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REVISION AND KEYS TO THE HIGHER CATEGORIES OF VEJOVIDAE (SCORPIONIDA)

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ABSTRACT

The higher categories of the Vejovidae have been revised and keys to these categories are presented. As part of the revision a new subfamily, the Hadrurinae, has been recognized. In the subfamily Syntropinae a new genus, *Vejovoidus*, has been introduced. In the subfamily Vejovinae new genera recognized are *Serradigitus* and *Pseudouroctonus*. Thirteen species previously placed in the genus *Uroctonus* have been shown to belong to the genus *Vejovis*. An extensive study of the value of trichobothria in scorpion systematics is presented. The systematic status of *Uroctonus fractus* is doubtful. It has been eliminated from the Vejovidae and apparently should be placed in the Chactidae where it will undoubtedly be synonymized.

INTRODUCTION

A revision of the Vejovidae is long overdue. With the introduction of ultraviolet detection (Stahnke, 1972) many new species are being discovered and placed into the literature with little regard to the more precise recognition of higher categories and in most instances without the characterization of the genera in which the new species are placed. This paper is a beginning toward a more precise recognition of the apparent higher categories through a careful study of the type-species as a point of departure.

The spelling "*Vejovis*" is used rather than the original "*Vaejovis*" as previously seemed correct (Stahnke, 1972). The decision is based on Art 23b of the International Code. The emendation *Vejovis* is a junior synonym (Art 33a) and has been in use since 1876 (Thorell, 1876). Therefore, on the basis of usage the spelling "*Vejovis*" appears to be correct according to the ICZN and is also etymologically correct (Stahnke, 1972).

The basic nomenclature used in this paper is that proposed by Snodgrass (1952) for the arthropods and adopted with additions, based on common usage, for the Scorpionida by Stahnke (1970). It is unfortunate that any group of specialists should seek to introduce and/or perpetuate a jargon that does not relate to the entire phylum. Zoology as a whole and scorpiology in particular are the losers by such practice.

It is hoped that this paper can render the service for the Vejovidae—especially the genus *Vejovis*—that Vachon's various studies did for what used to be the "catch-all" genus *Buthus* of the Buthidae.

PART I. THE FAMILY AND A KEY TO ITS SUBFAMILIES

VEJOVIDAE THORELL, 1876.

Vejovoidae Thorell, 1876, Ann. Mag. Nat. Hist. 17:10(part); Thorell, 1876, Atti. Soc. Italia Sci. 19:83,183(part); Karsch, 1879, Mitt. Muchen Entomol. Ver. 3(1):7,8,10,21 (part); Karsch, 1879, *op. cit.* 3(2)97-99,101,102(part). **Vejovidae** Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:5,176-189; Pocock, 1900, Fauna British India, Arachnida p. 64-75; Kraepelin, 1901, Bull. Mus. Paris 7:273; Kraepelin, 1905, Zool. Jahrb. Syst. 22:330-333,340,341,345; Kraepelin, 1913, Mitt. Nat. Mus. Hamburg 30:153-162; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57,58,88,108; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:15,151,162,163,168,170,184,190,191,195,199; Ewing, 1928, Proc. U.S. Natl. Mus. 73:7; Hoffmann, 1931, An. Inst. Biol. México 2:333; Mello-Leitão, 1932, Arq. Mus. Nac. 34:33, Mello-Leitão, 1934, An. Acad. Brasil Sci. 6(2):75,78-81; Mello-Leitão, 1934, Reun. Soc. Arg. Patol. Reg. Norte 8(51):5; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:280; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ. p. 67-111; Mello-Leitão, 1945, Arq. Mus. Nac. 40:118-133; Takashima, 1945, Acta Arachnol. 9(3/4):71; Gertsch, 1958, Amer. Mus. Novitates 1903:5-7; Bucherl, 1959, Mem. Inst. Butantan 29:270-272; Stahnke, 1961, Entomol. News 2:206-212; Gertsch and Allred, 1965, Brigham Young Univ. Sci. Bull., Biol. Ser., 6(4):3-14; Williams, 1966, Proc. California Acad. Sci. 34(8):419-428; Gertsch and Soleglad, 1966, Amer. Mus. Novitates 2278:1-54; Stahnke, 1967, Turtox News 45(9):223; Williams, 1968, Pan-Pac. Entomol. 44:313-321; Stahnke, 1969, Entomol. News 80:57-65; Williams, 1970, Proc. California Acad. Sci. 37(8):275-332; Williams, 1970, Occ. Papers California Acad. Sci. 87:1-26; Williams, 1970, Pan-Pac. Entomol. 46:1-11; Williams, 1970, *op. cit.*, 46:238-241; Williams, 1970, Proc. California Acad. Sci. 37(12)395-418; Bucherl, 1971, *Venomous Animals and Their Venoms* 3:328-329; Stahnke, 1971, *op. cit.*, 82:121-131; Gertsch and Soleglad, 1972, Bull. Amer. Mus. Nat. Hist. 148:553-607. **Vaejovidae**, Pocock, 1902, Biologia Centrali Americana, Scorp., Pedip., Solif. p. 4-19(part); Gertsch, 1938, Baylor Univ. Mus. Contrib. p. 18; Williams, 1971, Wasmann J. Biol. 29:37-63; Williams, 1972, Occ. Papers California Acad. Sci. 94:1-16; Hjelle, 1972, Occ. Papers California Acad. Sci. 92:7-29. **Scorpionidae (Vejovini)** Kraepelin, 1894, Mitt. Mus. Hamburg 11(1):7,181. Iuridae Pocock, 1893, Ann. Mag. Nat. Hist. 12:308(part); Laurie, 1896, Ann. Mag. Nat. Hist. 18:129(part).

Characters–All Vejovidae possess a subpentagonal sternum which is usually broader than long. Both coxal endite I's are narrowed, not truncate, along the anterior border. External and internal pedal spurs are present but never tibial spurs. Stigmata are generally slit-like but frequently subellipitical but not circular. Most vejovids have three pair of lateral eyes. This, however, is not a safe criterion for separation. Recently some forms have been taken from the same habitat and obviously belonging to the same specific taxon but some of the specimens had two pair of lateral eyes, others had three, while some had two on one side and three on the other. Then there is the genus *Paravejoviops* Banks which possesses only two pair of lateral eyes but possesses more vejovid characteristics than chactid. The size and position of these eyes vary within a species so that their systematic use at this level can be very misleading.

Considerable variation exists structurally in the Vejovidae. Pectines, for example, range in structure from a simple fused lamella with teeth bearing sensilla (Fig. 1A,B) (Scorpiopsinae) to the large forms (*Hadrurus*, *Paruroctonus*) made up of the marginal lamellae, numerous spherical to elongate vaulted middle lamallae, well developed fulcra

and numerous large teeth, bearing large areas of sensilla. (For detailed discussion see Carthy, 1968.) The entire pectine may bear only four teeth or over forty and be quite devoid of setae or densely hirsute.

The chaetotaxy of trichobothria is of considerable systematic importance. These are innervated, slender setae set in an alveolar depression with raised lips (Fig. 1D) and found on the femur, patella, and tibia of the pedipalps. They can be confused readily with what we will temporarily dub here as "pseudotrichobothria" (Fig. 1C) found on *Hadrurus* and other vejovids as well as on some Scorpionidae. True trichobothria have the peripheral

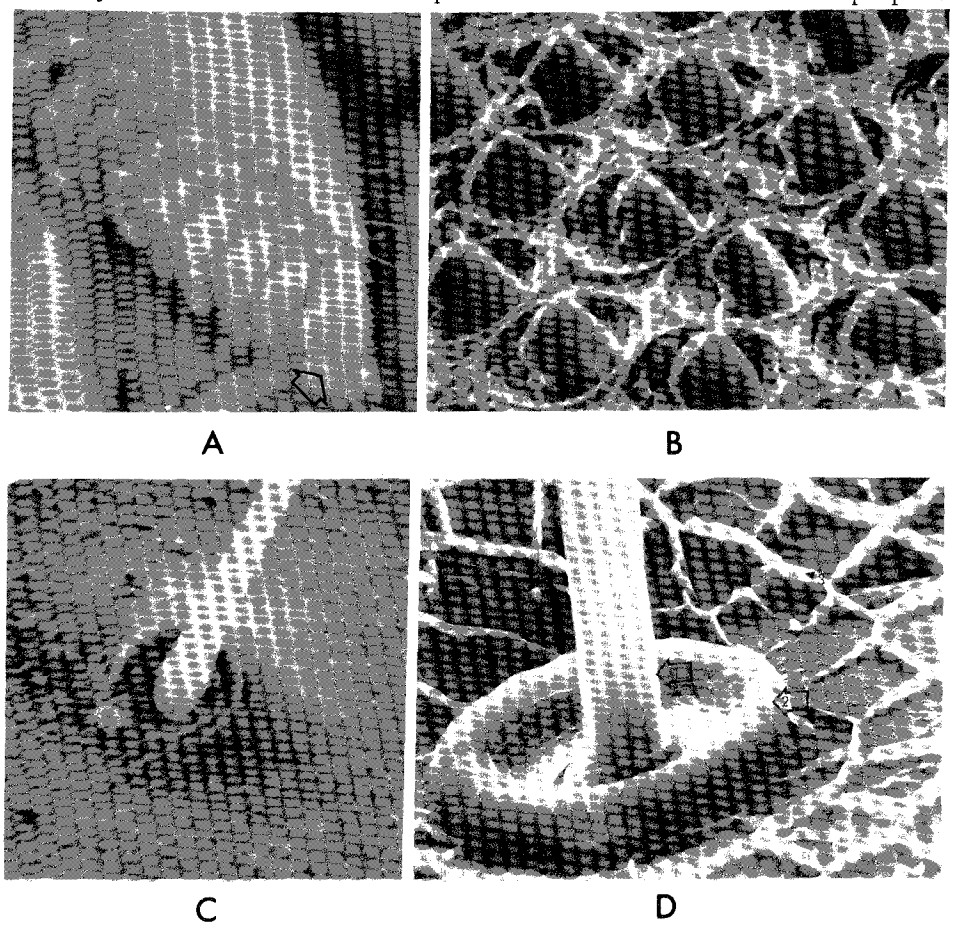

Fig. 1.–A, Pectinal teeth showing areas of sensilla; B, Micrograph of sensilla; C, Micrograph of basal portion of macrochaeta ("pseudotrichobothrium"); D, Micrograph of basal portion of trichobothrium showing (1) uniform shaft of setae and (2) raised lip of alveolus; (Micrographs from the unpublished work of J. Swafford, Electronmicroscope Laboratory, Department of Botany and Microbiology, Arizona State University).

ABBREVIATIONS USED IN FIGURES

ExS, Exterior Surface; InS, Interior Surface; InfS, Inferior Surface; SuS, Superior Surface; 72, Superior-interior keel; 75, Superior-exterior keel; 76, Exterior median keel; 77, Inferior-exterior keel; 87, Exterior marginal keel; 88, Secondary accessory keel; 89, Exterior secondary keel; 90, Digital keel; 91, Subdigital keel; 92, Inner secondary keel; 93, Subinner keel; 94, Interior marginal keel; Broken line, Vestigial keels; •, Macrochaetes; ○ Trichobothria (variance in diameter indicates relative variance in size of cup).

lips (frequently these are of a whitish color) elevated somewhat higher than the pseudo-forms and their setae are considerably more slender with a taper that is much more gradual. The shaft of the pseudo-forms more nearly fills the setal cup. The true forms also have a sort of ball and socket structure at their base. The size of trichobothria may vary on a given animal. Thus when setae are lost from preserved specimens differentiation between true and pseudotrichobothria in some species is extremely difficult. Sometimes the setae of pseudo-forms remain while those of the true forms are lost. Then comparing the base of the seta with the cup diameter may not always lead to satisfying conclusions. True trichobothria wave back and forth in response to very slight currents; pseudotrichobothria or other setae do not move even under relatively strong air currents.

Trichobothria seem to be genetically transmitted by clusters. Certain clusters are rather constant in the Vejovidae and among several other families. These apparently genetic clusters and the spatial relations between the trichobothria of the clusters, as well as between the clusters, seem to have systematic value. In this paper we attempt to show the evolutionary migration of the intra-cluster trichobothria and the clusters themselves. In order to accomplish this we have used the trichobothrial systems on the patella and tibia; those on the femur of vejovids are three in number and show very little migration, hence of little systematic importance.

As a base of comparison the trichobothrial system of the genus *Diplocentrus* (Diplocentridae) has been used (Fig. 2A,B). In this taxon the clusters are clearly defined and the trichobothria readily recognizable. In order to more clearly portray the patterns, stereograms of the patella and tibia are used. Since the proportions of the patella are unimportant to the distribution, a common pattern has been used in most cases. The tibia stereograms are more representative of the particular taxon involved. The keels of these structures are used to delimit their areas, e.g. the region between the superior and inferior marginal keels of the tibial manus is the "exterior surface" (Kraepelin's "hinterhand"), the digital extension of the interior marginal keel limits the superior surface of the tibial finger, etc.

Since Vachon's (1972) coding did not prove suitable for this study, a simple identification code for each cluster and the trichobothria within the cluster was formulated (Fig. 2A,B). A capital letter identifies the area in which the cluster is found on *Diplocentrus*; this is followed by a number to identify the individual trichobothrium. Thus the evolutionary migration of the individual trichobotrium is indicated very readily. No coding is needed at this stage that in itself would indicate the spatial relationship; when needed, this accomplished quantitatively by ratios. The anatomical cardinal directions (dorsal, etc.) are proving unsuitable and misleading on an appendage such as the pedipalp and thus avoided. There are no duplications of letters between the patellar and tibial systems. The code letters for the tibia are: **D**, tibial digit superior surface; **I**, inferior surface of tibial finger; **M**, distal area of superior tibial manus; **B**, basal area of superior tibial manus; **C**, central area of superior tibial manus; **E**, exterior surface of manus. The code letters for the patella are: **A**, interior ("anterior") surface; **P**, exterior ("posterior") surface; **V**, inferior ("ventral") surface. Additional coding is introduced as needed for trichobothria not serviced by the basic (diplocentrid) system.

The chelicerae are also of systematic importance. The denticle coding of Vachon (1963) will be used. Since the movable finger is generally forked, the tines will be referred to as superior and inferior tines. Only those structures that are distinctly developed as small teeth will be referred to as "denticles," other projections will be referred to as "dentoid" structures. The fixed finger is not forked. On its superior

margin are two teeth plus the sharp terminus (Vachon's **d**): the basal tooth is bicuspid (**mb**). This dentition is found also in other families of the order and is not of great systematic significance. In some taxa the inferior border bears denticles which are of systematic value. Proximal to the superior tine of the movable finger are three or four teeth. Again, this condition is quite common throughout the order. The length and position of the superior tine is of greater significance as are also the presence of denticles, tubercles and serrula on the inferior margin.

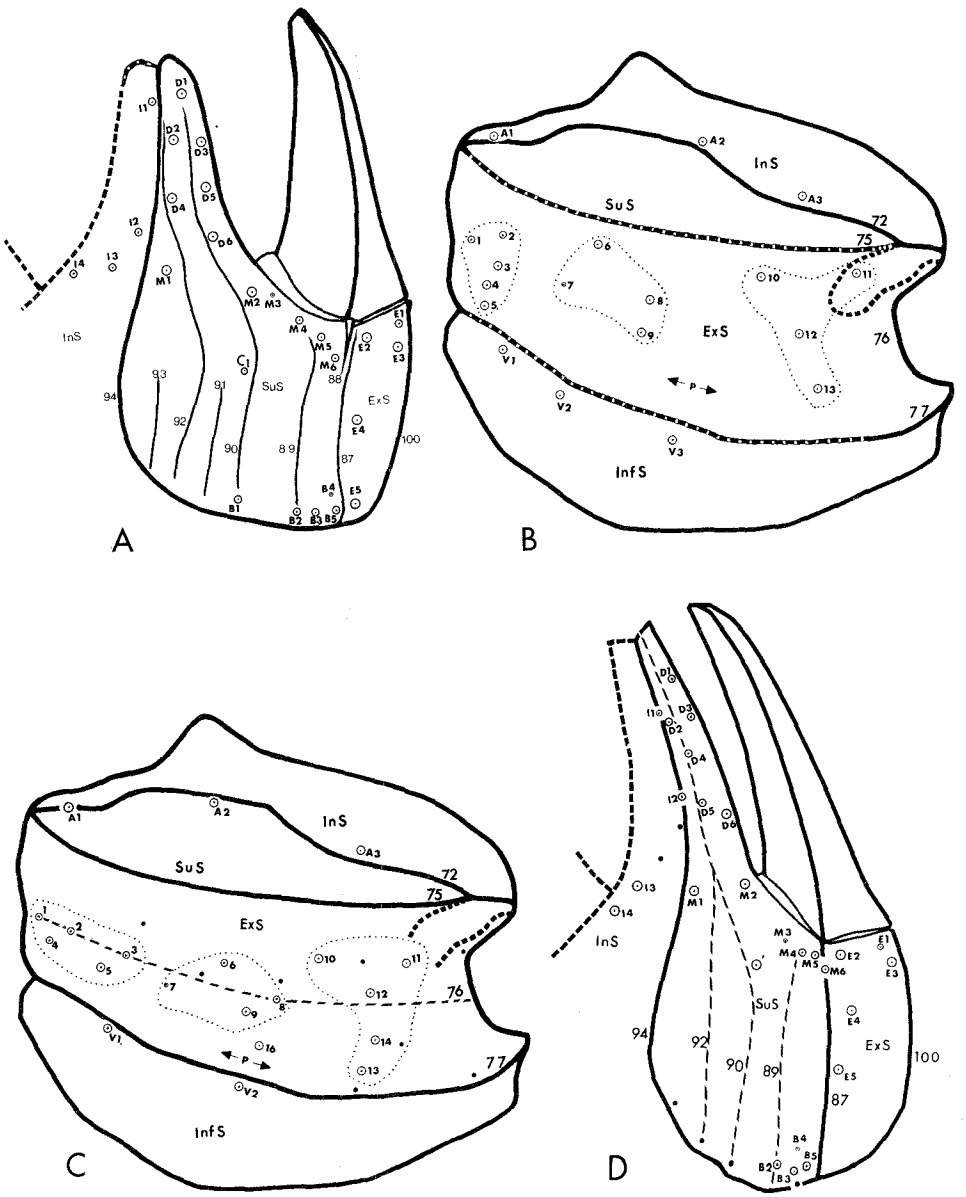

Fig. 2.–Trichobothrial systems: A, *Diplocentrus*, right chela with C_1 added; B, *Diplocentrus*, right patella; C, *Caraboctonus* right patella; D, *Caraboctonus*, right chela. (Right pedipalp used in all figures.)

In size the adults of the Vejovidae range from 130 mm (5 inches) to those only 20 mm (3/4 inches) in length. Although the pedipalp chela may be very slender to moderately broad, none of them are the powerful structures found in the *Heterometrus* of the Scorpionidae.

All the Vejovidae appear to be active burrowers (Stahnke, 1966). Many of them are psammophilous and equipped with macrochaete combs found principally on the tibia of the legs. Taxa that seem to be incapable of burrowing, such as the *Centruroides* of the Buthidae, do not seem to exist.

As far as is known, there are no vejovids that produce a venom sufficiently toxic to be lethal to man through natural sting. It is interesting to note, however, that in massive doses the venom of such forms as *Vejovis spinigerus* and *Hadrurus arizonensis* produce symptoms, such as excessive drooling, convulsions and fornication, which are parts of the syndrome produced by the venom of lethal buthid species.

Distribution—The Vejovidae are principally neartic and neotropical forms. They range from southwestern Canada to northern South America. The greatest number of species and the heaviest populations are found in southwestern United States and northern México. In the United States the greatest number of species seem to exist in California and Arizona and decreasing eastward and northward. Only one species (*Vejovis carolinianus* Beauvois, 1805) is known east of Louisiana; this has been taken as far north as Kentucky and Virginia. Only a relatively few species are known from South America. These are found in three monotypic genera: *Caraboctonus* of Peru and Chile; *Hadruroides* of Equador, Peru, Bolivia and Galapagos, and *Physoctonus* in Brazil. One subfamily, Iurinae, (one genus *Iurus* and two species) is found in Meridional Europe and Asia Minor. The subfamily Scorpiopsinae (two genera: *Scorpiops* and *Parascorpiops*) is found in India and the East Indies.

KEY TO THE SUBFAMILIES OF THE VEJOVIDAE

1a	Caudal segments I-IV with single inferior median keel . . . . . **Syntropinae** Kraepelin, 1905 (p. 113)
1b	Caudal segments I-IV with paired inferior median keels or remnants of such. 2
2a(1b)	Without well developed median claw (unguicular spine) on pretarsus. Ventral surface of tarsomere I with a row of papilla-like pads or setaceous tufts which fork distad in a Y-like manner and cover area of median claw . . . . . **Caraboctoninae** Kraepelin, 1905 (p. 113)
2b	Distinct median claw (unguicular spine) on pretarsus 3
3a(2b)	Inner edge of pedipalp tarsus with many imbricated oblique rows of denticles. Very large, curved tooth on inferior margin of cheliceral movable finger . . . . . **Iurinae** Thorell, 1876 (Jurinae Kraepelin, 1905) (p. 114)
3b	Inner edge of pedipalp tarsus without imbricated rows of denticles 4
4a(3b)	Median rows of small granules or denticles of inner edge of pedipalp tarsus flanked by large interior and exterior lateral granules or denticles which sometimes extend over only part of tarsal length. Movable finger of chelicera forked with both tines sub-equal in length . . . . . **Scorpiopsinae** Kraepelin, 1905 (p. 116)
4b	Inner edge of pedipalp tarsus with only large interior lateral denticles or granules. Movable finger of chelicera forked but superior tine always distinctly shorter than inferior tine 5

5a(4b) Trichobothria exceed 12 on inferior surface and 30 on exterior surface of pedipalp patella and exceed 16 on external surface of pedipalp manus (Figs. 5A,B, 6A) . . . . . **Hadrurinae** NEW SUBFAMILY (p. 116)

5b Trichobothria do not exceed 3 on inferior surface and 16 on exterior surface of pedipalp patella, nor do they exceed 5 on external surface of pedipalp manus (Figs. 6C,D, 9) . . . . . .**Vejovinae** Thorell, 1876 (p. 118)

PART. II. THE SUBFAMILIES AND KEYS TO THEIR GENERA

1. SYNTROPINAE KRAEPELIN, 1905.

Syntropinae Kraepelin, 1905, Zool. Jahrb. Syst. Band 22, Heft 3:323; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,184,191; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip., Band 5, Abt. 4, Buch 8:281; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ., p. 15-18,68; Mello-Leitão, 1945, Arq. Mus. Nac. 40:118; Gertsch, 1958, Amer. Mus. Novitates 1903:14-15.

Characters–Caudal segments I-IV with a single, inferior median keel. This cristate condition is also found in the following: Urodacinae (Scorpionidae), an exclusive Australian taxon; Hemiscorpioninae (Scorpionidae), exclusive to Arabia; Megacorminae (Chactidae), apparently confined to the State of Veracruz, México. In other respects these taxa may vary greatly, e.g. *Megacormus granosus* Gervais has small pectines consisting of four to six pectinal teeth and lacking fulcra. Its cauda (male) is about 1.2 times as long as the trunk. *Syntropis macrura* Kraepelin, on the other hand, has complex pectines consisting of about 29 teeth, fulcra and numerous middle lamellae while the cauda (male) is about 2.2 times the trunk length.

Distinctly serrate denticles are found on the inner edge of the pedipalp tibial finger and tarsus, similar to those found in *Serradigitus* (Vejovinae), and eight to nine interior lateral granules. The legs have well developed lateral claws on the pretarsus, two simple pedal spurs but no tibial spur. The inferior border of cheliceral movable finger devoid of denticles or dentoid structures. The pectines, whose length is greater than coxa IV, contain numerous subcircular middle lamellae and fulcra.

Three lateral eyes are present, the first one larger than the second and third. Sternum almost as long as wide. Stigmata elongate, slit-like. Sternite VII bears two lateral keels.

Two species are at present recognized: *Syntropis macrura* Kraepelin and *S. longiunguis* Williams. These two species differ greatly. The correlation between them, based on 34 variables, is only 0.65 and between *S. longiunguis* and *Vejovis mexicanus* (C. L. Koch) is 0.71. Obviously another genus should be recognized in this subfamily.

KEY TO THE GENERA OF SYNTROPINAE

1a. Dorsal caudal keels without large distal spine. Caudal segments I-IV length to width ratios range from about 2 to 7. . . . . *Syntropis* Kraepelin, 1900

1b. Dorsal caudal keels with large distal spine-like denticle. Caudal segments I-IV length to width ratios from about 1 to 3 . . . . . *Vejovoidus*, NEW GENUS

2. CARABOCTONINAE KRAEPELIN, 1905.

Caraboctoninae Kraepelin, 1905, Zool. Jahrb. Syst. Band 22, Heft 3:323; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57; Birula, 1917, Ann. Caucasian Mus., Scorp., Ser.

A, 5:163,183,191; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip., Band 5, Abt. 4, Buch 8:281; Stahnke, 1939, *Scorpions of Arizona.* Iowa State Univ. p. 15-18,69; Roewer, 1943, Senckenbergianna 26:236. **Hadruroidinae** Mello-Leitão, 1934, Ann. Acad. Brasil Sci. 6(2):81; Mello-Leitão, 1945, Arq. Mus. Nac. 40:119.

Characters–Caudal segments I-IV with paired interior median keels. Without well developed median claw (unguicular spine) on pretarsus. Ventral surface of tarsomere II with a row of papilla-like pads or setaceous tufts which fork distad in a Y-like manner and cover area of median claw. Middle lamellae of pectines few in number. Pedipalp tarsus inner edge with an irregular median row of granules. Two trichobothria on inferior surface of pedipalp patella and six on exterior surface of manus (Fig. 2C,D) (Fig. 3A,B). Chelicera movable finger forked with superior tine much shorter than inferior one and approaching a position at right angles to it. Bearing four denticles on superior surface with second one (**m**) very much larger than other three; inferior, basal surface with a large denticle. Fixed finger superior surface with two denticles, the basal one larger and bicuspid (**mb**), with both cusps strongly developed.

KEY TO THE GENERA OF THE CARABOCTONINAE

1a. Sternum about as wide as long with a deep longitudinal furrow. Caudal segment V with granulated lateral and median ventral keels; other segments with ventral surface bearing agranular vestigial keels. Supernumerary granules interspersed between large, interior lateral granules of pedipalp tarsus. Sternite VII without two pair granular lateral keels ..... *Hadruroides* Pocock, 1893

1b. Sternum much wider than long and at most with deep basal pit but without furrow. Caudal segment V ventral surface almost entirely agranular and without keels but segment I and II with granular lateral and median keels. Supernumerary granules lacking on interior surface of pedipalp tarsus; exterior lateral granules lacking. Sternite VII with two pair granular lateral keels .... *Caraboctonus* Pocock, 1893

3. IURINAE THORELL, 1876.

Iurini Thorell, 1876, Ann. Mag. Nat. Hist. 17:11(part); Pocock, 1893, Ann. Mag. Nat. Hist. 12:309(part); Laurie, 1896, Ann. Mag. Nat. Hist. 18:129. **Iurinae** Kraepelin, 1905, Zool. Jahrb. Syst. 22:341,345,351,352; Mello-Leitão, 1934, Ann. Acad. Brasil Sci. 6(2):80; Mello-Leitão, 1945, Arq. Mus. Nac. 40:118; Vachon, 1948, Ann. Nat. Hist. Mus. Wein 56:62,63. **Jurini** Karsch, 1879, Mitt. Munchen Entomol. Ver. 3(1):19(part); Karsch, 1879, Mitt. Munchen Entomol. Ver. 3(2):101. **Jurinae** Kraepelin, 1905, Zool. Jahrb. Syst. 22:331; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,185,191; Werner, 1934, Bronns Klassen und Ordnungen des Tierreich, Scorp., Pedip. Band 5, Abt. 4, Buch 8:282; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ. p. 15-18,69.

Characters–Sternum about as broad as long with slit-like longitudinal furrow throughout two-thirds of its length. Inner edge of pedipalp tarsus with about 12 imbricated oblique rows of denticles, each with a large denticle at its proximal end and flanked by 11 large interior lateral denticles; exterior lateral denticles and supernumerary granules lacking. Movable finger of chelicera forked with superior tine subparallel to inferior and

about two-thirds its length; superior margin with three, large subequal denticles; inferior margin with very large, curved teeth. Two teeth of fixed finger subequal to length; basal bicuspid tooth with cusps of moderate size. Pedipalp manus (Fig. 3C,D) exterior surface bearing five trichobothria, four of which are grouped at distal end; only four B's, with B1 missing, but seven M's and no C's; four I's and six D's. Patella with two trichobothria on superior surface, one on interior surface, one on inferior surface (Vachon, 1948, reports two on this surface). The female specimen at my disposal has clearly only one on both pedipalps and 11 pectinal teeth and 15 on exterior surface (eight above exterior median keel and seven below); P7 has migrated into basal division of P cluster. Pretarsus with

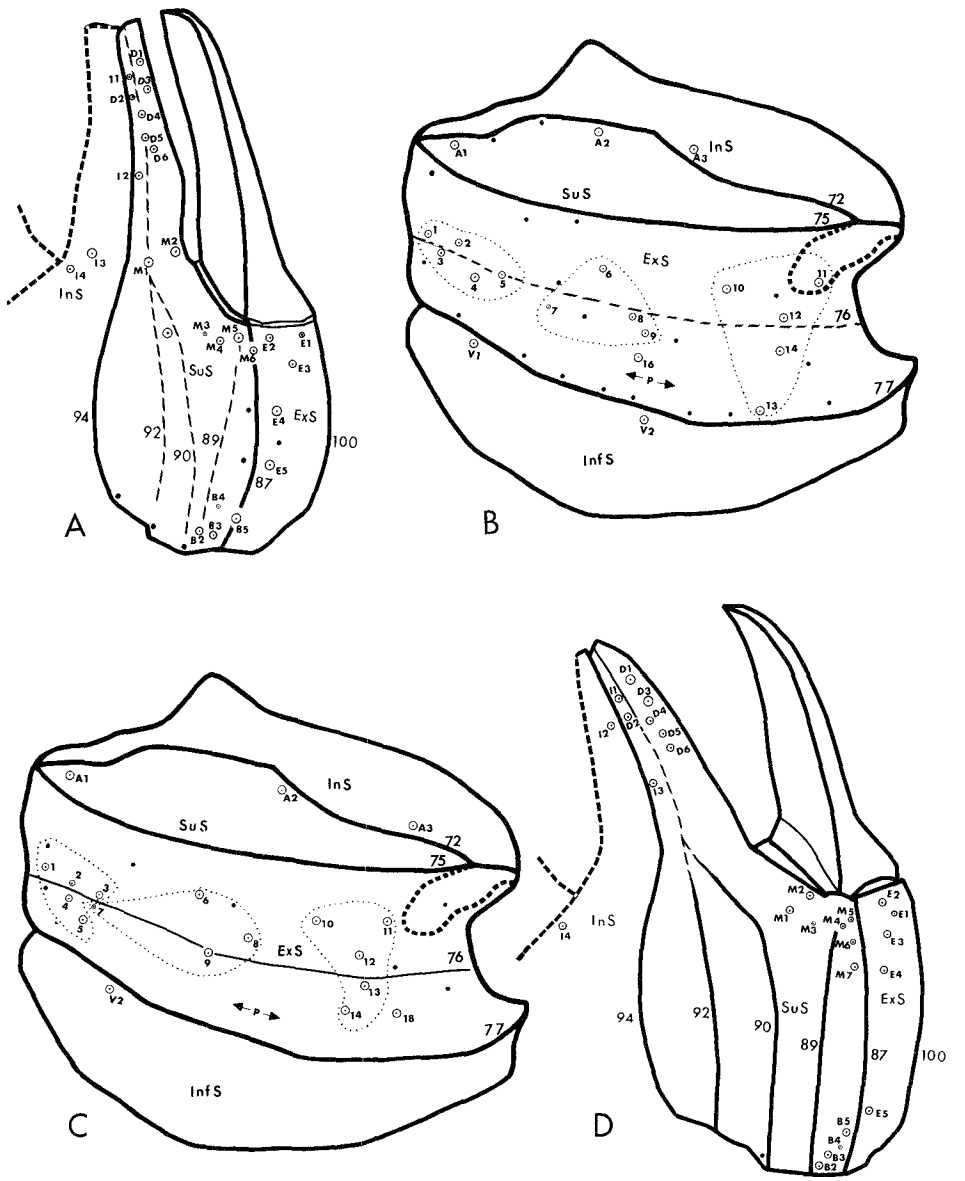

Fig. 3.–Trichobothrial systems: A-B, *Hadruroides*, chela and patella; C-D, *Iurus*, chela and patella.

well developed lateral and median claws. Pedal spurs strongly developed. Tarsomere II soles with median row of setaceous tufts (superficially appear as spines) that terminate distad in Y-like manner. The arms of the Y consist of flat, closely compact setaceous clusters.

All keels of pedipalp manus well developed, with the external keel very strongly so; external median keel of patella strongly developed. All caudal keels moderately to strongly developed with most of them bearing large, serrate denticles.

4. SCORPIOPSINAE KRAEPELIN, 1905.

Scorpiopsinae Kraepelin, 1905, Zool. Jahrb. Syst. 23:331,333,345; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57; Birula, 1917, Ann. Caucasian Mus., Scorp. Ser. A, 5:163,174,186,193; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:282; Mello-Leitão, 1934, Ann. Acad. Brasil Sci. 6(4):193,195; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ. p. 69; Mello-Leitão, 1945, Arq. Mus. Nac. 40:119; Takashima, 1945, Acta Arachnol. 9(3/4):71; Bucherl, 1971, *Venomous Animals and Their Venoms*. The Academic Press. Vol. 3:328.

Characters–Deep carapacial median notch. Two or three pairs of lateral eyes. Caudal segments I-IV with paired inferior median keels. Inner edge of pedipalp tarsus with large lateral denticles, or granules, interior and exterior to median rows of small denticles, or granules; sometimes lateral granules extend only over distal half of tarsus. Movable finger of chelicera with both tines subequal in length; superior margin bearing four denticles with second about twice the size of other three; inferior margin with four to six distinct denticles. Patella with strongly developed median exterior keel; manus strongly developed digital keel and moderately to strongly developed exterior marginal keel. On the exterior inferior margin of pedipalp patella (Fig. 4A-D) (Fig. C,D) are seven to 19 **V** trichobothria and on the exterior surface of the manus are five **E** trichobothria, four of which are inferior to the exterior marginal keel. The exterior and interior pedal spurs and the pretarsus lateral and median claws well developed. Pectines simple: Marginal lamella absent to distinct, middle lamellae not present or indistinct, fulcra absent or very minute, pectinal teeth five to 11. Stigmata elliptical.

KEY TO THE GENERA OF SCORPIOPSINAE

1a. Three pair lateral eyes . . . . . *Scorpiops* Peters, 1861
1b. Two pair lateral eyes . . . . . *Parascorpiops* Bank, 1928

HADRURINAE NEW SUBFAMILY.

Characters–This subfamily is primarily characterized by its large number of trichobothria (86 to 145) as compared with all the other subfamilies (45 to 63) (Table 1) (Figs. 5A,B, 6 A,B). When compared with the Vejovinae trichobothrial system (Figs. 6C,D, 9A-D) one notices that the great difference is due mainly to the increase in number and variation of pattern of the patella exterior surface (**P** cluster), the exterior margin of the inferior surface (**V** cluster) and the exterior surface of the manus (**E** cluster). Both genera (*Hadrurus* and *Anuroctonus*) have the **V** cluster extend onto the exterior surface (**VP** cluster) and the inferior-exterior keel turns onto the exterior surface but is vestigial on the margin from that point distad. (In contrast to this the 18 **V**'s of *Scorpiops*

montanus continues linearly on the inferior surface.) The exterior surface of the pedipalp manus has an **E** cluster of 17-19, instead of the customary five of Vejovinae. The **A, D, M, C,** and **B** clusters are typical vejovid in their composition.

The sternum is as long as or longer than wide; the median eyes are located approximately midway between the anterior and posterior margin and the carapace is as long or longer than the posterior width. The dorsal caudal keels are without a large terminal denticle; the ratio of caudal segment V length to width is over 2.65. The cheliceral movable finger is forked with the superior tine much shorter and placed nearly at right angles to the inferior tine. The inferior border of the movable finger bears a **bi** denticle.

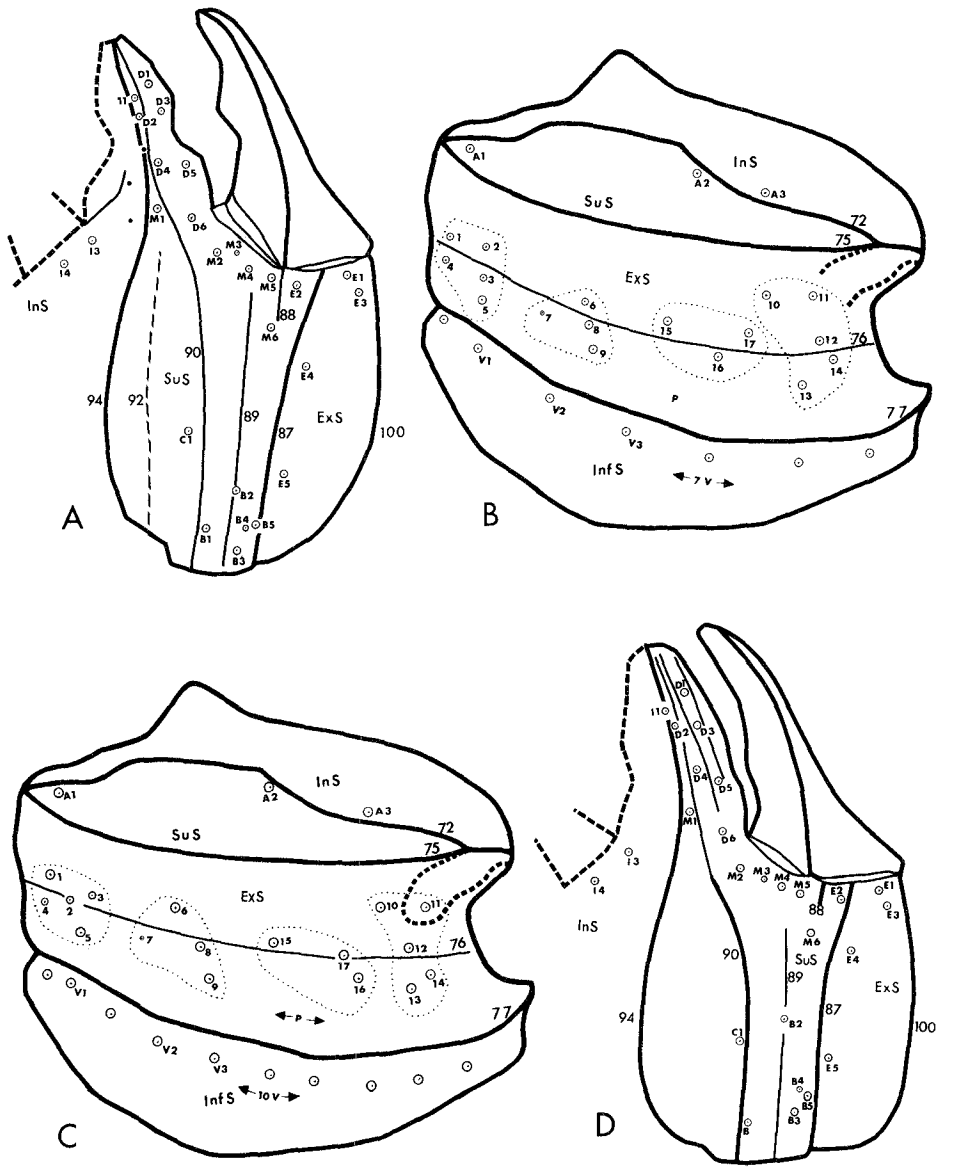

Fig. 4.–Trichobothrial systems: A-B, *Scorpiops petersi,* chela and patella; C-D, *S. longimanus,* patella and chela.

Members of this subfamily, when disturbed, do not flick their telson and run, but rather strike a defensive pose, with the cauda in a subvertical position and strut in a threatening manner. They are all active burrowers in either loose or hard soil. The venom is of low toxicity but a severe sting may cause local edema and ecchymosis.

The importance of the numerous trichobothria of this taxon was mentioned by Stahnke (1969) and Gertsch and Soleglad (1972) illustrated the patterns. Although the two genera assigned to this subfamily vary widely in some respects, the trichobothria indicate a closer affinity between them than to the genera herein assigned to the Vejovinae.

KEY TO THE GENERA OF THE HADRURINAE

1a. More than 25 trichobothria on inferior exterior margin of patella. Pectines with numerous middle lamellae, and 25 to 40 plus teeth. Inferior border of movable cheliceral finger bearing a single, large, sharp darkly pigmented **bi** tooth. Pedal spurs branched . . . . . ***Hadrurus*** Thorell, 1876.

1b. Less than 14 trichobothria on inferior exterior margin of pedipalp patella. Pectines with few (generally indistinct) lamellae and not over 13 teeth. Inferior border of movable cheliceral finger with small **bi** denticle. Pedal spurs simple spines. Aculeus of adult male with bulbous base . . ***Anuroctonus*** Pocock, 1893

5. VEJOVINAE THORELL, 1876.

Iurini Thorell, 1876, Ann. Mag. Nat. Hist. 17:11(part); Pocock, 1893, Ann. Mag. Nat. Hist. 12:306-309(part); Laurie, 1896, Ann. Mag. Nat. Hist. 18:129(part). **Jurinae** Karsch, 1879, Mitt. Munchen Entomol. Ver. 3:101(part). **Uroctoninae** Mello-Leitão, 1934, Ann. Acad. Brasil Sci. 6(2):81(part); Mello-Leitão, 1945, Arq. Mus. Nac. 40:119,128(part); Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Band 5, Abt. 4, Buch 8:283(part). **Vejovinae** Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57(part); Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,184,191(part); Hoffmann, 1931, Ann. Inst. Biol. México 2:333(part); Werner, 1934, *op. cit.* p. 282(part); Mello-Leitão, 1934, *op. cit.* p.79,80(part); Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ. p. 69(part); Mello-Leitão, 1945, *op. cit.* p. 118(part); Gertsch and Soleglad, 1972, Bull. Amer. Mus. Nat. Hist. 148:583. **Vejovini** Kraepelin, 1894, Mitt. Mus. Hamburg 11:7,181(part); Laurie, 1896, *op. cit.* p. 130(part).

Characters–Members of this subfamily have paired inferior median keels, or their vestiges, on the first four caudal segments. Normally three pairs of lateral eyes are present with the third pair usually distinctly the smallest; the median ocular tubercle is located anterior to the middle of the carapace; a distinct median claw (unguicular spine) is present on the pretarsus; the inner edge of the pedipalp tarsus bears a straight row of granules (denticles) which may be divided into a series of short, non-oblique rows, flanked by large interior lateral granules. Exterior lateral granules are absent as are also supernumerary granules. Tarsomere II with a row of short bristles or spinules. The cheliceral structures are characteristic of the family. Of importance in the vejovines are the size and position of the superior tine of the movable finger; the number, location and size of the teeth on its superior inner margin and the dentoid structures, the denticles, tubercles and serrula on the inferior margins of both fingers.

Trichobothria are distributed as follows: 3 on femur; patella with 3 A's, 2-3 V's, 13-14 P's, chela 3 I's, 6 D's, 6 M's, 1 C, 5 B's, and 5 E's. (See Table 1.)

All known members of this subfamily are efficient burrowers–many are psammophilic–, are positively geotropic and have a venom of low toxicity.

KEY TO THE GENERA OF THE VEJOVINAE

1a. Inferior surface of pedipalp patella with three trichobothria 2

1b. Inferior surface of pedipalp patella with two trichobothria 3

2a(1a). Caudal segment IV and V greatly dilated and telson vesicle narrower than segment I . . . . . ***Physoctonus*** Mello-Leitão, 1934

2b. Caudal segment IV and V not dilated excessively but subequal in width to other segments. Telson vesicle subequal in width to caudal segment I . . . . . ***Uroctonus*** Thorell, 1876

3a(1b). Inner edge of pedipalp tarsus with a continuous row of conspicuously serrate, subequal denticles, uninterrupted, or indefinitely so, by larger denticles. Terminal denticle extra-large, claw-like. Interior lateral, large flanking denticles vary in position and number. Female pectines with teeth 1 to 3 more paddle-like and somewhat larger than the others . . . . . ***Serradigitus*** NEW GENUS

3b. Inner edge of pedipalp tarsus with a series of non-oblique rows of small denticles, each row proximally terminating in a larger granule. Terminal denticle not excessively large or claw-like. Female pectines with teeth 1 to 3 not larger or more paddle-like than others 4

4a(3b). Inner inferior surface of movable cheliceral finger with 4 to 7 well developed denticles and 2 to 3 well developed denticles on inferior surface of fixed finger. Stigmata elongate ovoid . . . . . ***Pseudouroctonus*** NEW GENUS

4b. Inner inferior surface of movable cheliceral finger may be smooth, repand, or with 3 to 6 dentoid structures, often in form of angular scallops. Inferior surface of fixed finger may or may not have one or two broad tubercles or tubercular denticles 5

5a(4b). Inferior surface of both cheliceral finger smooth or slightly repand but not with angular scallops. Dorsal caudal furrow generally well developed. Dorsal keels (Fig. 7 D & F) of segments II to IV with distal granule more denticulate and larger than preceding ones; superior lateral keels with such condition only on segments II and III but the distal terminus of IV flat, subtriangular and projecting somewhat laterad. Ratio of caudal segment V length to width generally under 2.30 . . . . . ***Vejovis*** C. L. Koch, 1836

5b Inner inferior surface of movable cheliceral finger not smooth but may have a deeply repand edge or angular scallops; the fixed finger may bear 1 to 3 tubercles. Dorsal caudal furrow weakly developed. Distal granules of dorsal and superior lateral keels not noticeably larger or more denticulate than the preceding ones; terminus of dorsal keel on segment V not flat and triangular. Ratio of segment V length to width usually over 2.45 . . . . . *Paruroctonus* Werner, 1934

Remarks–The status of *Uroctonoides fractus* Chamberlin is doubtful and accordingly has been omitted from the Vejovidae. This taxon is based on only one male specimen whose caudal segment III and vesicle are missing. The type locality given is Quito, Ecuador, a region whose fauna is rich in chactids. This specimen possesses the following characteristics: Color, dark reddish brown, almost black, the legs paler. Anterior margin of carapace with very slight median notch, the bottom of which is an obtuse angle. Anterior and posterior median furrow well developed. Surface of carapace coarsely granular posteriad and laterad; tergites granular; sternite VII smooth and keelless; stigmata circular. Inferior surface of pedipalp patella with five trichobothria. Digital keel obsolete. Tarsus and tibial finger with conspicuous lobe, that of the tarsus obtuse, the other acute. Pectinal teeth seven; fulcra small and inconspicuous. Three pair of lateral eyes but the third pair are very minute. Median claw of pretarsus strongly developed; two pedal spurs; tarsal soles with five thick, thorn-like bristles. Specimen about the same size as an adult *Uroctonus mordax*.

All of the above characteristics are found on chactids in our collection from Quito. Careful examination of the region of the lateral eyes reveals a small, clear granule that could be mistaken for a minute third eye on some specimens. At this state of our investigation it seems highly probable that *U. fractus* is a chactid.

PART III. CHARACTERIZATION OF THE GENERA OF THE VEJOVIDAE

A. SYNTROPINAE

1. Genus *Syntropis* Kraepelin, 1900

Syntropis Kraepelin, 1900, Abhandl. Gebiete Naturwiss. 16:16,17; Birula, 1917, Ann. Caucasian Mus. Ser. A, 5:163; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:281; Mello-Leitão, 1945, Arq. Mus. Nac. 40:118; Stahnke, 1975, Proc. California Acad. Sci. 30(13):257-258.

Dorsal caudal keels without large distal spine-like denticle; similar to *Paruroctonus* (Vejovinae). Caudal segments elongate and slender, more so than the typical *Paruroctonus*, especially segments IV and V. Inner edge of pedipalp tarsus with a continuous row of sharply serrate denticles subdivided into short rows by six larger denticles. Eight large interior lateral cone-shaped granules, counting the two distal ones, are present. The tibial finger and tarsus terminate in a large claw-like denticle which bears on its terminus an elongate, whitish cap. Inferior median keel well developed on all segments; agranular on first three, fourth and part of fifth with confluent granules but distal half of fifth bearing serrate granules.

Type-species–Only known species, *S. macrura* Kraepelin, 1900.

Distribution–Central Baja California, México near Comondu.

2. **Vejovoidus** New Genus

Characters–Dorsal caudal keels with large terminal spine-like denticle and caudal segments not especially elongate. In both these respects similar to the typical *Vejovis* (Vejovinae). Inner edge of pedipalp tarsus with a continuous row of sharply serrate denticles subdivided into short rows by eight to nine large denticles. Eight to nine interior lateral granules present. Both tibial finger and tarsus terminate in a relatively small, cone-shaped denticle. Inferior median keel absent on segments I and II, vestigial and

Table 1. Trichobothrial systems.

	CHELA							PATELLA				
	I	D	M	B	C	E	Total	A	P	V	Total	Sum Total
Diplocentrus (model)	4	6	6	5	0	5	26	3	13	3	19	45
VEJOVIDAE												
Caraboctoninae												
Caraboctonus	4	6	6	4	1	5	26	3	15	2	20	46
Hadruroides	4	6	6	4	1	5	26	3	15	2	20	46
Iurinae												
Iurus	4	6	7	4	0	5	26	3	15	1	19	45
Vejovinae												
Uroctonus	3	6	6	5	1	5	26	3	13	3	19	45
Serradigitus	3	6	6	5	1	5	26	3	14	2	19	45
Pseudouroctonus	3	6	6	5	1	5	26	3	14	2	19	45
Vejovis spinigerus	3	6	6	5	1	5	26	3	14	2	19	45
Vejovis montereus	3	6	6	5	1	5	26	3	14	2	19	45
Paruroctonus gracilior	3	6	6	5	1	5	26	3	14	2	19	45
Paruroctonus boreus	3	6	6	5	1	5	26	3	14	2	19	45
Scorpiopsinae												
Scorpiops petersi	3	6	6	5	1	5	26	3	17	7	27	53
Scorpiops longimanus	3	6	6	5	1	5	26	3	17	10	30	56
Scorpiops montanus	3	6	6	5	1	5	26	3	17	18	38	64
Hadrurinae												
Anuroctonus	3	6	6	5	1	19	40	3	30	13	46	86
Hadrurus	10	6	6	5	1	17	45	3	62	35	100	145

agranular on III, smooth and confluent granules on IV and irregularly serrate on V.

Type-species–Only known species, *V. longiunguis* (Williams), 1969.

Distribution–West coast of central Baja California, México.

B. CARABOCTONINAE

3. Genus *Caraboctonus* Pocock, 1893

Caraboctonus Pocock, 1893, Ann. Mag. Nat. Hist. 12:92(part); Pocock, 1893, Ann. Mag. Nat. Hist. 12:329,330; Kraepelin, 1894, Mitt. Mus. Hamburg 11:209; Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:189; Birula, 1917, Fauna of Russia, Arach., Pedip. 8:189; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,191; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:284; Mello-Leitão, 1945, Arq. Mus. Nac. 40:119,120.

Characters–Besides the key characteristics this genus has on the inner margin of the pedipalp tarsus a series of about six longitudinal, oblique rows of denticles, the proximal denticle of each enlarged; also a large interior lateral denticle at the distal extremities of each row. Median ocular furrow lacking. Telson vesicle as wide as, or less than the width of segment V. Movable cheliceral finger with moderately large basal tooth on inferior margin. Sternum considerably wider than long but without deep median furrow. Sternite VII with two pair, granular lateral keels. Trichobothrial system as shown in Figs. 2 C-D.

Type-species–*C. keyserlingi* Pocock, 1893.

Other species–Apparently monotypic. See remarks under *Hadruroides*.

Distribution–Peru, Chile.

4. Genus *Hadruroides* Pocock, 1893

Caraboctonus Pocock, 1893, Ann. Mag. Nat. Hist. 12:92(part). ***Hadruroides***, Pocock, 1893, Ann. Mag. Nat. Hist. 12:329,330; Kraepelin, 1894, Mitt. Mus. Hamburg 11:206; Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:188,189; Pocock, 1900, Ann. Mag. Nat. Hist. 5:474, Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,191; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Band 5, Abt. 4, Buch 8:284; Roewer, 1943, Senckenbergianna, 26:236; Mello-Leitão, 1945, Arq. Mus. Nac. 40:119,120. ***Telegonus*** Koch, 1867, Verh. Zool. Bot. Ges. Wien, 17:237(part).

Characters–Besides the key characteristics this genus does not have the large interior lateral denticles of the pedipalp tarsus placed on the distal extremity of each oblique row. Median ocular furrow well developed. Telson vesicle as wide as, or wider, than caudal segment V. Movable cheliceral finger with a very strongly developed brown tooth (**bi**) on inferior surface (similar to *Hadrurus*). Sternum about as wide as long with deep median furrow. Sternite VII without lateral keel. Trichobothrial pattern as shown in Fig. 3 A,B; cluster D located more distad than in *Caraboctonus*. E1, 2, 3 nearly form isosceles triangle.

Type-species–*H. lunatus* (L. Koch), 1867.

Other species–Mello-Leitão (1945) recognized only one species; early writers (Pocock 1900) recognized more. With better sampling techniques and quantitative studies undoubtedly more species will be recognized.

Distribution–Equador, Peru, Bolivia into Chile, Galapagos.

C. IURINAE

5. Genus *Iurus* Thorell, 1876

See characteristics of subfamily.

Type-species–*I. dufoureius* (Brulle), 1832.

Other species–*I. kraepelini* Ubich, 1922 (doubtful).

Distribution–Greece, Crete, Samoa, Asia Minor.

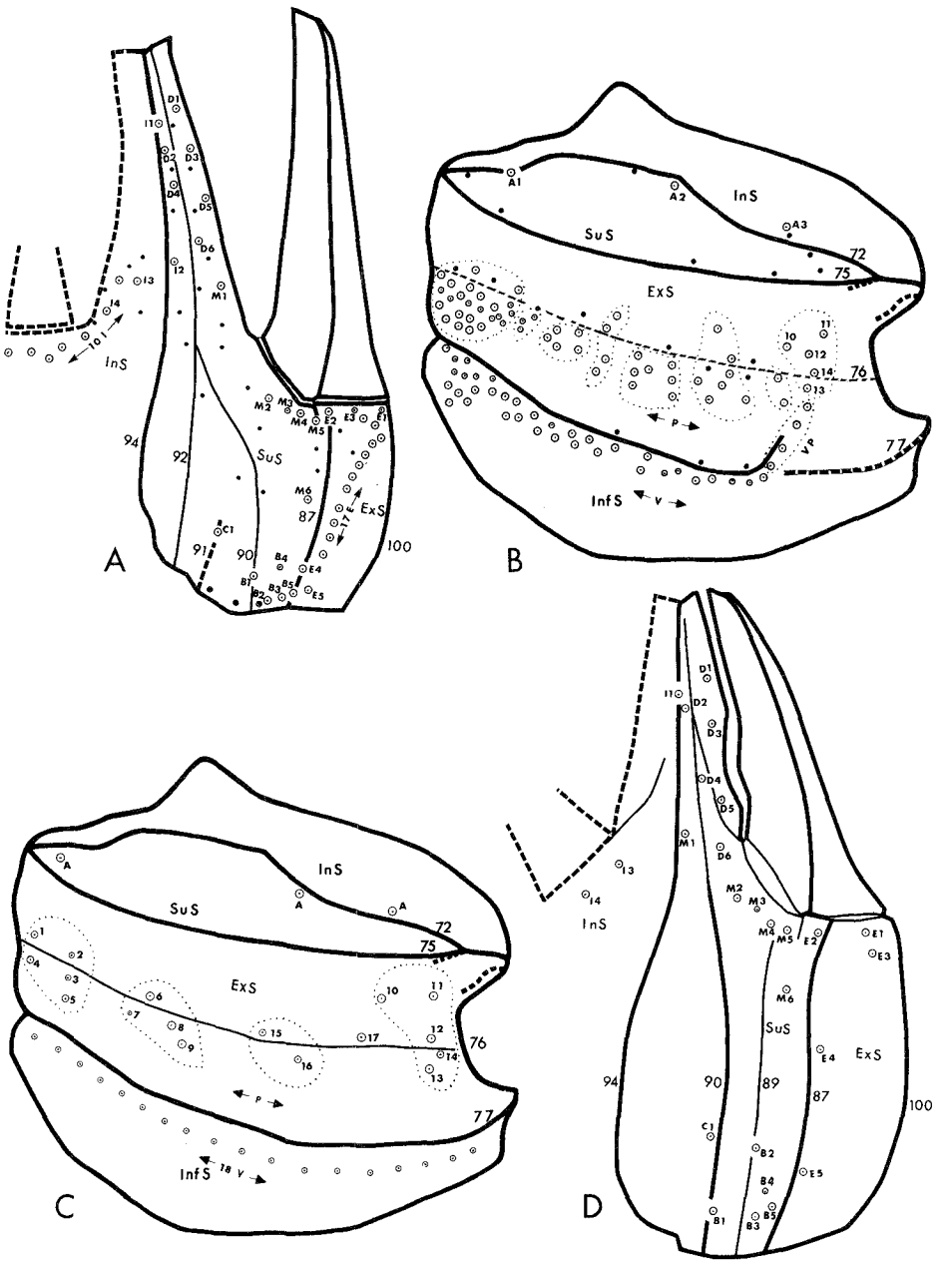

Fig. 5.–Trichobothrial systems: A-B, *Hadrurus* chela and patella; C-D, *Scorpiops montanus* patella and chela.

D. SCORPIOPSINAE

6. Genus *Scorpiops* Peters, 1861

Scorpiops Peters, 1861, Mon. Akad. Berlin 16:510; Thorell, 1876, Ann. Mag. Nat. Hist. 17:14; Karsch, 1879, Mitt. Munchen Entomol. Ver. 3:19; Thorell, 1889, Ann. Mus. Genova 27:573; Kraepelin, 1894, Mitt. Mus. Hamburg 11:185-188; Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:179; Pocock, 1900, Fauna of British India, Arach. p. 64; Kraepelin, 1913, Mitt. Mus. Hamburg 30:153; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1):57; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,191; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:283; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ. p. 14-16,18,69; Takashima, 1945, Acta Arachnol. 9(3/4):71.

Characters–Carapace with three pair lateral eyes and with deep median anterior notch. Seven to 19 trichobothria along exterior margin of inferior surface of pedipalp patella (Figs. 4 A-D; 5 C,D). Dorsal keels of cauda with terminal denticle larger than preceding ones; ventral keels indistinct. Pectines simple; pectinal teeth five to 11.

Type-species–*S. hardwicki* (Gervais), 1884.

Other species–At present about thirteen species and subspecies are recognized. The variation is so great among these that two or three genera should be recognized. Sufficient material was not available to make such a study at this time.

Distribution–The Deccan, South slope of the Himalayans from Punjab to Assam, then through Burma to Tenasserim (Lower Burma).

7. Genus *Parascorpiops* Banks, 1928

Parascorpiops Banks, 1928, J. Sarawak Mus. 3(11):505,506; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:283; Takashima, 1945, Acta Arachnol. 9(3/4):71.

Characters–Carapace with two pair lateral eyes and with deep median anterior notch. Ten trichobothria along exterior margin of inferior surface of pedipalp patella. Cauda with very low and lightly granulated keels; dorsal keels most strongly developed but without large terminal denticle. Ventral keels distinct. Female genital operculum undivided. Pectines simple. No distinct middle lamella or fulcra; pectinal teeth, male and female, six, with those of male much larger than female's.

Type-species–*P. montana* Banks, 1928.

Other species–Apparently monotypic.

Distribution–Mt. Poi, 4350-5450 feet; Mt. Dulit, 4000 feet, Sarawak, Borneo.

E. HADRURINAE

8. Genus *Hadrurus* Thorell, 1876

Hadrurus Thorell, 1876, Ann. Mag. Nat. Hist. 17:11 (Original citation, only part of key dichotomy); Thorell, 1876, Atti Della Soc. Italia Sci. Nat. 19:83 (Part of key); Karsch, 1879, Mitt. Munchen Entomol. Ver. 3:21 (No description); Pocock, 1894, J. Linn. Soc. Zool. 24:375,401; Pocock, 1894, Nat. Sci. 4:359,360; Kraepelin, 1894, Jahrb. Hamburg Wiss. Anst. 11:204,205; Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:187; Pocock, 1902, Biologia Centrali Americana, Scorp., Pedip., Solif., p. 5; Ewing, 1928, Proc. U.S. Natl. Mus. 73:7, Hoffmann, 1931, An. Inst. Biol. México, 2:334; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs Band 5, Abt. 4, Buch 8:282; Stahnke, 1939,

Scorpions of Arizona. Iowa State Univ. p. 103; Stahnke, 1945, Amer. Mus. Novitates, 1298:1-4; Diaz Najera, 1964, Rev. Inst. Salubr. Enferm. Trop. (México) 24:19,26,27,29; Gertsch and Allred, 1965, Brigham Young Univ. Sci. Bull., Biol. Ser., 6(4):12; Stahnke, 1969, Entomol. News 80:57,58; Williams, 1970, Occ. Papers California Acad. Sci. 87:3,4; Gertsch and Soleglad, 1972, Bull. Amer. Mus. Nat. Hist. 148:564,566; ***Buthus*** Wood, 1863a, Proc. Acad. Nat. Sci. Philadelphia, p. 108(part); Wood, 1863b, J. Acad. Nat. Sci. Philadelphia, Ser. 2, 5:367-368(Part).

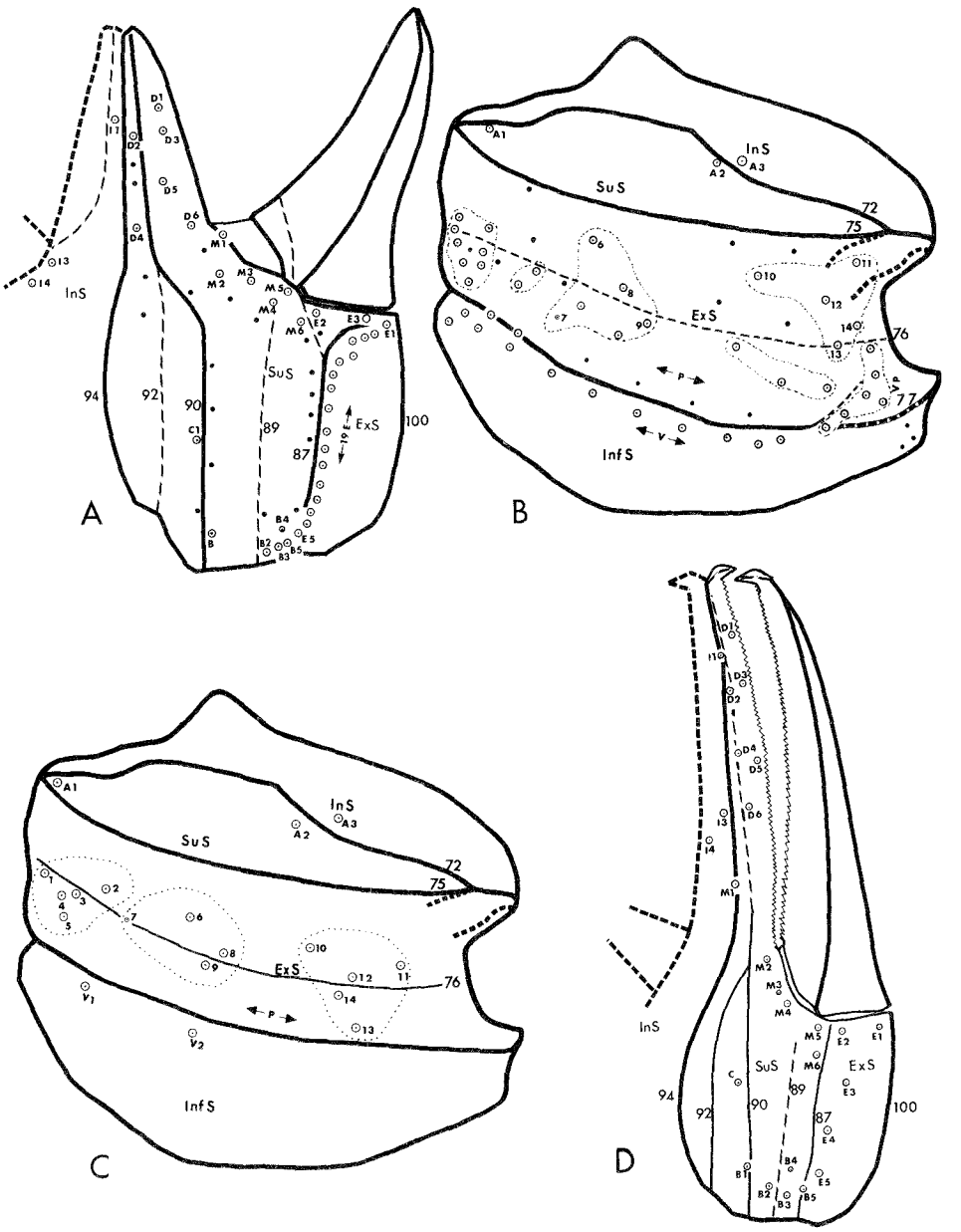

Fig. 6.–Trichobothrial systems: A-B, *Anuroctonus*, chela and patella; C-D, *Serradigitus*, patella and chela.

Characters–Numerous trichobothria (over 140; see Table 1) as compared to the relatively low count of 45 in the Vejovinae. This contrast is augmented when comparing the count of over 35 on the inferior surface of the patella with the count of two to three on that of the Vejovinae; a count of over 60 on the exterior patella surface with a count of 14 on the Vejovinae; and a count of over 15 on the exterior surface of the pedipalp manus in the **E** cluster compared to 5 on the Vejovinae. The genus *Hadrurus* is also very hirsute. Numerous macrochaetes (longer than the trichobothrial setae) are found on the pedipalps with a dense concentration on the walking legs, caudal segments, and especially the telson. On the inferior border of the cheliceral movable finger denticel **bi** is extremely large. Interior and exterior pedal spurs are present and these bear denticulate projections, the interior spurs with three to four denticles and the exterior with five to six. This condition is not encountered in any other taxa of the Vejovidae. The carapace length approximates the posterior width (L/W= 0.92-104). The median eyes situated slightly forward of the middle (ratio of distance from anterior margin to anterior edge of median eyes to carapace length 0.46-0.50). Third marginal lamella of pectines longer than second. In its defensive behavior it resembles the paruroctonids (Stahnke, 1966).

Type-species–*Hadrurus hirsutus* (Wood), 1863 (*nec* Williams, 1970).

Other species–*H. aztecus* Pocock, 1902; *H. arizonensis* Ewing, 1928; *H. pinteri* Stahnke, 1969; *H. spadix* Stahnke, 1940; *H. thayeri* Stahnke, 1969. Doubtful species not listed.

In his recent study of this genus, Williams (1970) somewhat arbitrarily changed the taxon representing the type-species. It is unfortunate that all the facts should not have been considered before introducing such confusion into the literature. He correctly reported that John Xantus de Vesey collected the original material that Wood (1863a and b) described. However, he failed to point out that de Vesey must have traveled the length of the Baja peninsula into Southern California from the nature of the material that he collected. From this material Wood described two species which he called *Buthus hirsutus* and *Buthus emarginaticeps*. As indicated above, his descriptions were published twice. In one the locality is given as Lower California and in the other only California. In both descriptions the type specimen size is reported as: length of body, 1 5/8 inches; of tail 2 5/8 inches or a total of approximately 4 1/4 inches. The specimen in the U.S. National Museum is only 3.3 inches (82.1 mm) long, with a trunk length of 1.4 inches (34.3 mm) and caudal length of 1.9 inches (47.8 mm).

In 1876 Thorell erected a new genus for the taxon, i.e. *Hadrurus*, and continued to recognize only two species, *Hadrurus hirsutus* and *H. emarginaticeps*. The latter is now considered as an anomalous specimen but Wood's description of it, together with that of *H. hirsutus*, reveals the true status of the material in his possession.

For *H. hirsutus* he states: "The common tint of the dorsum is a very dark reddish-brown, but varies greatly, in some specimens being as light as the legs, in others even olive. In the typical pattern, whilst the penultimate caudal segment is of the same reddish-brown as the body, the terminal is very light." In the description of *H. emarginaticeps* he states: "The color of our single specimen is an olive yellow tint, with a very dark crescentic blotch at the position of the median eyes. But this pattern does not differ from some individuals of the preceding species."

From this color description and other remarks, Wood had before him a conglomerate of specimens representing a number of species as now recognized. Color, and other characteristics, e.g. pedal spurs, thickness of metasoma, and 'the opposing edges of fingers are armed with obliquely longitudinal imbricated rows of small teeth' were of no signifi-

Table 2. A comparison of the type-species of *Uroctonus*, *Vejovis*, and *Pseudouroctonus*.

	P. reddelli	*U. mordax*	*V. mexicanus*
1. Length (mm)	♀ 56; ♂ 52	♀ 52; ♂ 51	♀ 49; ♂ 45
2. Stigmata	Elongate oval	Oval	Elongate ellip. to slit-like
3. No. pect. teeth	♀ 16-17; ♂ 18-19	♀ 8-9; ♂ 10-12	♀ 16-17; ♂ 18-19
4. No. mid. lamel.	♀ 10; ♂ 12	♀ 7; ♂ 11	♀ and ♂ 11-12
5. No. V trich.;	2	3	2
P	14	13	14
6. Dent. on inner inf. marg. chel. mov. finger	4-7 well developed	3-6 moderately developed	None
7. Dent. on inner inf. marg. chel. fixed finger	2-4 well formed	None	None
8. Carapace anter.	♀ 0.37; ♂ 0.39	♀ 0.48; ♂ 0.49	♀ 0.50; ♂ 0.38
9. Correlations	♀ : ♂ = 0.82	♀ : ♂ = 0.74	♀ : ♂ = 0.96
	♂ *P. r.* : ♂ *U. m.* = 0.62		
	♀ *P. r.* : ♀ *U. m.* = 0.71		
	♂ *P. r.* : ♀ *V. m.* = 0.76		
	♀ P. r. : ♀ *V. m.* = 0.82		
	♂ *V. m.* : ♂ *U. m.* = 0.51		
	♀ *V. m.* : ♀ *U. m.* = 0.61		
10. Ratios:			
a. Metasoma L./ Manus W.	♀ 7.73; ♂ 8.03	♀ 5.35; ♂ 6.14	♀ 9.0; ♂ 8.68
b. Femur L/D	♀ 5.58; ♂ 7.11	♀ 3.22; ♂ 3.38	♀ 4.5; ♂ 5.00
c. Seg. IV/VW	♀ 1.21; ♂ 1.19	♀ 1.39; ♂ 1.40	♀ 1.0; ♂ 0.94
d. Seg. IV L/W	♀ 1.70; ♂ 1.89	♀ 1.75; ♂ 1.77	♀ 1.26; ♂ 1.41
e. Carapace ant. L/median notch depth	♀ 9.63; ♂ 11.00	♀ 5.40; ♂ 6.00	♀ 10.00; ♂ 8.50

cance to him. He was impressed with the large macrochaetes and other setae, hence the name *hirsutus*. It is unfortunate that Thorell was also similarly impressed and failed to see that more than "two species" were represented.

Hoffman (1931) was the first to recognize the error and designated the "crescentic" form as *Hadrurus hirsutus* (Fig. 7 B,C) and Stahnke (1939, 1945, 1969), likewise, recognized this taxon as representing the type-species. Thus on the basis of priority and use, designating intent, the "crescentic" form fully described and illustrated by Hoffmann (1931) is the valid taxon to represent *Hadrurus hirsutus* (Wood), the type-species of *Hadrurus* Thorell, and *Hadrurus thayeri* Stahnke must be recognized as the species endemic to the southern portion of the Baja peninsula.

Distribution–Arizona, Northern Utah and Nevada, Southern California and Mexico.

9. Genus *Anuroctonus* Pocock, 1893

Anuroctonus Pocock, 1893, Ann. Mag. Nat. Hist. 12:328; Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:183; Kraepelin, 1901, Bull. Mus. Paris 7:274; Pocock, 1902, Biologia Centrali Americana, Scorp., Pedip., Solif. p. 13; Banks, 1910, Pomona Coll. J. Entomol. 2:186; Penther, 1913, Ann. K. K. Nat. Hist. Hof. Mus. p. 247; Ewing, 1928, Proc. U.S.

Nat. Mus. 73:14; Hoffmann, 1931, An. Inst. Biol. México 2(4):403-405; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:284; Gertsch, 1958, Amer. Mus. Novitates 1903:14; Gertsch, 1965, Brigham Young Univ. Sci. Bull., Biol. Ser., 6(4):11; Williams, 1966, Proc. California Acad. Sci. 34(8):419-428; McDaniel, 1968, Entomol. News 79:278; Hjelle, 1972, Occ. Papers California Acad, Aci. 92:7,8; Gertsch, 1972, Bull. Amer. Mus. Nat. Hist. 148:564,565. ***Centrurus*** Wood, 1863, J. Acad. Natl. Sci. Philadelphia Apr. p. 111; Wood, 1863, J. Acad. Natl. Sci. Philadelphia 5:360,372. ***Oncocentrus*** Thorell, 1894, Bull. Soc. Entomol. Italia 25:375. ***Uroctonus*** Karsch, 1879, Mitt. Munchen Entomol. Ver. 3:103(part); Kraepelin, 1894, Mitt. Mus. Hamburg 11:196(part).

Characters–The trichobothrial patterns (Figs. 6 A,B) of *Anuroctonus* differs less than other Vejovidae than do the *Hadrurus* patterns (Table 1). The latter differs in clusters **V**, **P**, **I**, and **E**, whereas *Anuroctonus* differs in **V**, **P**, **D**, and **E** with the striking differences in clusters **V**, **P**, and **E**. *Anuroctonus* has a total trichobothrial count of 98 against only 48 on the Vejovinae.

The sternum is longer than broad. Pectines with one to four indistinct to moderately distinct middle lamellae. Pectine teeth: five to nine in the female, 6 to 11 in the male. Chelicera movable finger with very short superior tine, set at right angles to inferior tine; superior margin bears four denticles with one and two subequal, three and four very small and equal in size; inferior margin usually with a **bi** denticle which may be very small and difficult to locate because of the heavy hirsute condition. Usually this denticle is of moderate size and occasionally flanked by one to two dentoid structures. Genital papillae more triangular than cylindrical in form. Adult male aculeus with bulb near base but it is lacking in immature males. Caudal segment V wider than deep. Carapace with three pair distinct lateral eyes with one and two generally larger than number three. A fourth small eye appears to be present on some specimens but is missing on others.

Type-species–*A. phaiodactylus* (Wood), 1863.

Other species–Apparently monotypic but there are some extreme color variations.

Distribution–In our collection are specimens from Arizona, Central and Southern California, Nevada, and Utah. Other accounts on distribution are: Utah Territory (Wood, 1863b), Virginia (Pocock, 1893), Guatemala (Thorell, 1894), Texas (Kraepelin, 1901), Denver, Colorado (Pocock, 1902), Ciudad, Mexico (one Male) (Penther, 1913). Hoffman (1931) states "the species exists in the Mexican Republic apparently only in Baja California." He very likely was not aware of Penther's report.

The localities of Virginia and Guatemala are doubtful. However, Thorell's account credits Dr. G. Eisen as collector and places the specimen in the Guatemala collection of the Florentine Museum. Pocock received his Virginia specimen from the collection of Owens College, Manchester. His remarks are of interest: "I have seen a single specimen (female, with normal aculeus) from Virginia . . . Karsch . . . referred it to *Uroctonus*, and characterizes *Uroctonus* as having a series of teeth on the lower border of the digit of the chelicera. Dr. Marx also referred it to *Uroctonus*. But I cannot see any series of teeth at all comparable to the series presented by *Uroctonus*. On the contrary, there is only one tooth, not so large it is true as the one on *Hadrurus*, but occupying the same position, and the edge in front of this may be fairly roughened; but there is no structure presented that I should call a series of teeth."

This writer concurs with the observations of Pocock after examining a large series from the localities indicated above. The trichobothria, however, are now the positive differ-

entiating characteristics for *Anuroctonus*. The bulb on the aculeus is not reliable since it is not present on large juveniles and the cheliceral teeth are also unreliable in adult specimens since these are frequently worn off very seriously from digging in hard, compact soil.

F. VEJOVINAE

10. Genus *Physoctonus* Mello-Leitão, 1934

Physoconus Mello-Leitão, 1934, An. Acad Bras. Sci. Río. 6(2):75-6; Mello-Leitão, 1945, Arq. Mus. Nac. 40:129.

The following is taken from the original description: Carapace with anterior median notch and three pair of lateral eyes; median ocular furrow present. Inferior edge of movable cheliceral finger with two blunt, well separated denticles and that of the fixed finger has a small hypophysis. Sternum pentagonal; length and width about equal. Well developed median claw on pretarsus. Last two caudal segments greatly dilated; ratio of widths of segment IV to I = 1.35; that of segment V to I = 1.47. Segment V width 2.5 times that of telson vesicle which is narrower than segment I. Stigmata linear. Tergite I-VI with median keel; VII with lateral keels. Pedipalp tarsus with an inner continuous row of granules flanked by 25 interior lateral granules; exterior lateral granules and supernumerary granules lacking. Patella with three V inferior trichobothria.

Type-species–*P. physurus* M.L., 1934.

Other species–Apparently monotypic.

Distribution–Northeast Brazil.

11. Genus *Uroctonus* Thorell, 1876

Uroctonus Thorell, 1876, Ann. Mag. Nat. Hist. 17:11; Thorell, 1876, Att. Soc. Italia Sci. 19:196; Karsch, 1879, Mitt. Munchen Entomol. Ver. 3(1):19; Karsch, 1879, Mitt. Munchen Entomol. Ver. 3(2):101-103; Pocock, 1893, Ann. Mag. Nat. Hist. 12:328; Thorell, 1894, Bull. Soc. Entomol. Italia 25:374; Kraepelin, 1894, Mitt. Mus. Hamburg 11:193(part); Kraepelin, 1899, Das Tierreichs, Scorp., Pedip. 8:182; Pocock, 1902, Biologia Centrali Americana, Scorp., Pedip., Solif. p. 14; Borelli, 1909, Portici Boll. Lab. Zool. 3:324; Comstock, 1912, *The Spider Book*, New York, p. 30; Ewing, 1928, Proc. U.S. Natl. Mus. 73:15; Hoffmann, 1931, An. Inst. Biol. México 2(4):402; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:283,284; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ. p. 70; Hjelle, 1972, Occ. Papers California Acad. Sci. 92:9(part); Gertsch and Soleglad, 1972, Bull. Amer. Mus. Nat. Hist. 148:553-564(part).

Characters–The carapace has a pronounced anterior median notch; the ratio of the anterior carapace length to the median notch depth is about 5.4 female, 6.00 male. The total taper of the carapace is about 0.48 mm/mm length (male and female); the anterior taper is about 0.65 (female), 0.79 (male) mm/mm length and the posterior taper is about 0.37 (female), 0.32 (male) mm/mm of posterior length. The median ocular furrow is lacking. Three pair of lateral eyes are present with the first two well developed but the third much smaller and placed at about 45° to the other two. The median eyes are of moderate size and placed near the front: The ratio of the anterior length to the total length is about 0.38; the ratio of the carapace length to the diameter of the eyes is about 16.25 to 17.25; the ratio of the median ocular tubercle width to the diameter of the eyes

is about 2.5 female, 2.38 male; the median eyes are about 1.54 times the width of the first lateral eye; the distance between the median eyes is about 1.33 times their diameter.

The inferior surface of the cheliceral movable finger bears from three to six denticles; occasionally some may be serrate and some truncate, but more often they are all more elongate tubercular. The inferior surface of the fixed finger is devoid of denticles or tubercles. The inferior tine of the movable finger is more than twice the length of the superior tine; the superior margin bears four denticles with the second at least twice the size of the other three which are subequal.

The pedipalp tarsus inner edge has a continuous row of granules divided into six short rows by five large granules; flanking this row are seven to eight large interior lateral granules; the tibial finger bears seven large interior lateral granules; no exterior lateral granules or supernumerary granules are present.

The dorsal caudal furrow is weakly to moderately developed. The distal terminal granule of the caudal dorsal and superior lateral keels are not denticulate or spinous (Fig. 7A) and not distinctly larger than the other granules. The distal terminus of the superior lateral keel of segment IV does not bear an enlarged, subtriangular projection (Fig. 7A). The ratio of caudal segment V length to width ranges from 2.52-3.22 (females); 2.42-3.18 (male); the ratio of telson vesicle width to segment V width ranges from 1.00-1.41 (female); 1.04-1.20 (male).

For trichobothrial patterns of *Uroctonus* see Fig. 8 A,B and Table 1. Some ratios between trichobothrial distances are: Distance between D1-D6 to D1-M1 = 1.09; between E1-E4 to E1-E5 = 0.45; between E2-E4 to E2-E5 = 0.45.

The sternum is broader than long; ratio of breadth to length about 1.56 to 1.65 (female); 1.80 (male). Stigmata elongate elliptical but not circular as in Chactidae. Sternite VII lateral keels from obsolete to slight vestiges; never well developed.

Type-species–*U. mordax* Thorell, 1876.

Other species–Using the type-species of the genus *Vejovis*, *V. mexicanus*, as a basis for judgement the following species placed in *Uroctonus* by Gertsch and Soleglad (1972) must be considered as belonging to the genus *Vejovis* (which see): *U. montereus*, *U. rufulus*, *U. sequoia*, *U. bogerti*, *U. williamsi*, *U. andreas*, *U. angelenus*, *U. lindsayi*, *U. chicano*, *U. apacheanus*, *U. cazieri*, *U. huachuca* is doubtful. *U. grahami* appears to be *Uroctonus*. *U. glimmei* Hjelle, 1972, also belongs to the genus *Vejovis*. *U. yosemitensis* (Ewing), 1928 (=*V. yosemitensis*); based on a quantitative study of the type.

Distribution–In our collection we have *Uroctonus*, as herein characterized, from Arizona, Utah, Oregon and the length of California. Thorell (1894) recorded *Urocontus* from Guatemala and Hoffmann (1931) reported it from Baja. Thus far these last two localities have not been confirmed.

12. **Serradigitus**, new genus

Characters–The inner edge of the pedipalp tarsus has a continuous row of conspicuously serrate, subequal denticles, uninterrupted, or indefinitely so, by larger denticles. The terminal denticle is abnormally large and claw-like and bears on its terminus an elongated whitish cap. Interior lateral, large flanking denticles vary in position and number from six on the type-species up to 16 on other species.

Female pectines with teeth number one to three more paddle-like and somewhat larger than the others. Stigmata elongate elliptical.

For trichobothrial patterns of type-species see Fig. 6 C,D and Table 1. Ratio of distances on pedipalp patella of P7-P6 and P6-P9 = 1.24. On *V. spinigerus*, a typical

vejovid, this ratio equals about 0.69. On this type-species pedipalp tibia the ratio of the distance between **D**1-D6 and **D**1-M1 equals 0.73. For *V. spinigerus* this ratio is about 0.81 and for *V. mexicanus* about 0.91. The ratio of the distance between **D**1-D2 and **D**2-D3 for the type-species is 2.85; for *V. spinigerus* 1.67 and *V. mexicanus* is 1.46.

The total trichobothria on the femur is three, the patella 19 and tibia 27 or a sum total of 49. It differs from *Uroctonus* in having two **V**'s instead of three, 14 **P**'s instead of 13, and four **I**'s instead of three. It differs from *Vejovis* in having four **I**'s instead of three.

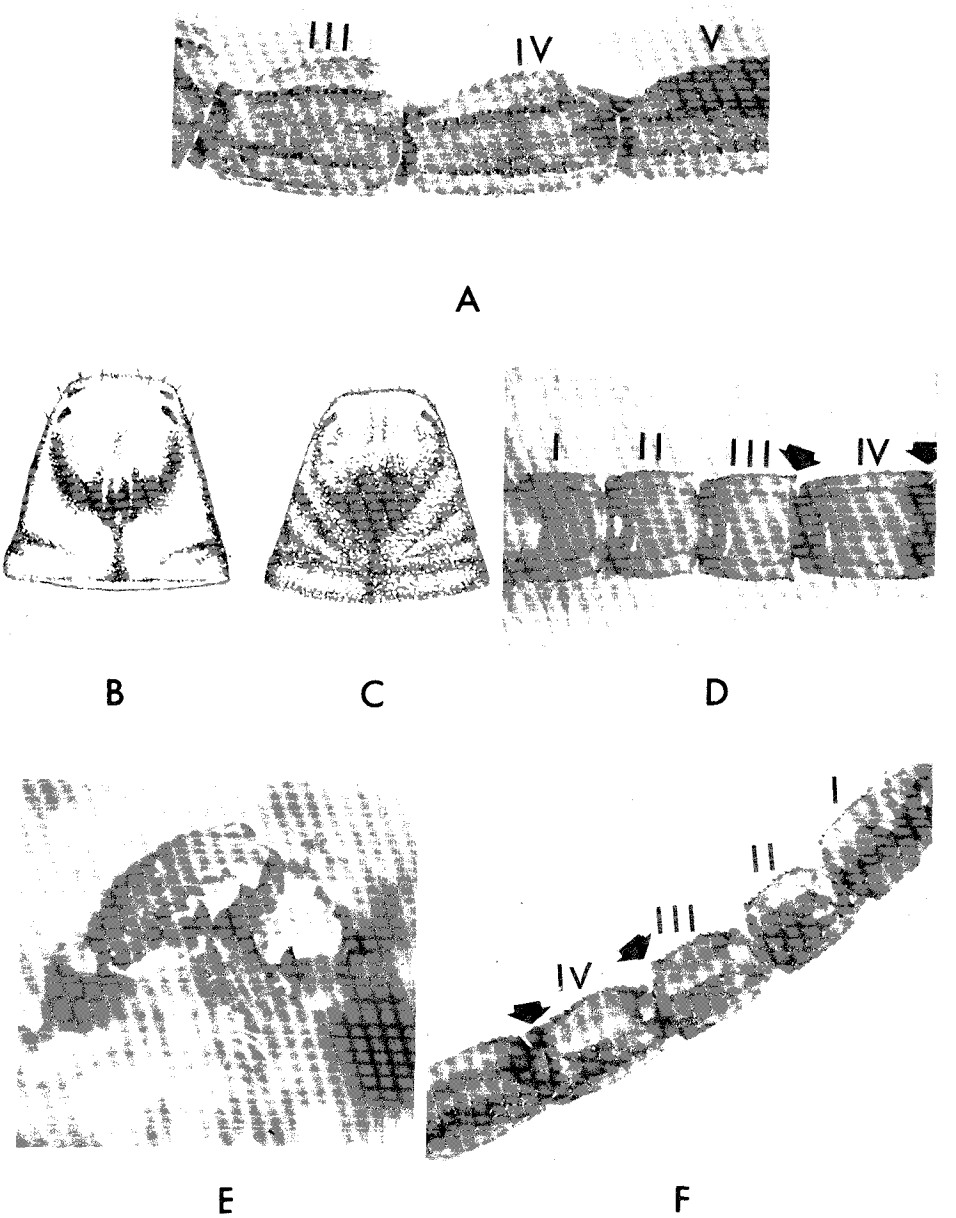

Fig. 7.–A, *Uroctonus* caudal segments (B-C from Hoffmann, 1931); B, *H. hirsutus* carapace; C, *H. aztecus*; D, *Vejovis spinigerus*, caudal segments; E, inferior cheliceral denticles of *Pseudouroctonus*; F, *Vejovis mexicanus*, caudal segments.

Type-species–*Serradigitus wupatkiensis* (Stahnke), 1940 (=*Vejovis wupatkiensis*).

Other species–*S. gertschi* (Williams), 1970 (=*V. gertschi*); *S. harbisoni* (Williams), 1970 (=*V. harbisoni*); *S. minutis* (Williams), 1970 (=*V. minutis*); *S. gramenestris* (Williams), 1970 (=*V. gramenestris*); *S. deserticola* (Williams), 1970 (=*V. deserticola*); et al.

Distribution–From southern Wyoming, western Colorado and New Mexico, Utah, Nevada, central and southern California, Arizona; Baja California and Sonora, Mexico.

13. **Pseudouroctonus**, new genus

Characters–This taxon has been mistaken for *Uroctonus* and *Vejovis mexicanus* by the lay scorpiologist. Its only known representative is a dark, reddish brown species. The stigmata are elongate ovoid. The female pectine has 10 subcircular, vaulted middle lamellae and the male 12. The genital operculum is completely divided on the male but only the posterior one-third is divided on the female. The superior interior margin of the cheliceral movable finger bears four denticles of which the second is very much larger than the other subequal three; the inferior inner margin bears from four to seven well developed denticles. The inferior margin of the fixed finger bears two or three relatively large denticles (Fig. 7E). The inner edge of the pedipalp tarsus bears a continuous row of small denticulate granules broken into shorter rows by four large denticulate granules and is flanked by five large interior granules plus two large ones on the distal terminus; terminal tooth not claw-like. Supernumerary teeth lacking. See Fig. 9 A,B and Table 1 for trichobothrial systems.

Type-species–*Pseudouroctonus reddelli* (Gertsch and Soleglad), 1972 (=*V. reddelli*).

Other species–Possibly one more species as yet undescribed.

Distribution–See excellent list in Gertsch and Soleglad. Our specimens come mainly from Brehmer Cave, New Braunfels and San Marcos, Texas. Several were taken under boards and one under a door mat.

For a comparison of the type-species of *Uroctonus*, *Vejovis*, and *Pseudouroctonus* see Table 2.

14. Genus *Vejovis* Koch, 1836

Vaejovis Koch, 1836, Arach., 3:51; Koch, 1837, Uber Arachnidensystems, Nürmberg 1:38; Gervais, 1844, Scorpions, 3:50, in Walckenaer, Ins. Apt.; Peters, 1861, Monbr. Ak. Bert. 16:510; Pocock, 1898, Ann. Mag. Nat. Hist. 1:394; Pocock, 1902, Biología Centrali Americana, Scorp., Pedip., Solif. p. 8; Borelli, 1909, Bo. Lab. Zool. Gen. Agraria 3:234; Herrera, 1917, Bol. Dir. Estr. Biol. México 2:271; Ewing, 1928, Proc. U.S. Natl. Mus. 2730:7; Roewer, 1943, Senckenbergianna 26:235; Hjelle, 1972, Occas. Papers California Acad. Sci. 92:20. ***Vejovis*** Thorell, 1876, Ann. Mag. Nat. Hist. 17:10 (emend.); Kraepelin, 1894, Mitt. Mus. Hamburg 11:198; Laurie, 1896, Ann. Mag. Nat. Hist. 18:130; Kraepelin, 1899, Das Tierreich, Scorp., Pedip. 8:133; Comstock, 1912, *The Spider Book*, New York, p. 31; Penther, 1913, Ann. K. K. Nat. Hist. Hof. Mus. p. 247; Birula, 1917, Fauna of Russia, Arach., Scorp. 1(1)57; Birula, 1917, Ann. Caucasian Mus., Ser. A, 5:163,191; Hoffmann, 1931, Ann. Inst. Biol. México 2(4)346; Mello-Leitão, 1934, Ann. Acad. Brasil Sci. 6(2):77; Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Scorp., Pedip. Band 5, Abt. 4, Buch 8:282; Stahnke, 1939, *Scorpions of Arizona*, Iowa State Univ., pp. 70-72; Mello-Leitão, 1945, Arq. Mus. Nac. 40:118; Gertsch and Allred, 1965, Brigham Young Univ. Sci. Bull., Biol. Ser., 6(4)3(part); Gertsch and Soleglad, 1966, Amer. Mus. Novitates 2278:3(part); Williams, 1970, Pan-Pac. Entomol., 46:1; Gertsch and Soleglad

1972, Bull. Amer. Mus. Nat. Hist. 148:593. ***Buthus***, Wood, 1863, J. Acad. Nat. Sci. Philadelphia 5:368-371; Wood, 1864, Proc. Acad. Nat. Sci. Philadelphia p. 109.

Characters–From a study of the syntypes of *Vejovis mexicanus* Koch, the type-species and closely related taxa, the following appear to be significant generic characteristics:

Carapace approximately as long as broad (male may be slightly longer than broad) with an anterior-posterior taper of 0.48-0.53 male and 0.38-0.47 female mm/mm length. Three pair lateral eyes; the first two well developed but the third may be small or

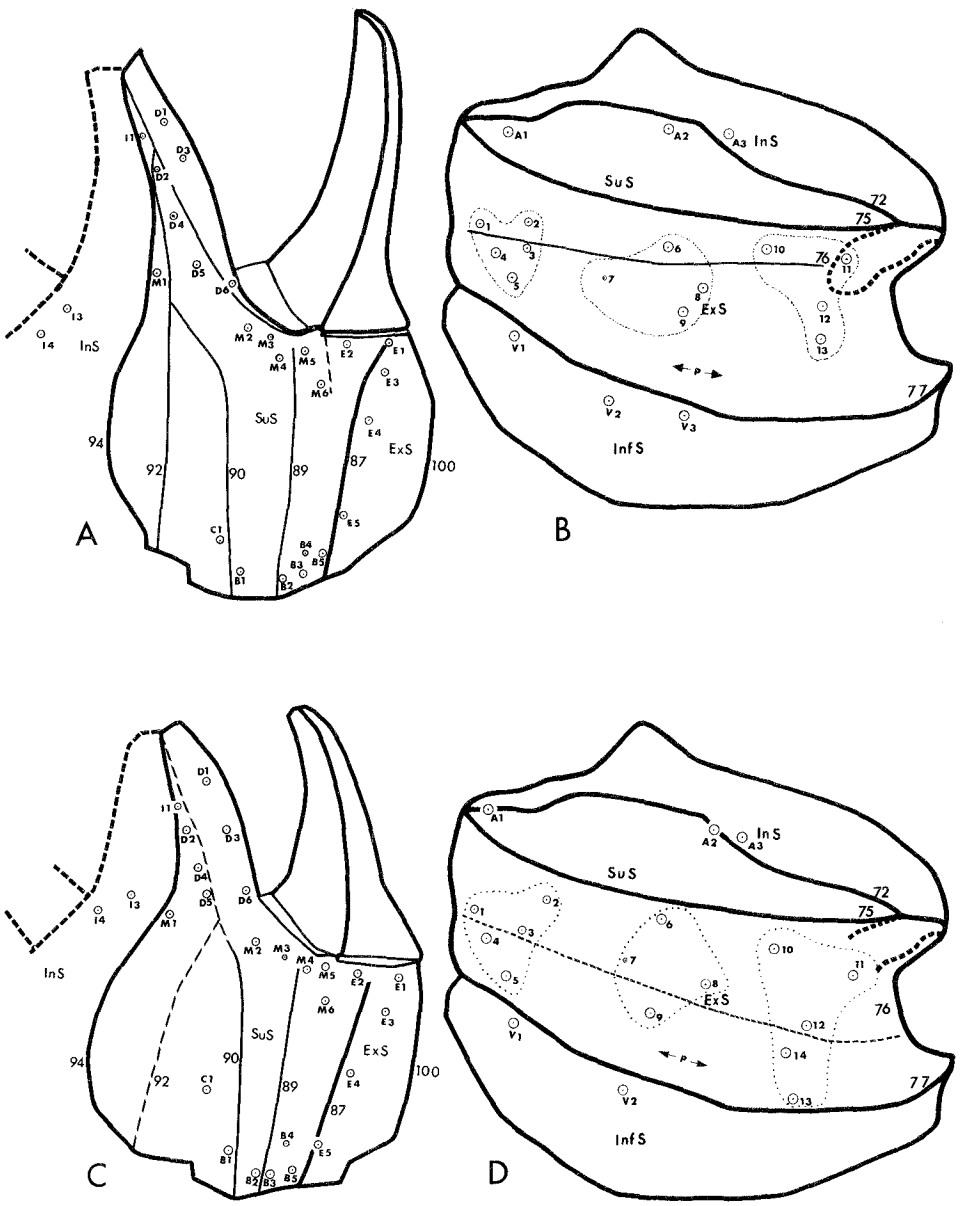

Fig. 8.–Trichobothrial systems: A-B, *Uroctonus* chela and patella; C-D, *Vejovis montereus* chela and patella.

obsolete. Median eyes weakly to moderately developed and located about 0.30-0.35 of carapace length from anterior margin which may be straight to moderately notched. The sternum is about as broad as long or broader than long with a deep median groove.

Inferior surfaces of cheliceral fingers without denticles or tubercles; the inner inferior edge of movable finger may be repand. Pedipalp tarsus inner edge bears a straight row of small granules divided into a series of six smaller rows, including a short distal row, by five large denticles, or possibly seven rows due to a large granule sometimes present midway in the basal granular row. Seven interior lateral denticles are present. Exterior lateral denticles and supernumerary granules are lacking. For trichobothrial patterns see Fig. 9 C,D, and Table 1.

Tarsomere II with a median row of short bristles or spinlets on soles. Legs without macrochaete combs.

Dorsal and superior lateral keels of cauda with distal granule more denticulate (or spinous) and larger than preceding ones; the distal terminus of superior lateral keels of segment IV flat, subtriangular and projecting somewhat laterad (Fig. 7 D,F). Ratio of caudal segment V length to width generally under 2.30.

Genital operculum of male divided entire length, female undivided or divided approximately two-thirds the length. Pectines with fewer than 16 middle lamellae organized in a single row. Stigmata elongate elliptical to slit-like.

The genus *Vejovis* differs from *Uroctonus* as shown in Table 3.

Type-species–*V. mexicanus* Koch, 1836.

Table 3. Inter-generic differences between *Vejovis* and *Uroctonus*.

	V. mexicanus	*U. mordax*
1. Ratio metasoma L : manus L	♀ 9.00 ♂ 8.68	♀ 5.35 ♂ 6.14
2. R. carapace anterior L : notch depth	11:00 to infin.	5.00 to 6.00
3. Ratio of carapace L:W	♀ 1.00 ♂ 1.13	♀ 0.93 ♂ 0.97
4. R. caudal segment V L:W	♀ 2.00 ♂ 2.06	♀ 2.52-3.22 ♂ 2.42-3.18
5. Ratio of carapace med. W.: med. ocular W	♀ 5.00 ♂ 4.88	♀ 5.90 ♂ 5.68
6. Trichobothria V	2	3
7. Denticles on inferior surface chel. M.F.	0	3 to 6

Table 4. Correlations showing inter-generic relationships between *Vejovis* and *Uroctonus*.

	V. mexicanus		*U. mordax*	
	male	female	male	female
P. gracilior	0.35	0.40	0.33	0.53
P. vachoni	0.55	0.58	0.29	0.26
P. boreus	0.50	0.63	0.35	0.57
U. mordax	0.51	0.61	–	–

Other species–*V. carolinianus* Beauvois, 1905 (=*V. carolinus* Koch, 1843); *V. nitidulus* Koch, 1843; *V. punctipalpi* (Wood), 1863; *V. eusthenura* (Wood), 1863; *V. spinigerus* (Wood), 1863; *V. punctatus* Karsch, 1879; *V. crassimanus* Pocock, 1898; *V. pusillus* Pocock, 1898; *V. granulatus* Pocock, 1898; *V. bilineatus* Pocock, 1898; *V. flavus* Banks, 1900; *V. minimus* Kraepelin, 1911; *V. hirsuticauda* Banks, 1928; *V. confusus* Stahnke, 1940; *V. jonesi* Stahnke, 1940; *V. lapidicola* Stahnke, 1940; *V. vorhiesi* Stahnke, 1940; *V. coahuilae* Williams, 1966; *V. gilvus* Williams, 1968; *V. diazi* Williams, 1970; *V. hoffmanni* Williams, 1970; *V. gravicaudus* Williams, 1970; *V. waeringi* Williams, 1970; *V.*

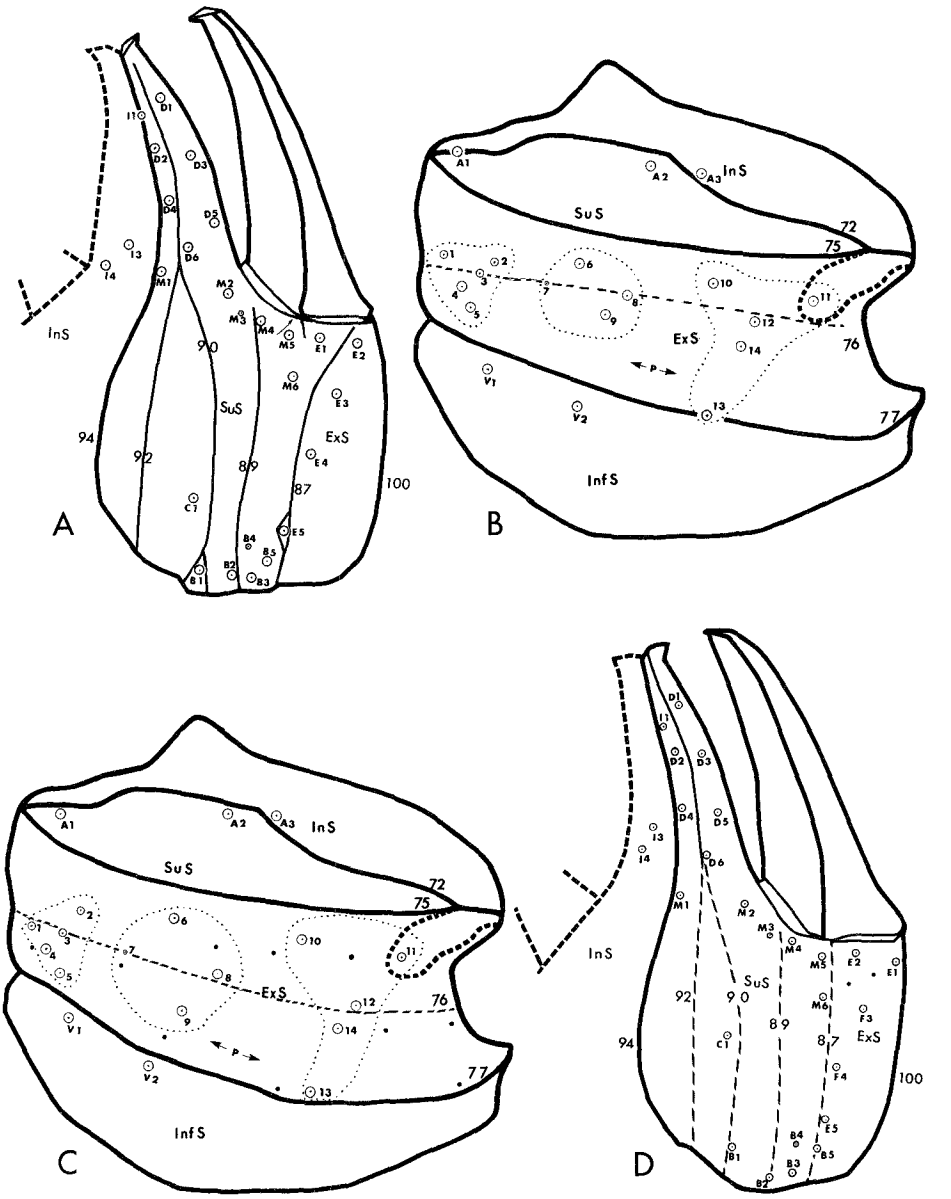

Fig. 9.–Trichobothrial systems: A-B, *Pseudouroctonus* chela and patella; C-D, *Vejovis*, patella and chela.

coloradensis Williams, 1970; *V. galbus* Williams, 1970; *V. ivei* Gertsch and Soledad, 1972; *V. vaquero* G & S, 1972; *V. waueri*G & S, 1972; *V. andreas*(G & S), 1972; *V. bogerti* (G & S), 1972; *V. montereus* (G & S), 1972; *V. sequoia* (G & S), 1972; *V. williamsi* (G & S), 1972; *V. angelenus* (G & S), 1972; *V. lindsayi* (G & S), 1972; *V. chicano* (G & S), 1972; *V. apacheanus* (G & S), 1972; *V. cazieri* (G & S), 1972; *V. glimmei* (Hjelle), 1972.

Species that appear to be of doubtful status have been omitted.

Distribution—*Vejovis* have been taken as far south as Veracruz, Mexico and as far north as northern California. Apparently only one species extends to our eastern seaboard. Westward the number of species begin to increase in eastern Texas with the greatest number of species known from Arizona, California; Baja California, Mexico, and mainland Mexico. The center of distribution seems to be in Mexico. Undoubtedly many more new species will be uncovered in this area. With the increased use of U.V. light detection many more species will not only be found in Mexico, but also in New Mexico, Colorado, and Texas.

15. Genus *Paruroctonus* Werner, 1934

Uroctonoides Hoffmann, 1931, Ann. Inst. Biol. México 2(4)405 (*nec.* Chamberlin, 1920, Mus. Sci. Bull. Brooklyn 3:35-44). *Paruroctonus* Werner, 1934, Bronns Klassen und Ordnungen des Tierreichs, Band 5, Abt. 4, Buch 8:283; Stahnke, 1957, Entomol. News 68:253-259; Williams, 1972, Occ. Papers California Acad. Sci. 94:1-16. *Hoffmanniellus* Mello-Leitão, 1934, An. Acad. Brasil Sci. 6(2)75-82. *Vejovis*, Gertsch and Allred, 1965, Brigham Young Univ. Sci. Bull., Biol. Ser., 6(4)3,4(part); Gertsch and Soleglad, 1966, Amer. Mus. Novitates 2278:3-52(part).

Characters—This rather distinctive taxon, first introduced into the literature by Hoffmann (1931) as *Uroctonoides* has given subsequent taxonomists difficulty, because they like Hoffmann have tried to characterize it with a few subjective characteristics. As his name for the taxon suggests, he considered it closely related to *Uroctonus*. According to his description this conclusion seems to be based primarily upon the presence of dentoid structures on the inferior inner margin of the cheliceral movable finger. *Uroctonus* has definite denticles, some of which are often distinctly serrate while those of *Paruroctonus gracilior* are at best angular scallops. Werner (1934) discovered that the name *Uroctonoides* was occupied (see synonymy) but in renaming it apparently made the same error when he introduced the name *Paruroctonus*. He then placed the genus in the Uroctoninae. However, in his key to the subfamilies the dichotomy leading to this taxon reads "pectines with indefinite, or not over 6 middle lamellae." In his description of *Paruroctonus* he states that it has 18 middle lamellae. Gertsch and Allred (1965) likewise emphasized the cheliceral structures. Since they considered the chelicera similar in structure in *Uroctonus*, *Vejovis*, and *Paruroctonus* they gave the latter only subgeneric status. Williams (1972) correctly tries to remove the focus from cheliceral denticles or dentoid structures but errs by his inadequate characterization of the genus. For example, his statement that the genital operculum of vejovid females is completely fused is incorrect. On *V. mexicanus* and other species the genital operculum is only partially fused along the median, longitudinal furrow. Also, distinct denticles, he states, are always present on the inferior border of the movable cheliceral fingers of *Paruroctonus*. Sometimes only a strongly repand condition prevails and never are distinct denticles found, as in *Uroctonus* and *Pseudouroctonus*, but at most only angular scallops. Furthermore, his statement that the pedipalp palms of *Paruroctonus* are "somewhat less swollen"

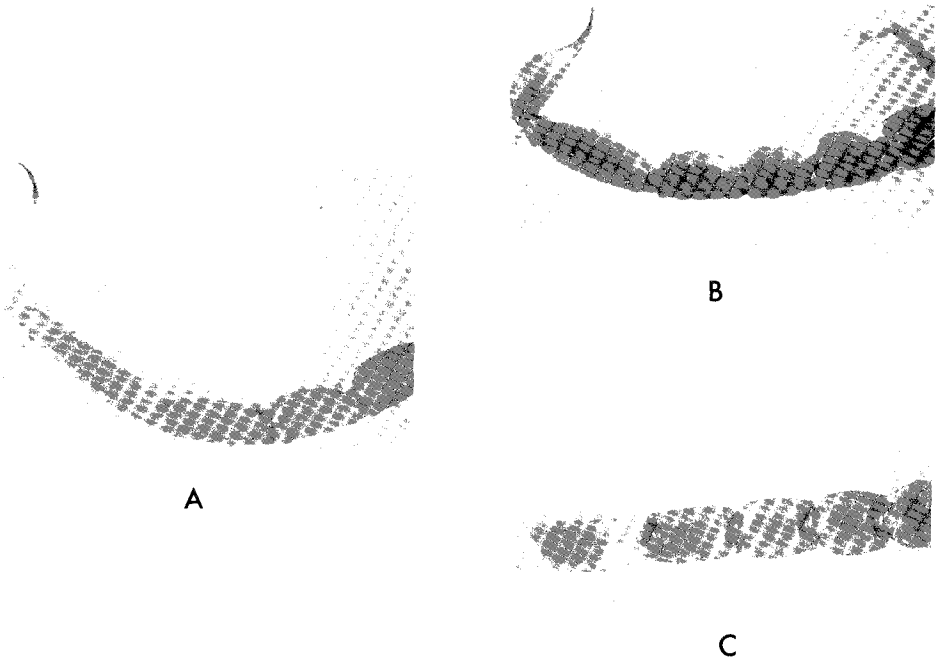

Fig. 10.–Cauda: A, *P. gracilior;* B-C, *P. boreus.*

than *Uroctonus* certainly does not clearly differentiate these taxa. This may be a visual impression but actually the opposite seems to be true. The ratio of manus length to width for the male *U. mordax* is about 1.45, that of *P. vachoni* 1.39, and of *P. gracilor* 1.35. Even the ratio of total tibial length to manus width shows *U. mordax* as 2.37 and *P. gracilior* 2.30. The ratio of manus length to thickness gives similar results, i.e. *Uroctonus* manus actually is not more swollen than that of *Paruroctonus.*

Paruroctonus boreus (Girard) appears more closely related to *Vejovis mexicanus* than the more typical *Paruroctonus*. In fact a more analytical study of the entire genus may indicate that "*boreus*" is representative of a subgenus or perhaps another genus.

Hoffmann's "*gracilior*" designation of the type-species seems more descriptive of the genus than his *Uroctonoides*. This over-all impression is primarily due to the long, slender cauda. The ratio of the length/width of segment V in the typical form ranges from 3.79 to 4.10 and the atypical forms, such as *P. boreus* and *P. aquilionalis* range from 2.45 to 3.04. In contrast, these ratios for *Vejovis*, except for a few unusual forms, do not go above 2.30 and very frequently below 2.00.

In *Paruroctonus* the dorsal and superior lateral keels do not have the distal granule noticeably larger or more denticulate, nor is the distal terminus of the dorsal keel on segment V flat and subtriangular (Fig. 10). The dorsal caudal furrow is also weakly developed. In this respect it resembles *Uroctonus* (Fig. 7A) but is in sharp contrast to *Vejovis* (Fig. 7 D,F).

Paruroctonus has three pair of well developed lateral eyes with the third pair of smaller diameter but always distinct. The median eyes are often relatively large on the typical forms and may be from 2.3 to 3.0 times the diameter of the first pair of lateral eyes; on *P. boreus* this may reduce to 1.65 in females and 2.00 in males. On *Uroctonus* this ratio lowers to 1.54 in females and in males and on *V. mexicanus* to 1.00 in females and 1.15

in males. In *Paruroctonus* the ratio of the carapace length to the diameter of the median eyes ranges from approximately 9.50 to 14.19; this ratio in *Uroctonus* ranges from 16.25 to 17.25 and in *V. mexicanus* from 17.10 to 18.79. The anterior margin of the carapace on *Paruroctonus* is either straight or projects slightly. The total anterior-posterior taper of *Paruroctonus* ranges from 0.31-0.38 mm/mm of length, whereas the *Uroctonus* taper is about 0.48 mm/mm of length. The anterior taper of the *Paruroctonus* ranges from 0.33-0.50 mm/mm of length but this ratio for both *Uroctonus* and *V. mexicanus* ranges from 0.67-0.79 mm/mm of length.

The cheliceral fixed finger of *Paruroctonus* has the usual vejovid denticulate structure. On the movable finger the superior tine is distinctly shorter than the inferior one and may be subparallel, or almost at right angles, to the inferior tine. Of the four denticles on the superior margin of the movable finger one, three, and four are subequal but two is about twice the size of either of the other three. The inferior edge of the movable finger is not smooth but may be deeply repand or bear angular scallops. The inferior surface of the fixed finger may bear one to three tubercles or tubercular denticles.

A general concept of the inter-generic relationships may be obtained from Table 4 which shows correlations derived from forty-one variables.

The typical trichobothrial systems for the genus are shown in Fig. 11 A,D and in Table 1.

Type-species–*P. gracilior* (Hoffmann), 1931.

Other species–*P. boreus* (Girard), 1853; *P. aquilionalis* (Stahnke), 1940; *P. mesaensis* Stahnke, 1957; *P. vachoni* Stahnke, 1961; *P. bantai* (Gertsch and Soleglad), 1966; *P. stahnkei* (G & S), 1966; *P. xanthus* (G & S), 1966; *P. luteolus* (G & S), 1966; *P. auratus* (G & S), 1966; *P. becki* (Gertsch and Allred), 1965; *P. utahensis* (Williams), 1968; *P. pallidus* (Williams), 1968; *P. shulovi* (Williams), 1970; *P. minckleyi* (Williams), 1968; *P. grandis* (Williams), 1970; *P. pumilis* (Williams), 1970; *P. pseudopumilus* (Williams), 1970; *P. viscainensis* (Williams), 1970.

Species that seem to be of doubtful status have been omitted.

Distribution–In our collection we have specimens from Osoyoso, B.C., Canada; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, Texas, Utah, Washington, Wyoming; throughout the Baja peninsula and the states of Sonora, Chihuahua, and Coahuila.

Ewing (1928) reports species of this genus from South Dakota and Nebraska. Hoffmann (1931) gives the type locality of *P. gracilior* as Aguascalientes, Mexico.

Its center of distribution appears to be Arizona, California, Nevada and into northern Mexico and the Baja peninsula.

DISCUSSION

The trichobothria appear to be excellent indicators of systematic affinity. Table 1 shows that C1 is not found on *Diplocentrus* but is present on all Vejovidae except *Iurus*. The five trichobothria of the **E** cluster are present in all taxa except the Hadrurinae; this subfamily is sharply different from all the others. However, on the chela are found the characteristic family patterns in the **D**, **M**, and **B** clusters.

From the consistency displayed in other subfamilies it seems obvious that the Scorpiopsinae should be divided into more genera. Such a decision should be supported, however, by quantitative data taken from an ample sampling.

The Vejovinae show a fairly consistent pattern so that generic status is determined

mainly from other characteristics and quantitative comparisons. However, the migration of trichobothria within the clusters seem to be significant. In *Uroctonus* V3 is present but in *Pseudouroctonus*, with only V1 and V2 present, P13 has migrated onto the inferior-exterior keel in such a manner as to suggest that V3 is a migrant P13. The significance of migration at the species level will have to be determined through careful quantitative studies. For example, in the **D** and **P** clusters, are such differences as the formation by certain trichobothria of isoceles, scalene, equilateral, etc. triangles of systematic significance? If so very excellent key characteristics will be available regardless of the scorpion's age. Even now the recognition of the vast differences in the number and

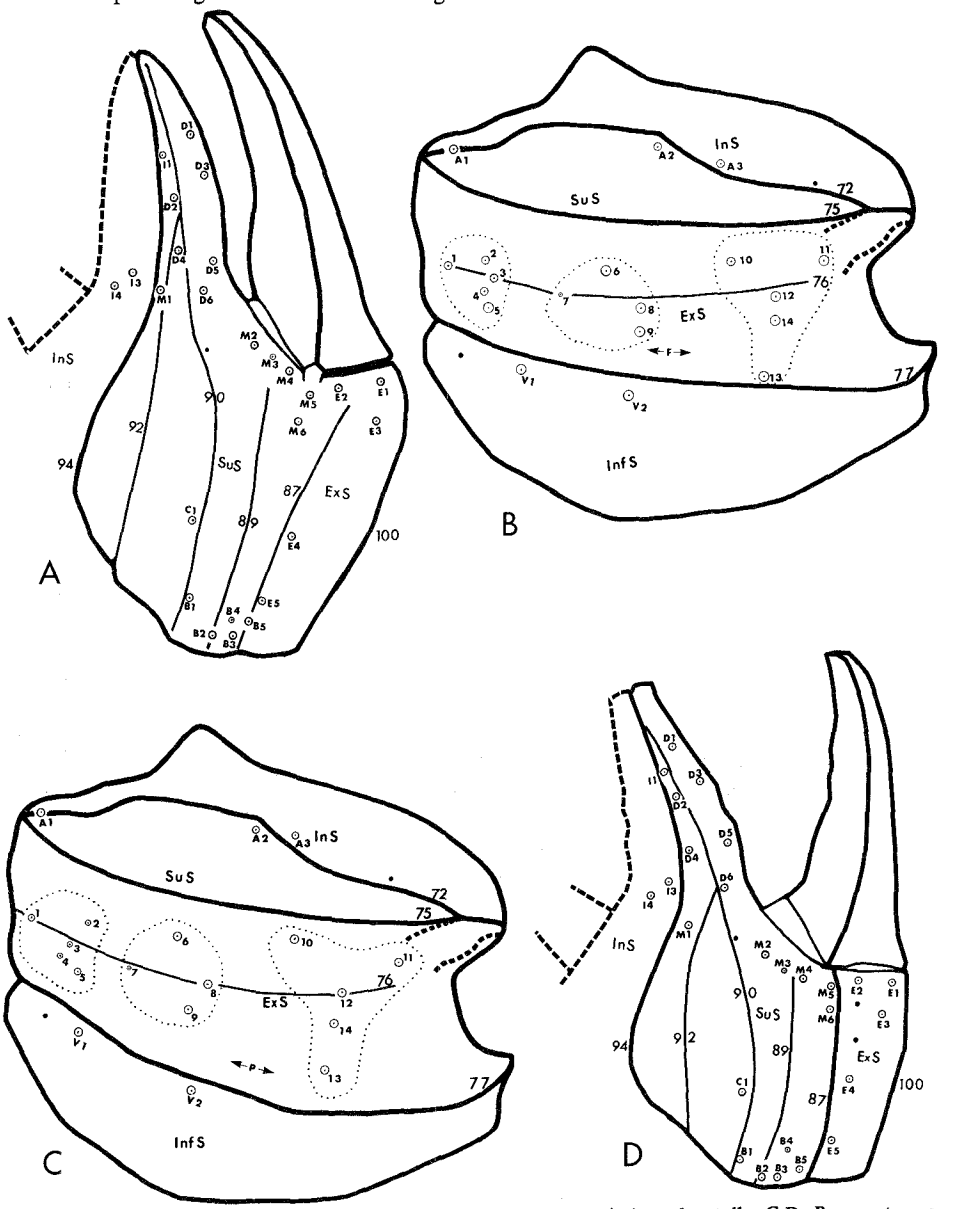

Fig. 11.–Trichobothrial systems: A-B, *Paruroctonus gracilior*, chela and patella; C-D, *Paruroctonus boreus*, patella and chela.

arrangement of these setae on the Hadrurinae make for quick and positive identification of taxon status of juveniles of these taxa.

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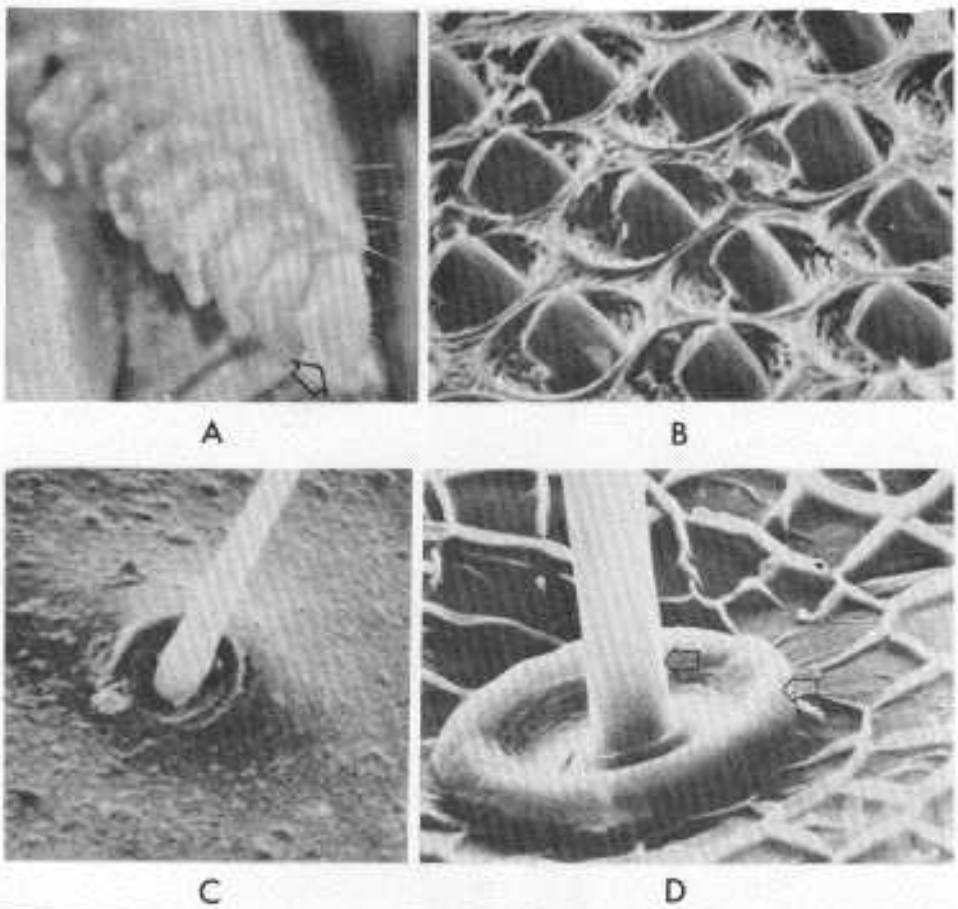
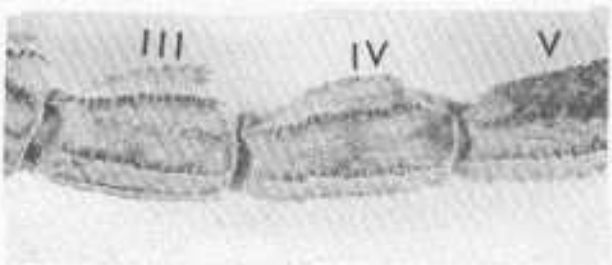


Fig. 1.–A, Pectinal teeth showing areas of sensilla; B, Micrograph of sensilla; C, Micrograph of basal portion of macrochaeta ("pseudotrichobothrium"); D, Micrograph of basal portion of trichobothrium showing (1) uniform shaft of setae and (2) raised lip of alveolus; (Micrographs from the unpublished work of J. Swafford, Electronmicroscope Laboratory, Department of Botany and Microbiology, Arizona State University).

ABBREVIATIONS USED IN FIGURES

ExS, Exterior Surface; InS, Interior Surface; InfS, Inferior Surface; SuS, Superior Surface; 72, Superior-interior keel; 75, Superior-exterior keel; 76, Exterior median keel; 77, Inferior-exterior keel; 87, Exterior marginal keel; 88, Secondary accessory keel; 89, Exterior secondary keel; 90, Digital keel; 91, Subdigital keel; 92, Inner secondary keel; 93, Subinner keel; 94, Interior marginal keel; Broken line, Vestigial keels; •, Macrochaetes; ○ Trichobothria (variance in diameter indicates relative variance in size of cup).



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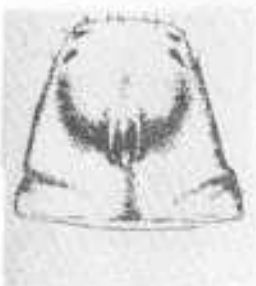

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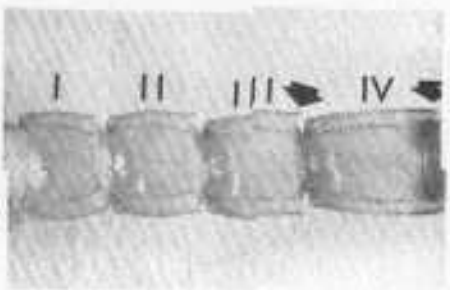

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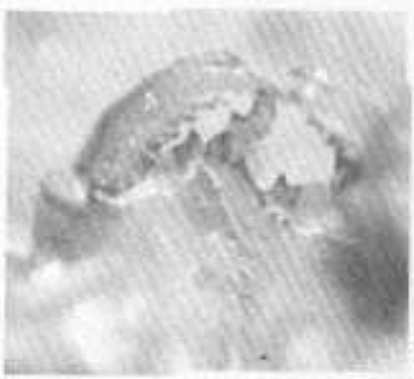

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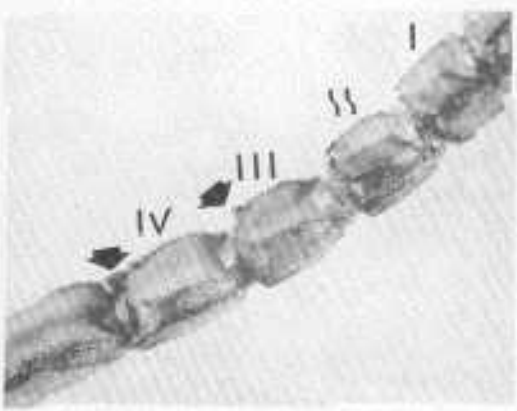

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Fig. 7.–A, *Uroctonus* caudal segments (B-C from Hoffmann, 1931); B, *H. hirsutus* carapace; C, *H. aztecus*; D, *Vejovis spinigerus*, caudal segments; E, inferior cheliceral denticles of *Pseudouroctonus*; F, *Vejovis mexicanus*, caudal segments.

A

B

C

Fig. 10.–Cauda: A, *P. gracilior*; B-C, *P. horeus*.

ERRATA

Stahnke, H. L. 1974. Revision and Keys to the higher catagories of Vejovidae (Scorpionida). J. Arachnol. 1:107-141.

Page 112, line 12, word 8: Change "fornication" to "formication."

Page 114, line 10, word 6: Change "six" to "five."

Page 116, line 24: Change "(Fig. C,D)" to "(Fig. 5C,D)."

Page 128, line 14: Change "98" to "89."

Page 129, line 7: Change "*Physoconus*" to "*Physoctonus*."

Page 131, line 5: Change "27" to 26." Line 6: Change "49 to "48." Delete line 7.