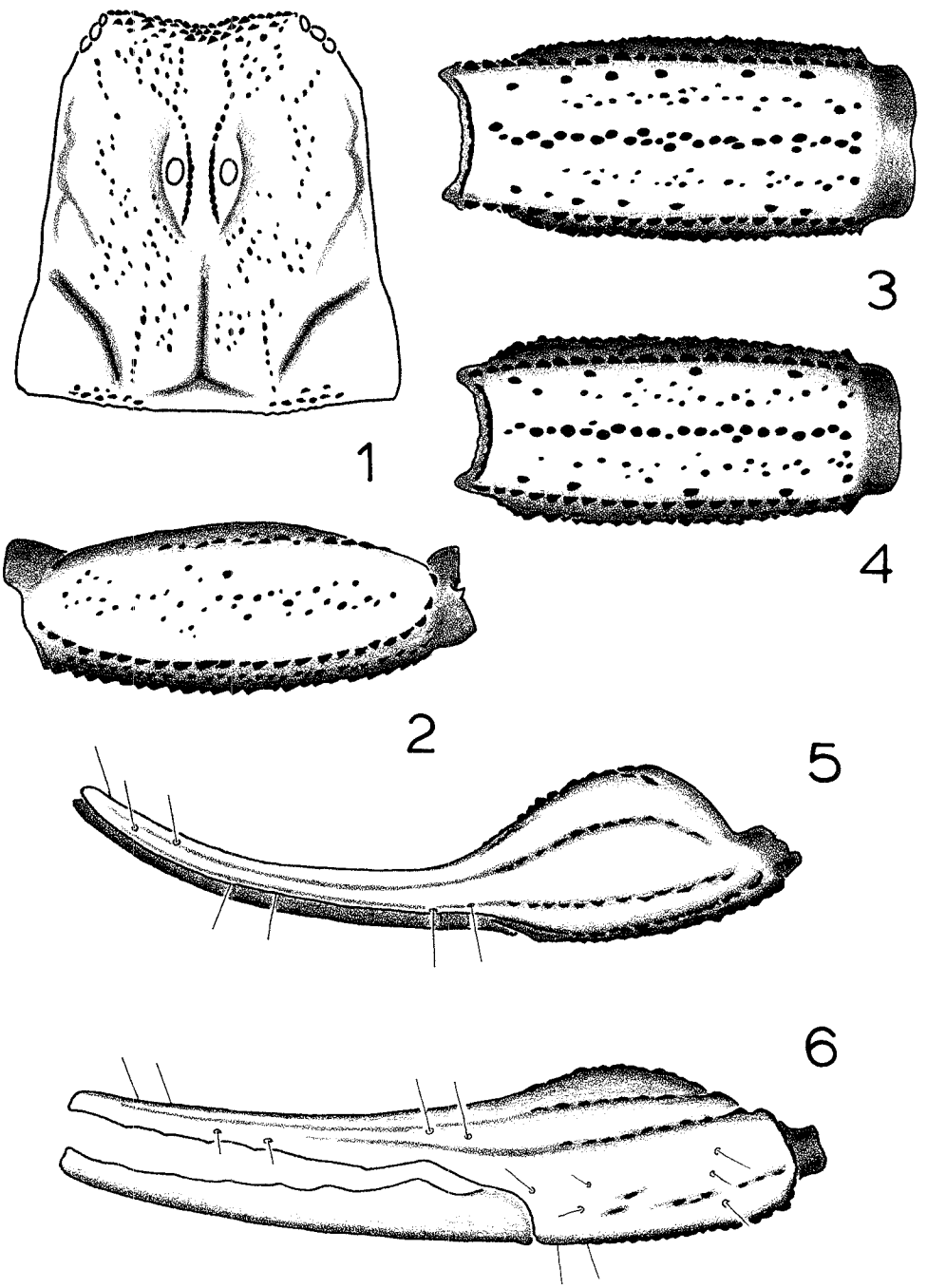
smooth to sparsely, minutely granulose. Segment V (Figs. 2-4) with dorsolateral, lateromedian, ventrolateral, and ventromedian carinae moderately strong, with large granules. Intercarinal areas on segment V: dorsal smooth, laterals moderately granulose; ventrals with keel-like, submedian longitudinal rows of scattered, medium-sized granules. Telson medium brown with moderately dense, uniform dark brown tinging throughout except for one pair of narrow submedian longitudinal bands ventrally; moderately setose, smooth to subgranulose; subaculear spine small, directed towards apex of aculeus.

Chelicera–Yellow to light brown, teeth reddish brown. Dentition on fixed and movable fingers as in other members of the genus.

Pedipalp–Yellowish brown, tibia tinged medium to dark brown distally, chelal fingers reddish brown. Orthobothriotaxia A (Vachon 1974). Femur pentacarinate, keels strong and granulose; dorsal trichobothria in *alpha* pattern (Vachon 1975). Tibia heptacarinate: anterior keels strong, coarsely granulose; other carinae moderate to strong with closely

Table 1.–Measurements (in millimeters) of *Centruroides koesteri* Kraepelin.

	Females		Males	
	Holotype	Adult	Adult	Subadult
Total length	64.40	72.70	74.80	57.30
Carapace length	6.90	7.70	7.20	5.40
Mesosoma length	18.80	21.50	17.60	14.50
Metasoma length	38.70	43.50	50.00	37.40
I length	5.00	5.70	7.00	5.10
width	3.50	4.10	3.40	2.90
II length	6.10	6.90	8.50	6.20
width	3.50	4.10	3.30	2.80
III length	6.60	7.30	9.20	6.70
width	3.50	4.10	3.30	2.70
IV length	7.10	7.90	9.50	7.10
width	3.50	4.05	3.50	2.90
V length	7.50	8.20	9.30	7.00
width	3.50	4.00	3.90	3.20
Telson length	6.40	7.50	6.50	5.30
Vesicle length	3.80	4.50	4.00	3.20
width	2.40	2.80	2.90	2.20
depth	2.20	2.60	2.40	1.80
Aculeus length	2.60	3.00	2.50	2.10
Pedipalp length	25.50	28.50	30.30	23.20
Femur length	6.00	6.90	7.60	5.80
width	1.80	2.10	1.90	1.50
Tibia length	7.00	7.60	8.00	6.40
width	2.60	3.20	2.50	2.10
Chela length	12.50	14.00	14.70	11.00
width	2.90	3.70	4.20	2.20
depth	3.20	3.90	3.00	2.50
Movable finger length	8.20	9.40	9.10	7.10
Fixed finger length	7.10	8.10	8.40	6.20
Chelicera length	3.40	3.70	3.30	2.70
Chela length	2.40	2.60	2.40	1.90
width	1.70	2.00	1.80	1.30
Movable finger length	1.80	2.00	1.80	1.30
Fixed finger length	1.00	1.10	0.90	0.80
Pectinal tooth counts	23-23	23-24	24-24	23-23



Figs. 1-6.–*Centruroides koesteri* from Costa Rica: 1, carapace of holotype female; 2, lateral aspect of metasomal segment V of holotype; 3, ventral aspect of metasomal segment V of holotype; 4, ventral aspect of metasomal segment V of subadult male; 5, dorsal aspect of left pedipalp chela of holotype; 6, exterior aspect of left pedipalp chela of holotype.

spaced, uniform medium granules. Chela (Figs. 5-6): dorsal and ventral keels on internal face moderate to strong, coarsely granulose; dorsomedian keel moderately strong, moderately granulose, extending through length of fixed finger; dorsoexternal keel weak, subgranulose, extending through length of fixed finger; exteromedian keel strong, subgranulose, extending through basal one-half of fixed finger length; exteroventral carina vestigial, subgranulose to smooth; ventromedian keel strong, granulose, directed towards external condyle of movable finger articulation. Dentate margin of fixed finger with eight oblique rows of granules; on movable finger with eight oblique rows, and a short apical "row" of three to four granules.

Legs–Yellow, tibia and tarsomere I with diffuse dark-brown tinging basally.

Variability.–The specimens examined range in carapace lengths from 3.1 to 7.7 mm, and apparently represent five distinct size (and age ?) classes. Smaller individuals (carapace length less than 4.5 mm) in general appear darker than larger specimens, displaying diffuse brownish tinging on the legs and posterior submedian areas of the carapace, moderate tinging on the pedipalps and tergites, and fairly dense tinging on the ventral areas of the metasoma and the interocular triangle of the carapace. The smaller individuals lack the lateral "bulgings" on metasomal segment V which are so distinctive on larger specimens (Figs. 3-4). Individuals considered to be adult or subadult (the two larger size-classes available) have the pedipalp chela fingers reddish-brown, contrasting sharply with the yellowish to light-brown manus; whereas the smaller individuals have fingers the same color, or slightly darker than the manus.

Table 2.- Variability in pectinal tooth counts observed in *Centruroides koesteri* Kraepelin, from Costa Rica. Expressed as the number of combs observed with a given tooth count.

		Tooth count				
	n	22	23	24	25	26
Males	7	3	5	4	1	1
Females	8	1	6	8	1	0
Juveniles	4	2	3	2	0	0

Adult and subadult males differ considerably from all other individuals in metasomal proportions, having segment IV longer than segment V, and the length-to-width ratio of segments II and III greater than 2.0; whereas other sex and age classes have segment IV shorter than segment V, and a length-to-width ratio on segments II and III of less than 2.0. There appears to be no significant intersexual differences in pectinal tooth counts (Table 2).

Specimens examined.–COSTA RICA: no specific locality, 10 June 1905 (H. Köster), holotype female (ZIZMH). *Provincia de Guanacaste*: Playas del Coco (sea level), 19 August 1965 (R. D. Sage), one male (CAS); Rio Sandillal on Panamerican Highway, February 1966 (C. E. Valerio), one teneral subadult male (UCR); Organization for Tropical Studies' Finca "Palo Verde," 6 km NE Puerto Humo (on Río Tempisque), 16-22 January 1978 (C. E. Valerio, W. G. Eberhard, and O. F. Francke), 3 males, 5 females, 4 juveniles (author's collection), 2 males, 2 females (AMNH).

NOTES AND REMARKS

Ecological notes.–The vegetation in Guanacaste Province, Costa Rica, where I have collected *C. koesteri* consists of: (a) tropical semi-evergreen and deciduous forest on slopes with well-drained soils, and (b) tropical scrub and thorn forest on flat areas that are

subject to flooding during the wet season. Both vegetation types have been cleared for grazing in large areas, resulting in (c) an anthropogenic savanna-type vegetation.

Scorpion collecting was done on the three plant formations present; rock- and log-rolling during the day, and with a portable ultraviolet light source at night. Three scorpion species were found, in order of decreasing abundance, as follows: *Centruroides margaritatus* (Gervais), an undescribed diplocentrid, and *C. koesteri*. *Centruroides margaritatus* is the only species found in, but not restricted to, both the scrub and thorn forest and the savanna. It was found using both collecting techniques, under rocks and logs during daytime collecting; and on the substrate, on low vegetation, and on tree trunks at night. *Centruroides koesteri* occurred exclusively in the tropical semi-evergreen and deciduous forest, was taken only at night during blacklight collecting, and appears to be arboreal in habits. Only one of the 16 specimens found in over 20 man-hours of blacklighting was collected on the ground at the base of a tree; the others were on tree trunks and often a considerable distance from the ground. No specimens of *C. koesteri* were found in about as many hours of rock-rolling. Should the arboreal nature of *C. koesteri* be confirmed by future observations, it might explain why this species is relatively rare in collections made before the advent of blacklighting.

Comparative descriptions.—In addition to *C. koesteri*, five species of *Centruroides* known to occur in Central America have eight rows of granules on the fingers of the pedipalp chelae. *Centruroides thorelli* (Kraepelin) is a very small species, adults usually under 45 mm in total length, with dark-brown to black longitudinal stripes on the carapace and tergites, and pectinal tooth counts of 13-18 in females and 18-20 in males. *Centruroides flavopictus* (Pocock) is a medium-sized species, adults about 65-70 mm in total length, uniformly dark colored but sometimes with a lighter median longitudinal band, and pectinal tooth counts of 16-20 in females and 19-22 in males. *Centruroides ochraceus* (Pocock) is a medium-sized species, adults about 65-75 mm in total length, yellowish brown with moderately tinged carapace and tergites, and pectinal tooth counts of 25-28 in females and 28-30 in males. *Centruroides subgranosus* (Kraepelin) is a small species, adults 45-60 mm in total length (in males the metasoma is about eight times longer than the carapace), uniformly yellowish, with an elongate vesicle about three times longer than wide, vestigial carinae on metasomal segment V, and pectinal tooth counts of 22-23 in females and 24-25 in males. *Centruroides margaritatus* (Gervais) is a large species, adults 95-135 mm in total length, medium brown to blackish, and in Costa Rica with pectinal tooth counts of 25-29 in females and 26-34 in males.

Centruroides testaceus (Geer), under which *C. koesteri* had been synonymized by some authors, is known only from the Caribbean islands of Montserrat and Hispaniola. *C. testaceus* is a medium-sized species, adults about 75-85 mm in total length, uniformly light colored except for the darker pedipalp fingers, with obsolete keels on metasomal segment V, with a length-to width ration of metasomal segment I greater than 2.00 in males, greater than 1.70 in females (in *C. koesteri* these ratios are 1.75-2.05 in males, 1.35-1.45 in females), and pectinal tooth counts of 20-22 in females, 23-24 in males.

In addition to the differential characters indicated above, *C. koesteri* is very distinctive in color pattern, the shape of metasomal segment V, the rather large and well-isolated granulation of the metasomal carinae, the presence of weak to moderate lateral inframedian carinae on metasomal segment II, and the extent of granular development on the carinae of the pedipalp chelae. It further differs from *C. margaritatus*, its closest relative in my opinion, in the reduction of carapacial and tergal granulation, the absence

of a median depression in the basal piece of pectines, and the relative proportions of the manus and fingers of the pedipalp chela (fingers proportionately longer in *C. koesteri*).

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