Scorpions of the genus *Diplocentrus* (Diplocentridae) from Sonora, Mexico, with description of a new species

W. David Sissom
Department of Biology & Geosciences
West Texas A & M University
WTAMU Box 808
Canyon, TX 79016

and

Anne L. Wheeler
2417 Capehart Road
Richmond, VA 23294

Introduction

To date, only two references place members of the genus *Diplocentrus* in Sonora, Mexico. The first was a passing comment by Francke (1975) that *D. spitzeri* Stahnke occurs in northeastern Sonora. The specimens he examined and used in his systematic studies on that species are the same as the ones reported here for the first time from a specific Sonoran locality. The second reference was by Sissom and Walker (1992) listing a single record of *D. gertschi* Sissom and Walker from Libertad on the northern coast.

Examination of material from the American Museum of Natural History (AMNH), the California Academy of Sciences (CAS), and the Academy of Natural Sciences (ANS) indicates that, in addition to *D. spitzeri* and *D. gertschi*, another distinct species occurs in the Alamos and Navajoa areas in southern Sonora. This species is described as new below. It should be noted that a juvenile specimen from the vicinity of Benjamin Hill was also examined that was unassignable with certainty to any of the above species. This indicates that the genus has a wider distribution in Sonora than demonstrated even by the specimens listed in this report.

Nomenclature and mensuration utilized herein essentially follows that of Stahnke (1970), with the following exceptions: carinal terminology and cheliceral measurements are after Francke (1975, 1977) and trichobothrial terminology is after Vachon (1974). Specimens in the senior author's collection are listed in the records sections as "WDS".

Because *D. spitzeri* and the new species are both quite similar to *D. peloncillensis* Francke, the latter is included in the tables for comparison; in addition, the hemispermatophore of this species is also drawn. *D. peloncillensis* was described from only 6 males, 1 female, and 1 juvenile. The data presented here for *D. peloncillensis* are derived from these and new specimens available since the original description was published (Francke 1975), thereby providing a better understanding of variation in this species.

Diplocentrus gertschi Sissom & Walker, 1992

Diagnosis: Adult males up to 45 mm long, females up to 52 mm long. Base color dark orange brown to brown, with distinct dusky markings throughout. Carapace with coarse granulation restricted to area surrounding anterior margin and anterior median furrow; remainder of carapace densely finely granular and punctate. Tergite VII weakly bilobed, granulose. Pectinal tooth count 13-15 in males, 9-12 in females. Metasoma I-IV with 10 keels: dorsolateral and lateral supramedian carinae moderate to strong and crenulate, especially on III-IV; lateral inframedian, ventrolateral, and ventral submedian carinae weaker, granular on segments III-IV. Metasoma II length/width 0.97-1.14; V length/width 2.30 -2.46 in males, 1.88-2.19 in females. Ratio of cheliceral chela length/chela width 1.42-1.55; fixed finger length/chela width ratio 0.75-0.87; movable finger length/chela length 0.85-0.94. Pedipalps:

dorsal surface of femur distinctly convex, width equal to depth; pedipalp patella with one strong, smooth dorsal carina; chela fixed finger length/ carapace length 0.62-0.69; movable finger length/ carapace length 0.94-1.00; dorsal and external surfaces of chela palm extensively reticulate, with outer palm carinae poorly to moderately developed. Chela length/width ratio 1.79-2.06; movable finger length/metasoma V length 0.95-1.04 in males, 1.16-1.21 in females. Modal tarsomere 11 spine formula: 4/5: 5/5-6: 6/6: 6/6.

Distribution: In Sonora, known only from Libertad (see comments); also known from southern Sinaloa, Nayarit, and northwestern Jalisco.

Comments: With the exception of a single specimen from Libertad, Sonora, this species is known from the more southerly Mexican states of Sinaloa, Nayarit, and Jalisco. The Sonoran record, however, represents a disjunction of approximately 1 000 kilometers and for that reason alone seems to justify further investigation. Recent collections along the coast of Sonora (but not at the precise locality) failed to yield more specimens of this species.

Sonoran Record: Libertad, 12 April 1949 (G. M. Bradt), I male (AMNH).

Diplocentrus spitzeri Stahnke, 1961
(Figs. 1-3)

Distribution: In Sonora, known only from the Sierra de los Ajos Mountains near Cananea; also known from Santa Cruz Co., Arizona, USA.

Diagnosis: Adults 40-52 mm in length. Base color of adults brownish with pedipalps, distal metasomal segments, and telson orange brown to reddish brown; legs yellow brown. Anterior carapacial margin with moderate granulation. Pectinal tooth counts 13-16 in males (predominantly 14 to 15) and 10-13 in females (predominantly 11 to 12). Metasomal segments I-IV: Dorsolateral and lateral supramedian carinae moderate to strong, granular. Lateral inframedian carinae strong and granulose on I, weak and granular on II, and absent on III-IV. Ventrolateral carinae strong, granulose on I-II; moderate, granular on III; vestigial, smooth on IV. Ventral submedian carinae strong, granulose on I-II; moderate, granular on III; absent on IV. Pedipalp: Femur dorsal face somewhat convex in proximal third of segment; dorsoexternal carina moderate, granular throughout. Male cheia with moderate reticulate network of granular ridges; female chela faintly so. Morphometrics: Movable finger length/metasoma V length = 1.06- 1.13 in males, 1. 13-1.30 in females; movable finger length/chela width = 1.16-1.30; pedipalp chela length/width = 1.95-2.09 (both sexes); male metasomal segment III length/width 1.21-1.34; metasomal segment V length/width 2.32-2.60 in males, 2.00-2.47 in females. Hemispermatophore as in Figs. 1-3; lamella very slender, dorsal margin of median lobe moderately crenulate. Modal tarsomere II spine formula 6/6: 6/6-7: 7/7: 7/7.

Comments: The diagnosis provided will serve to easily distinguish *D. spitzeri* from other forms occurring in Sonora and will also work well to separate it from another closely related species, *D. peloncillensis* Francke, from southwestern New Mexico and southeastern Arizona. Additional morphometric characters to separate these two species may be found in Francke (1975) as well as Table 1 herein.

Record: Mexico: Sonora: Sierra de los Ajos Mts., near Cananea, 12-13 August 1969 (R. M. Haradon, W. E. Savary), 6 males, 2 subadult males, 1 juv. male, 7 females, 2 subadult females, 2 juv. females (CAS).

Diplocentrus williamsi, new species
(Figs. 4-5, 8-14)

Type Data.— Adult holotype male from 21 mi S Navajoa (0-100 m), 4 September 1957 (T. J. Cohn and E. R. Tinkham); deposited in the American Museum of Natural History, New York.

Etymology.- The specific epithet is a patronym honoring Dr. Stanley C. Williams for his contributions to scorpion systematics.

Distribution.- Known from southern Sonora, particularly the Guaymas, Alamos, and Navajoa areas.

Comparative Diagnosis: *Diplocentrus williamsi* is most closely related to *D. spitzeri* and *D. peloncilliensis* Francke. The three species are all similar in pectinal tooth counts, cheliceral morphometrics, and metasomal carination.

The dorsoexternal carina of the pedipalp femur in *D. williamsi* is vestigial and mostly smooth, but

occasionally with a few rounded granules. In the other two species, the dorsoextenal carina is well developed and distinctly granular throughout. The dorsal face of the pedipalp femur is very flat in *D. williamsi* (especially in males), but is slightly convex proximally and concave distally in the other two species. The inner face of the femur in *D. williamsi* bears only about 8-10 large, pigmented granules (and some smaller ones), whereas in the other species the inner femoral face is much more granulose (at least 15-20 larger pigmented granules in addition to smaller ones). Also, in *D. williamsi,* the carapace and tergites bear a well-defined pattern of dusky markings, but such markings are weak or virtually absent in the other two species. *Diplocentrus williamsi* tends to be much darker in base coloration (often dark reddish brown) than either of the other two, but some specimens are light. The lighter coloration in some *D. williamsi* may be due to the manner in which they were preserved or perhaps they are specimens that had recently molted.

In addition, a number of morphometric differences exist to separate males of *D. williamsi* from males of *D. spitzeri* (Table 1). The pedipalps and metasomal segments are much more slender in *D. williamsi*. Further, these features are sexually dimorphic in *D. williamsi,* but not so in *D. spitzeri.* Tarsomere II spine counts for the prolateral rows of legs I, III, and IV also differ in the two species, although some overlap exists. in *D. williamsi,* 88% of the specimens examined had five spines in the prolateral row of leg I, whereas 63% of *D. spitzeri* possess six spines in the same position. On leg III, 83% of *D. williamsi* had six prolateral spines and 74% of *D. spitzeri* possess seven prolateral spines; and on leg IV, 77% of *D. williamsi* had six prolateral spines, whereas 86% of *D. spitzeri* possess seven such spines (all percentages for D. *spitzeri* are derived from Francke 1975).

Hemispermatophores of the three species show some potentially important differences.The hemispermatophore of *D. spitzeri* has a very slender distal lamina that tapers distally and has the dorsal margin of the median capsular lobe distinctly crenuiated (Figs.1-3); that of D. *williamsi* typically has a relatively broad distal lamina and the dorsal margin of the median lobe is weakly crenulated (Figs. 4-5); that of *D. peloncillensis* bears a very slender distal lamina with a feebly granular dorsal margin on the median lobe (Figs. 6-7). Variation exists in the Alamos population that renders these characters tentative until further study (see "Variation" under the description of *D. williamsi).*

Description of Holotype.— Coloration: carapace and tergites light orange brown with distinct dusky underlying markings; venter yellow brown with light yellow pectines; metasoma uniformly orange brown; telson yellow orange; pedipalps rich orange brown with dark reddish brown keels, granulation, and chela finger dentition; chelicerae light yellow brown with brownish mottling on manus; legs yellow brown basally, tarsi yellowish.

Prosoma: Carapace (Fig. 8) with a few moderate-sized granules restricted to anterior margin; remainder of carapace smooth, somewhat lustrous. Sternum with eight pairs of setae and a single median seta anterior to sternal furrow. Mesosoma: Tergites I-VI acarinate, lustrous, provided with moderately dense, fine granulation; tergite VII acarinate, not noticeably bilobed, with moderately dense coarse granulation on lateral portions. Genital opercula with eight pairs of setae in posterior half; pectines with 15 teeth on each side. Sternites III-VI smooth and lustrous, moderately setose; sternite VII with lateral carinae weak, granular and median carinae faint, lightly granular.

Metasoma (Fig. 9): Segments I-IV: Dorsolateral carinae on I-IV weak to moderate, each with several rounded granules. Lateral supramedian carinae on I strong, granulose; on II-IV moderate, granular. Lateral inframedian carinae on I strong, granulose; on II moderate, granular; on III weak, represented by a few rounded granules; on IV essentially obsolete. Ventrolateral carinae on I strong, granulose; on II moderate, irregularly crenulate; on III-IV moderate, with a few irregular crenulations. Ventral submedian carinae on I-II weak, irregularly granular, on III-IV essentially obsolete indicated by a few rounded granules. Intercarinal spaces smooth, lustrous. Segment V: Dorsolateral carinae moderate, granular; lateromedian carinae obsolete; ventrolateral, ventromedian, and transverse carinae strong, with enlarged spinoid denticles. Intercarinal spaces smooth, lustrous. Telson ventral aspect moderately hirsute, with only a few fine granules adjacent to proximal submarginal denticles.

Chelicerae:Fixed finger distinctly shorter than (0.78X) chela width; movable finger distinctly shorter than (0.84X) chela length.

Pedipalps: Trichobothrial pattern Type C, orthobothriotaxic (Vachon 1974). Femur (Fig.10) with dorsointernal and ventrointernal carinae strong, each consisting of a series of subconical granules; dorsoexternal carina vestigial, represented by a short proximal series of granules; ventroexternal carina obsolete. Dorsal femoral surface flat, with scattered fine granules on distal portion; ventral surface with some coarse granulation along ventrointernal carina; inner face with 8-10 large, darkly pigmented granules and a number of smaller ones. Patella (Figs. 11-12) with dorsointernal carina weak, smooth; ventrointernal carina strong, granulose; ventroexternal carina weak, smooth; other carinae obsolete. Inner face with moderate basal tubercle and several flanking medium-sized granules; other faces smooth. Chela (Figs.13-14) with dorsal marginal carina moderate, granulose; dorsal secondary carina weak, smooth; digital carina moderate, smooth; external secondary carina vestigial, moderate and smooth on proximal part of hand; ventromedian carina strong, smooth; two weak inner carinae present, the ventralmost granular; dorsointernal carina moderate, granulose. Weak reticulations present on dorsal and external chela faces.

Hemispermatophore as in Figs. 5-6 (see also diagnosis).

Legs: Tarsomere II spine formula 5/6 5/6: 5/6 5/6: 6/7 6/7: 7/7 6/7.

Female. Sexual dimorphism that is typical of other members of *Diplocentrus* also occurs in this species. The tergites, and especially tergite VII, are not as granular as in the male, and the carinae of the metasoma and pedipalps are somewhat weaker. The carinae of the pedipalp femur and patella are weaker.The outer surface of the pedipalp chela palm is smooth, gently rounded, and lustrous; the dorsal marginal carina is vestigial and granulose, the digital carina is feeble and smooth, and the ventromedian carina is moderate and smooth. Pectinal tooth counts are lower (see below). There are also considerable differences in morphometrics; specifically, the metasomal segments are not as slender as in the male and the pedipalp chela is proportionately wider and deeper.

Variation.- There is considerable variation in base coloration, ranging from light orange brown with brownish underlying markings to dark reddish brown with dense dusky markings. There is no apparent geographical pattern or noticeable differences in other characters associated with the color differences; further, some of this variation may be attributable to the state of preservation. Young specimens are, as in other *Diplocentrus,* yellowish to yellow brown with variable underlying markings.

Although most specimens are in the neighborhood of 40-45 mm in total length, a few specimens are somewhat larger. In particular, a male from the Sierra de Alamos collected by T. Walker is approximately 52 mm long; the female from the same locality is about 59 mm long. The hemispermatophore of this male has a very slender and tapering distal lamina in comparison to other specimens from Alamos and those of the paratopotype males from the Navajoa area; in fact, it is as slender as that seen in *D. spitzeri.* Search for other distinguishing features between these specimens was futile. This observation suggests that studies on hemispermatophore variation are desperately needed before their full value (or lack thereof) in diplocentrid systematics can be appreciated. At this time it seems premature to consider the large specimens from the Sierra de Alamos to be a different species solely on body size and hemispermatophore morphology.

Pectinal tooth counts in *D. williamsi* varied as follows: in males, there were seven combs with 13 teeth, 16 combs with 14 teeth, 15 combs with 15 teeth, and two combs with 16 teeth; in females there were one comb with nine teeth, two combs with 10 teeth, 13 combs with 11 teeth, 16 combs with 12 teeth, and two combs with 13 teeth. Variation in morphometrics is given in Table 1; variation in tarsomere II spine formulas is summarized in Table 2.

Measurements. Holotype Male (in mm): total l, 41.79; carapace l, 5.27; mesosoma l, 12.99; metasoma I, l7.67 (metasoma I l/w, 2.75/2.63; metasoma II l/w, 2.98/2.40; metasoma III l/w, 3.28/2.31; metasoma IV l/w, 3.86/2.08; metasoma V l/w, 4.80/1.87); telson l, 4.33; telson vesicle l/w/d, 3.51/2.14/1.73; aculeus l, 0.82; pedipalp l, 19.41 (femur l/w, 4.88/1.99; patella l/w, 4.94/1.87; chela l/w/d, 9.59/3.80/2.46); pedipalp chela fixed finger l, 4.27; movable finger l, 5.91.

Paratype female, 8 mi N. Alamos (in mm): total 1, 42.83; carapace l, 6.14; mesosoma l, 15.57; metasoma l, 16.67 (metasoma I l/w, 2.63/3.04; metasoma II l/w, 2.93/3.04; metasoma III l/w, 3.04/2.49; metaso-

ma IV l/w, 3.45/2.31; metasoma V l/w, 4.62/2.11); telson l, 4.45; telson vesicle l/w/d, 3.63/2.37/1.87; aculeus l, 0.82; pedipalp l, 20.04 (femur l/w, 4.62/2.16; patella l/w, 4.83/2.16; chela l/w/d, 10.53/4.71/3.16); pedipalp chela fixed finger l, 4.45; movable finger l, 6.38.

Records.- MEXICO: Sonora: Alamos, Sierra de Alamos (3800 ft., oak woodland), 30 March 1970 (T. Walker), 1 paratype male, 1 paratype female (AMNH); Alamos, Sierra de Alamos, January, year? (V. Roth), 2 paratype males, 1 paratype subadult male, 1 paratype juv. female (WDS); N. side of Sierra de Alamos (2000 m, 27.02N:108.55W), 13-14 November 1972 (V. Roth), 1 paratype subadult male (AMNH); 8 mi N Alamos on Cuchajaqui River (under rock), 23 December 1965 (M. M. Eells), 1 paratype female (AMNH); 7 mi SE Alamos, 12 August 1960 (P.H. Arnaud, Jr., E. S. Ross, D. C. Rentz), 1 paratype male, 1 paratype juv. male (CAS); 6.1 mi SW Alamos on bank of Cuchajaqui River (west side), 25 January 1966 (B. Winokur, M. Nickerson, C. Mays), 1 paratype subadult male, I paratype female, 2 paratype subadult females (CAS); 10 mi N Alamos, 19 July 1954 (W.J. Gertsch), 1 paratype juv. male, 1 paratype female (AMNH); Arroyo de la Aduana, 2 mi NW Alamos on dirt road off Alamos-Navajoa highway (under very damp rocks, fallen wood), 10 August 1966 (H. L. Heringhi), 1 paratype subadult female, 1 paratype juv. (CAS); 8 mi SE Alamos, Arroyo Cuchajaqui, Easter 1963 (collector?), 1 paratype female (CAS-HLS); Arroyo de Alamos, 6 mi SE Alamos on Guirocoba Road, 13 August 1966 (H. L. Heringhi), I paratype female (CAS): Alamos area between Alamos and Navajoa, early August 1966 (H. L. Heringhi), 2 paratype subaduit males, 1paratype juv. (CAS); on Johnny Clark's ranch, 6 mi NW Alamos along Alamos-Navajoa Road), 30 August 1966 (H. L. Heringhi), 1 paratype female (CAS); Los Cuates, 12 mi NW Alamos on Alamos-Navajoa Road, then 2 mi E on rock outcrop, July 1966 (H.L.Heringhi), 1 paratype subadult female (CAS); 65 mi N Los Mochis (Sinaloa), 17 June 1968 (H.L. Stahnke), 1 paratype subadult female (CAS); 7.1 mi on road to Mina Verde from Alamos, 24 January 1966 (B. Winokur, M. A. Nickerson, H. L. Heringhi), 1 paratype subaduit female (CAS); 17 mi S Navajoa, 12 October 1973 (S.C. Williams, K. B. Black), 1 paratype subadult female (CAS); 21 mi S Navajoa (0-100m), 4 September 1957 (T.J. Cohn, E.R. Tinkham), 1 holotype male, 3 paratype males (AMNH); Rancho Naranjo (27.13 N: 108.45 W), 7-12 February 1 968 (V. Roth), 2 juvs. (AMNH); Sierra La Chana, near San Bernardino (no date or collector), 1 female, 1 subadult male (ANS); 2 mi N Tepustete, then 1 mi toward NW hills (under granite rock; dry arroyo with thorn-forest vegetation), 1 7 July 1966 (H. L. Heringhi), 2 **juvs.** (CAS).

Key to the species of *Diplocentrus* from Sonora, Mexico

1. Pedipalp femur with dorsal surface distinctly convex, with femur depth essentially equal to width; pedipalp chelae of males strongly reticulate ..... *gertschi*
   Pedipalp femur with dorsal surface flat or only slightly convex in proximal third, in either case with femur depth distinctly less than width; pedipalp chelae of males only weakly to moderately reticulate 2

2. Pedipalp femur with dorsoexternal carina vestigial to moderate, mostly smooth with a few rounded proximal granules; body typically dark reddish brown to brown, always with distinct dusky underlying markings; pedipalp chelae relatively slender, with chela length/width ratio 2.35-2.57 in males, 2.11-2.24 in females; male metasoma III length/width ratio 1.36-1.48 ..... *williamsi*
   Pedipalp femur with dorsoexternal carina well developed and distinctly granular to granulose throughout; color light brown to light reddish brown, at most with very faint dusky markings; pedipaip chelae relatively broad, with chela length/width ratio 1.95-2.10; male metasoma III length/width ratio 1.21-1.34 ..... *spitzeri*

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Table 1. Morphometrics of *D. peloncillensis* Francke, *Diplocentrus spitzeri* Stahnke, and D. *williamsi,* new species. In consideration of possible sampling error, data reported by Francke (1975) are separated from those taken from specimens actually measured during the study; some specimens were measured in both studies. Interspecific variation in these ratios should be interpreted with caution because they are based on small sampie sizes. For additional morphometric data on *D. peloncillensis and D. spitzeri,* consult Francke (1975). Abbreviations are as follows: l=length, w=width, d=depth.

Adult Males

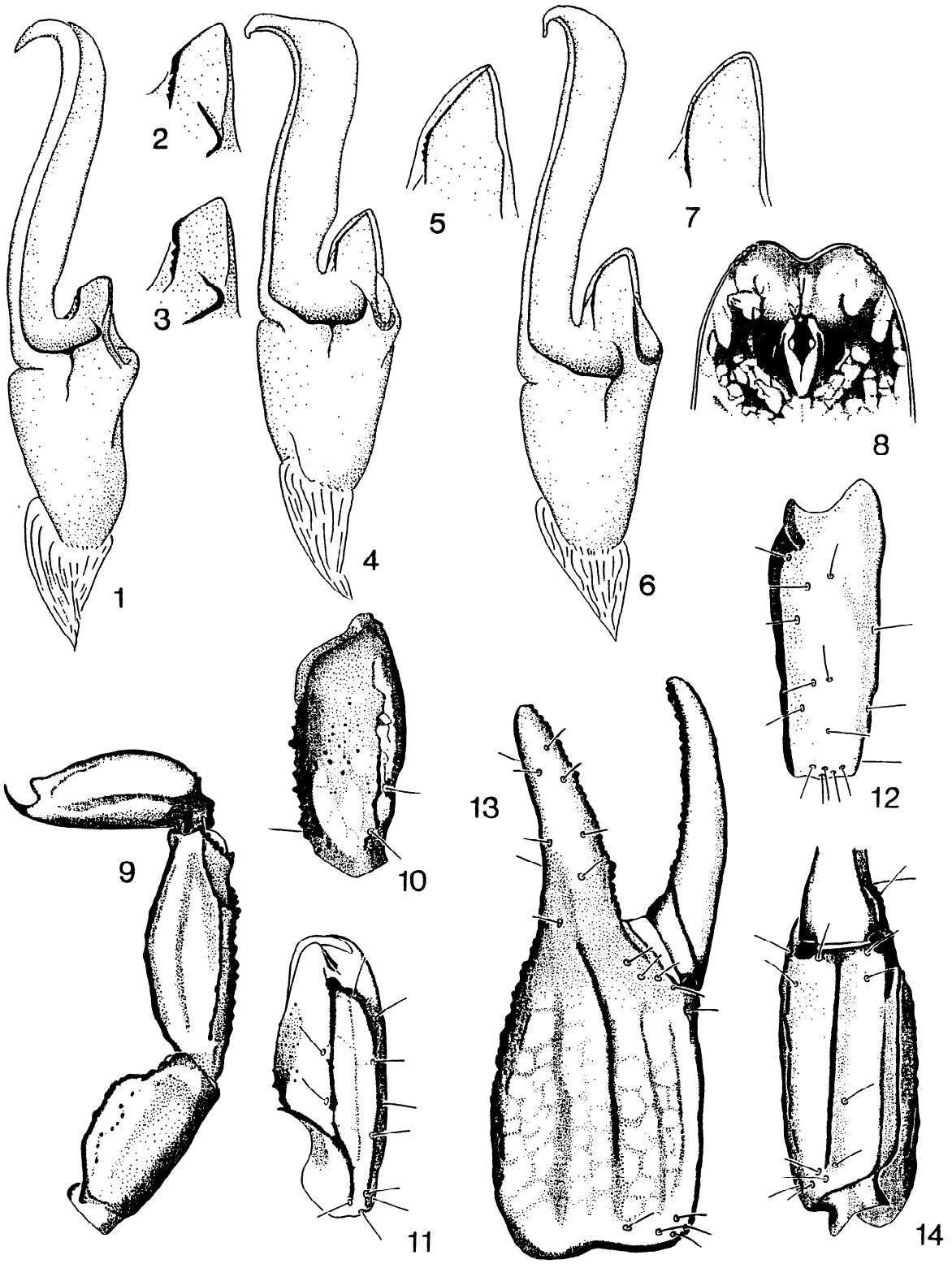
Ratio	*D. peloncillensis*	*D. spitzeri*	*D. williamsi*
	(n = 6) (Francke: n = 5)	(n = 9) (Francke: n = 17)	(n = 7)
Chela l/w	2.07-2.27	2.02-2.09	2.3 5-2.57
Francke (1975)	2.20-2.38	1.96-2.11	
Chela l/d	2.88-3.68	2.93-3.35	3.46-3.90
Fixed Finger l/carapace 1	0.72-0.91	0.71-0.75	0.77-0.85
Movable finger l/metasoma V l	1.08-1.29	1.06-1.13	1.17-1.36
Francke (1975):	1.22-1.34	1.10-1.23	
Metasoma III l/w	1.28-1.40	1.21-1.34	1.36-1.48
Movable Finger l/chela w	1.24-1.39	1.20-1.27	1.37-1.57
Francke 1975)	1.32-1.43	1.20-1.30	

Adult Females

Ratio	*D. peloncillensis*	*D. spitzeri*	*D. williamsi*
	(n = 24) (Francke: n = 1)	(n = 12) (Francke: n = 9)	(n = 7)
Chela l/w	2.06-2.27	1.95-2.10	2.11-2.24
Francke (1975)	2.21	1.98-2.15	
Chela l/d	2.67-3.43	2.74-3.16	2.86-3.33
Fixed finger l/carapace 1	0.68-0.83	0.62-0.74	0.67-0.76
Movable finger l/metasoma V l	1.20-1.32	1.13-1.30	1.22-1.40
Francke (1975)	1.33	1.21-1.32	
Metasoma III l/w	1.11-1.2 5	1.09-1.27	1.17-1.39
Movable Finger l/chela w	1.25-1.33	1.16-1.30	1.24-1.37
Francke (1975)	1.33	1.20-1.28	

Table 2. Variation in tarsomere II spination in *D. spitzeri*, *D. williamsi*, new species, *D. peloncillensis*. Data for *D. spitzeri* are taken from Francke (1975); data for *D. peloncillensis* also from Francke (I 975), but supplemented with new material.

Leg	Spine row	Number of Spines 4	5	6	7	8
				D. spitzeri		
I	Prolateral		29	50		
	Retrolateral		1	60	18	
II	Prolateral		4	71	6	
	Retrolateral			39	42	
III	Prolateral			20	58	
	Retrolateral			1	73	4
IV	Prolateral			11	70	
	Retrolateral			3	70	8
				D. williamsi		
I	Prolateral		52	7		
	Retrolateral		7	45	6	
II	Prolateral		15	40	3	
	Retrolateral			33	24	
III	Prolateral			49	10	
	Retrolateral			8	50	1
IV	Prolateral		2	44	11	
	Retrolateral		1	3	51	3
				D. peloncillensis		
I	Prolateral	4	30	15		
	Retrolateral		2	73	9	
II	Prolateral	1	22	61		
	Retrolateral			61	22	
III	Prolateral		2	69	14	
	Retrolateral			12	72	1
IV	Prolateral		1	58	24	
	Retrolateral			4	74	5



Figs. 1-14. Dorsal aspect of right hemispermatophores of *Diplocentrus* spp. 1-3, *D. spitzeri, 4-5, D. williamsi,* new species; 6-7, *D. peloncillensis.* Morphology of *Diplocentrus williamsi,* new species. All figures are of holotype male unless otherwise specified. 8, anterior portion of carapace, dorsal aspect; 9, lateral aspect of metasomal segments IV, V, and telson; 10, dorsal aspect of pedipaip femur; 11, dorsal aspect of pedipalp patella; 12, external aspect of pedipalp patella; 13, external aspect of peclipalp chela; 14, ventral aspect of pedipalp chela.