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Phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905, based on morphology, mitochondrial and nuclear DNA

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Abstract

The first rigorous analysis of the phylogeny of the North American vaejovid scorpion subfamily Syntropinae is presented. The analysis is based on 250 morphological characters and 4221 aligned DNA nucleotides from three mitochondrial and two nuclear gene markers, for 145 terminal taxa, representing 47 species in 11 ingroup genera, and 15 species in eight outgroup genera. The monophyly and composition of Syntropinae and its component genera, as proposed by Soleglad and Fet, are tested. The following taxa are demonstrated to be para- or polyphyletic: Smeringurinae; Syntropinae; Vaejovinae; Stahnkeini; Syntropini; Syntropina; Thorelliina; *Hoffmannius*; *Kochius*; and *Thorellius*. The spinose (hooked or toothed) margin of the distal barb of the sclerotized hemi-mating plug is demonstrated to be a unique, unambiguous synapomorphy for Syntropinae, uniting taxa previously assigned to different subfamilies. Results of the analysis demonstrate a novel phylogenetic relationship for the subfamily, comprising six major clades and 11 genera, justify the establishment of six new genera, and they offer new insights about the systematics and historical biogeography of the subfamily, and the information content of morphological character systems.

Introduction

The Nearctic vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 is a morphologically and ecologically diverse group of scorpions that includes some of the largest and most robust vaejovids, reaching adult lengths of 94 mm, and some of the smallest, at 14 mm (González-Santillán and Prendini, 2013). Syntropinae are endemic to North America, extending from Oregon and Utah to Texas, USA, and throughout Mexico to the Isthmus of Tehuantepec in Chiapas and Oaxaca, and occur in a variety of habitats, including sand dunes and rocky desert, subtropical deciduous forest and pine-oak forest, from sea level to more than 3500 m. Like other vaejovids, many Syntropinae are substratum specialists (Prendini, 2001a), inhabiting substrata within a limited range of hardness and composition for which they display ecomorphological adaptations (Williams, 1987; Polis, 1990). Lithophilous, lapidicolous and psammophilous ecomorphotypes are all represented in the subfamily. Consequently, many Syntropinae are endemic to particular geological formations (e.g. isolated mountain ranges and sand dune systems), and occupy restricted distributional ranges (Williams, 1980).

The taxonomic history of the subfamily, discussed further below, is inextricably linked to that of the fam-

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ily Vaejovidae Thorell, 1876, the generic composition of which has undergone considerable modification since first proposed (Thorell, 1876; Pocock, 1893; Laurie, 1896a,b; Kraepelin, 1905; Stahnke, 1974; Francke and Soleglad, 1981; Sissom, 1990, 2000; Stockwell, 1992; Soleglad and Fet, 2003, 2005, 2006, 2008; Graham and Soleglad, 2007; Francke and Ponce-Saavedra, 2010). Vaejovidae are currently restricted to North American taxa, but the monophyly and composition of the family, like that of its component genera and suprageneric taxa, have not been satisfactorily tested. The two cladistic analyses previously conducted (Stockwell, 1989; Soleglad and Fet, 2003), the first of which was never published and the second severely criticized (Prendini and Wheeler, 2005), suffer from the same flaws. Both were based on supraspecific terminals, the monophyly of which was assumed rather than tested (Prendini, 2000, 2001b), and applied a peculiar method of character coding, which forced character transformations based on preconceived notions of phylogenetic relationship and/or character evolution (Prendini and Wheeler, 2005). Recent revisions to the suprageneric classification of Vaejovidae, published by Soleglad and Fet (2005, 2006, 2008) in their self-edited, online journal, are not based on quantitative cladistic analysis.

The first rigorous analysis of the phylogeny of Vaejovidae, focusing on subfamily Syntropinae, is presented here. This analysis addresses the limitations of previous analyses based on morphology alone (Stockwell, 1989; Soleglad and Fet, 2003) by comprehensive taxon sampling, with species as terminals and a dataset comprising 250 morphological characters and 4221 aligned DNA nucleotides from three mitochondrial and two nuclear gene markers. The monophyly and composition of Syntropinae and its component genera, as proposed by Soleglad and Fet (2005, 2006, 2008), are tested, offering new insights about the systematics and historical biogeography of the subfamily.

Taxonomic history of Syntropinae

Syntropinae was among the five subfamilies Kraepelin (1905) originally recognized in Vaejovidae. The subfamily was created to accommodate the monotypic genus, *Syntropis* Kraepelin, 1900, endemic to the Baja California Peninsula of Mexico, and defined on the presence of a single ventral median carina on metasomal segments I–IV. It remained monotypic for more than 70 years. Attempts to organize the diversity of taxa presently accommodated within it are recounted below.

In Hoffmann's (1931) monograph on Mexican scorpions, *Vaejovis* C.L. Koch, 1836 was grouped into three "sections", two of which were precursors of the *eusthenura* and *intrepidus* groups (Williams, 1970a; Sissom, 1989b) that would later become genera presently included within Syntropinae. Hoffmann (1931) distinguished these sections on the basis of body size and carination of the metasoma and pedipalp chela. Hoffmann (1931) studied many specimens from mainland Mexico, but examined little material from northern Mexico and Baja California. Williams (1968, 1969, 1970a,b,c, 1971a,b, 1974, 1980) conducted extensive fieldwork in these areas, resulting in descriptions of several new genera and species. Williams (1969) collected new material of *Syntropis* for the first time since its description and described a second species of the genus. Stahnke (1974) created a new genus, *Vejovoidus* Stahnke, 1974, for Williams' (1969) second species, and included the two monotypic genera in Syntropinae based on the shared presence of a single ventral median carina on metasomal segments I–IV. Subsequent authors expressed doubts about the validity of the subfamily as defined by Stahnke (1974), arguing that the single ventral median carina probably evolved independently in *Syntropis* and *Vejovoidus* (Soleglad, 1976; Francke, 1982; Sissom, 1990), but the subfamily was not dissolved until later (Stockwell, 1992).

Williams (1970a,b, 1971b) was the first to propose species groups within *Vaejovis*, including two of the most diverse clades to be later incorporated within Syntropinae, the *eusthenura* group, based in part on Hoffmann's (1931) "first section" of *Vaejovis*, and the *punctipalpi* group (Tables 1 and 2). The *eusthenura* group was characterized by acarinate pedipalps and ventral surfaces of the metasomal segments, whereas the *punctipalpi* group was characterized by the presence of granular carinae on these segments. Williams (1980) also described *Paravaejovis* Williams, 1980; another monotypic vaejovid genus from Baja California, characterized primarily by a neobothriotaxic pedipalp chela, to accommodate a species previously placed in the *pumilis* group of *Vaejovis* (Williams, 1970b,c). Haradon (1983, 1984a,b, 1985) suggested that *Paravaejovis* was more closely related to another vaejovid genus, *Paruroctonus* Werner, 1934, and to the *borregoensis* microgroup of that genus in particular, with which Haradon (1984b) suggested it might be subordinate, based on a suite of characters mostly associated with psammophily. Most subsequent authors accepted the hypothesis that *Paravaejovis* is related to *Paruroctonus* (Sissom, 1990, 2000; Stockwell, 1992; Soleglad and Fet, 2003, 2008) rather than an alternative hypothesis, discussed by Stockwell (1989, 1992) and Soleglad and Fet (2008), that it could be related to *Syntropis* and the *eusthenura*, *intrepidus* and *punctipalpi* groups of *Vaejovis*, with which it shares a unique character of the hemispermatophore.

By the 1990s, Stockwell (1989, 1992) and Sissom (1990) identified problems with the genera and species groups of Vaejovidae proposed earlier (Hoffmann, 1931; Williams, 1970a, 1971a; Soleglad, 1973; Sissom

Table 1
Generic and suprageneric classification of the North American scorpion family Vaejovidae Thorell, 1876 proposed by Stockwell (1989) in an unpublished PhD dissertation

- Syntropinae Kraepelin, 1905[†]
  - “Paruroctonini”*
    - *Paravaejovis* Williams, 1980
    - *Paruroctonus* Werner, 1934
    - *Smeringurus* Haradon, 1983[†]
    - *Vejovoidus* Stahnke, 1974
  - “Sissomiini”
    - *Sissomius* Ponce-Saavedra and Beutelspacher, 2001, *nomen nudum*[‡] [= *Vaejovis nitidulus* group]
  - Syntropini Kraepelin, 1905*
    - “*Franckeus*”[§] [= *Vaejovis punctipalpi* group]*
    - *Lissovaejovis* Ponce-Saavedra and Beutelspacher, 2001, *nomen nudum*[‡] [= *Vaejovis eusthenura* group]*
    - *Serradigitus* Stahnke, 1974
    - *Syntropis* Kraepelin, 1900
  - “Uroctonini”
    - *Pseudouroctonus* Stahnke, 1974 [= *Vaejovis minimus* group, in part][†]
    - *Uroctonites* Williams and Savary, 1991
    - *Uroctonus* Thorell, 1876
- Vaejovinae Thorell, 1876*
  - *Vaejovis* C.L. Koch, 1836*

[*] Groups not recovered as monophyletic in the analyses presented here.

[†] Stockwell (1992) synonymized Syntropinae Kraepelin, 1905 with Vaejovidae, elevated *Smeringurus* Haradon, 1983 to the rank of genus from its former rank as a subgenus of *Paruroctonus* Werner, 1934, and revised the diagnosis of *Pseudouroctonus* Stahnke, 1974 to include the former *minimus* group of *Vaejovis*.

[‡] Ponce-Saavedra and Beutelspacher (2001) published two of Stockwell’s (1989) names, “*Lissovaejovis*” and “*Sissomius*”, without designating type species for either.

[§] Stockwell (1989) applied the name “*Franckeus*” to the former *punctipalpi* group of *Vaejovis* C.L. Koch, 1836.

Table 2
Generic and suprageneric classification of the North American scorpion family Vaejovidae Thorell, 1876 proposed by Soleglad and Fet (2008) in an online publication, *Euscorpius*

- Smeringurinae Soleglad and Fet, 2008*
  - Paravaejovini Soleglad and Fet, 2008
    - *Paravaejovis* Williams, 1980
  - Smeringurini Soleglad and Fet, 2008
    - *Paruroctonus* Werner, 1934
    - *Smeringurus* Haradon, 1983
    - *Vejovoidus* Stahnke, 1974
- Syntropinae Kraepelin, 1905*
  - Stahnkeini Soleglad and Fet, 2006*
    - *Gertschius* Graham and Soleglad, 2007
    - *Serradigitus* Stahnke, 1974
    - *Stahnkeus* Soleglad and Fet, 2006
    - *Wernerius* Soleglad and Fet, 2008
  - Syntropini Kraepelin, 1905*
    - Syntropina Kraepelin, 1905*
      - *Hoffmannius* Soleglad and Fet, 2008 [= *Vaejovis eusthenura* group]*
      - *Syntropis* Kraepelin, 1900
  - Thorelliina Soleglad and Fet, 2008*
    - *Kochius* Soleglad and Fet, 2008 [= *Vaejovis punctipalpi* group]*
    - *Thorellius* Soleglad and Fet, 2008 [= *Vaejovis intrepidus* group]*
- Vaejovinae Thorell, 1876*
  - *Franckeus* Soleglad and Fet, 2005[†] [= *Vaejovis nitidulus* group, in part]
  - *Pseudouroctonus* Stahnke, 1974
  - *Uroctonites* Williams and Savary, 1991
  - *Vaejovis* C.L. Koch, 1836*

[*] Groups not recovered as monophyletic in the analyses presented here.

[†] Soleglad and Fet (2008) published the name “*Franckeus*” but applied it to a subsection of the former *nitidulus* group of *Vaejovis* instead (see “*Franckeus*” in Table 1).

and Francke, 1985; Sissom, 1989b). Stockwell (1989) presented the first cladistic analysis of the family (Fig. 1), based on morphological characters scored for supraspecific terminal taxa representing the vaejovid genera and four of the species groups of *Vaejovis* recognized at the time. Stockwell (1989) also proposed a revised suprageneric classification of Vaejovidae (Table 1) that included three new genera, formal names for the well-established *eusthenura*, *nitidulus* and *punctipalpi* groups of *Vaejovis* (Williams, 1970a, 1971a; Sissom and Francke, 1985). Two of these genera were later published by Ponce-Saavedra and Beutelspacher (2001), but without designating type species.

Stockwell (1992) later published some of his proposed revisions to the classification of Vaejovidae, including the transferal of *Nullibrotheas* Williams, 1974 to Chactidae Pocock, 1893 and the elevation of Scorpiopidae Kraepelin, 1905 (as “Scorpiopsidae”) to the rank of family, but not the new genera or revised suprageneric taxa. Stockwell (1992, p. 409) synonymized Syntropinae with Vaejovidae, contradicting his earlier decision, and leaving the family without suprageneric taxa, while suggesting that “distinct groupings within this family are clear enough to recognize subfamilies, but I will defer on this subject until a later time”. Additionally, Stockwell (1992, pp. 408, 409) noted:

> Among the Vaejovinae, *Syntropis* appears to share at least one potential synapomorphy with the *punctipalpi*, *eusthenura*, and *intrepidus* groups of *Vaejovis* Koch, 1836 (i.e., the presence of numerous spines on the margin of the distal barb of the mating plug, a feature not present in other vaejovids) … the presence of a spiny distal barb margin on the spermatophore mating plug is a potential synapomorphy uniting the *eusthenura*, *punctipalpi*, and *intrepidus* groups, *Syntropis*, and *Paravaejovis*.

Stockwell’s (1992) observation was prescient, for the group of genera and species mentioned above, and the synapomorphy uniting them, corresponds to the monophyletic group of taxa recovered in the analyses presented here, and redefined as subfamily Syntropinae by González-Santillán and Prendini (2013). In spite of observing that the distal barb margin is “armed with a row of teeth … in the *V. punctipalpi* and *V. eusthenura* groups, *Syntropis*, and *Paravaejovis*”, Stockwell (1989,

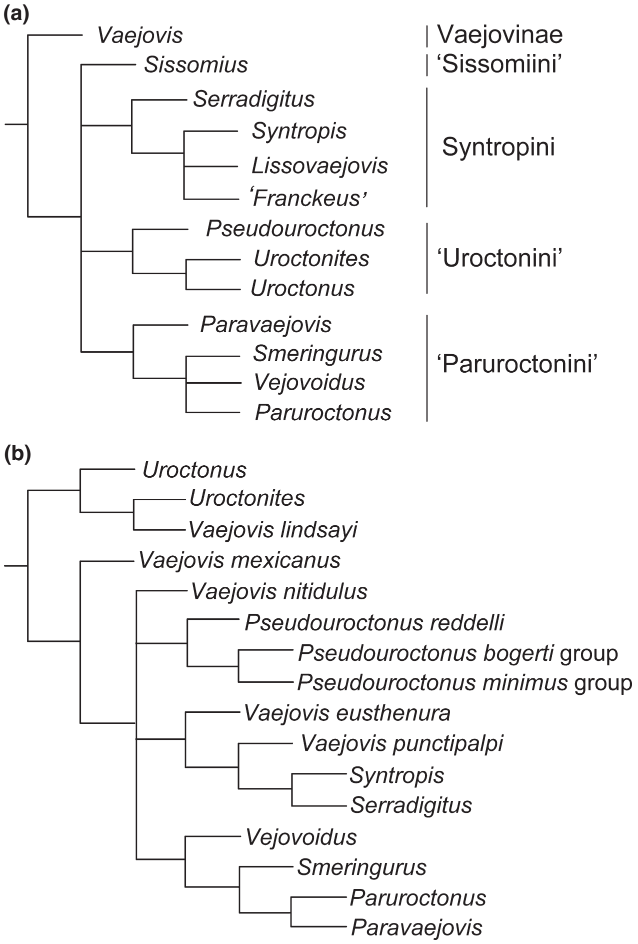

Fig. 1. Stockwell's (1989, 1996) unpublished hypotheses of phylogenetic relationship within the North American scorpion family Vaejovidae Thorell, 1876. (a) Stockwell's (1989, p. 405, fig. 257) cladogram and suprageneric classification, based on morphological characters scored for supraspecific terminal taxa representing the genera recognized at the time, and the species groups of the genus *Vaejovis* C.L. Koch, 1836 recognized by Williams (1970a, 1971a) and Sissom and Francke (1985). (b) Stockwell's (1996) "phylogram", a tree diagram not based on empirical data, posted on the Tree of Life website (http://tolweb.org/Vaejovidae/6224).

pp. 131, 132) followed Haradon's (1984b) opinion that *Paravaejovis* shares "many derived character states with *Paruroctonus*, *Smeringurus* Haradon, 1983 and *Vejovoidus*", and grouped it with these genera in his unpublished tribe "Paruroctonini" (Table 1).

Sissom (2000, p. 503) summarized the taxonomic history, generic and species composition of Vaejovidae, listed ten genera and five species groups (the *eusthenura*, *intrepidus*, *mexicanus*, *nitidulus* and *punctipalpi* groups) of the paraphyletic genus *Vaejovis*, and noted that "the phylogenetic relationships of the genera are still obscure, and it is not possible at this time to recognize subfamilies or tribes … [but] it is likely that such a classification will be a reality before long".

Soleglad and Fet (2005, 2006, 2008) coopted Stockwell's (1989) unpublished revisions to the generic and suprageneric classification of the Vaejovidae with some, mostly nomenclatural, variations (Table 2). Syntropinae was restricted to Stockwell's (1989) former tribe "Syntropini". *Serradigitus* Stahnke, 1974 and three new genera were separated into tribe Stahnkeini Soleglad and Fet, 2006, from *Syntropis* and another three new genera, *Hoffmannius* Soleglad and Fet, 2008, *Thorellius* Soleglad and Fet, 2008 and *Kochius* Soleglad and Fet, 2008, respectively created to accommodate the former *eusthenura*, *intrepidus* and *punctipalpi* groups of *Vaejovis*, and placed in two subtribes of Syntropini Kraepelin, 1905. Stockwell's (1989) tribe "Paruroctonini" was removed from Syntropinae and renamed subfamily Smeringurinae Soleglad and Fet, 2008, with the monotypic tribe Paravaejovini Soleglad and Fet, 2008 erected for *Paravaejovis*. No quantitative cladistic analysis justifying these changes (Fig. 2), many taken directly from Stockwell's (1989) unpublished dissertation (*vide* Soleglad and Fet, 2008, pp. 1, 2), was presented. Most of the "new" genera are names for species groups proposed by others (Hoffmann, 1931; Williams, 1970a, 1971a; Sissom and Francke, 1985; Sissom, 1989b), the monophyly of which has never been tested, and the diagnoses of which rely heavily on morphometrics lacking a theoretical basis (e.g. "maximized ratios"; Fet and Soleglad, 2002, p. 5).

Kuarapu Francke and Ponce-Saavedra, 2010, another new genus, possibly related to Syntropinae based on the spinose margin of the distal barb of the hemi-mating plug, was recently described. Francke and Ponce-Saavedra (2010) discussed its placement in the context of Soleglad and Fet's (2008) classification of Vaejovidae, noting that the classification was not rigorously evaluated and when it is, the monophyly of several components may be falsified. Francke and Ponce-Saavedra's (2010) prediction was confirmed in the analyses presented here. González-Santillán and Prendini (2013) provided a revised classification of Syntropinae.

Materials and methods

Material examined

Scorpion specimens were collected across the geographical distribution of the subfamily, mostly by ultraviolet (UV) light detection at night (Stahnke, 1972) using portable UV lamps, comprising mercury vapour tubes attached to a chromium reflector, and powered by a 12 V, 7 amp/h battery, or Maglite flashlights modified with UV light-emitting diode (LED) attachments. Some specimens were collected during the day, by turning over rocks and other objects on

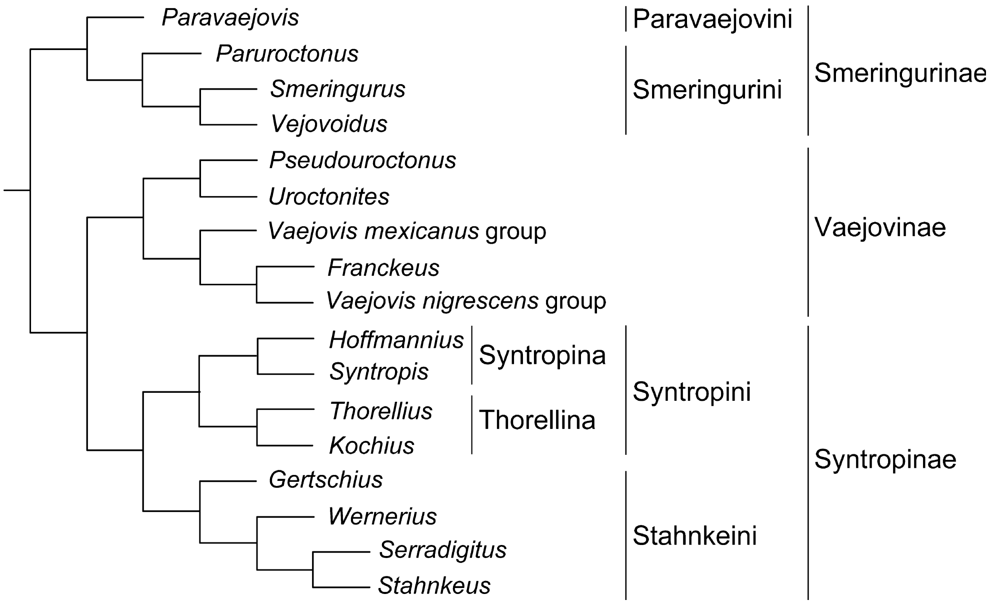

Fig. 2. Soleglad and Fet's (2008, p. 76, fig. 196) "phylogram", a hypothesis of phylogenetic relationship within the North American scorpion family Vaejovidae Thorell, 1876 not based on empirical data, and revised classification of the family.

the ground. Most specimens were preserved in 80% ethanol for morphological study. One or two juvenile specimens and, when available, an adult conspecific from the same collection event, were preserved in 95% ethanol for DNA isolation, following standard procedures (Prendini et al., 2002, 2003). Voucher specimens for DNA isolation were databased and assigned unique identifiers (Appendix 1). Additional material was borrowed from museum collections (Appendix 2).

Taxon sampling

The classification of Syntropinae employed here follows González-Santillán and Prendini (2013). The ingroup comprised all genera assigned to Syntropini by Soleglad and Fet (2008), and all except four of the 54 described species and subspecies in these genera, including the type species of each (Appendices 1 and 2). Only *Konetontli kuarapu* (Francke and Ponce-Saavedra, 2005), *Paravaejovis flavus* (Banks, 1900) (a nomen dubium), *Paravaejovis galbus* (Williams, 1970) and *Syntropis aalbui* Lowe et al., 2007 were omitted because fresh material could not be obtained for DNA isolation.

The following additional taxa were included to test their membership of the ingroup. *Kuarapu purhepecha* Francke and Ponce-Saavedra, 2010 and *Paravaejovis pumilis* (Williams, 1970), two species with a spinose margin on the distal barb of the hemi-mating plug, were included to test previous hypotheses of relationship to the other taxa with the spinose distal barb margin (Stockwell, 1989, 1992; Francke and Ponce-Saavedra, 2010). *Konetontli acapulco* (Armas and Martín-Frías, 2001), *Konetontli chamelaensis* (Williams, 1986), *Konetontli nayarit* (Armas and Martín-Frías, 2001) and *Konetontli pattersoni* (Williams and Haradon, 1980), four Mexican species with a subaculear tubercle, assigned to Vaejovinae Thorell, 1876 by Soleglad and Fet (2008), were included to test their relationship with *Wernerius* Soleglad and Fet, 2008, another vaejovid taxon with a subaculear tubercle, and to test whether the structure was independently derived in these taxa.

Sixteen exemplar species, representing 15 species and eight genera assigned to Smeringurinae and Vaejovinae by Soleglad and Fet (2008), comprised the outgroup. Analyses were rooted on *Smeringurus grandis* (Williams, 1970), based on unpublished evidence that Smeringurinae is the basal clade of Vaejovidae. Rooting on *S. grandis* permitted the position of *P. pumilis*, assigned to the monotypic tribe Paravaejovini of Smeringurinae by Soleglad and Fet (2008), and the monophyly of Smeringurinae, to be tested. *Vaejovis pequeno* Hendrixson, 2001 and an undescribed species of *Serradigitus* were added to the outgroup for the following reasons. Both species possess a smooth distal barb margin of the hemi-mating plug but lack the putative synapomorphy of Stahnkeini, that is, serrated dentition of the pedipalp chela fingers (Soleglad and Fet, 2008). Hendrixson (2001) suggested two species as possible relatives of *V. pequeno*: *Maaykuyak waueri* (Gertsch and Soleglad, 1972), as *Vaejovis waueri* Gertsch and Soleglad, 1972, assigned to genus *Hoffmannius* of tribe Syntropini by Soleglad and Fet (2008), and *Gertschius agilis* (Sissom and Stockwell, 1991), as *Serradigitus agilis* Sissom and

Stockwell, 1991, assigned to tribe Stahnkeini by Soleglad and Fet (2008). The inclusion of *V. pequeno* and the undescribed *Serradigitus* species in the analyses presented here was intended to test the relationship of *V. pequeno* to *M. waueri*, *Serradigitus* and *Gertschius* Graham and Soleglad, 2007.

Between two and six conspecific terminals, usually representing individuals from geographically distant, allopatric populations, were included to represent each ingroup species, when available. In total, 145 terminals, 130 of which comprised the ingroup, were included to represent 18 genera and 62 species of Vaejovidae.

Morphological data

All characters were coded based on direct examination of adult male and female specimens comprising 145 specimen-lots, to ensure consistency and repeatability in the concepts of characters and states, avoid misrepresentation, and facilitate reinterpretation of previous work, as required (Prendini et al., 2003). The morphological data matrix presented here forms part of a larger matrix for the family Vaejovidae (in prep.), from which 250 characters were selected for the analysis of Syntropinae (Appendices 3–6). The matrix comprised 45 quantitative characters (setal counts on the pedipalp and metasomal carinae, coded as ranges) and 205 qualitative characters from the following character systems: colour and infuscation (26); chelicerae (4); shape, topography (6) and surface ornamentation (3) of carapace; carination (36), surface ornamentation (7), shape (4), finger lobes and notches (10), finger dentition (8), and trichobothria (18) of pedipalps; lobes, notches (10) and dentition (8) of pedipalp chela fingers; proportions and ornamentation (2), setation (14) and spinules (5) of legs; genital operculum (2); hemispermatophore (13); pectines (5); carination (3) and surface ornamentation (6) of mesosoma; carination (23) and surface ornamentation (3) of metasoma; telson (7).

Sixty-one legacy characters incorporated in the matrix (Appendix 6), from Lamoral (1980), Stockwell (1989), Prendini (2000, 2003, 2004), Fet et al. (2001), Soleglad and Sissom (2001), Prendini et al. (2003, 2010), Soleglad and Fet (2003), Francke and Prendini (2008), and Volschenk and Prendini (2008), were critically reassessed by examination of specimens, and often modified (reinterpreted, fused or split). An attempt was made to avoid *a priori* judgements of character reliability; hence, only legacy characters or character states that were difficult to visualize and score unambiguously were discarded.

Care was taken during the coding of qualitative characters to observe logical and biological independence of characters (Wilkinson, 1995), as dependent characters, for example, serial structures with the same character states, would outweigh the evidence used for phylogenetic inference and introduce redundancy (Fitzhugh, 2006). Presumed dependent characters and/or states were identified by covariation, that is, an identical distribution in multiple species, and fused as necessary to mitigate this issue. An effort to avoid inapplicable entries, which have an insidious effect on phylogenetic analyses, was made by composite coding (Maddison, 1993; Wilkinson, 1995; Strong and Lipscomb, 1999) and redefining characters (Fitzhugh, 2006), resulting in 111 binary and 94 multistate characters. No assumptions were made concerning character transformation. Qualitative characters were treated as unordered/non-additive (Fitch, 1971).

Quantitative characters were analysed as such (Goloboff et al., 2006) and treated as additive/ordered (Werner, 1961; Farris, 1970). This procedure is preferred to methods for converting quantitative character data into qualitative characters (Mickevich and Johnson, 1976; Archie, 1985; Goldman, 1988; Felsenstein, 1988; Thiele, 1993; Rae, 1998; Wiens, 2001) because the original values are retained and problems with overlapping ranges are avoided. A standardization method was applied to reduce the values for characters with extreme ranges, for example, 0–30 to between 0–2, by running the TNT script “stand.run” with argument 2 in effect (Goloboff et al., 2006; C.I. Mattoni, pers. comm.).

DNA sequencing

Five gene markers that evolve at different rates and provide phylogenetic resolution at different, overlapping taxonomic levels were selected to reconstruct the phylogeny of Syntropinae (Prendini et al., 2003, 2005). The small-subunit ribosomal RNA gene (18S rDNA) and the D3 region of the large-subunit ribosomal RNA gene (28S rDNA) were amplified from the nuclear genome, and the small-subunit ribosomal RNA gene (12S rDNA), large-subunit ribosomal RNA gene (16S rDNA) and cytochrome *c* oxidase subunit I gene (COI) from the mitochondrial genome.

Genomic DNA was extracted, amplified and sequenced using standard procedures (Nishiguchi et al., 2002; Prendini et al., 2002, 2005). The following adjuvants were added to assist polymerase chain reaction (PCR) amplifications as required: bovine serum albumine; dimethyl sulphoxide; magnesium chloride. Alternatively, Illustra Hot Start Mix RTG beads (GE Healthcare) were used. Primer sequences (Appendix 7) were removed and complementary strands of DNA assembled into consensus sequences, edited, and checked for quality using Sequencher 5.0 (Gene Codes Corporation).

In total, 725 sequences were generated from 145 samples for the study (Appendix 8). All except one ingroup COI sequence (*Kochius punctipalpi* 1679) of 790 bp, were complete. The 12S fragment was the most variable in length among the genetic markers, ranging from 332 to 335 bp in the outgroup and 329 to 335 bp in the ingroup: 332 bp (6 outgroups/10 ingroups), 333 (4/4), 334 (2/0), 335 (4/2), 329 (0/23), 330 (0/59), 331 (0/31). The 16S fragment varied from 480 to 486 bp in the outgroup and 480 to 483 bp in the ingroup, with greater variation in the outgroup: 480 bp (1/6), 481 (1/24), 482 (9/66), 483 (3/34), 484 (1/0), 486 (1/0). Length variation was minimal in 18S: 1761 bp (7/130), 1762 (1/0), 1763 (8/0); and in 28S: 514 bp (11/123), 515 (0/3), 516 (5/4). All complete COI sequences were 1078 bp in length.

DNA sequence alignment and phylogenetic analysis

Edited sequences of the four gene markers with length variation (18S, 28S, 12S and 16S) were aligned with MAFFT 6 (http://mafft.cbrc.jp/alignment/server/; Katoh et al., 2002, 2005, 2009; Katoh and Toh, 2008). The G-INS-i strategy was applied in MAFFT due to the trivial variation in sequence length and short gap openings expected, using default settings (Katoh et al., 2005). Alignments obtained with MAFFT were analysed using MEGA 5.05 (Tamura et al., 2011) to calculate genetic content and transition : transversion ratios (Table 3).

Nine data partitions were defined: quantitative morphological characters; qualitative morphological characters; all morphological characters; 18S; 28S; 12S; 16S; COI; five gene markers. The morphological and molecular data partitions were analysed separately to determine the phylogenetic signal in each, and an optimal topology for both partitions identified using sensitivity analysis. Simultaneous analysis of all the data was conducted to generate a preferred phylogenetic hypothesis based on all available evidence. Separate and simultaneous analyses of the molecular data were conducted, with gaps treated as a fifth character state and as missing data.

Analyses were conducted with parsimony in TNT 1.1 (Goloboff et al., 2003b) using new technology analyses (Nixon, 1999; Goloboff, 1999; Goloboff et al., 2003a, 2008). Initial test runs were conducted in order to establish the appropriate search strength. The following analytical procedures were then conducted: 300 random addition sequences; 10 sectorial searches using RSS, CSS and XSS, fusing trees five times during each; 200 iterations of ratchet; 10 iterations of tree fusing with global fusing every three hits, and dumping fused trees to avoid clogging; and a final iteration of TBR. This aggressive search ensured that the minimum length tree was retrieved at least 50 times. Cladograms were prepared with TNT and edited with Adobe Illustrator CS5.1.

Sensitivity analysis

The sensitivity of the data to different weighting regimes was explored by analysis with equal weighting (EW) and implied weighting (IW) against homoplasy,

Table 3

Genomic data statistics for aligned DNA sequences of two nuclear and three mitochondrial gene markers used for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905: aligned length (base-pairs); number and percentage of variable positions; number and percentage of parsimony-informative (PI) positions, including gaps (and percentage of aligned length); number and percentage of conserved (invariant) positions; percentage nucleotide composition; percentage of transitions (ts) and transversions (tv) for each nucleotide combination and overall. Numbers for COI represent total, first, second and third codon positions (COI 1 2 3), respectively. Calculations were conducted using the maximum composite likelihood test (mcl) under the Tamura et al. (2004) model of substitution

	Nuclear		Mitochondrial			
	Ribosomal				Protein-coding	
	18S	28S	12S	16S	COI (1 2 3) %	Total
Length (bp)	1764	520	366	493	1078	4221
Variable (%)	45 (3)	52 (10)	211 (58)	216 (44)	442 (41)	966 (23)
PI (%)	30 (2)	28 (5)	162 (44)	175 (36)	394 (37)	789 (19)
Conserved (%)	1718 (97)	466 (90)	143 (39)	271 (55)	636 (59)	3234 (77)
A	25	23	42	37	23 (28 27 15)	27
C	28	32	13	15	21 (16 29 18)	24
G	24	26	8	11	14 (3 15 24)	19
T	23	19	37	37	41 (53 29 43)	29
ts						
A↔G	20	29	25	34	47 (48 17 78)	36
C↔T	49	43	34	27	17 (32 78 9)	21
tv						
A↔C	3	4	2	2	3 (0 0 2)	4
A↔T	4	3	8	7	4 (3 1 1)	6
C↔G	4	5	3	3	4 (2 1 1)	5
G↔T	3	3	8	7	8 (5 1 3)	4
ts : tv	2.38	2.41	0.93	1.22	1.57 (2.35 15.40 5.18)	1.30

with different values of the concavity constant, *k* (Goloboff, 1993; Prendini, 2000; Prendini et al., 2003; Goloboff et al., 2008; Alvarez-Padilla et al., 2009; Lopardo et al., 2010). This approach improves support values and the performance of phylogenetic analyses in general (Goloboff et al., 2008).

The morphological and molecular data, with gaps as a fifth character state or as missing data, were analysed separately and simultaneously with EW or IW in TNT. The script "salva" (http://tnt.insectmuseum.org/index.php/Implied_weighting) was modified to perform equal weighting and implied weighting searches, with *k* values increasing by one unit from three to 100. The command string for each search was "piwe = *x*; hold 1200 xmult = level 10", where "piwe" establishes the strength of the weighting, and "*x*" represents *k* values; "hold 1200" specifies the number of trees to be saved in memory (in this case, 1200); and "xmult = level 10" is the most stringent heuristic search strategy: 14 replications of Wagner tree builds as a starting point for each hit autoconstrained, including TBR, constrained and random sectorial searches with 36 iterations of tree drifting and 10 iterations of tree fusing, identifying the shortest tree and performing a final iteration of tree fusing (Goloboff et al., 2008). This script also calculated a strict consensus tree for each search. This strategy was conducted after establishing that the same tree length and topology was recovered with an initial, more aggressive search.

Results of the sensitivity analyses with different gap treatments and weighting regimes are presented as 50% majority rule consensus trees (Margush and McMorris, 1981). Nodes that appear in the majority rule consensus but collapsed in the strict consensus were obtained under the majority of weighting regimes, hence more confidence may be placed in the supposition that they are robustly supported by the data than in the alternatives, retrieved only under specific weighting regimes (Prendini et al., 2003). The fit/distortion curve of the implied weighting concavity constant, *k*, may produce topologies of greater similarity at higher *k* values (Goloboff, 1993; Mirande, 2009), potentially biasing majority rule consensus trees towards higher *k* values. The TNT command "unique" was therefore applied to produce consensus trees based on unique topologies, in addition to those based on all trees recovered. Nodal stability to the analytical combination of data partition and weighting regime was plotted in the form of a "Navajo rug" (Giribet, 2003).

Tree length, fit, consistency indices (CI) and retention indices (RI), based on phylogenetically informative characters only (Bryant, 1995), were calculated for each topology with the TNT script "stats.run" (http://tnt.insectmuseum.org/index.php/Scripts). The highest average symmetric resampling value, expressed as differences in group frequency (GC values for group recovered/contradicted), was used as an optimality criterion (Goloboff et al., 2003a, 2008) to select a topology from the separate and simultaneous analyses of the morphological and molecular data. The optimal topology retrieved by simultaneous analysis of the morphological data and the molecular data with gaps as a fifth character state, was regarded as the preferred hypothesis for the phylogenetic relationships of Syntropinae. Simultaneous analysis is widely preferred because it maximizes explanatory power, conveys several sources of independent characters and permits the emergence of secondary signals (Farris, 1983, 1986; Kluge, 1989; Farris and Kluge, 1986; Nixon and Carpenter, 1996).

Apomorphies were listed for selected clades in the preferred hypothesis (Appendix 9). The fit, CI and RI for each morphological character system in the preferred hypothesis were also calculated in order to compare the average homoplasy and information content among different morphological character systems, using the TNT script "CharStats.run" (https://sites.google.com/site/teosiste/tp/archivos). The fit for the EW topologies was calculated using the default ($k = 3$) value in TNT.

Resampling and support

Resampling and nodal support were calculated with TNT. Symmetric resampling, presented as group frequency (GF) and group frequency difference (GC), that is, group supported/contradicted, was conducted using 200 pseudoreplicates with a removal probability of 33% and search strength applied with the command "xmult = level 6".

Absolute Bremer support (ABS; Bremer, 1994) and relative Bremer support (RBS; Goloboff and Farris, 2001; Goloboff et al., 2003a, 2008) up to 48 extra steps were calculated for the preferred hypothesis (see Table 6 later). The ABS is difficult to interpret and cannot be compared among different data matrices, hence the discussion on support focuses on RBS, which is scaled from 0 to 100, providing a more intuitive percentage index of the support for nodes (Goloboff and Farris, 2001; Brower, 2006). Successive calculation of trees one step longer, retaining up to 1000 trees in memory during each search, was conducted in TNT using the command string "sub *x* hold 1000; bb = tbr fillonly", where "*x*" is the number of extra steps longer (1–48) generating 48 000 trees.

Partitioned Bremer support (PBS; Baker and DeSalle, 1997) was calculated in order to assess the contribution of each partition to the total Bremer support, using the TNT script "pbsup.run" (http://nymphalidae.utu.fi/cpena/software.html).

Results

Genomic data

As observed in Scorpionidae Latreille, 1802 by Prendini et al. (2003), the mitochondrial gene markers were more variable, with 44, 36 and 37% of sites parsimony-informative for 12S, 16S and COI, respectively, than the nuclear markers, with 2 and 5% of sites parsimony-informative for 18S and 28S, respectively (Table 3). The total number of parsimony-informative sites (789) represents 19% of the 4221 aligned nucleotides in the molecular dataset. The aligned 12S and 16S contained more gaps due to the presence of variable loops and other secondary structures characteristic of ribosomal genes (Hickson et al., 1996; Buckley et al., 2000).

The relative purine and pyrimidine content was consistent with reports for Scorpionidae (Prendini et al., 2003) and other arthropods (DeSalle et al., 1987; Edgecombe et al., 2000). The AT-bias of the mitochondrial gene markers was confirmed, with A and T comprising 79, 74 and 64% of the nucleotide composition for 12S, 16S and COI, respectively. This bias is probably due to the tendency for methylation in adenine and thymine, documented extensively in vertebrates and more recently in invertebrates, especially arthropods (Glastad et al., 2011; Lyko and Maleszka, 2011). Nucleotide composition was more evenly distributed in the nuclear gene markers (Table 3), due to a relatively higher proportion of C and G, comprising 52 and 58% of the nucleotide composition for 18S and 28S, respectively.

The proportion of transitions (ts) and transversions (tv) and the ts : tv ratio were similar for the nuclear ribosomal markers, 18S and 28S, but higher than the expected ratio of 2 (Table 3), based on assumptions that there are twice as many transversions as transitions, and that substitutions are equally likely. C↔T transitions were more numerous in both markers.

The proportion of ts and tv and the ts : tv ratio were also similar for the mitochondrial ribosomal markers, 12S and 16S, but lower than the nuclear markers, with approximately equal numbers of transitions and transversions (Table 3). C↔T transitions were more numerous in the 12S, whereas A↔G transitions were more numerous in the 16S.

The 1078 bp fragment of COI corresponded to 359 amino acids. Nucleotide proportions at first, second and third codon positions varied considerably, but there was a low proportion of G (3%) and a high proportion of T (53%) in the first position (Table 3). The ts : tv ratio was lowest for the first position and highest for the second position.

Separate morphological analyses

Separate analyses of the 239 informative morphological characters with EW or IW with 98 k values retrieved between four and ten most-parsimonious trees (MPTs) in each case (Table 4). The majority rule consensus of 637 unique topologies (Fig. 3a) recovered the same clades and genera as the consensus based on all MPTs. The clade comprising (Stahnkeini + *Vaejovis pequeno*), hereafter referred to as Stahnkeini, the clade comprising (*Kuarapu* + *Balsateres* + (*Thorellius* + *Kochius*)), hereafter referred to as the *Kochius* clade, and the genera *Chihuahuanus* González-Santillán and Prendini, 2013, *Mesomexovis* González-Santillán and Prendini, 2013, and *Paravaejovis* were consistently polyphyletic. Syntropinae was monophyletic only in the IW analyses with k = 8 and 9 (Table 5). The genera *Balsateres* González-Santillán and Prendini, 2013, *Kochius*, *Konetontli* González-Santillán and Prendini, 2013, *Maaykuyak* González-Santillán and Prendini, 2013, *Syntropis*, *Thorellius* and *Vizcaino* González-Santillán and Prendini, 2013 were monophyletic in all analyses. *Paravaejovis pumilis* was placed within the former *eusthenura* group of *Vaejovis*, for which Soleglad and Fet (2008) devised the name *Hoffmannius*, in all of the analyses.

The optimal topology with the highest average symmetric resampling value (GF = 41.2, GC = 40.5), a strict consensus of seven MPTs with length 1633, CI 0.25, RI 0.81 and fit 129.48, was retrieved by EW (Table 4 and Fig. 3b; see also Fig. 7a). As with the majority rule consensus trees, Syntropinae, Stahnkeini, the *Kochius* clade and the genera *Chihuahuanus*, *Mesomexovis* and *Paravaejovis* were polyphyletic (Table 5). *Balsateres*, *Kochius*, *Konetontli*, *Maaykuyak*, *Syntropis*, *Thorellius* and *Vizcaino* were monophyletic and received high resampling values (> 80).

Separate molecular analyses

Separate analyses of the molecular data with gaps as a fifth character state or as missing data consistently generated a single MPT with IW (Table 4). Analyses with EW recovered eight MPTs with gaps as a fifth state, and six with gaps as missing data.

The topologies of analyses with gaps as a fifth state or as missing data, with EW or IW with 98 k values, differed only in the monophyly of *Kochius* and *Maaykuyak* (Table 5) and the frequency with which particular clades and taxa were recovered. Stahnkeini, Syntropinae, the *Kochius* clade and the genera *Balsateres*, *Chihuahuanus*, *Mesomexovis*, *Paravaejovis*, *Syntropis* and *Vizcaino* were consistently monophyletic; *Konetontli* and *Thorellius* consistently paraphyletic (Fig. 4a). *Kochius* was monophyletic in most analyses, except with EW or IW with k = 3–7

Table 4
Tree statistics for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Length, consistency index (CI), retention index (RI) and fit of most parsimonious trees (MPTs) obtained by separate and simultaneous (Simul) analyses of the morphological (Mor) and molecular (concatenated aligned DNA sequences of two nuclear and three mitochondrial gene markers; Mol) datasets, with equal weighting (EW) and implied weighting (IW), under ten values of the concavity constant (*k*). Results of additional implied weighting analyses, conducted with *k* values 3–100 (98 total) not shown. Analyses of the molecular dataset were conducted with gaps as a fifth state (+) and as missing data (–). Optimal tree topologies, indicated in boldface, yielded the highest average symmetric resampling values, in GC units, on nodes for the morphological dataset (41), the molecular dataset with gaps as a fifth state (75), and the simultaneous analysis of the morphological dataset and the molecular dataset with gaps as a fifth state (80)

	MPTs	Length	CI	RI	Fit
Mor					
IW: 3	10	1663	0.24	0.80	127.09
IW: 10	6	1636	0.25	0.81	71.50
IW: 20	7	1636	0.25	0.81	44.69
IW: 30	4	1636	0.25	0.81	32.62
IW: 40	5	1630	0.25	0.81	25.70
IW: 50	5	1630	0.25	0.81	21.20
IW: 60	7	1630	0.25	0.81	18.05
IW: 70	7	1630	0.25	0.81	15.71
IW: 80	10	1630	0.25	0.81	13.91
IW: 90	7	1630	0.25	0.81	12.48
EW	**7**	**1633**	**0.25**	**0.81**	**129.48**
Mol +/–					
IW: 3	1/1	9007/8878	0.16/0.17	0.58/0.63	458.59/451.41
IW: 10	1/1	8975/8839	0.17/0.17	0.58/0.63	291.07/287.70
IW: 20	1/1	8955/8821	0.17/0.17	0.59/0.63	200.82/198.77
IW: 32	**1/1**	**8947/8819**	**0.17/0.17**	**0.59/0.63**	**148.61/147.21**
IW: 40	1/1	8947/8812	0.17/0.17	0.59/0.63	127.06/125.91
IW: 50	1/1	8946/8809	0.17/0.17	0.59/0.63	107.74/106.79
IW: 60	1/1	8945/8809	0.17/0.17	0.59/0.63	93.61/92.795
IW: 70	1/1	8945/8806	0.17/0.17	0.59/0.63	82.80/82.10
IW: 80	1/1	8944/8806	0.17/0.17	0.59/0.63	74.25/61.56
IW: 90	1/1	8944/8806	0.17/0.17	0.60/0.63	67.32
EW	8/6	8944/8900	0.16/0.17	0.60/0.63	460.80–461.21/453.23–454.44
Simul +/–					
IW: 3	1/1	10711/10580	0.17/0.17	0.63/0.63	595.04/586.85
IW: 10	1/1	10685/10562	0.17/0.17	0.63/0.63	370.51/366.55
IW: 18	**1/1**	**10682/10545**	**0.17/0.17**	**0.63/0.63**	**268.70/266.12**
IW: 30	1/1	10682/10545	0.17/0.17	0.63/0.63	193.30/191.55
IW: 40	1/1	10682/10545	0.17/0.17	0.63/0.63	157.44/156.05
IW: 50	1/1	10670/10544	0.17/0.17	0.63/0.63	133.03/181.39
IW: 60	1/1	10670/10537	0.17/0.17	0.63/0.63	115.28/114.32
IW: 70	1/1	10670/10537	0.17/0.17	0.63/0.63	101.77/100.93
IW: 80	1/1	10670/10537	0.17/0.17	0.63/0.63	91.12/90.38
IW: 90	1/1	10670/10537	0.17/0.17	0.63/0.63	82.51/81.84
EW	1/1	10895/10748	0.17/0.17	0.63/0.63	269.29/588.96

and gaps as a fifth state, and with EW or IW with $k = 3–9$ and gaps as missing data. *Maaykuyak* was monophyletic in all analyses except with EW or IW with $k = 33–100$ and gaps as a fifth state. *Paravaejovis pumilis* was consistently placed within the former *eusthenura* group of *Vaejovis*.

The optimal topology with the highest average symmetric resampling values on nodes (74.8), a single MPT with length 8947, CI 0.17, RI 0.6 and fit 148.61, was retrieved by IW with $k = 32–36$ and gaps as a fifth state (Table 4 and Fig. 4b; see also Fig. 7b). This topology recovered the same clades and genera as the majority rule consensus of all MPTs obtained by analyses with EW or IW with 98 *k* values, and gaps as a fifth state. The consensus of 15 unique topologies obtained by analyses with gaps as a fifth state (Fig. 4a) and the consensus of 16 unique topologies obtained with gaps as missing data recovered the same clades and genera as the optimal topology, except that *Maaykuyak* was monophyletic and the relative positions of the *Kochius* clade, *Chihuahuanus*, *Mesomexovis* and *Paravaejovis* were altered. The consensus of all MPTs obtained by analyses with gaps as missing data was identical to the consensus of 15 unique topologies obtained with gaps as a fifth state (Fig. 4a) and the consensus of 16 unique topologies obtained with gaps

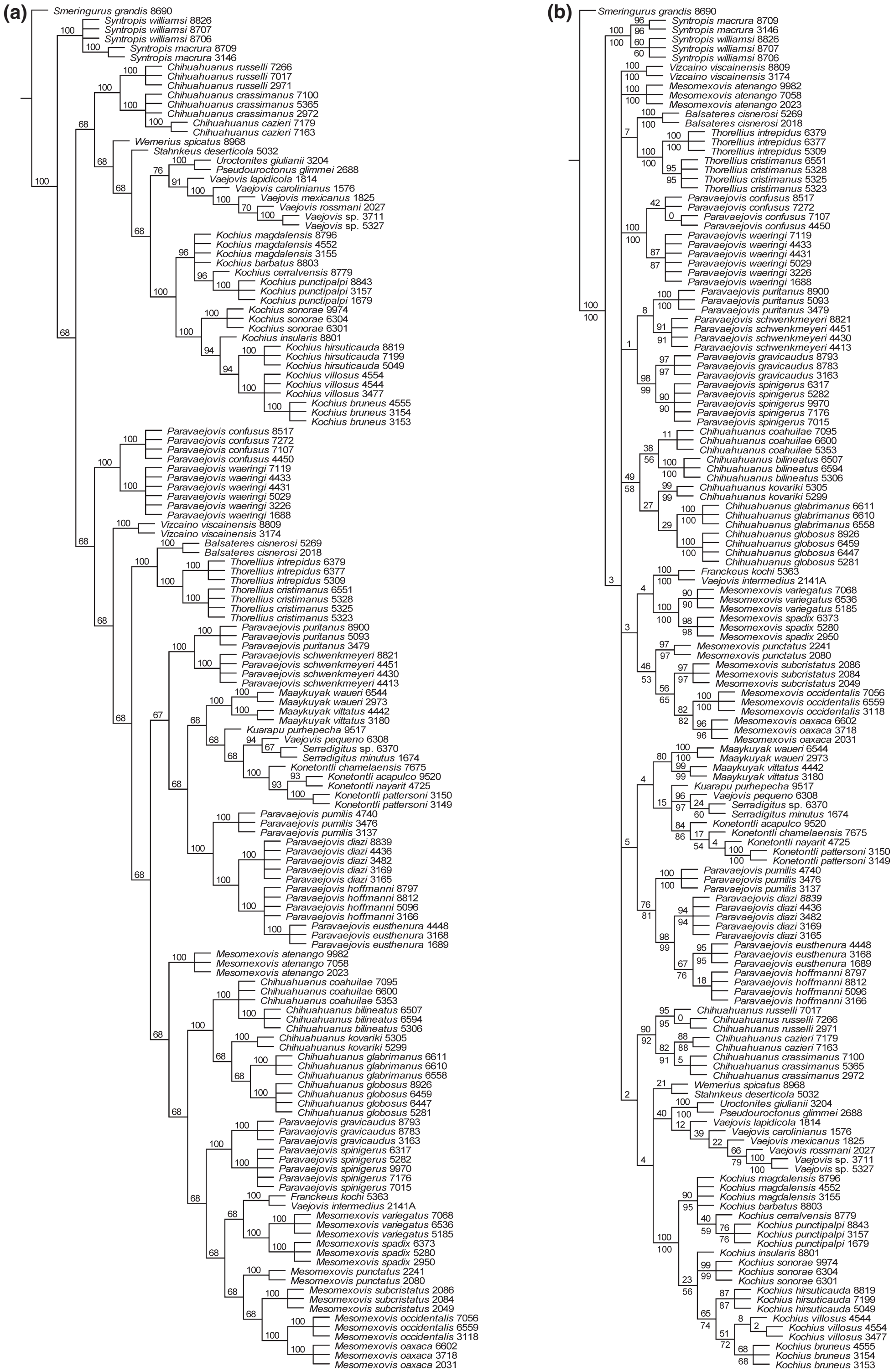

Fig. 3. Phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 obtained by analysis of 45 quantitative and 205 qualitative morphological characters. (a) Majority rule (50%) consensus of 637 unique topologies obtained by analyses with equal weighting and implied weighting under 98 values of the concavity constant (*k*). Nodes with frequencies less than 50% are collapsed. Numbers above branches at uncollapsed nodes indicate frequencies greater than 50%. (b) Strict consensus of seven most-parsimonious trees (MPTs) obtained by analysis with equal weighting, the optimal topology for the morphological dataset, which yielded the highest average symmetric resampling values on nodes (Table 4). Numbers above branches indicate symmetric resampling GC values (group frequency difference). Numbers below branches indicate GF (group frequency) values above 50%.

Table 5
Nodal stability for selected clades and taxa in phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 (classification follows González-Santillán and Prendini, 2013), based on separate and simultaneous (Simul) analyses of the morphological (Mor) and molecular (concatenated aligned DNA sequences of two nuclear and three mitochondrial gene markers, Mol) datasets with equal weighting (EW) and implied weighting (IW) under 98 values of the concavity constant (*k*). Analyses of the molecular dataset were conducted with gaps as a fifth state (+) and as missing data (−). Highlighted cells indicate clades and taxa recovered under the various parameters applied

		Balsateres	*Chihuahuanus*	*Kochius*	*Kochius* clade	*Konetontli*	*Maaykuyak*	*Mesomexovis*	*Paravaejovis*	Stahnkeini	Syntropinae	*Syntropis*	*Thorellius*	*Vizcaino*
Mor	IW: 3–4	■		■		■	■				■	■	■	■
	IW: 5–100, EW	■		■		■	■					■	■	■
Mol +	IW: 3–7	■	■		■		■	■	■	■	■	■		■
	IW: 8–32	■	■	■	■		■	■	■	■	■	■		■
	IW: 33–100	■	■	■	■			■	■	■	■	■		■
	EW	■	■		■			■	■	■	■	■		■
Mol –	IW: 3–9	■	■		■		■	■	■	■	■	■		■
	IW: 10–100	■	■	■	■		■	■	■	■	■	■		■
	EW	■	■		■		■	■	■	■	■	■		■
Simul +	IW: 3–48, 63	■	■	■	■	■	■	■	■	■	■	■	■	■
	IW: 49–62, 64–66	■	■	■		■	■	■	■	■	■	■	■	■
	IW: 67–100, EW	■	■	■	■		■	■	■	■	■	■	■	■
Simul –	IW: 3–59	■	■	■	■	■	■	■	■	■	■	■	■	■
	IW: 60–100, EW	■	■	■	■		■	■	■	■	■	■	■	■

as missing data, except for a reversal in the positions of *Chihuahuanus* and the *Kochius* clade, and greater resolution among the two basalmost clades of the outgroup.

Simultaneous analyses

Simultaneous analyses of the morphological data and the molecular data with gaps as a fifth state or as missing data consistently generated a single MPT with EW or IW (Table 4). The topologies of analyses with gaps as a fifth state and as missing data, with EW or IW with 98 *k* values, differed only in the monophyly of the *Kochius* clade (Table 5), the placement of *Mesomexovis* and the frequency with which particular clades and taxa were retrieved (Fig. 5a and b).

No genera or suprageneric taxa were consistently paraphyletic. Stahnkeini, Syntropinae and the genera *Balsateres*, *Chihuahuanus*, *Kochius*, *Kuarapu*, *Maaykuyak*, *Mesomexovis*, *Paravaejovis*, *Syntropis*, *Thorellius* and *Vizcaino* were consistently monophyletic (Table 5). The *Kochius* clade was monophyletic in all analyses except IW with k = 49–62, 64–66 and gaps as a fifth state. *Konetontli* was monophyletic in all analyses except EW or IW with k = 67–100 and gaps as fifth state, and EW or IW with k = 60–100 and gaps as missing data.

The optimal topology with the highest average symmetric resampling (GC) values on nodes (79.7), a single MPT with length 10682, CI 0.17, RI 0.63 and fit 268.70, was retrieved by IW with k = 18 and gaps as a fifth state (Table 4 and Figs 6 and 7c). Stahnkeini, Syntropinae and the genera *Chihuahuanus*, *Kochius*, *Maaykuyak*, *Syntropis*, *Thorellius* and *Vizcaino* received GF and GC values over 70 on this topology, whereas the *Kochius* clade, *Konetontli*, *Mesomexovis* and *Paravaejovis* received values 50 or less (Table 6). *Balsateres*, *Kochius*, *Syntropis*, *Thorellius* and *Vizcaino* received RBS values over 80, Syntropinae, Stahnkeini, the *Kochius* clade and *Chihuahuanus* received values 60–75, and *Konetontli*, *Maaykuyak*, *Mesomexovis* and *Paravaejovis* received values less than 50. On average,

Fig. 4. Phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 obtained by analysis of 4221 aligned DNA nucleotides from two nuclear (18S rDNA, 28S rDNA) and three mitochondrial (12S rDNA, 16S rDNA, cytochrome oxidase I) gene markers. (a) Majority rule (50%) consensus of 15 unique topologies obtained by analyses in which gaps were treated as a fifth state. Nodes with frequencies less than 50% are collapsed. Numbers above branches at uncollapsed nodes indicate frequencies greater than 50%. Numbers below branches indicate frequencies greater than 50% that differed in the majority rule (50%) consensus of 16 topologies obtained by analyses in which gaps were treated as missing data. (b) Single MPT obtained by analysis of 4221 aligned DNA nucleotides from two nuclear (18S rDNA, 28S rDNA) and three mitochondrial (12S rDNA, 16S rDNA, cytochrome oxidase I) gene markers with implied weighting under $k = 32$, the optimal topology for the molecular dataset, which yielded the highest average symmetric resampling values on nodes (Table 4). Numbers above branches indicate symmetric resampling GC values (group frequency difference), supporting (positive) or contradicting (negative) groups. Numbers below branches indicate GF values (group frequency) values above 50%.

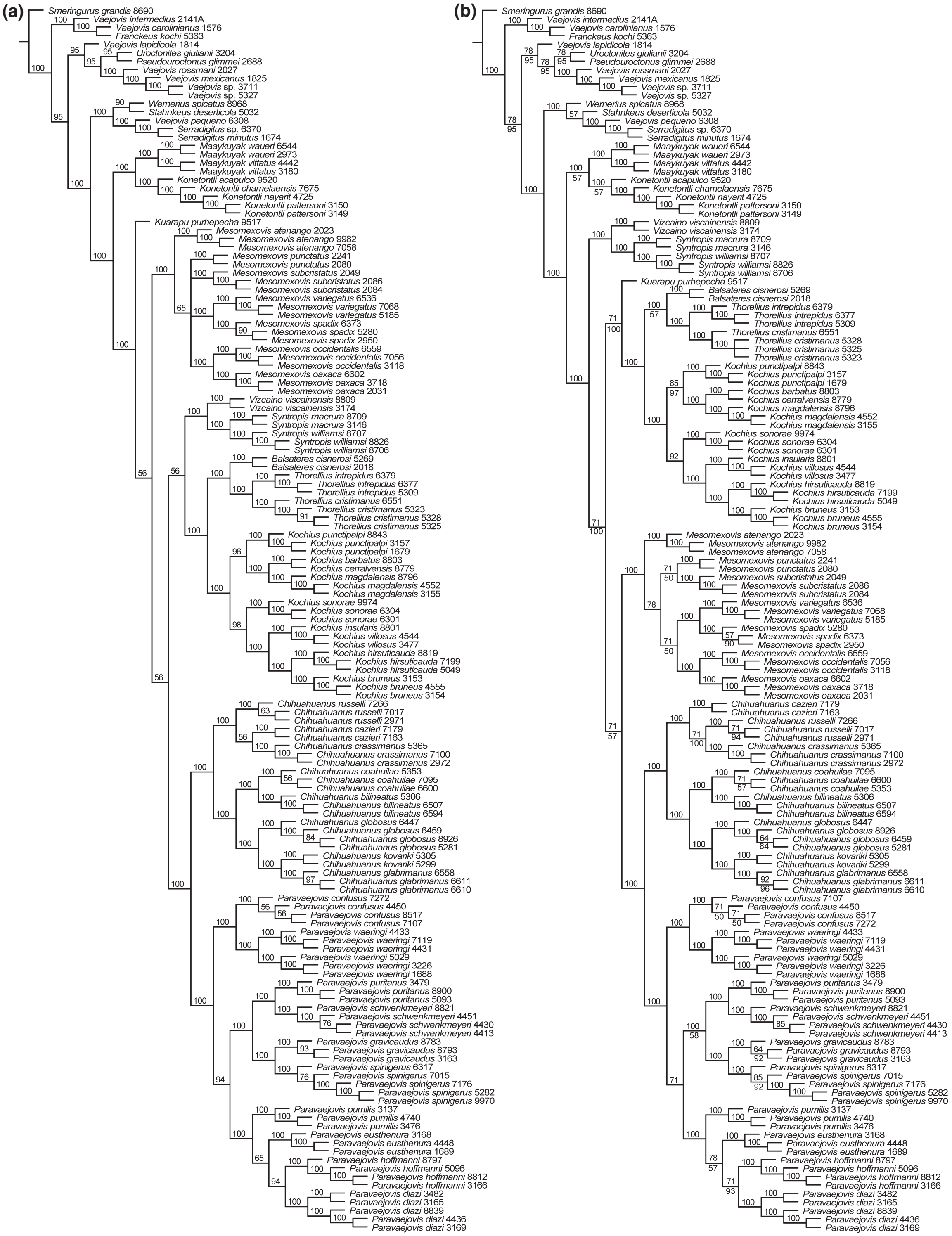

Fig. 5. Phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 obtained by simultaneous analysis of 250 morphological characters and 4221 aligned DNA nucleotides from two nuclear (18S rDNA, 28S rDNA) and three mitochondrial (12S rDNA, 16S rDNA, cytochrome oxidase I) gene markers with equal weighting and implied weighting under 98 values of the concavity constant (*k*). (a) Majority rule (50%) consensus of 99 most parsimonious trees (MPTs) obtained by analyses in which gaps were treated as a fifth state (Table 4). Numbers above branches at uncollapsed nodes indicate frequencies greater than 50%. (b) Majority rule (50%) consensus of 14 unique topologies obtained by analyses in which gaps were treated as a fifth state or as missing data. Nodes with frequencies less than 50% are collapsed. Numbers above branches at uncollapsed nodes indicate frequencies greater than 50%. Numbers below branches indicate frequencies greater than 50% that differed in the majority rule (50%) consensus of 99 MPTs obtained by analyses in which gaps were treated as missing data.

14 clades and taxa received a GF value of 84, a GC of 79 and an RBS value of 70 (Table 6).

The optimal topology recovered the same clades and genera as the majority rule consensus of MPTs obtained by analyses with EW or IW with 98 *k* values, and gaps treated as missing data, as well as the consensus of 14 unique topologies obtained with gaps as a fifth state and the consensus of 14 unique topologies obtained with gaps as missing data (Fig. 5b). The consensus of all MPTs obtained by analyses with gaps as a fifth state (Fig. 5a) recovered most of the same clades and genera as the optimal topology, except that the *Kochius* clade was rendered polyphyletic by a change in the relative positions of *Mesomexovis* and the clade comprising *Syntropis* and *Vizcaino*.

Homoplasy in morphological characters

All except 11 of the 250 morphological characters were informative in the preferred hypothesis of Syntropinae phylogeny. The mean and median homoplasy content (CI, RI and fit) of the 22 morphological character systems on the preferred phylogeny is summarized in Fig. 8.

The mean CI for the character systems ranged from 0.15 to 0.67, but was generally low, only the CI for the chelicerae, genital operculum, hemispermatophore and mesosomal carination exceeding 0.50. The median CI followed a similar trend, except that the values were generally lower, with only the CI for the genital operculum exceeding 0.50. The mean RI ranged from 0.41 to 0.94, and was generally high, exceeding 0.50 in 21 of the 22 character systems. This trend was more evident with the median RI, in which only the values for quantitative morphological characters were below 0.50. The lowest mean and median RI were obtained for the quantitative characters. The mean fit values ranged from 0.17 to 0.70, with a similar range for the median fit.

It is apparent from these statistics that homoplasy is rampant in most of the morphological character systems, especially colour and infuscation, pedipalp surface ornamentation and pedipalp chela finger lobes and notches, in which the CI is near or below 0.2 and the RI above 0.7. The least homoplastic character systems in this dataset appear to be the genital operculum and, to a lesser extent, the chelicerae, in which the mean CI is above 0.6 and the mean RI above 0.5. Despite the homoplasy, there is a considerable phylogenetic signal in the morphological dataset, based on the RI values and the PBS.

Stability and support

Partitioned Bremer support values for genera, suprageneric taxa and clades on the preferred hypothesis of Syntropinae phylogeny (Table 6) identified some incongruence among the data partitions, but confirmed the utility of the different partitions for resolving relationships at different levels in the tree.

The morphological data supported more clades and taxa, but with generally lower support values, than the molecular data. Quantitative morphological characters supported ten clades and taxa and contradicted two, whereas qualitative morphological characters supported six and contradicted five. The support values from the qualitative characters were generally higher than those from the quantitative characters.

The molecular data partitions supported six to eight clades and taxa (Table 6). The mitochondrial 16S marker, the most widely used in phylogenetic analyses on scorpions (e.g. Fet et al., 2001, 2002, 2003; Gantenbein et al., 2001), supported eight clades and taxa and contradicted one, whereas the mitochondrial 12S marker supported six and contradicted five. The mitochondrial COI marker supported seven clades and taxa, with generally higher support values than the 16S and 12S markers, and contradicted four, also with high values. The nuclear 18S marker supported seven clades and taxa and contradicted none, whereas the nuclear 28S marker supported six and contradicted one. The lower information content of the nuclear markers in the dataset may be due to their slower nucleotide substitution rate.

The sensitivity analysis and PBS illustrated the complementarity of the different data partitions to the topology recovered in the simultaneous analysis. Various taxa, recovered as monophyletic only in the separate morphological analyses, for example *Konetontli* and *Thorellius*, or molecular analyses, for example *Chihuahuanus*, *Mesomexovis* and *Paravaejovis* (Tables 5 and 6), were recovered in the majority of simultaneous analyses, suggesting that support for these taxa improved with the combination of independent sources of data. The simultaneous analysis was also more resilient to variation in the analytical parameters (treatment of gaps and intensity of weighting against homoplasy).

Stahnkeini was contradicted by 12S and qualitative morphological characters and mildly supported by the other data partitions except 16S (Table 6). Syntropinae was supported by five partitions, with highest support from 16S and COI, and contradicted by two. *Maaykuyak* was supported by quantitative morphological characters, 12S and 18S, but contradicted by qualitative morphological characters and 16S. *Konetontli* was supported by both morphological data partitions and 16S, but contradicted by 28S and COI. *Syntropis* was supported by all data partitions. *Vizcaino* was supported by qualitative morphological characters, COI, 12S and 16S. The *Kochius* clade was supported by quantitative morphological characters, both nuclear markers and COI, and contradicted by qualitative morphological characters and 12S. *Balsateres* was sup-

Table 6
Nodal support, nodal stability, apomorphies and partitioned Bremer support for selected clades and taxa in phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 (classification follows González-Santillán and Prendini, 2013). Symmetric resampling values, in GF and GC units, absolute Bremer support (ABS) and relative Bremer support (RBS) values and branch lengths (BL), that is, total number of morphological and molecular apomorphies, are presented for the optimal topology obtained by simultaneous analysis of the morphological (Mor) dataset and the molecular (concatenated aligned DNA sequences of two nuclear and three mitochondrial gene markers, Mol) dataset with gaps as a fifth state, obtained with equal weighting and implied weighting under $k = 18$. Results of sensitivity analysis of the morphological dataset and the molecular dataset, with gaps as a fifth state (+) and as missing data (–), analysed with equal weighting and implied weighting under 98 values of k, are expressed as the percentage recovery of each clade or taxon indicated. Partitioned Bremer support analysis was based on seven partitions: qualitative morphological characters (Qual), quantitative morphological characters (Quant), two nuclear (18S and 28S) and three mitochondrial (12S, 16S and COI) markers. Highlighted cells indicate no effect (0) or contradictory (negative) support

		Balsateres	*Chihuahuanus*	*Kochius*	*Kochius* clade	*Konetontli*	*Kuarapu*	*Maaykuyak*	*Mesomexovis*	*Paravaejovis*	Stahnkeini	Syntropinae	*Syntropis*	*Thorellius*	*Vizcaino*	All nodes (mean)
Resampling and support	GF	100	80	100	38	79	–	94	54	74	99	100	100	100	100	84
	GC	100	70	100	22	62	–	89	38	63	99	100	100	100	100	79
	ABS	1.7	0.2	0.6	0.1	0.1	–	0.3	0.1	0.1	0.5	0.5	2.2	0.3	1.3	0.4
	RBS	100	60	83	64	39	–	47	39	23	75	70	98	84	97	70
Apomorphies	BL	70	12	27	11	14	99	32	11	14	35	34	97	28	64	–
Sensitivity analysis (% recovery)	Mor	100	0	100	0	100	100	100	0	0	0	2	100	100	100	–
	Mol +	100	100	95	100	0	100	31	100	100	100	100	100	0	100	–
	Mol –	100	100	92	100	0	100	99	100	100	100	100	100	0	100	–
	Simul +	100	100	100	84	65	100	100	100	100	100	100	100	100	100	–
	Simul –	100	100	100	100	59	100	100	100	100	100	100	100	100	100	–
Partitioned Bremer support	Qual	11	0	16	–13	3	–	–14	–13	0	–11	–16	5	17	14	2
	Quant	1	–4	1.9	2	1	–	5	2	–1	4	2	9	1	0	0.4
	18S	2	0	0	2	0	–	7	2	0	4	2	3	0	0	0.4
	28S	1	0	0	2	–1	–	0	2	0	4	2	3	0	0	0.5
	12S	0	2	1	–2	0	–	5	–2	3	–2	–2	10	–5	8	2
	16S	11	3	0	0	1	–	–3	0	1	0	11	13	2	8	3
	COI	43	–4	–10	5	–11	–	0	5	–11	14	7	21	–15	20	0.5

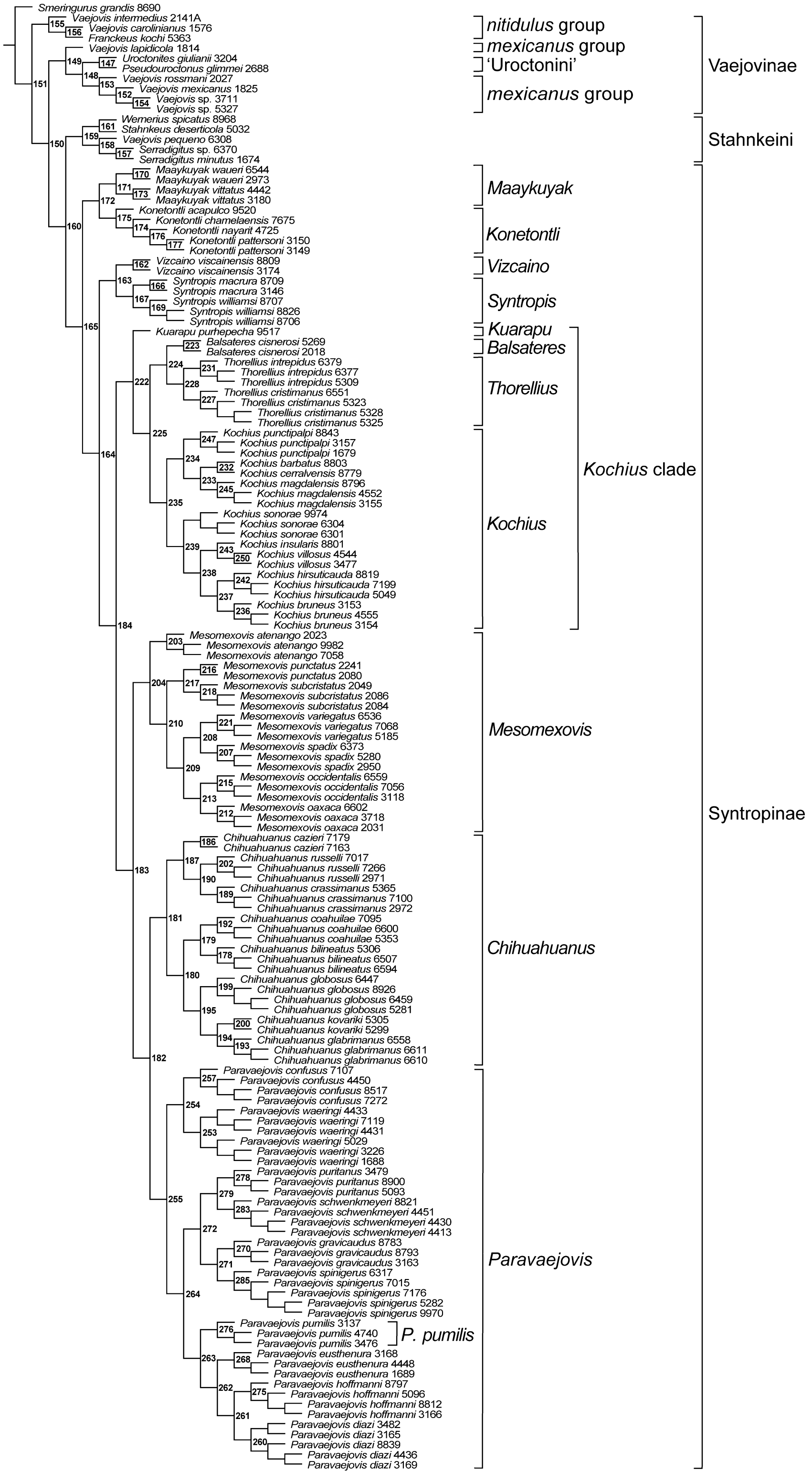

Fig. 6. Phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 obtained by simultaneous analysis of 250 morphological characters and 4221 aligned DNA nucleotides from two nuclear (18S rDNA, 28S rDNA) and three mitochondrial (12S rDNA, 16S rDNA, cytochrome oxidase I) gene markers. The optimal topology, a single most-parsimonious tree (length, 10682; CI, 0.17; RI, 0.63; fit, 268.70; average symmetric resampling value, 79.7) obtained by analysis with implied weighting under $k = 18$ and gaps treated as a fifth state (Table 4). Apomorphies, relative Bremer support, symmetric resampling GF (group frequency) values above 50% and GC values (group frequency difference, i.e. supported/contradicted) of nodes, numbered in bold typeface, are provided in Appendix 9.

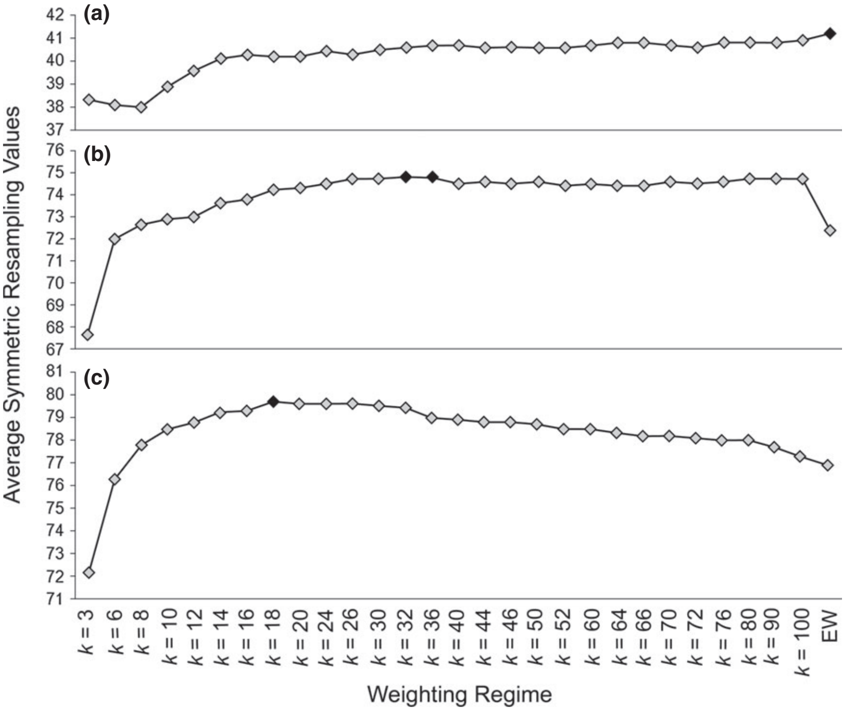

Fig. 7. Average symmetric resampling values for GC values (group frequency difference, i.e. supported/contradicted) on phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905, obtained by analyses with equal weighting (EW) and implied weighting (IW) with 28 values of the concavity constant (*k*). Black diamonds indicate optimal topologies, with the highest average symmetric resampling values. (a) Analyses of 45 quantitative and 205 qualitative morphological characters. (b) Analyses of 4221 aligned DNA nucleotides from two nuclear (18S rDNA, 28S rDNA) and three mitochondrial (12S rDNA, 16S rDNA, cytochrome oxidase I) gene markers, in which gaps were treated as a fifth state. (c) Simultaneous analyses of 250 morphological characters and 4221 aligned DNA nucleotides, in which gaps were treated as a fifth state.

ported by all partitions except 12S. *Kochius* was supported by both morphological partitions and 12S, but contradicted by both nuclear markers and COI. *Thorellius* was supported by both morphological data partitions and 16S, but contradicted by 12S and COI. *Mesomexovis* was supported by quantitative morphological characters, both nuclear markers and COI, but contradicted by qualitative morphological characters and 12S. *Chihuahuanus* was supported by 12S and 16S, but contradicted by quantitative morphological characters and 18S. *Paravaejovis* was supported by 12S and 16S, and contradicted by quantitative morphological characters.

Although symmetric resampling and Bremer support are based on fundamentally different premises, the values obtained from these procedures were generally similar (Fig. 6 and Table 6). The RBS values were mostly lower than the GC values, except for the *Kochius* clade. Support values of many clades and taxa were correlated with their stability in the sensitivity analysis, with some exceptions. For example, *Thorellius*, which received high GC and RBS values, was not recovered in the separate molecular analyses. This observation not only illustrates the potential difference between stability and support but also reinforces the importance of simultaneous analysis. Average symmetric resampling values in GC units obtained by separate and simultaneous analyses of the morphological and molecular datasets with EW and IW with 28 values of the concavity constant (*k*) are presented in Fig. 7. Optimal support values for the separate morphological analysis were obtained with EW (GC, 40.5), for the separate molecular analysis with IW and $k = 32$–36 (GC, 74.8) and for the simultaneous analysis with IW and $k = 18$ (GC, 79.7).

Discussion

Paraphyly and redefinition of Syntropinae

Soleglad and Fet (2008) recognized three subfamilies, four tribes and two subtribes within Vaejovidae (Table 2 and Fig. 2), concepts coopted from Stockwell's (1989) unpublished revisions (Table 1 and Fig. 1a). None of these suprageneric taxa, as defined by Soleglad and Fet (2008), were monophyletic in the analyses presented here. The monophyly of Smeringurini was not tested.

A clade comprising (*Wernerius* (*Stahnkeus* (*Serradigitus* + *Vaejovis pequeno*))), with high RBS (75), GF and GC (99) values in the optimal topology (Appen-

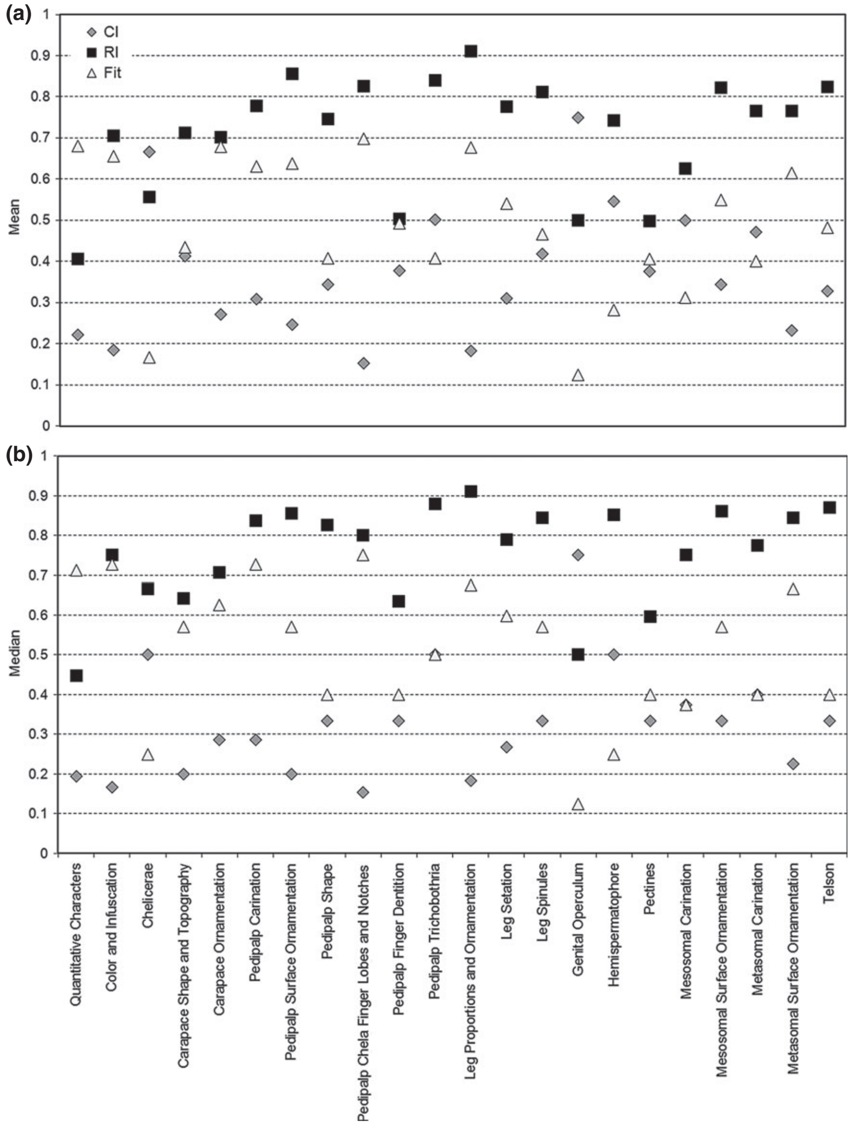

Fig. 8. Mean (a) and median (b) homoplasy statistics, that is, consistency index (CI), retention index (RI) and fit, for parsimony-informative morphological characters, arranged by character system (Appendix 6), on optimal phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905 (Fig. 6).

dix 9), was recovered in the separate analyses of the molecular data and in the simultaneous analyses. The grouping of *Serradigitus*, *Stahnkeus* Soleglad and Fet, 2006 and *Wernerius* corresponds with Soleglad and Fet's (2008) Stahnkeini, and agrees in part with a former hypothesis of Sissom (1993) concerning the relationships of these taxa. However, the inclusion of *Vaejovis pequeno* renders Syntropinae and Stahnkeini paraphyletic (Table 2). *Vaejovis pequeno* was considered *incertae sedis* by Hendrixson (2001) and included as *incertae sedis* in Syntropinae by Soleglad and Fet (2008).

The sister group relationship between *Konetontli*, species included within Vaejovinae by Soleglad and Fet (2008), and *Maaykuyak*, species assigned to *Hoffmannius* by Soleglad and Fet (2008), renders Syntropinae, Vaejovinae, Syntropini and Syntropina Kraepelin, 1905 paraphyletic (Table 2). The placements of *Kochius* and *Thorellius*, that is, Thorelliina Soleglad and Fet, 2008, as well as the polyphyly of *Hoffmannius* (discussed below), render Syntropina polyphyletic. The placement of *Paravaejovis pumilis* renders Smeringurinae, Syntropinae, Syntropini and Syntropina paraphyletic.

These results justify the redefinition of Syntropinae, excluding taxa formerly accommodated in Stahnkeini (*Gertschius*, *Serradigitus*, *Stahnkeus* and *Wernerius*) and including taxa formerly accommodated in

Smeringurinae (*Paravaejovis*) and Vaejovinae (*Konetontli*), and the abolition of Paravaejovini, Thorellina and *Hoffmannius* (González-Santillán and Prendini, 2013). As redefined, Syntropinae was monophyletic in two separate analyses of the morphological data, all separate analyses of the molecular data and all simultaneous analyses, and received high RBS (70), GF and GC (100) values on the optimal topology (Appendix 9). The spinose (hooked or toothed) margin of the distal barb of the sclerotized hemi-mating plug is a unique, unambiguous synapomorphy for the subfamily, which was also supported by 30 molecular apomorphies. Six major monophyletic groups and 11 genera were recovered in the subfamily, as follows: ((*Konetontli* + *Maaykuyak*) ((*Syntropis* + *Vizcaino*) ((*Kuarapu* (*Kochius* (*Balsateres* + *Thorellius*))) (*Mesomexovis* (*Chihuahuanus* + *Paravaejovis*)))). As a consequence of the polyphyly of *Hoffmannius*, *Kochius* and *Thorellius*, six new genera were described and the diagnoses of five genera revised by González-Santillán and Prendini (2013).

Abolition of Paravaejovini

Haradon (1984b) was the first to propose that *Paravaejovis pumilis* is closely related and possibly subordinate to the *borregoensis* microgroup of *Paruroctonus*, a hypothesis that has since been widely accepted (Stockwell, 1989, 1992; Lourenço and Sissom, 2000; Sissom, 1990, 2000; Soleglad and Fet, 2008). The *borregoensis* microgroup comprises minute psammophilous vaejovids characterized by the absence of a mid-retrosuperior (mrs) macroseta (part of the retroventral series in the terminology used here) on the basitarsus of leg II, also observed in *Paravaejovis*, which shares with the *borregoensis* microgroup several other characters, some sexually dimorphic, concerning the carapace, pectines, legs and metasoma (Haradon, 1984b).

Stockwell (1989) included *Paravaejovis* as a component of "Paruroctonini" (Table 1 and Fig. 1a), the group that Soleglad and Fet (2008) renamed Smeringurinae (Table 2 and Fig. 2) without testing its monophyly or composition. The putative relationship of *P. pumilis* to *Paruroctonus* and other Smeringurinae, further elaborated by Soleglad and Fet (2003, 2008), was falsified by the analyses presented here. *Paravaejovis pumilis* was not recovered close to *S. grandis*, the exemplar species for Smeringurinae. All except 2% of the separate analyses of the morphological data placed *P. pumilis* in a monophyletic group containing *Vaejovis eusthenura* (Wood, 1863), the type species of *Hoffmannius*, and other species transferred to *Paravaejovis* by González-Santillán and Prendini (2013): this relationship was supported by high GF (74), moderate GC (63) and low RBS (23) values on the optimal topology (Appendix 9). The putatively synapomorphic psammophilous characters uniting *P. pumilis* with the *borregoensis* group and other Smeringurinae are more parsimoniously explained as convergence. The neobothriotaxic pedipalp chela, another diagnostic difference on the basis of which *P. pumilis* was separated from other vaejovids (Williams, 1980; Soleglad and Fet, 2008), may be disregarded as autapomorphic and thus uninformative about its phylogenetic placement.

The placement of *P. pumilis* renders Smeringurinae and Syntropinae paraphyletic (Table 2) and justifies the synonymy of Paravaejovini with Syntropinae (González-Santillán and Prendini, 2013). The inclusion of *P. pumilis* within Syntropinae is not a new hypothesis, however. It was first advanced by Stockwell (1992) as an alternative to placing this species within "Paruroctonini". *Paravaejovis pumilis* shares the diagnostic synapomorphy of Syntropinae, that is, the spinose distal barb margin of the sclerotized hemi-mating plug on the hemispermatophore, which was noted, and yet disregarded, by Stockwell (1989, 1992) and Soleglad and Fet (2008).

Konetontli, *a new genus with a subaculear tubercle*

González-Santillán and Prendini (2013) proposed a new genus, *Konentontli*, to accommodate five species united, among other characters, by the possession of a subaculear tubercle on the telson, an uncommon character among vaejovid scorpions. Only nine vaejovid species (one in synonymy) with a conspicuous subaculear tubercle have been described to date (Haradon, 1974; Williams, 1980, 1986; Sissom, 1993; Armas and Martín-Frías, 2001; Baldazo-Monsivaiz, 2003; Francke and Ponce-Saavedra, 2005; Webber et al., 2012). The subaculear tubercle was suggested as a potential diagnostic synapomorphy for these species (Armas and Martín-Frías, 2001). However, two of them, *Vaejovis mumai* Sissom, 1993 and *Vaejovis spicatus* Haradon, 1974, appeared to be more closely related to *Serradigitus*, based for example on the modified basal pectinal tooth in females (Sissom, 1993). Soleglad and Fet (2008) subsequently created *Wernerius* to accommodate the latter two species (a third was added by Webber et al., 2012), retaining the others in *Vaejovis* (i.e. the *mexicanus* group, all that remained after "new" names were assigned to the other groups). Some previous authors did not consider these species related to members of the *mexicanus* group, however. Williams (1980, 1986) placed the type species, *Vaejovis pattersoni* Williams and Haradon, 1980 and *Vaejovis chamelaensis* Williams, 1986 in the *eusthenura* group. Sissom (2000, p. 542) retained *V. chamelaensis* in the *eusthenura* group but transferred *V. pattersoni* to the *mexicanus* group based on the opinion "that it is closely related to members of the *mexicanus* group (e.g., *V. granulatus* Pocock) from mainland Mexico". The species described subsequently by Armas and Martín-Frías (2001), Baldazo-Monsivaiz (2003) and Francke and Ponce-Saavedra (2005) were also retained in *Vaejovis* (i.e., the *mexicanus* group) by Soleglad and Fet (2008), without testing their phylogenetic position or possible relationship to *Hoffmannius*, the "new" name for Williams' (1970a) *eusthenura* group.

Examination of the subaculear tubercle in the present study confirmed at least two character states, noted earlier by Francke and Ponce-Saavedra (2005), a conical tubercle with a sharp tip in *Wernerius* and a laterally compressed tubercle with a rounded tip in other taxa. These tubercles may be associated with smaller granules, forming a compound subaculear tubercle. Hughes (2011) noted the presence of one or more low subaculear tubercles in *Vaejovis cashi* Graham and Soleglad, 2007, *Vaejovis deborae* Ayrey, 2009 and *Vaejovis electrum* Hughes, 2011, of the *vorhiesi* complex of *Vaejovis*, and *Serradigitus joshuaensis* (Soleglad, 1972). The tubercles of these taxa are much less developed, however, and may represent a third state. A small subaculear tubercle was also observed in an undescribed *Vaejovis* species included in the present study.

Given the diverse taxa in which a subaculear tubercle has been observed, it is unsurprising that it is not synapomorphic for all vaejovids that bear it. The phylogenetic positions of taxa with a subaculear tubercle in the preferred hypothesis suggest multiple independent derivations within the family: two in the *mexicanus* group (*Vaejovis* sp.) and the *vorhiesi* complex (*V. cashi*, *V. deboerae* and *V. electrum*) of *Vaejovis*; two within Stahnkeini (*Wernerius* and *S. joshuaensis*); and one in Syntropinae (*Konetontli*).

The species assigned to *Konetontli* by González-Santillán and Prendini (2013) were monophyletic in all separate analyses of the morphological data and most simultaneous analyses, and were not related to the exemplar species of *Wernerius* or the *mexicanus* group of *Vaejovis* included in the analysis, instead forming a monophyletic group with *Maaykuyak*, placed basal to all other Syntropinae. Their placement in the *mexicanus* group of *Vaejovis* (Sissom, 2000; Francke and Ponce-Saavedra, 2005) and hence in Vaejovinae (Table 2; Soleglad and Fet, 2008) was therefore falsified and the creation of a new genus, *Konetontli*, justified on the basis of their phylogenetic position and unique, diagnostic character combination (González-Santillán and Prendini, 2013). In addition to the laterally compressed subaculear tubercle with a blunt tip, sometimes associated with smaller tubercles situated anteriorly along the ventral median carina of the telson vesicle, *Konetontli* is supported by the position of trichobothrium *ib* at RD7; the matte median surface of tergites III–VI and three molecular apomorphies. The genus received high GF (79), moderate GC (62) and low RBS (39) values on the optimal topology (Appendix 9).

The placement of *Wernerius* within Stahnkeini was confirmed by the separate analyses of the molecular data and by the simultaneous analyses, which placed the exemplar species of this genus in a monophyletic group with *Serradigitus* and *Stahnkeus*, as originally proposed by Sissom (1993), due to the absence of a spinose distal barb margin on the hemi-mating plug of the hemispermatophore and a modified basal pectinal tooth in the female, among other characters.

The undescribed *Vaejovis* species with a subaculear tubercle that resembles the species of *Konetontli* in small body size (14–25 mm), trichobothrium *ib* situated between RD6 and RD7 and mottled, infuscated tergites, was consistently placed within the *mexicanus* group *sensu stricto*, based, among other characters, on the absence of a sclerotized hemi-mating plug.

Maaykuyak, *a new genus of basal Syntropinae*

González-Santillán and Prendini (2013) proposed a new genus, *Maaykuyak*, to accommodate *Vaejovis vittatus* Williams, 1970 and *Vaejovis waueri*. Both species were previously assigned to the *eusthenura* group of *Vaejovis* (Williams, 1980; Sissom, 2000), renamed *Hoffmannius* by Soleglad and Fet (2008), but without quantitatively testing its monophyly or composition. However, *Hoffmannius* was consistently polyphyletic in the analyses presented here. The two species assigned to *Maaykuyak* by González-Santillán and Prendini (2013) were not closely related to the species Soleglad and Fet (2008) assigned to *Hoffmannius*, instead forming a monophyletic group with former members of the *mexicanus* group of *Vaejovis*, assigned to *Konetontli* by González-Santillán and Prendini (2013).

The creation of *Maaykuyak* was based on the phylogenetic position and unique, diagnostic character combination of its component species (González-Santillán and Prendini, 2013). *Maaykuyak* is distinguished from other taxa by the synapomorphy of two retroventral macrosetae on the leg IV telotarsus, instead of three or four as observed in most vaejovid taxa, and is unique among Syntropinae in possessing a moderate oval whitish glandular area medially on the dorsal surface of the telson, which is more developed in males. The metasomal segments of *Maaykuyak* are more setose, especially on the ventral and lateral carinae, than in most other vaejovid taxa, except for a few species of *Mesomexovis* and *Paravaejovis*. *Maaykuyak* was also supported by 12 molecular apomorphies and received high GF and GC (100) values, and moderate RBS values (94) on the optimal topology (Appendix 9).

Polyphyly of Syntropina

Soleglad and Fet (2008) followed Stockwell (1989, 1992) in proposing a sister group relationship between *Syntropis* and the *eusthenura* group species assigned to *Hoffmannius* (Fig. 2), a hypothesis consistently falsified in the analyses presented here (Fig. 6). *Syntropis* was recovered as the sister taxon of *Vizcaino*, the only remnant of *Hoffmannius* with which it was associated, in the majority of analyses, including the optimal topology.

Although the polyphyly of *Hoffmannius* rendered Syntropina polyphyletic, *Syntropis* was consistently monophyletic, with high GF, GC (100) and RBS (98) values on the optimal topology (Appendix 9). The unique apomorphic character combination of this genus includes: high pectinal tooth counts and macrosetal counts on carinae of the pedipalps and metasomal segments; shallow median ocular tubercle; glabrous carapace interocular surface; partial ventral retrolateral carinae of the pedipalp femur; distal landmark macroseta on the prolateral ventral carina of the pedipalp patella aligned with trichobothrium *i*; eight prolateral denticles on the fixed finger of the pedipalp chela, with PD7 and PD8 separated, rather than adjacent; leg basitarsus III with six ventral macrosetae; relatively long pectines in the female; ventral submedian carinae surface of sternite VII with a distinct flat whitish glandular area extending almost the entire length of the segment in the male; terminal granules of the dorsal lateral and lateral median carinae of metasomal segments I–IV similar in size to preceding granules; ventral median carinae on metasomal segments I–IV costate to crenulate. The genus was also supported by 53 molecular apomorphies.

Vizcaino, *a new genus from the Vizcaino Desert*

Vejovis viscainensis Williams, 1980; originally placed in the *eusthenura* group of *Vaejovis*, and then assigned to *Hoffmannius* (Soleglad and Fet, 2008), was among numerous species that rendered *Hoffmannius* polyphyletic in the analyses presented here. This species was not monophyletic with other species assigned to *Hoffmannius*, and was monophyletic with *Syntropis* in the simultaneous analyses with gaps as a fifth state, and the optimal topology (Figs 5a and 6).

The creation of a monotypic genus for this species was justified on the basis of its phylogenetic position and unique, diagnostic character combination (González-Santillán and Prendini, 2013). A unique combination of apomorphic psammophilous character states, including slender, elongate spinules of the basitarsi and telotarsi and setal combs on legs I–III in both sexes, distinguishes *Vizcaino* from other syntropine genera. Other characters include: five rows of median denticles on the chela movable finger, with the first row, usually represented by one to three granules, being absent; trichobothria *ib* and *it* situated at RD6 and between RD5 and RD6, respectively; the proximal row of spinules on the ventral surface of the telotarsi arranged as a loop or cluster; and 53 molecular apomorphies. *Vizcaino* was consistently monophyletic with high GF, GC (100) and RBS (97) values on the optimal topology (Appendix 9).

Abolition of Thorelliina

Although Sissom (1989b) suggested a possible relationship between the former *intrepidus* and *punctipalpi* groups of *Vaejovis*, Soleglad and Fet (2008) were the first to formalize it when they united the two groups, renamed *Thorellius* and *Kochius*, respectively, into subtribe Thorelliina. Thorelliina was monophyletic in all separate analyses of the molecular data and all simultaneous analyses, and corresponds to the group (*Balsateres* (*Kochius* + *Thorellius*)), but its position rendered Syntropina paraphyletic and it was therefore abolished by González-Santillán and Prendini (2013).

Thorelliina was recovered within a larger group, the *Kochius* clade, containing the monotypic genus *Kuarapu*, in all separate analyses of the molecular data and most simultaneous analyses, but was weakly supported (GF, 38; GC, 22; RBS, 64) in the optimal topology (Appendix 9). The *Kochius* clade was supported by low setal counts on the dorsolateral and ventrosubmedian carinae of metasomal segment IV, retrolateral and prolateral carinae of the pedipalp femur, ventral median carina of the patella and retrolateral median carina of the chela, and by four molecular apomorphies (Appendix 9). *Kochius* and *Kuarapu* share the presence of a distinct, raised, whitish triangular boss, restricted to the posteromedial third of sternite VII in the male.

Position of Kuarapu

Francke and Ponce-Saavedra (2010) discussed the placement of *Kuarapu* in the context of Soleglad and Fet's (2008) classification, and offered two alternatives: placement within Syntropini (Table 2), based on the spinose distal barb margin of the hemi-mating plug of the male hemispermatophore; or within Stahnkeini, based on the medial position of trichobothria *ib* and *it* on the pedipalp chela fixed finger. The analyses presented here confirm the first hypothesis, based on the spinose distal barb margin of the hemi-mating plug, uniquely synapomorphic for Syntropinae. The presence of four or five (most commonly four) ventrodistal spinules of the leg telotarsi, noted by Francke and Ponce-Saavedra (2010), also supports this placement.

The alternative hypothesis offered by Francke and Ponce-Saavedra (2010), suggesting that the spinose margin evolved independently in *Kuarapu* and Syntropinae, was falsified. According to these authors, the medial position of trichobothria *ib* and *it* on the pedipalp chela fixed finger is potentially synapomorphic for *Kuarapu*, *Stahnkeus* and *Serradigitus*. However, reinterpretation of this character, based on the placeholder approach (Prendini et al., 2010), revealed the same derivation in other Syntropinae not considered by Francke and Ponce-Saavedra (2010). Trichobothrium *ib* is situated at RD6 and *it* between RD5 and RD6 in *Vizcaino* and several species of *Paravaejovis*, for example, *Paravaejovis confusus* (Stahnke, 1940), as well as *Kuarapu*, *Stahnkeus* and *Serradigitus*. Therefore, this character is not synapomorphic for *Kuarapu*, *Stahnkeus* and *Serradigitus*, but evolved independently in these taxa.

Francke and Ponce-Saavedra (2010) argued further that *Kuarapu* and Stahnkeini could be related based on the serrate condition of the pedipalp finger dentition and its hook-like termination. A reassessment revealed that the dentition of *Kuarapu* resembles other Syntropinae, in which the retrolateral and median denticles are rounded and similar in size to the prolateral denticles, rather than most Stahnkeini (except *Gertschius*, *Wernerius* and *Vaejovis pequeno*), in which the retrolateral and median denticles are laterally compressed and more prominent than the prolateral denticles, which are rounded. The serrated condition of the fingers of *Kuarapu* is modest, and evident mainly in the distal rows of median denticles, but never approaches the condition observed in *Serradigitus* and *Stahnkeus*. However, the enlarged terminal denticles on the pedipalp chela fixed and movable fingers of *Kuarapu* resemble those of *Serradigitus* and *Stahnkeus*. Other characters of *Kuarapu* include a shallow median ocular tubercle, long pectines and 75 molecular apomorphies.

Balsateres, *a new genus from the Balsas Depression*

The original description of *Vaejovis cisnerosi* Ponce-Saavedra and Sissom, 2004 noted that this species is unique in possessing obsolete, smooth carinae on the dorsal and lateral surfaces of the metasoma, and the lowest count of metasomal setae among vaejovids. Ponce-Saavedra and Sissom (2004) refrained from assigning *V. cisnerosi* to one of the five species groups of *Vaejovis* recognized at the time, on account of its unique morphology. Soleglad and Fet (2008) subsequently assigned it to *Thorellius*, Hoffmann's (1931) "second section" of *Vaejovis*, later termed the *intrepidus* group by Sissom (1989b), based on the absence of an anterior emargination of the carapace, the moderately robust manus with pronounced carinae of the pedipalp chela and the position of trichobothrium *Dt* distal to the midpoint of the manus. Santibáñez-López and Sissom (2010) also referred this species to the *intrepidus* group.

The creation of a monotypic genus for this species was justified by its unique diagnostic character combination (González-Santillán and Prendini, 2013). Seven synapomorphic character states, associated with its glabrous integument, support the genus: partially developed, smooth prolateral dorsal carinae of the pedipalp chela; smooth median lateral, posterolateral and posteromedian surfaces of the carapace and intercarinal surfaces of the post-tergites; smooth dorsal lateral carinae of metasomal segments I–IV; absence of lateral median carinae on segments I–III and V. Additional characters include smooth lateral inframedian carinae on metasomal segment I; smooth lateral median carinae on segment IV; vestigial, smooth ventral lateral carinae on segment V; absence of ventral lateral carinae on segments I–IV and dorsal lateral and ventral median carinae on segment V; and 44 molecular apomorphies. *Balsateres* received high support values (GF and GC, 100; RBS, 100) on the optimal topology (Appendix 9).

Polyphyly and redefinition of Thorellius

González-Santillán and Prendini (2013) redefined *Thorellius* to accommodate a subset of species originally assigned to Hoffmann's (1931) "second section" of *Vaejovis*, later termed the *intrepidus* group by Sissom (1989b), and renamed *Thorellius* by Soleglad and Fet (2008), without quantitatively testing its monophyly or composition. As defined by Soleglad and Fet (2008), *Thorellius* was consistently polyphyletic, and the group of species assigned to it by González-Santillán and Prendini (2013) consistently monophyletic in the analyses presented here, with high support values (GF and GC, 100; RBS, 84) on the optimal topology (Appendix 9).

Vaejovis occidentalis Hoffmann, 1931 and *Vaejovis subcristatus* Pocock, 1898, previously assigned to the *intrepidus* group of *Vaejovis* (Sissom, 1989b; Lourenço and Sissom, 2000; Sissom, 2000) and then to *Thorellius* (Soleglad and Fet, 2008), were consistently monophyletic with the other species assigned to *Mesomexovis* by González-Santillán and Prendini (2013), to which they were transferred accordingly. Soleglad and Fet (2008) noted the comparatively slender chelae and weak granulation of these species, but failed to test those observations quantitatively. González-Santillán and Prendini (2013) created *Balsateres* to accommodate *Vaejovis cisnerosi*, formerly placed in *Thorellius* by Soleglad and Fet (2008) and in the *intrepidus* group by Santibáñez-López and Sissom (2010).

Soleglad and Fet's (2008) four putative diagnostic characters fail to satisfactorily delimit *Thorellius*. The first character, absence of indentation on the anterior carapace margin, is a point on a continuum. Among the taxa included in the present analysis, a straight or convex margin without an indentation also occurs in *Kuarapu*, *Smeringurus*, *Syntropis*, *Vaejovis*, *Vizcaino* and some species of *Paravaejovis*. Shallow, moderate or deep emarginations are observed in *Mesomexovis oaxaca* (Santibáñez-López and Sissom, 2010), *Thorellius cristimanus* (Pocock, 1898) and *Chihuahuanus crassimanus* (Pocock, 1898), respectively. The second character, a morphometric ratio of metasomal segments IV and V, was based on measurements of "selected species". The criteria for selection were unspecified but imply an assumption of monophyly that was not tested. The third character, carinae of metasomal segments I–III smooth to granular, represents the range of variation in ornamentation of any carina on a scorpion. The fourth character, chelal carinae usually smooth to "strongly marbled" may refer to ornamentation (smooth) or pigmentation (marbled), and suffers from the same problems as the third.

As redefined by González-Santillán and Prendini (2013), *Thorellius* is supported by the following character combination: partially developed, granular retrolateral dorsal carina of the pedipalp chela; dark brown to reddish-brown base colour of the carapace; infuscate dorsal intercarinal surfaces of the pedipalp femur and patella; high macrosetal counts on the dorsolateral carinae of metasomal segments I–IV; and five molecular apomorphies.

Polyphyly and redefinition of Kochius

González-Santillán and Prendini (2013) redefined *Kochius* to accommodate species originally assigned only to Williams' (1971a) *punctipalpi* group of *Vaejovis*, renamed *Kochius* by Soleglad and Fet (2008) without quantitatively testing its monophyly or composition. As defined by Soleglad and Fet (2008), *Kochius* was consistently polyphyletic, and the group of species assigned to it by González-Santillán and Prendini (2013) consistently monophyletic in the analyses presented here, with high support values (GF and GC, 100; RBS, 83) on the optimal topology (Appendix 9).

Vaejovis cazieri Williams, 1968; *Vaejovis crassimanus* Pocock, 1898 and *Vaejovis russelli* Williams, 1971, previously assigned to the *punctipalpi* group of *Vaejovis* (Williams, 1971a,b; Sissom, 2000) and then to *Kochius* (Soleglad and Fet, 2008), and *Kochius kovariki* Soleglad and Fet, 2008, were consistently monophyletic with the other species assigned to *Chihuahuanus* by González-Santillán and Prendini (2013), to which they were transferred accordingly. *Vaejovis atenango* Francke and González-Santillán, 2007, previously assigned to the *punctipalpi* group (Francke and González-Santillán, 2007) and then to *Kochius* (Soleglad and Fet, 2008), was consistently monophyletic with the other species assigned to *Mesomexovis* by González-Santillán and Prendini (2013), to which it was transferred accordingly. Soleglad and Fet (2008) noted the relatively more slender pedipalp chelae, reduced granulation and broader metasomal segments of these five species, compared with other species of *Kochius*, but failed to test those observations quantitatively.

Soleglad and Fet's (2008) four putative diagnostic characters fail to satisfactorily delimit *Kochius*. The first character, the "well defined, but subtle, anterior emargination" of the carapace, and the second character, the morphometric ratio of metasomal segments IV and V, were criticized above. The third and fourth characters, concerning the development and granulation of the pedipalp chela carinae and the ventral submedian carinae of metasomal segments I–III, although rather unspecific, appear to be more reliable and an attempt was made to describe them more precisely (González-Santillán and Prendini, 2013).

As redefined by González-Santillán and Prendini (2013), *Kochius* is supported by the following character combination: densely shagreened intercarinal surfaces of post-tergites I–VII and sternite VII; low macrosetal counts on the retrolateral dorsosubmedian and prolateral ventral carinae of the pedipalp femur, ventral prolateral carinae of the pedipalp patella, and dorsal median and retrolateral median carinae of the pedipalp chela; prolateral ventral carina absent and ventral retrolateral carina partially developed on the pedipalp femur; markedly granular retrolateral dorsosubmedian and retrolateral median carinae of the pedipalp patella; trichobothrium Eb_1 situated on the ventral retrolateral carina and trichobothrium V_4 on the ventral surface of the pedipalp chela manus; and five molecular apomorphies.

Mesomexovis*, a new genus from central Mexico*

González-Santillán and Prendini (2013) created a new genus, *Mesomexovis*, to accommodate seven species previously assigned to the *eusthenura*, *intrepidus* and *punctipalpi* groups of *Vaejovis*. These groups, first proposed by Hoffmann (1931), Williams (1970a, 1971a) and Sissom (1989b), were respectively renamed *Hoffmannius*, *Thorellius* and *Kochius* by Soleglad and Fet (2008) without quantitatively testing their monophyly and composition. However, all three genera, as defined by Soleglad and Fet (2008), were consistently polyphyletic, and the group of species assigned to *Mesomexovis* by González-Santillán and Prendini (2013) consistently monophyletic in all separate analyses of the molecular data and all simultaneous analyses of the molecular and morphological data.

Mesomexovis is supported by high macrosetal counts on the dorsolateral carinae of metasomal segments III–V; eight retroventral macrosetae on the basitarsus of leg III, and nine molecular apomorphies. Although the genus received low GF (54), GC (38) and RBS (39) values on the optimal topology (Appendix 9), it was insensitive to variation in implied weighting regime and gap treatment (as a fifth state or missing data).

Mesomexovis atenango (Francke and González-Santillán, 2007) was placed basal to other species of the genus in the preferred hypothesis, with high RBS (98), GF and GC (100) values (Appendix 9). It was previously assigned to the *punctipalpi* group of *Vaejovis* (Francke and González-Santillán, 2007) and then to *Kochius* (Soleglad and Fet, 2008), based on the weak carinae of the pedipalp chela and ventral surfaces of metasomal segments I–IV. However, this species lacks the diagnostic characters of *Kochius*, for example the raised whitish triangular boss in the posteromedial third of sternite VII.

Mesomexovis occidentalis (Hoffmann, 1931) and *Mesomexovis subcristatus* (Pocock, 1898) were previously assigned to Hoffmann's (1931) "second section" of *Vaejovis*, later termed the *intrepidus* group by Sissom (1989b): these species were erroneously assigned to *Thorellius* by Soleglad and Fet (2008) because relevant characters were not tested quantitatively. Soleglad and Fet's (2008) putatively diagnostic morphometric ratios indicated that the pedipalp chela manus of both species is less robust than others assigned to *Thorellius*. Additionally, *M. occidentalis* and *M. subcristatus* possess a maximum of eight retroventral macrosetae on the basitarsus of leg III, rather than nine as in *Thorellius*. The total body length and pectinal tooth counts of males and females in both species are also lower than in *Thorellius*. On the other hand, these characters are similar to those observed in other species of *Mesomexovis*.

Chihuahuanus, *a new genus from the Chihuahuan Desert*

González-Santillán and Prendini (2013) created a new genus, *Chihuahuanus*, to accommodate eight species previously assigned to Williams' (1970a, 1971a) *eusthenura* and *punctipalpi* groups of *Vaejovis*, many of which were originally part of Hoffmann's (1931) "first section" of that genus. Soleglad and Fet (2008) renamed these groups *Hoffmannius* and *Kochius*, respectively, without quantitatively testing their monophyly and composition. However, both genera, as defined by Soleglad and Fet (2008), were consistently polyphyletic, and the group of species assigned to *Chihuahuanus* by González-Santillán and Prendini (2013) consistently monophyletic in the separate analyses of the molecular data and in the simultaneous analyses.

The species of *Chihuahuanus* uniquely exhibit a small to moderate white fusiform glandular area on the dorsal surface of the telson vesicle, anterior to the base of the aculeus, and trichobothrium *et* is situated between RD3 and RD4 in all except *Chihuahuanus bilineatus* (Pocock, 1898), in which it is situated at RD4. *Chihuahuanus* was supported by ten molecular apomorphies, received high GF values (80) and moderate GC (70) and RBS (60) values on the optimal topology (Appendix 9), and was insensitive to variation in the implied weighting regime and gap treatment (as a fifth state or missing data).

Chihuahuanus cazieri (Williams, 1968), *Chihuahuanus crassimanus* (Pocock, 1898) and *Chihuahuanus russelli* (Williams, 1971a,b) were previously assigned to the *punctipalpi* group (Williams, 1971a,b; Lourenço and Sissom, 2000; Sissom, 2000) and then, along with *Chihuahuanus kovariki* (Soleglad and Fet, 2008), to *Kochius*. *Chihuahuanus kovariki* was deeply nested within *Chihuahuanus*, sister to *C. glabrimanus*, whereas the other three species formed a basal monophyletic group. The superficial resemblance of these species to *Kochius* was apparently based on the emarginate anterior carapace margin, which presents a small median indentation, and the finely granular carinae of the pedipalp chela and ventral surfaces of the metasomal segments (Soleglad and Fet, 2008). However, these species lack the markedly granular retrolateral dorsosubmedian and retrolateral median carinae of the pedipalp patella, which are unique to *Kochius*.

Abolition of Hoffmannius *and redefinition of* Paravaejovis

Hoffmannius was created to accommodate species mostly assigned to Williams' (1970a) *eusthenura* group of *Vaejovis*, and Hoffmann's (1931) "first section" of *Vaejovis*, before it. However, this genus was consistently polyphyletic in the phylogenetic analyses presented. Species assigned to *Maaykuyak*, *Mesomexovis* and *Vizcaino* by González-Santillán and Prendini (2013), which formerly resided in the *eusthenura* group (Williams, 1970a, 1980; Lourenço and Sissom, 2000; Sissom, 2000) and were subsequently transferred to *Hoffmannius* (Soleglad and Fet, 2008), were not monophyletic with the other species assigned to *Hoffmannius* in some or all analyses.

Furthermore, *Paravaejovis pumilis*, type species of the monotypic genus, *Paravaejovis*, was retrieved, in all except 2% of the separate analyses of the morphological data, in a monophyletic group containing *Vaejovis eusthenura*, the type species of *Hoffmannius*, implying that *Hoffmannius* is a junior synonym of

Paravaejovis. In view of the unambiguous phylogenetic position of the type species of *Paravaejovis*, González-Santillán and Prendini (2013) abolished *Hoffmannius*. Ten species, formerly placed in the *eusthenura* group and/or *Hoffmannius*, were transferred to *Paravaejovis*, four species to *Chihuahuanus*, and four to *Mesomexovis*. Many of these species, for example, *Chihuahuanus bilineatus*, *Chihuahuanus coahuilae* (Williams, 1968), *Paravaejovis gravicaudus* (Williams, 1970) and *Paravaejovis spinigerus* (Wood, 1863), and the species of *Mesomexovis*, resemble one another in possessing smooth carinae on the pedipalp chelae, variegated pigmentation patterns on the carapace and tergites, and smooth, pigmented carinae on the ventral surfaces of the metasoma. These similarities, which are most parsimoniously explained by convergence, may account for their previous recognition as members of the same genus or species group (Lourenço and Sissom, 2000; Sissom, 2000; Soleglad and Fet, 2008). The three genera, placed in a pectinate arrangement, (*Mesomexovis* (*Chihuahuanus* + *Paravaejovis*)), formed the sister group of the *Kochius* clade in the optimal topology.

As redefined by González-Santillán and Prendini (2013), *Paravaejovis* was supported by six molecular apomorphies and trichobothrium Et_5 situated at the base of the fixed finger, aligned with or distal to the articulation, and removed from trichobothrium Et_4. The genus was insensitive to variation in the implied weighting regime and gap treatment (as a fifth state or missing data) and was consistently recovered in all separate analyses of the molecular data and all simultaneous analyses (Table 5), despite moderate GF values (74) and low GC (63) and RBS (23) values on the optimal topology (Appendix 9).

Relationships within Vaejovinae

Although not the focus of this study, relationships among exemplars of the paraphyletic outgroup Vaejovinae portrayed by the optimal topology (Fig. 6) confirmed some previous hypotheses and falsified others. A monophyletic group comprising (*Vaejovis intermedius* (*Franckeus kochi* + *Vaejovis carolinianus*)), recovered in all separate molecular and simultaneous analyses, received high GF and GC (100) values and moderate RBS (69) values on the optimal topology (Appendix 9). This group corresponds to the *nitidulus* group of *Vaejovis* originally defined by Sissom and Francke (1985), for which Stockwell (1989) proposed the name "Sissomiini" (Table 1 and Fig. 1a). Its composition calls into question subsequent decisions to transfer *Vaejovis carolinianus* (Beauvois, 1805) to the *mexicanus* group of *Vaejovis* (Sissom, 1991a; Stockwell, 1996; Capes, 2001; Sissom and González-Santillán, 2004) and create a new genus, *Franckeus* Soleglad and Fet, 2005, for a section of the group bearing a single accessory trichobothrium (Soleglad and Fet, 2005).

A monophyletic group comprising *Uroctonites giulianii* (Williams and Savary, 1991) and *Pseudouroctonus glimmei* (Hjelle, 1972), recovered in all separate morphological and simultaneous analyses, received high GF (88) and GC (79) values and low RBS (32) values on the optimal topology (Appendix 9). This group corresponds, in part, to the "Uroctonini" originally defined by Stockwell (1989; Table 1 and Fig. 1a) and accommodated within Vaejovinae by Soleglad and Fet (2008; Table 2 and Fig. 2).

The placement of various species currently assigned to *Vaejovis* confirms the paraphyly of this genus (Soleglad, 1973; Sissom, 2000). A monophyletic group comprising *Vaejovis rossmani* Sissom, 1989, *Vaejovis mexicanus* C.L. Koch, 1836 and an undescribed species of *Vaejovis*, recovered in all analyses, received high GF, GC (100) and RBS (77) values on the optimal topology (Appendix 9). This group corresponds to the *mexicanus* group *sensu stricto* (Santibáñez-López and Francke, 2010). Placement of "Uroctonini" sister to the *mexicanus* group *sensu stricto*, to the exclusion the *Vaejovis lapidicola* (Stahnke, 1940), an exemplar of the *vorhiesi* complex (Sissom, 2000; McWest, 2009; Ayrey and Soleglad, 2011; Ayrey, 2012), in all analyses also confirms the paraphyly of the *mexicanus* group (Ayrey, 2009; Graham and Bryson, 2010; Hughes, 2011; Graham et al., 2012).

Diversification and biogeography of Syntropinae

Many genera and more inclusive clades of Syntropinae are geographically delimited (González-Santillán and Prendini, 2013). For example, *Chihuahuanus*, *Mesomexovis* and *Paravaejovis* are each distributed in biogeographical regions with unique physiography, geology, fauna and flora (i.e. Goldman and Moore, 1945; Riddle and Hafner, 2006); *Chihuahuanus* is endemic to the Chihuahuan desert; *Mesomexovis* is distributed along the Pacific coast of Mexico and the slopes of the Trans-Mexican Volcanic Belt (TMVB); *Paravaejovis* ranges from the Baja California Peninsula to the Sonoran, Mojave and Great Basin deserts.

Vicariance, induced by three major geological events, probably accounts for much of the diversification and distribution of Syntropinae. First, the orogeny of the Sierra Madre Occidental during the Miocene, ca. 34–27 Ma (Axelrod, 1979; Ortega-Gutiérrez and Guerrero-García, 1982) may have promoted vicariance between taxa distributed to the east and west, and allopatric speciation in the intervening valleys and ranges. This would account for the distributions of taxa such as *Chihuahuanus* and

Maaykuyak waueri, which are endemic to the Chihuahuan desert.

Second, the separation of the Baja California Peninsula from the mainland during the late Miocene, ca. 12–5 Ma (Gastil et al., 1983) may have promoted vicariance between taxa distributed on the peninsula and the mainland, explaining the disjunct distributions of several clades and genera: *Maaykuyak*, with *Maaykuyak vittatus* (Williams, 1970) on the peninsula and *M. waueri* in the Chihuahuan Desert; *Konetontli*, with one species on the peninsula and the others along the Pacific coast of Mexico; the *Kochius* clade, with *Kochius* on the peninsula and adjacent Sonoran and Mojave deserts, and *Balsateres*, *Kuarapu* and *Thorellius* along the Pacific coast and in central Mexico. Divergence in isolation on the peninsula may account for its endemic genera, *Syntropis* and *Vizcaino*, and the much higher diversity and endemism of *Kochius* and *Paravaejovis*, compared with the deserts of the mainland.

Third, uplift of the TMVB during the Miocene, ca. 11–7 Ma (Ortega-Gutiérrez and Guerrero-García, 1982; Ferrari et al., 2000; Ferrusquía-Villafranca and González-Guzmán, 2005) may have created a barrier that promoted vicariance between taxa distributed to the north and south, and promoted allopatric speciation in the intervening valleys and ranges. This would account for the distributions of taxa such as *Mesomexovis* and *Thorellius*, restricted to the area south of the TMVB.

The emergence of sandy and rocky deserts in the Baja California Peninsula, northern Mexico and the southwestern USA appears to be responsible for the diversification of substratum-specialist psammophilous and, to a lesser extent, lithophilous species, in accordance with the model proposed by Prendini (2001a). The results presented here imply that psammophily evolved independently on multiple occasions: in *Balsateres*, inhabiting the Balsas Depression; several species of *Chihuahuanus*, for example, *Chihuahuanus globosus* (Borelli, 1915), inhabiting the Chihuahuan Desert; most species of *Paravaejovis* inhabiting the Baja California Peninsula and extending into the Mojave and Sonoran deserts; and *Vizcaino*, inhabiting the Vizcaino Desert of the Baja California Peninsula. Lithophily evolved independently in *Kuarapu*, inhabiting the Balsas Depression, and *Syntropis*, inhabiting the Baja California Peninsula (as well as *Stahnkeus* and *Serradigitus* inhabiting the Mojave, Sonora and Great Basin deserts).

The diversity and distributions of Syntropinae appear to be explained mostly by a combination of vicariance, induced by geological events, and allopatric speciation, promoted by substratum-specialization. It remains unclear, however, as to why the distribution of Syntropinae does not extend beyond the Isthmus of Tehuantepec, where the habitat (e.g. on the Yucatan Peninsula) is similar to that in other subtropical areas inhabited by members of the subfamily (e.g. *Konetontli*, *Mesomexovis* and *Thorellius*) and where two other speciose scorpion genera – the buthid, *Centruroides* Marx, 1890, and the diplocentrid, *Diplocentrus* Peters, 1861, ubiquitous and sympatric with Syntropinae throughout most of their distribution – occur.

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References

Acosta, E., Candido, D.M., Buckup, H., Brescovit, A.D., 2008. Description of *Zabius gaucho* (Scorpiones, Buthidae), a new species from southern Brazil, with an update about the generic diagnosis. J. Arachnol. 36, 491–501.

Alvarez-Padilla, F., Dimitrov, D., Giribet, G., Hormiga, G., 2009. Phylogenetic relationships of the spider family Tetragnathidae (Araneae, Araneoidea) based on morphological and DNA sequence data. Cladistics 25, 109–146.

Arango, C.P., Wheeler, W.C., 2007. Phylogeny of the sea spiders (Arthropoda, Pycnpogonida) based on direct optimization of six loci and morphology. Cladistics 23, 255–293.

Archie, J.W., 1985. Methods for coding variable morphological features for numerical taxonomic analysis. Syst. Zool. 34, 326–345.

Armas, L.F. de., Martín-Frías, E., 2001. Dos nuevos *Vaejovis* (Scorpiones: Vaejovidae) de Guerrero y Nayarit, México. Solenodon 1, 8–16.

Axelrod, D.I., 1979. Age and origin of Sonoran Desert vegetation. Occas. Pap. Calif. Acad. Sci. 132, 1–74.

Ayrey, R.F., 2009. Sky Island *Vaejovis*: a new species (Scorpiones: Vaejovidae). Euscorpius 86, 1–12.

Ayrey, R.F., 2012. A new *Vaejovis* from the Mogollon Highlands of northern Arizona (Scorpiones: Vaejovidae). Euscorpius 148, 1–13.

Ayrey, R.F., Soleglad, M.E., 2011. A new species of *Vaejovis* from Prescott, Arizona (Scorpiones: Vaejovidae). Euscorpius 114, 1–15.

Baker, R.H., DeSalle, R., 1997. Multiple sources of character information and the phylogeny of Hawaiian *Drosophila*. Syst. Biol. 46, 654–673.

Baldazo-Monsivaiz, J.G., 2003. *Vaejovis zihuatanejensis*, nueva especie de alacran del Estado de Guerrero, México (Scorpiones: Vaejovidae). Entomol. Mex. 2, 67–72.

Bremer, K., 1994. Branch support and tree stability. Cladistics 10, 295–304.

Brower, A.V.Z., 2006. The how and why of branch support and partitioned branch support, with a new index to assess partition incongruence. Cladistics 4, 378–386.

Bryant, H.N., 1995. Why autapomorphies should be removed: a reply to Yeates. Cladistics 11, 381–384.

Buckley, T.R., Simon, C., Flook, P.K., Misof, B., 2000. Secondary structure and conserved motifs of the frequently sequenced domains IV and V of the insect mitochondrial large subunit rRNA gene. Insect Mol. Biol. 9, 565–580.

Capes, E.M., 2001. Description of a new species in the *nitidulus* group of the genus *Vaejovis* (Scorpiones, Vaejovidae). J. Arachnol. 29, 42–46.

Cranston, P.S., Humphries, C.J., 1988. Cladistics and computers: a chironomid conundrum? Cladistics 4, 72–92.

Crowe, T.M., 1994. Morphometrics, phylogenetic models and cladistics – means to an end or much to do about nothing. Cladistics 10, 77–84.

DeSalle, R., Freedman, T., Prager, E.M., Wilson, A.C., 1987. Tempo and mode of sequence evolution in mitochondrial DNA of Hawaiian *Drosophila*. J. Mol. Evol. 26, 157–164.

Edgecombe, G.D., Wilson, G.D.F., Colgan, D.J., Gray, M.R., Cassis, G., 2000. Arthropod cladistics: combined analysis of histone H3 and U2 snRNA sequences and morphology. Cladistics 16, 155–203.

Farris, J.S., 1970. Methods for computing Wagner trees. Syst. Zool. 19, 83–92.

Farris, J.S. 1983. The logical basis of phylogenetic analysis. In: Platnick, N.I., Funk, V.A. (Eds.), Advances in Cladistics. Columbia University Press, New York, pp. 7–36.

Farris, J.S., 1986. On the boundaries of phylogenetic analyses. Cladistics 2, 14–27.

Farris, J.S., 1990. Phenetics in camouflage. Cladistics 6, 91–100.

Farris, J.S., Kluge, A.G., 1986. Synapomorphy, parsimony, and evidence. Taxon 35, 298–306.

Felsenstein, J., 1988. Phylogenies and quantitative characters. Ann. Rev. Ecol. Evol. Syst. 19, 445–471.

Ferrari, L., Conticelli, S., Vaggelli, G., Petrone, C.M., Manetti, P., 2000. Late Miocene volcanism and inter-arc tectonics during the early development of the Trans-Mexican Volcanic Belt. Tectonophysics 318, 161–185.

Ferrusquía-Villafranca, I., González-Guzmán, L.I. 2005. Northern Mexico's landscape, Part II: the biotic setting across time. In: Cartron, J.-L., Ceballos, E.C., Felger, R.S. (Eds.), Biodiversity, Ecosystems, and Conservation in Northern Mexico. Oxford University Press, New York, pp. 39–51.

Fet, V., Soleglad, M.E., 2002. Morphology analysis supports presence of more than one species in the "*Euscorpius carpathicus*" complex (Scorpiones: Euscorpiidae). Euscorpius 31, 1–13.

Fet, V., Soleglad, M.E., Barker, M.D. 2001. Phylogeny of the "hirsutus" group of the genus *Hadrurus* Thorell, 1876 based on morphology and mitochondrial DNA (Scorpiones: Iuridae). In: Fet, V., Selden, P.A. (Eds.), Scorpions 2001. In Memoriam Gary A. Polis. British Arachnological Society, Burnham Beeches, UK, pp. 139–160.

Fet, V., Gantenbein, B., Fet, E.V., Popa, V., 2002. *Euscorpius carpathicus* (Linneaus, 1767) from Romania (Scorpiones: Euscorpiidae): Mitochondrial DNA data. Biogeographica 78, 141–147.

Fet, V., Gantenbein, B., Gromov, A.V., Lowe, G., Lourenço, W.R., 2003. The first molecular phylogeny of Buthidae (Scorpiones). Euscorpius 4, 1–10.

Fet, V., Soleglad, M.E., Brewer, M.S., Neff, D.P.A., Norton, M.L., 2006. Vestigial serrula in scorpion genera *Paravaejovis*, *Paruroctonus*, *Smeringurus* and *Vejovoidus* (Scorpiones: Vaejovidae). Euscorpius 49, 1–10.

Fitch, W.M., 1971. Toward defining the course of evolution: minimum change for a specified tree topology. Syst. Zool. 20, 406–416.

Fitzhugh, K., 2006. The philosophical basis of character coding for the inference of phylogenetic hypotheses. Zool. Scr. 35, 261–286.

Folmer, O., Black, M., Hoeh, W., Lutz, R., Vrijenhoek, R., 1994. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates. Mol. Mar. Biol. Biotechnol. 3, 294–299.

Francke, O.F., 1975. A new species of *Diplocentrus* from New Mexico and Arizona (Scorpionida: Diplocentridae). J. Arachnol. 2, 107–118.

Francke, O.F., 1977. Scorpions of the genus *Diplocentrus* Peters from Oaxaca, Mexico. J. Arachnol. 4, 145–200.

Francke, O.F., 1982. Studies of the scorpion subfamilies Superstitioninae and Typhlochactinae, with description of a new genus (Scorpiones, Chactidae). Bull. Assoc. Mex. Cave Stud. Texas Mem. Mus. 8, 51–61.

Francke, O.F., González-Santillán, E., 2007. A new species belonging to the *Vaejovis punctipalpi* group (Scorpiones, Vaejovidae) from southern Mexico. J. Arachnol. 34, 586–591.

Francke, O.F., Ponce-Saavedra, J., 2005. A new *Vaejovis* (Scorpiones: Vaejovidae) with a subaculear tooth from Michoacán, Mexico. Revista Ibérica de Aracnología 12, 63–68.

Francke, O.F., Ponce-Saavedra, J., 2010. A new genus and species of scorpion (Scorpiones: Vaejovidae) from Michoacán, Mexico. Bol. Soc. Entomol. Aragonesa 46, 51–57.

Francke, O.F., Prendini, L., 2008. Phylogeny and classification of the giant hairy scorpions, *Hadrurus* Thorell (Iuridae Thorell): a reappraisal. Syst. Biodivers. 6, 205–223.

Francke, O.F., Soleglad, M.E., 1981. The family Iuridae Thorell (Arachnida, Scorpiones). J. Arachnol. 9, 233–258.

Gantenbein, B., Fet, V., Barker, M.D. 2001. Mitochondrial DNA reveals a deep, divergent phylogeny in *Centruroides excilicauda* (Wood, 1863) (Scorpiones: Buthidae). In: Fet, V., Selden, P.A.

(Eds.), Scorpions 2001. In Memoriam Gary A. Polis. British Arachnological Society, Burnham Beeches, UK, pp. 235–244.

Gastil, B., Minch, J., Phillips, R.P. 1983. The geology and ages of islands. In: Case, T.J., Cody, M.L. (Eds.), Island Biogeography in the Sea of Cortez. University of California Press, San Diego, pp. 13–25.

Gertsch, W.J., Soleglad, M.E., 1972. Studies of North American scorpions of the genus *Uroctonus* and *Vejovis*. Bull. Am. Mus. Nat. Hist. 148, 549–608.

Giribet, G., 2003. Stability in phylogenetic formulations, and its relationship to nodal support. Syst. Biol. 52, 554–564.

Giribet, G., Carranza, S., Baguñá, J., Riutort, M., Ribera, C., 1996. First molecular evidence for the existence of a Tardigrada + Arthropoda clade. Mol. Biol. Evol. 13, 76–84.

Glastad, K.M., Hunt, B.G., Yi, S.V., Goodisman, M.A.D., 2011. DNA methylation in insects: on the brink of the epigenomic era. Insect Mol. Biol. 20, 553–565.

Goldman, N., 1988. Methods for discrete coding of morphological characters for numerical analysis. Cladistics 4, 59–71.

Goldman, E.A., Moore, R.T., 1945. The biotic provinces of Mexico. J. Mammal. 26, 347–360.

Goloboff, P.A., 1993. Estimating character weights during tree search. Cladistics 9, 83–91.

Goloboff, P.A., 1998. Tree searches under Sankoff parsimony. Cladistics 14, 229–237.

Goloboff, P.A., 1999. Analyzing large data sets in reasonable times: solutions for composite optima. Cladistics 15, 415–428.

Goloboff, P.A., Farris, J.S., 2001. Methods for quick consensus estimation. Cladistics 17, S26–S34.

Goloboff, P.A., Farris, J.S., Källersjö, M., Oxelman, B., Ramírez, M.J., Szumik, C.A., 2003a. Improvements to resampling measures of group support. Cladistics 19, 324–332.

Goloboff, P.A., Farris, J.S., Nixon, K.C. 2003b. T.N.T. Tree Analysis Using New Technology. Program and documentation available from the authors and at www.zmuc.dk/public/phylogeny

Goloboff, P.A., Mattoni, C.A., Quinteros, A.S., 2006. Continuous characters analyzed as such. Cladistics 22, 1–13.

Goloboff, P.A., Farris, J.S., Nixon, K.C., 2008. TNT, a free program for phylogenetic analysis. Cladistics 24, 774–786.

González-Santillán, E., Prendini, L., 2013. Redefinition and generic revision of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905, with descriptions of six new genera. Bull. Am. Mus. Nat. Hist. 382, 1–71.

Graham, M.R., Bryson, R.W., 2010. *Vaejovis montanus* (Scorpiones: Vaejovidae), a new species from the Sierra Madre Occidental of Mexico. J. Arachnol. 38, 285–293.

Graham, M.R., Fet, V., 2006. Serrula in retrospect: a historical look at scorpion literature (Scorpiones: Orthosterni). Euscorpius 48, 1–19.

Graham, M.R., Soleglad, M.E., 2007. A new scorpion genus representing a primitive taxon of tribe Stahnkeini, with a description of a new species from Sonora, Mexico (Scorpiones: Vaejovidae). Euscorpius 57, 1–13.

Graham, M.R., Ayrey, R.F., Bryson, R.W., 2012. Multivariate methods support the distinction of a new highland *Vaejovis* (Scorpiones: Vaejovidae) from Sierra de los Ajos, Mexico. J. Arachnol. 40, 281–290.

Haradon, R.M., 1974. *Vaejovis spicatus*: a new scorpion from California (Scorpionida: Vaejo- vidae). Pan-Pacific Entomol. 50, 23–27.

Haradon, R.M., 1983. *Smeringurus*, a new subgenus of *Paruroctonus* Werner (Scorpiones, Vaejovidae). J. Arachnol. 11, 251–270.

Haradon, R.M., 1984a. New and redefined species belonging to the *Paruroctonus baergi* group (Scorpiones, Vaejovidae). J. Arachnol. 12, 205–221.

Haradon, R.M., 1984b. New and redefined species belonging to the *Paruroctonus borregoensis* group (Scorpiones, Vaejovidae). J. Arachnol. 12, 317–339.

Haradon, R.M., 1985. New groups and species belonging to the nominate subgenus *Paruroctonus* (Scorpiones, Vaejovidae). J. Arachnol. 13, 19–42.

Harrison, R.G., Randal, D.M., Wheeler, W.C., 1987. Mitochondrial DNA variation in field crickets across a narrow hybrid zone. Mol. Biol. Evol. 24, 363–371.

Hendrixson, B.E., 2001. A new species of *Vaejovis* (Scorpiones, Vaejovidae) from Sonora, Mexico. J. Arachnol. 29, 47–55.

Hendrixson, B.E., Bond, J.E., 2009. Evaluating the efficacy of continuous quantitative characters for reconstructing the phylogeny of a morphologically homogeneous spider taxon (Araneae, Mygalomorphae, Antrodiaetidae, *Antrodiaetus*). Mol. Phylogenet. Evol. 53, 300–313.

Hickson, R.E., Simons, C., Cooper, A., Spicer, G.S., Sullivan, J., Penny, D., 1996. Conserved sequence motifs, alignment, and secondary structure for the third domain of animal 12S rRNA. Mol. Biol. Evol. 13, 150–169.

Hoffmann, C.C., 1931. Monografías para la entomología médica de México. Monografía Num. 2, Los escorpiones de México. Primera parte: Diplocentridae, Chactidae, Vaejovidae. Anal. Instit. Biol. Univ. Nac. Autón. Méx. 2, 291–408.

Hughes, G.B., 2011. Morphological analysis of montane scorpions of the genus *Vaejovis* (Scorpiones: Vaejovidae) in Arizona with diagnosis and description of a new species. J. Arachnol. 39, 420–438.

Katoh, K., Toh, H., 2008. Recent developments in the MAFFT multiple sequence alignment program. Brief Bioinform. 9, 286–298.

Katoh, K., Misawa, K., Kuma, K., Miyata, T., 2002. MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform. Nucleic Acids Res. 30, 3059–3066.

Katoh, K., Kuma, K., Toh, H., Miyata, T., 2005. MAFFT Version 5: improvement in accuracy of multiple sequence alignment. Nucleic Acids Res. 2, 511–518.

Katoh, K., Asimenos, G., Toh, H., 2009. Multiple alignment of DNA sequences with MAFFT. Methods Mol. Biol. 537, 39–64.

Kluge, A., 1989. A concern for evidence and a phylogenetic hypothesis of relationships among *Epicrates* (Boidae, Serpentes). Syst. Zool. 38, 7–25.

Kocher, T.D., Thomas, W.K., Meyer, A., Edwards, S.V., Paabo, S., Villablanca, F.X., Wilson, A.C., 1989. Dynamics of mitochondrial DNA evolution in animals: amplification and sequencing with conserved primers. Proc. Natl Acad. Sci. USA 86, 6196–6200.

Kraepelin, K. 1899. Scorpiones und Pedipalpi. In: Dahl, F. (Ed.), Das Tierreich (Arachnoidea). Herausgegeben von der Deutschen Zoologischen Gesellschaft. R. Friedländer und Sohn Verlag, Berlin, Vol. 8, pp. 1–265.

Kraepelin, K., 1905. Die geographische Verbreitung der Skorpione. Zool. Jahrb. Abtheil. Syst. 22, 321–364.

Kraepelin, K., 1908. Die sekundären Geschlechtscharaktere der Skorpione, Pedipalpen und Solifugen. Mitt. Naturhist. Mus. (2. Beih. Jahrb. Hamburg. Wissenschaft. Anstalten) 25, 181–225.

Lamoral, B.H., 1979. The scorpions of Namibia (Arachnida, Scorpionida). Ann. Natal Mus. 23, 497–784.

Lamoral, B.H. 1980. A reappraisal of the suprageneric classification of recent scorpions and their zoogeography. In: Gruber, J. (Ed.), Verhandlungen, 8 Internationaler Arachnologen Kongress abgehalten an der Universität für Bodenkultur Wien, 7–12 Juli, 1980. H. Egermann, Vienna, pp. 439–444.

Laurie, M., 1896a. Notes on the anatomy of some scorpions, and its bearing on the classification of the order. Ann. Mag. Nat. Hist. 17, 185–193.

Laurie, M., 1896b. Further notes on the anatomy and development of scorpions, and their bearing on the classification of the order. Ann. Mag. Nat. Hist. 18, 121–133.

Lopardo, L., Giribet, G., Hormiga, G., 2010. Morphology to the rescue: molecular data and the signal of morphological characters in combined phylogenetic analyses – a case study from mysmenid spiders (Araneae, Mysmenidae), with comments on the evolution of web architecture. Cladistics 27, 278–330.

Lourenço, W.R., Sissom, W.D. 2000. Scorpiones. In: Llorente, B., González, E., Papavero, N. (Eds.), Biodiversidad, taxonomía y biogeografía de artrópodos de México: Hacia una síntesis de su conocimiento. Universidad Nacional Autónoma de México, Mexico City, pp. 115–135.

Lyko, F., Maleszka, R., 2011. Insects as innovative models for functional studies of DNA methylation. Trends Genet. 27, 127–131.

Maddison, W.P., 1993. Missing data versus missing characters in phylogenetic analysis. Syst. Biol. 42, 576–581.

Margush, T., McMorris, F.R., 1981. Consensus n-trees. Bull. Math. Biol. 43, 239–244.

McWest, K.J., 2009. Tarsal spinules and setae of vaejovid scorpions (Scorpiones: Vaejovidae). Zootaxa 2001, 1–16.

Mickevich, M.F., Johnson, M.S., 1976. Congruence between morphological and allozyme data in evolutionary inference and character evolution. Syst. Zool. 27, 143–158.

Mirande, J.M., 2009. Weighted parsimony phylogeny of the family Characidae (Teleostei: Characiformes). Cladistics 25, 574–613.

Nishiguchi, M.K., Doukakis, P., Egan, M., Goldstein, P.Z., Kizirian, D., Phillips, A., Prendini, L., Rosenbaum, H.C., Torres, E., Wyner, Y., DeSalle, R., Giribet, G. 2002. DNA isolation procedures. In: DeSalle, R., Giribet, G., Wheeler, W.C. (Eds), Methods and Tools in Biosciences and Medicine. Techniques in Molecular Evolution and Systematics. Birkhäuser Verlag AG, Basel, pp. 249–287.

Nixon, K.C., 1999. The parsimony ratchet, a new method for rapid parsimony analysis. Cladistics 15, 407–428.

Nixon, K.C., Carpenter, J.M., 1996. On simultaneous analysis. Cladistics 12, 221–241.

Nunn, G.B., Theisen, B.F., Chirstensen, B., Arctander, P., 1996. Simplicity-correlated size growth of the nuclear 28S ribosomal RNA D3 expansion segment in the crustacean order isopoda. J. Mol. Evol. 42, 211–223.

Ochoa, J.A., Botero-Trujillo, R., Prendini, L., 2010. On the troglomorphic scorpion *Troglotayosicus humiculum* (Scorpiones, Troglotayosicidae), with first description of the adults. Am. Mus. Novit. 3691, 1–19.

Ortega-Gutiérrez, F., Guerrero-García, J.C. 1982. The geological regions of Mexico. In: Palmer, A.R. (Ed.), Perspectives in Regional Geological Synthesis. Geological Society of America, Boulder, CO, pp. 99–104.

Pimentel, R.A., Riggins, R., 1987. The nature of cladistic data. Cladistics 3, 201–209.

Pocock, R.I., 1893. Notes on the classification of scorpions, followed by some observations on synonymy, with descriptions of new genera and species. Ann. Mag. Nat. Hist. 12, 303–330.

Polis, G.A. 1990. Ecology. In: Polis, G.A. (Ed.). The Biology of Scorpions. Stanford University Press, Stanford, CA, pp. 247–293.

Ponce-Saavedra, J., Beutelspacher, C.R. 2001. Alacranes de Michoacán UMSNH. Ediciones Michoacanas, Morelia, Michoacán, Mexico.

Ponce-Saavedra, J., Sissom, W.D., 2004. A new species of the genus *Vaejovis* (Scorpiones, Vaejovidae) endemic to the Balsas basin of Michoacán, Mexico. J. Arachnol. 32, 539–544.

Prendini, L., 2000. Phylogeny and classification of the superfamily Scorpionoidea Latreille 1802 (Chelicerata, Scorpiones): an exemplar approach. Cladistics 15, 1–78.

Prendini, L. 2001a. Substratum specialization and speciation in southern African scorpions: the Effect Hypothesis revisited. In: Fet, V., Selden, P.A. (Eds.), Scorpions 2001. In Memoriam Gary A. Polis. British Arachnological Society, Burnham Beeches, UK, pp. 113–139.

Prendini, L., 2001b. Species or supraspecific taxa as terminals in cladistic analysis? Groundplans versus exemplars revisited. Syst. Biol. 50, 290–300.

Prendini, L., 2003. A new genus and species of bothriurid scorpion from the Brandberg Massif, Namibia, with a reanalysis of bothriurid phylogeny and a discussion of the phylogenetic position of *Lisposoma* Lawrence. Syst. Entomol. 28, 149–172.

Prendini, L., 2004. Systematics of the genus *Pseudolychas* Kraepelin (Scorpiones: Buthidae). Ann. Entomol. Soc. Am. 97, 37–63.

Prendini, L., Wheeler, W.C., 2005. Scorpion higher phylogeny and classification, taxonomic anarchy, and standards for peer review in online publishing. Cladistics 21, 446–494.

Prendini, L., Hanner, R., DeSalle, R. 2002. Obtaining, storing and archiving specimens and tissue samples for use in molecular studies. In: DeSalle, R., Giribet, G., Wheeler, W.C. (Eds), Methods and Tools in Biosciences and Medicine. Techniques in Molecular Evolution and Systematics. Birkhäuser Verlag AG, Basel, pp. 176–248.

Prendini, L., Crowe, T.M., Wheeler, W.C., 2003. Systematics and biogeography of the family Scorpionidae (Chelicerata: Scorpiones), with a discussion on phylogenetic methods. Invertebr. Syst. 17, 185–259.

Prendini, L., Weygoldt, P., Wheeler, W.C., 2005. Systematics of the *Damon variegatus* group of African whip spiders (Chelicerata: Amblypygi): evidence from behaviour, morphology and DNA. Org. Divers. Evol. 5, 203–236.

Prendini, L., Francke, O.F., Vignoli, V., 2010. Troglomorphism, trichobothriotaxy and typhlochactid phylogeny (Scorpiones, Chactoidea): more evidence that troglobitism is not an evolutionary dead-end. Cladistics 26, 117–142.

Rae, T.C., 1998. The logical basis for the use of continuous characters in phylogenetic analysis. Cladistics 14, 221–228.

Riddle, B.R., Hafner, D.J., 2006. A step-wise approach to integrating phylogeographic and phylogenetic biogeographic perspectives on the history of a core North American warm desert biota. J. Arid Environ. 66, 435–461.

San Martín, P.R., 1965. Escorpiofauna Uruguaya II. *Bothriurus rochensis*, nueva especie de Bothriuridae del Uruguay. Com. Zool. Mus. Hist. Nat. Montevideo 106, 1–22.

Santibáñez-López, C., Francke, O.F., 2010. New and poorly known species of the *mexicanus* group of the genus *Vaejovis* (Scorpiones: Vaejovidae) from Oaxaca, Mexico. J. Arachnol. 38, 555–571.

Santibáñez-López, C., Sissom, W.D., 2010. A new species of the *Vaejovis eusthenura* group in Oaxaca, Mexico (Scorpiones: Vaejovidae). Zootaxa 2493, 49–58.

Simon, C., Frati, F., Beckenbach, A., Crespi, B., Liu, H., Flook, P.K., 1994. Evolution, weighting, and phylogenetic utility of mitochondrial gene sequences and a compilation of conserved polymerase chain reaction primers. Ann. Entomol. Soc. Am. 87, 651–700.

Sissom, W.D., 1989a. Systematic studies on *Vaejovis granulatus* Pocock and *Vaejovis pusillus* Pocock with descriptions of six new related species (Scorpiones: Vaejovidae). Rev. Arachnol. 8, 131–157.

Sissom, W.D., 1989b. Redescription of *Vaejovis occidentalis* Hoffmann with a revised diagnosis for *Vaejovis subcristatus* Pocock (Scorpiones: Vaejovidae). Rev. Arachnol. 8, 179–187.

Sissom, W.D. 1990. Systematics, biogeography and paleontology. In: Polis, G.A. (Ed.), The Biology of Scorpions. Stanford University Press, Stanford, CA, pp. 64–160.

Sissom, W.D., 1991a. Systematic studies on the *nitidulus* group of the genus *Vaejovis*, with descriptions of seven new species (Scorpiones, Vaejovidae). J. Arachnol. 19, 4–28.

Sissom, W.D., 1991b. The genus *Vaejovis* in Sonora, Mexico (Scorpiones, Vaejovidae). Insecta Mundi 5, 215–225.

Sissom, W.D., 1993. A new species of *Vaejovis* (Scorpiones, Vaejovidae) from western Arizona, with supplemental notes on the male of *Vaejovis spicatus* Haradon. J. Arachnol. 21, 64–68.

Sissom, W.D. 2000. Family Vaejovidae. In: Fet, V., Sissom, W.D., Lowe, G., Braunwalder, M.E. (Eds.), Catalog of the Scorpions of the World (1758–1998). New York Entomological Society, New York, pp. 503–553.

Sissom, W.D., Francke, O.F., 1985. Redescription of some poorly known species of the *nitidulus* group of the genus *Vaejovis* (Scorpiones, Vaejovidae). J. Arachnol. 13, 243–266.

Sissom, W.D., González-Santillán, E., 2004. A new species and new records for the *Vaejovis nitidulus* group, with a key to the Mexican species (Scorpiones, Vaejovidae). Texas Mem. Mus. Speleol. Monogr. 6, 1–8.

Soleglad, M.E., 1973. Scorpions of the *mexicanus* group of the genus *Vejovis* (Scorpionida, Vejovidae). Wasmann J. Biol. 31, 351–372.

Soleglad, M.E., 1976. A revision of the scorpion subfamily Megacorminae (Scorpionida: Chactidae). Wasmann J. Biol. 34, 251–303.

Soleglad, M.E., Fet, V., 2003. High-level systematics and phylogeny of the extant scorpions (Scorpiones: Orthosterni). Euscorpius 11, 1–175.

Soleglad, M.E., Fet, V., 2005. A new scorpion genus (Scorpiones: Vaejovidae) from Mexico. Euscorpius 24, 1–13.

Soleglad, M.E., Fet, V., 2006. Contributions to scorpion systematics. II. Stahnkeini, a new tribe in scorpion family Vaejovidae (Scorpiones: Chactoidea). Euscorpius 40, 1–32.

Soleglad, M.E., Fet, V., 2008. Contributions to scorpion systematics. III. Subfamilies Smeringurinae and Syntropinae (Scorpiones: Vaejovidae). Euscorpius 71, 1–115.

Soleglad, M.E., Sissom, W.D. 2001. Phylogeny of the family Euscorpiidae Laurie, 1896: a major revision. In: Fet, V., Selden, P.A. (Eds.), Scorpions 2001. In Memoriam Gary A. Polis. British Arachnological Society, Burnham Beeches, UK, pp. 25–111.

Stahnke, H.L., 1970. Scorpion nomenclature and mensuration. Entomol. News 81, 297–316.

Stahnke, H.L., 1972. U.V. light, a useful field tool. Bioscience 22, 604–607.

Stahnke, H.L., 1974. Revision and keys to the higher categories of Vejovidae. J. Arachnol. 1, 107–141.

Stockwell, S.A. 1989. Revision of the phylogeny and higher classification of scorpions (Chelicerata). PhD Thesis, University of California, Berkeley.

Stockwell, S.A., 1992. Systematic observations on North American Scorpionida with a key and checklist of the families and genera. J. Med. Entomol. 29, 407–422.

Stockwell, S.A. 1996. Vaejovidae. Version 1. Retrieved October 2013. http://tolweb.org/Vaejovidae/6224

Strong, E.E., Lipscomb, D., 1999. Character coding and inapplicable data. Cladistics 15, 363–371.

Tamura, K., Nei, M., Kumar, S., 2004. Prospects for inferring very large phylogenies by using the neighbor-joining method. Proc. Natl Acad. Sci. USA 101, 11030–11035.

Tamura, K., Peterson, D., Peterson, N., Stecher, G., Nei, M., Kumar, S., 2011. MEGA5, Molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. Mol. Biol. Evol. 28, 2731–2739.

Thiele, K., 1993. The Holy Grail of the perfect character: the cladistic treatment of morphometric data. Cladistics 9, 275–304.

Thorell, T., 1876. On the classification of scorpions. Ann. Mag. Nat. Hist. 4, 1–15.

Vachon, M. 1952. Études sur les Scorpions. Institut Pasteur d'Algérie, Algiers.

Vachon, M., 1963. De l'utilité, en systématique, d'une nomenclature des dents de chelicères chez les scorpions. Bull. Mus. Nat. Hist. Nat. 35, 161–166.

Vachon, M., 1973. [1974]. Étude des caractères utilisès pour classer les familles et les genres de scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie, sigles trichobothriaux et types de trichobothriotaxie chez les scorpions. Bull. Mus. Nat. Hist. Nat. 140, 857–958.

Valdez-Cruz, N.A., Dávila, S., Licea, A., Corona, M., Zamudio, F.Z., García-Valdes, J., Boyer, L., Possani, L.D., 2004. Biochemical, genetic and physiological characterization of venom components from two species of scorpions: *Centruroides exilicauda* Wood and *Centruroides sculpturatus* Ewing. Biochimie 86, 387–396.

Volschenk, E.S., Prendini, L., 2008. *Aops oncodactylus* gen. *et* sp. nov., the first troglobitic urodacid (Urodacidae: Scorpiones) with a reassessment of cavernicolous, troglobitic, and troglomorphic scorpions. Invertebr. Syst. 22, 235–257.

Wagner, W.H. Jr. 1961. Problems in the classification of ferns. In: Recent Advances in Botany. IX International Botanical Congress. University of Toronto Press, Toronto, pp. 841–844.

Webber, M.M., Graham, M.R., Jaeger, J.R., 2012. *Wernerius inyoensis*, an elusive new scorpion from the Inyo Mountains of California (Scorpiones, Vaejovidae). ZooKeys 177, 1–13.

Werner, F. 1934. Scorpiones, Pedipalpi. In: Bronn, H.G., Klassen und Ordnungen des Tierreichs, Bd. 5, Abt. IV, Buch 8, Lief. 1–2. Akademische Verlaggesellschaft, Leipzig, pp. 1–316.

Wheeler, W.C., Cartwright, P., Hayashi, C.Y., 1993. Arthropod phylogeny: a combined approach. Cladistics 9, 1–39.

Whiting, M.F., 2002. Mecoptera is paraphyletic: multiple genes and phylogeny of Mecoptera and Siphonaptera. Zool. Scr. 31, 93–104.

Whiting, M.F., Carpenter, J.M., Wheeler, Q.D., Wheeler, W.C., 1997. The Strepsiptera problem: phylogeny of the holometabolous insect orders inferred from 18S and 28S ribosomal DNA sequences and morphology. Syst. Biol. 46, 1–68.

Wiens, J.J., 2001. Character analysis in morphological phylogenetics: problems and solutions. Syst. Biol. 50, 689–699.

Wilkinson, M., 1995. A comparison of two methods of character construction. Cladistics 11, 297–308.

Williams, S.C., 1968. Scorpions from northern Mexico: five new species of *Vejovis* from Coahuila, Mexico. Occas. Pap. Calif. Acad. Sci. 68, 1–24.

Williams, S.C., 1969. A new species of *Syntropis* from Baja California Sur, Mexico with notes on its biology (Scorpionida, Vejovidae). Pan-Pacific Entomol. 45, 285–291.

Williams, S.C., 1970a. New scorpions belonging to the eusthenura group of *Vejovis* from Baja California, Mexico (Scorpionida: Vaejovidae). Proc. Calif. Acad. Sci. 37, 395–417.

Williams, S.C., 1970b. A new species of scorpion belonging to the pumilis group of the genus *Vejovis* (Scorpionida, Vejovidae). Pan-Pacific Entomol. 46, 181–183.

Williams, S.C., 1970c. Scorpion fauna of Baja California, Mexico: eleven new species of *Vejovis* (Scorpionida: Vaejovidae). Proc. Calif. Acad. Sci. 31, 275–332.

Williams, S.C., 1970d. A systematic revision of the giant hairy scorpion genus *Hadrurus*. Occas. Pap. Calif. Acad. Sci. 87, 1–62.

Williams, S.C., 1971a. New and little known scorpions belonging to the punctipalpi group of the genus *Vejovis* from Baja California, Mexico, and adjacent area (Scorpionida, Vaejovidae). Wasmann J. Biol. 29, 37–63.

Williams, S.C., 1971b. A redescription of the scorpion *Vaejovis crassimanus* Pocock (Scorpionida: Vejovidae). Pan-Pacific Entomol. 47, 44–47.

Williams, S.C., 1974. A new genus of North American scorpions with a key to the North American genera of Vaejovidae. Proc. Calif. Acad. Sci. 40, 1–16.

Williams, S.C., 1980. Scorpions of Baja California, Mexico and adjacent islands. Occas. Pap. Calif. Acad. Sci. 135, 1–127.

Williams, S.C., 1986. A new species of *Vaejovis* from Jalisco, Mexico (Scorpiones: Vaejovidae). Pan-Pacific Entomol. 62, 355–358.

Williams, S.C., 1987. Scorpion bionomics. Ann. Rev. Entomol. 32, 275–295.

Williams, S.C., Savary, W.E., 1991. *Uroctonites*, a new genus of scorpion from western North America (Scorpiones: Vaejovidae). Pan-Pacific Entomol. 67, 272–287.

Appendix 1

Tissue samples and associated voucher specimens from which DNA was extracted and sequenced for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Samples, stored in the Ambrose Monell Cryocollection (AMCC) of the American Museum of Natural History, New York (AMNH), and vouchers, in the AMNH collection of Arachnida and Myriapoda, share the same number.

Outgroup

***Franckeus kochi* (Sissom, 1991):** Mexico: Hidalgo: *Municipio de Mixquihuala*: Valle del Mezquital, 8.vii.2005, R. Encino, 1 juv. (AMCC [LP 5363]).

***Pseudouroctonus glimmei* (Hjelle, 1972):** USA: California: *Stanislaus Co.*: Frank Raines Park, 2.3 miles southwest on El Puerto Canyon Road [37°25′03.58″N 121°22′06.7″W], 21.iii.2004, E.S. Volschenk and W.E. Savary, 1 juv. (AMCC [LP 2688]).

***Serradigitus minutus* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de Los Cabos*: Cabo San Lucas, 15 miles east [22°53.383′N 109°54.933′W], 1.vi.1999, M.E. Soleglad, 1 juv. (AMCC [LP 1674]).

***Serradigitus* sp.:** Mexico: Sinaloa: *Municipio de La Cruz*: Casas Viejas, 24°02′24.8″N 106°48′54.6″W, 92 m, 13.vii.2006, P. Berea, 1 ♂ (AMCC [LP 6370]).

***Smeringurus grandis* (Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Punta Calamajue (abandoned fishing village), 29°41.119′N 114°09.774′W, 5.4 m, 1.vii.2008, H. Montaño and E. González, 1 subad. ♂ (AMCC [LP 8690]).

***Stahnkeus deserticola* (Williams, 1970):** USA: California: *Inyo Co.*: Death Valley National Park: Saline Valley Marsh, along Saline Valley Road, 36°41.651′N 117°49.917′W, 326 m, 4.ix.2005, R. Mercurio and L. Prendini, 1 subad. ♂ (AMCC [LP 5032]).

***Uroctonites giulianii* Williams and Savary, 1991:** USA: California: *Inyo Co.*: Inyo National Forest: White Mountains, roadside of Highway 168, 37°15′16.6″N 118°09′22.7″W, 2110 m, 15.viii.2004, W.E. Savary, R. Mercurio, K. Bamba and M. McCoy, 1 juv. (AMCC [LP 3204]).

***Vaejovis carolinianus* (Beauvois, 1805):** USA: South Carolina: 16.v.2000, 1 ♀ (AMCC [LP 1576]).

***Vaejovis intermedius* Borelli, 1915:** USA: Texas: *Culberson Co.*: Indio Research Station, near Van Horn [30°40′30.12″N 104°54′48.79″W], ix.2002, L. Esposito, 1 ♀ (AMCC [LP 2141A]).

***Vaejovis lapidicola* Stahnke, 1940:** USA: Arizona: *Coconino Co.*: Flagstaff, red sandstone quarry, southeast end Switzer Mesa, just north of junction US Route 66 and Enterprise Road, 35°11.873′N 111°37.749′W, ca. 7117 ft, 3.viii.2000, J. and C. Bigelow, 1 ♂ (AMCC [LP 1814]).

***Vaejovis mexicanus* C.L. Koch, 1836:** Mexico: Distrito Federal: *Delegación Coyoacán*: house [19°20′58.54″N 99°09′42.35″W], 18.xii.2001, E. González, 1 ♀ (AMCC [LP 1825]).

***Vaejovis pequeno* Hendrixson, 2001:** Mexico: Sonora: *Municipio de Soyopa*: Sierra El Encinal, 9 km from crossroad on Highway Mex 16 to El Encinal 28°35.412′N 109°27.148′W, 380 m, 24.vi.2006, E. González and P. Berea, 1 ♀ (AMCC [LP 6308]).

***Vaejovis rossmani* Sissom, 1989:** Mexico: Tamaulipas: *Municipio de Hidalgo*: Conrado Castillo [23°56′17.35″N 99°28′48.17″W], 29.vii.2002, O. Francke and L. Prendini, 1 ♀ (AMCC [LP 2027]).

***Vaejovis* sp.:** Mexico: Chiapas: *Municipio de Ocozocuautla de Espinosa*: El Aguacero, 16°45.374′N 93°31.468′W, 25.v.2005, O. Francke, M. Córdova, A. Jaimes and J. Ballesteros, 1 ♂ (AMCC [LP 5327]); Ocozocoautla–Cintalapa road, between El Aguacero and Rio Subterraneo, km marker 107, 16°45′29.4″N 93°31′30.6″W, 2.xi.2004, O. Francke, R. Paredes and G. Villegas, 1 ♀ (AMCC [LP 3711]).

***Wernerius spicatus* (Haradon, 1974):** USA: California: *Riverside Co.*: Joshua Tree National Park: Little San Bernardino Mountains, Berdoo Canyon, 6.9 miles northeast on Berdoo Canyon Road from Berdoo Canyon Road/Dillon Road junction on Berdoo Canyon Road, 33°49′45.32″N 116°05′44.67″W, 2945 ft, 3.viii.208, Z.J. Valois and W.E. Savary, 1 ♂ (AMCC [LP 8968]).

Ingroup

***Balsateres cisnerosi* (Ponce-Saavedra and Sissom, 2004):** Mexico: Michoacán: *Municipio de Carácuaro*: Las Cocinas, Highway Nocupetaro–Carácuaro, 19°01.880′N 101°14.067′W, 672 m, 14.vii.2005, O. Francke, J. Ponce, M. Córdova, A. Jaimes, G. Francke and V. Capovilla, 1 subad. ♂ (AMCC [LP 5269]). *Municipio de Churumuco de Morelos*: Churumuco [18°39.393′N 101°39.124′W], 8.ix.2001, R. Cancino, 1 ♂ (AMCC [LP 2018]).

***Chihuahuanus bilineatus* (Pocock, 1898):** Mexico: Guanajuato: *Municipio de San Luis de La Paz*: San Luis de La Paz, 7 km east, 21°18.714′N 100°25.601′W, 2117 m, 24.viii.2006, O. Francke, W.D. Sissom, G. Casper, T. Anton, V. Torti, H. Montaño, C. Santibáñez and A. Ballesteros, 1 ♀ (AMCC [LP 6594]). San Luis Potosí: *Municipio de Ciudad del Maíz*: Puerto Santa Catarina, 22°18.223′N 99°37.268′W, 1214 m, 22.viii.2006, O. Francke, W.D. Sissom, G. Casper, T. Anton, V. Torti, H. Montaño, C. Santibáñez and A. Ballesteros, 1 ♀ (AMCC [LP 6507]). Zacatecas: *Municipio de Fresnillo*: Colonia Guanajuato, 23°04.749′N 103°05.139′W, 2250 m, 6.vii.2005, O. Francke, J. Ponce, M. Córdova, A. Jaimes, G. Francke and V. Capovilla, 1 ♀ (AMCC [LP 5306]).

***Chihuahuanus cazieri* (Williams, 1968):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Dunas de Yeso, 26°51.765′N 102°10.476′W, 776 m, 18.vii.2006, O. Francke, W.D. Sissom, M. Córdova, A. Jaimes and A. Ballesteros, 1 ♂ (AMCC [LP 7163]); Sierra San Marcos, 26°54′47.63″N 102°08′15.23″W, 761 m, 18.vii.2006, E. González, B. Hendrixson, K. McWest and S. Grant, 1 ♂ (AMCC [LP 7179]).

***Chihuahuanus coahuilae* (Williams, 1968):** Mexico: Durango: *Municipio de Gómez Palacio*: Dinamita, 25°44.089′N 103°40.400′W, 1328 m, 29.vii.2005, O. Francke, H. Montaño, J. Ballesteros and C. Durán, 1 ♂ (AMCC [LP 5353]). Coahuila: *Municipio de Cuatro Ciénegas*: Ojo de Agua, Ejido El Oso, 1039 m, 19.vii.2006, O. Francke, W.D. Sissom, K. McWest, B. Hendrixson, S. Grant, A. Jaimes, M. Córdova, E. González and A. Ballesteros, 1 ♂ (AMCC [LP 6600]). USA: New Mexico: *Luna Co.*: Little Florida Mountains, 1.6 km southeast on Bonita Road from turnoff on Gap Road, 32°09′29.4″N 107°35′18.9″W, 1761 m, 3.ix.2007, L. Prendini and J. Huff, 1 juv. (AMCC [LP 7095]).

***Chihuahuanus crassimanus* (Pocock, 1898):** Mexico: Durango: *Municipio de Tlahualilo*: Highway 49, at deviation Montes Claros–Tlahualilo de Zaragoza, 26°09.242′N 103°31.284′W, 1107 m, 6.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 juv. (AMCC [LP 5365]). USA: New Mexico: *Hidalgo Co.*: Granite Gap, Peloncillo Mountains, 32°05′43.1″N 108°58′13.7″W, 1367 m, 4.ix.2007, L. Prendini and J. Huff, 1 subad. ♂ (AMCC [LP 7100]). Texas: *Brewster Co.*: Black Gap Wildlife Management Area, 6.5 miles past Camp 6 on Camp 14 Road [29°32.842′N 102°54.629′W], 16.vii.2004, L. Jarvis, W.D. Sissom and T. Anton, 1 ♂ (AMCC [LP 2972]).

***Chihuahuanus glabrimanus* (Sissom and Hendrixson, 2005):** Mexico: Guanajuato: *Municipio de San Diego de la Unión*: San Diego de la Unión, 8 km south, 21°23.144′N 100°53.452′W, 2078 m, 28.vii.2006, O. Francke, M. Córdova, A. Jaimes, E. González and A. Ballesteros, 1 juv. (AMCC [LP 6611]). Nuevo León: *Municipio de Galeana*:

Providencia, 3 km northeast, 25°08.651′N 100°39.04′W, 1980 m, 17.vii.2006, O. Francke, E. González, M. Córdova, J. Ballesteros and A. Jaimes, 1 ♂ (AMCC [LP 6558]). San Luis Potosí: *Municipio de Ciudad del Maíz*: Puerto Santa Catarina, 22°18.223′N 99°37.268′W, 1214 m, 22.viii.2006, O. Francke, W.D. Sissom, G. Casper, T. Anton, V. Torti, H. Montaño, C. Santibáñez and A. Ballesteros, 1 juv. (AMCC [LP 6610]).

***Chihuahuanus globosus* (Borelli, 1915):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Sierra San Marcos, 26°54′47.63″N 102°08′15.23″W, 761 m, 18.vii.2006, E. González, B. Hendrixson, K. McWest and S. Grant, 1 ♀ (AMCC [LP 6447]). *Municipio de Viesca*: Dunas de Bilbao, 25°25.586′N 102°53.654′W, 1098 m, 20.vii.2006, O. Francke, K. McWest, M. Córdova, A. Jaimes and A. Ballesteros, 1 ♂ (AMCC [LP 6459]). Durango: *Municipio de Tlahualilo*: Highway 49, at deviation Montes Claros–Tlahualilo de Zaragoza, 26°09.242′N 103°31.284′W, 1107 m, 6.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 juv. (AMCC [LP 5281]). USA: Texas: *Brewster Co.*: Big Bend National Park: Boquillas Canyon, 29°12.002′N 102°55.029′W, 2.viii.2008, W.D. Sissom, T. Anton and G. Casper, 1 ♂ (AMCC [LP 8926]).

***Chihuahuanus kovariki* (Soleglad and Fet, 2008):** Mexico: Durango: *Municipio de Pánuco de Coronado*: La Mina, Highway 137, between Pánuco de Colorado and San José de Avino, 24°31.809′N 104°18.941′W, 2217 m, 9.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 juv. (AMCC [LP 5305]). *Municipio de Santiago Papasquiaro*: Highway 36, marker km 9, between crossroad San Andres Atotonilco and La Laguna de la Chaparra, 25°05.306′N 105°31.530′W, 2095 m, 11.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 ♂ (AMCC [LP 5299]).

***Chihuahuanus russelli* (Williams, 1971):** USA: Arizona: *Cochise Co.*: Pinaleño Mountains, foothills 7.4 km from junction of Highway 191 on Highway 366, 32°41′33.9″N 109°45′13.3″W, 1132 m, 25.vii.2007, J. Huff, 1 ♂ (AMCC [LP 7017]). New Mexico: *Quay Co.*: Glenrio, ca. 2.4 km west on Old US Route 66, 35°10′08.0″N 103°04′05.3″W, 1169 m, 3.ix.2007, K. McWest, H.M. Burrell and K.S.M. Torres, 1 juv. (AMCC [LP 7266]). Texas: *Brewster Co.*: Black Gap Wildlife Management Area, 4 miles past Camp 6 on Camp 14 Road [29°32.842′N 102°54.629′W], 16.vii.2004, L. Jarvis, W.D. Sissom and T. Anton, 1 ♂ (AMCC [LP 2971]).

***Kochius barbatus* (Williams, 1971):** Mexico: Baja California Sur: *Municipio de La Paz*: Las Cruces, 4 km northwest, 24°13.511′N 110°07.410′W, 31 m, 24.vi.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8803]).

***Kochius bruneus* (Williams, 1971):** Mexico: Baja California Sur: *Municipio de Comondú*: San Miguel de Comondú, 2 km southwest, 26°01′48.3″N 111°50′57″W, 199 m, 12.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 juv. (AMCC [LP 3153]). *Municipio de Loreto*: Loreto, 15 km west, 25°58′38.5″N 111°27′53.1″W, 213 m, 13.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♂ (AMCC [LP 3154]); Loreto, ca. 3 km south along gravel road to San Javier, from junction with Route 1, [25°59′48.14″N 111°23′03.88″W], 38 m, 8.vii.2005, E. González, R. Mercurio, W.E. Savary and L. Prendini, 1 ♂ (AMCC [LP 4555]).

***Kochius cerralvensis* (Williams, 1971):** Mexico: Baja California Sur: *Municipio de La Paz*: Isla Cerralvo, southwest side, 24°10′56.66″N 109°53′14.7″W, 0–50 m, 27.v.2008, I.G. Nieto and E. González, 1 ♂ (AMCC [LP 8779]).

***Kochius hirsuticauda* (Banks, 1910):** Mexico: Baja California: *Municipio de Ensenada*: Punta Calamajue, abandoned fishing village, 29°41.119′N 114°09.774′W, 5.4 m, 1.vii.2008, H. Montaño and E. González, 1 ♀ (AMCC [LP 8819]). USA: California: *Inyo Co.*: Death Valley National Park: Grapevine Canyon, Saline Valley Road, 36°33.591′N 117°35.219′W, 1290 m, 4.ix.2005, R. Mercurio and L. Prendini, 1 ♂ (AMCC [LP 5049]). *San Bernardino Co.*: Park Moabi Road, 9.7 km from intersection with I-40, 34°42′35.7″N 114°30′59.7″W, 231 m, 9.ix.2007, L. Prendini and J. Huff, 1 subad. ♂ (AMCC [LP 7199]).

***Kochius insularis* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de La Paz*: Isla Espíritu Santo, Playa Bonanza, 24°27.364′N 110°18.471′W, 0–50 m, 31.v.2008, I.G. Nieto and E. González, 1 ♂ (AMCC [LP 8801]).

***Kochius magdalensis* (Williams, 1971):** Mexico: Baja California Sur: *Municipio de La Paz*: La Paz, 50 km northwest, 24°05′56.2″N 110°43′41″W, 256 m, 7.vii.2004, O. Francke, E. González and A. Valdez, 1 ♀ (AMCC [LP 3155]); La Paz, ca. 20 km north, junction Route 1 and road to San Juan de la Costa, 24°13.383′N 110°35.766′W, 20 m, 9.vii.2005, L. Prendini, E. González and R. Mercurio, 1 juv. (AMCC [LP 4552]); El Pilar, ca. 20 km northeast of Las Pocitas, 24°28.762′N 111°01.125′W, 92 m, 25.vi.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8796]).

***Kochius punctipalpi* (Wood, 1863):** Mexico: Baja California Sur: *Municipio de Los Cabos*: Cabo San Lucas, 15 miles east [22°53.383′N 109°54.933′W], 1.vi.1999, M.E. Soleglad, 1 ♀ (AMCC [LP 1679]); Santiago, 23°26′24.5″N 109°43′34.6″W, 225 m, 9.vii.2004, O. Francke, E. González and A. Valdez, 1 juv. (AMCC [LP 3157]); San Bartolo, 6 km southwest, 23°41.816′N 109°50.800′W, 100 m, 13.vii.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8843]).

***Kochius sonorae* (Williams, 1971):** Mexico: Sonora: *Municipio de Navojoa*: Microwave antenna, Cerro Prieto, ca. 15 km east of Navojoa, 27°04.937′N 109°17.435′W, 375 m, 23.ix.2009, E. González and J.L. Castelo, 1 juv. (AMCC [LP 9974]). *Municipio de Soyopa*: Plutarco Elias Calles Dam, Ejido el Novillo, 28°58.827′N 109°30.160′W, 258 m, 22.vi.2006, P. Berea and E. González, 1 ♂ (AMCC [LP 6301]). *Municipio de Yecora*: La Palma Agujerada Ranch, between Tepoca and Guizamopa, road SON 117, 28°28.722′N 109°10.298′W, 847 m, 23.vi.2006, P. Berea and E. González, 1 ♂ (AMCC [LP 6304]).

***Kochius villosus* (Williams, 1971):** Mexico: Baja California: *Municipio de Ensenada*: Misión de San Francisco de San Borja de Adac, 28°44.607′N 113°45.233′W, 433 m, 13.vii.2005, E. González and W.E. Savary, 1 ♂ (AMCC [LP 4544]). *Municipio de Loreto*: Juncalito, 25°49.892′N 111°19.691′W, 5 m, 20.v.2004, R. Mercurio, M. Nishiguchi et al., 1 ♂ (AMCC [LP 3477]).

***Konetontli acapulco* (Armas and Martín-Frías, 2001):** Mexico: Guerrero: *Municipio de José Azueta*: Colonia Agua de Correa, 17°38.698′N 101°31.093′W, 72 m, 1.viii.2008, O. Francke, H. Montaño, J. Ponce and A. Quijano, 1 ♀ (AMCC [LP 9520]).

***Konetontli chamelaensis* (Williams, 1986):** Mexico: Jalisco: *Municipio de La Huerta*: Estación Biológica Chamela, Cutzmala, 19°29.875′N 105°02.608′W, 97 m, 30.viii.2007, O. Francke et al., 1 juv. (AMCC [LP 7675]).

***Konetontli nayarit* (Armas and Martín-Frías, 2001):** Mexico: Nayarit: *Municipio de Tepic*: Jesus María Corte, 4 km north, 2 km along gravel road east of main paved road, ca. 30 km north Tepic, 21°45.203′N 104°51.213′W, 126 m, 29.vii.2005, E. González and R. Mercurio, 1 ♀ (AMCC [LP 4725]).

***Konetontli pattersoni* (Williams and Haradon, 1980):** Mexico: Baja California Sur: *Municipio de Los Cabos*: Sierra de La Laguna, 23°41′10″N 109°56′41.1″W, 850 m, 9.vii.2004, O. Francke, E. González and A. Valdez, 1 juv. (AMCC [LP 3149]); Sierra de La Laguna, 23°33′01.6″N 109°59′27.4″W, 1800 m, 21.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♀ (AMCC [LP 3150]).

***Kuarapu purhepecha* Francke and Ponce-Saavedra, 2010:** Mexico: Michoacán: *Municipio de la Huacana*: El Vado, 18°48.858′N 101°54.954′W, 248 m, 30.vii.2008, O. Francke, H. Montaño, J. Ponce and A. Quijano, 1 juv. (AMCC [LP 9517]).

***Maaykuyak vittatus* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de Comondú*: San Miguel de Comondú, 26°02′26.7″N 111°49′55.3″W, 220 m, 12.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♂ (AMCC [LP 3180]). *Municipio de La Paz*: La Paz, ca. 38 km north, 1 km off Route 1 on Ley Federal de la Reforma Agraria, 24°03.609′N 110°36.777′W, 256 m, 9.vii.2005, W.E. Savary and E. González, 1 ♂ (AMCC [LP 4442]).

***Maaykuyak waueri* (Gertsch and Soleglad, 1972):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Ojo de Agua, Ejido El Oso, 27°03.36′N 102°13.56′W, 1039 m, 19.vii.2006, O. Francke, W.D. Sissom, K. McWest, B. Hendrixson, S. Grant, A. Jaimes, M. Córdova, E. González and A. Ballesteros, 1 ♂ (AMCC [LP 6544]). USA: Texas: *Brewster Co.*: Black Gap Wildlife Management Area, 1.1 miles down south fork of Camp 18 Road [29°32.842′N 102°54.629′W], 18.vii.2004, L. Jarvis and T. Anton, 1 juv. (AMCC [LP 2973]).

***Mesomexovis atenango* (Francke and González-Santillán, 2007):** Mexico: Guerrero: *Municipio de Ahuelicán*: Ahuelicán, 2 km west, Cerro de la Coronilla, 18°00.977′N 99°31.72′W, 853 m, 30.i.2009, A. Valdez, O. Francke, R. Parede, S. Soriano and T. López, 1 subad. ♀ (AMCC [LP 9982]). *Municipio de Atenango del Río*: Atenango del Río [18°09.516′N 99°04.162′W], 17.viii.2000, E. González, O. Delgado, M. Capes and O. Francke, 1 juv. (AMCC [LP 2023]). *Municipio de Tepecoacuilco de Trujano*: Ahuehuepan, 2 km west, 18°00.911′N 99°31.407′W, 867 m, 14.vi.2007, O. Francke, J. Ponce et al., 1 subad. ♂ (AMCC [LP 7058]).

***Mesomexovis oaxaca* (Santibáñez-López and Sissom, 2010):** Mexico: Oaxaca: *Municipio de San Pablo Villa Mitla*: Mitla, 4.5 km east, 17°15.642′N 96°32.427′W, 23.vii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 1 ♂ (AMCC [LP 2031]). *Municipio de San Pedro Juchatengo*: San Pedro Juchatengo, 3 km west, 16°21.824′N 97°06.584′W, 845 m, 27.vi.2006, O. Francke, A. Valdez, G. Villegas, H. Montaño and C. Santibáñez, 1 juv. (AMCC [LP 6602]). *Municipio de Totolapan*: Totolapan, 4 km north, 16°41′45.9″N 96°18′52.1″W, 1078 m, 1.xi.2004, O. Francke, R. Paredes and G. Villegas, 1 ♂ (AMCC [LP 3718]).

***Mesomexovis occidentalis* (Hoffmann, 1931):** Mexico: Guerrero: *Municipio de Acapulco*: Cumbres de Llano Largo, 16°49.505′N 99°49.999′W, 371 m, 16.vi.2007, O. Francke et al., 1 juv. (AMCC [LP 7056]). *Municipio de La Unión*: Majahua, north of Zihuatanejo, 17°47.831′N 101°44.65′W, 11 m, 24.v.2006, O. Francke, A. Valdez, H. Montaño and A. Ballesteros, 1 ♂ (AMCC [LP 6559]). Oaxaca: *Municipio de Huatulco*: Puerto Escondido, 15°50′40.9″N 97°01′11.9″W, 11.vii.2002, R. Cancino, 1 ♂ (AMCC [LP 3118]).

***Mesomexovis punctatus* (Karsch, 1879):** Mexico: Estado de México: *Municipio de Otumba*: Santiago Tolman, Cerro Gordo, 19°43.667′N 98°47.317′W, 26.vii.2002, S. Reynaud and E. González, 1 ♀ (AMCC [LP 2241]). Hidalgo: *Municipio de Zimapán*: Microwave antenna, Zimapán, 20°44′47″N 99°20′54″W, 1900 m, 3.viii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 1 ♂ (AMCC [LP 2080]).

***Mesomexovis spadix* (Pocock, 1898):** Mexico: Aguascalientes: *Municipio de Aguascalientes*: Potrero Los López, 22°05′35.07′N 102°31′19.76′W, 2139 m, 22.viii.2003, F. Pérez, 1 ♀ (AMCC [LP 2950]). Guanajuato: *Municipio de León*: San Antonio de Padua [20°34.517′N 100°57.217′W], 29.vii.2004, P. Berea, 1 juv. (AMCC [LP 6373]). Zacatecas: *Municipio de Jalpa*: Jalpa, 5 km southwest, 21°38.569′N 103°03.425′W, 1564 m, 7.viii.2005, O. Francke, J. Ponce, M. Córdova, A. Jaimes, G. Francke and V. Capovilla, 1 ♀ (AMCC [LP 5280]).

***Mesomexovis subcristatus* (Pocock, 1898):** Mexico: Oaxaca: *Municipio de Cuicatlán*: Tomellin, 17°45.180′N 96°57.237′W, 605 m, 23.vii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 1 ♂ (AMCC [LP 2086]). *Municipio de Santiago Nacaltepec*: El Moral, 21 km north, 17°34.753′N 96°56.976′W, 1535 m, 23.vii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 1 ♂ (AMCC [LP 2084]). Puebla: *Municipio de Tehuacán*: Tehuacán, 2 km east, 18°24.002′N 97°22.867′W, 1435 m, 25.vii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 1 ♀ (AMCC [LP 2049]).

***Mesomexovis variegatus* (Pocock, 1898):** Mexico: Estado de México: *Municipio de Malinalco*: Malinalco, ca. 19 km south, on gravel road off State Route 4, 18°52.197′N 99°26.990′W, 1530 m, 25.vii.2005, E. González and R. Mercurio, 1 ♂ (AMCC [LP 5185]). Guerrero: *Municipio de Chilpancingo*: Amojileca, 17°34.090′N 99°34.145′W, 1484 m, 20.vi.2007, O. Francke et al., 1 juv. (AMCC [LP 7068]). Morelos: *Municipio de Tlaquiltenango*: Estación del CEAMISH, 2 km northeast, Quilamula, 18°30.657′N 99°00.798′W, 1086 m, 26.i.2006, M. Córdova and A. Jaimes, 1 subad. ♂ (AMCC [LP 6536]).

***Paravaejovis confusus* (Stahnke, 1940):** Mexico: Sonora: *Municipio de Puerto Peñasco*: Sonoyta, 95 km northwest, off Route 2, west of Microondas Cerro Lava, 32°06.175′N 113°47.105′W, 273 m, 28.vi.2005, R. Mercurio and E. González, 1 ♂ (AMCC [LP 4450]). USA: Arizona: *Maricopa Co.*: Surprise, west of Phoenix, soft soil flats north White Tanks Mountains, 33°38′19.4″N 112°28′22.3″W, 418 m, 2007, Z. Valois, K.J. McWest, H.M. Burrell et al., 1 juv. (AMCC [LP 7272]). *Yavapai Co.*: Alamo Road, north side, 34°10′4.43″N 113°01′56.57″W, 867 m, 10.v.2008, Z. Valois and B. Hendrixson, 1 ♀ (AMCC [LP 8517]). California: *San Bernardino Co.*: Twentynine Palms, 45 km east on Highway 62, 34°04′37.0″N 115°34′03.8″W, 572 m, 11.ix.2007, L. Prendini and J. Huff, 1 juv. (AMCC [LP 7107]).

***Paravaejovis diazi* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de Comondú*: Ciudad Constitución, 32 km southwest, 24°55′17″N 111°58′5.5″W, 26 m, 11.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♀ (AMCC [LP 3165]); south of El Cayuco "Fish Camp", 24°34.672′N 111°40.645′W, 23 m, 24.v.2004, R. Mercurio, M. Nishiguchi et al., 1 juv. (AMCC [LP 3482]). *Municipio de La Paz*: La Paz, 75 km northwest, 24°05′56.2″N 110°45′41″W, 256 m, 7.vii.2004, O. Francke, E. González and A. Valdez, 1 ♂ (AMCC [LP 3169]); La Paz, ca. 5 km north, junction Route 1 and road to San Juan de la Costa, 24°08.500′N 110°28.566′W, 30 m, 9.vii.2005, R. Mercurio, W.E. Savary, L. Prendini and E. González, 1 ♀ (AMCC [LP 4436]); San Evaristo, 5 km south, 24°52.901′N 110°41.404′W, 5–50 m, 12.vii.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8839]).

***Paravaejovis eusthenura* (Wood, 1863):** Mexico: Baja California Sur: *Municipio de La Paz*: La Paz, 18 km southeast, 24°02′45.9″N 110°08′51.9″W, 625 m, 8.vii.2004, O. Francke, E. González and A. Valdez, 1 ♀ (AMCC [LP 3168]). *Municipio de Los Cabos*: Cabo San Lucas, 15 miles east [22°53.383′N 109°54.933′W], 1.vi.1999, M.E. Soleglad, 1 ♀ (AMCC [LP 1689]); San José del Cabo, ca. 10 km south off Route 1, 23°01.762′N 109°43.49′W, 50 m, 10.vii.2005, W.E. Savary, E. González and R. Mercurio, 1 juv. (AMCC [LP 4448]).

***Paravaejovis gravicaudus* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de Comondú*: San Miguel de Comondú, 2 km southwest, 26°01′48.3″N 111°50′57″W, 199 m, 12.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 juv. (AMCC [LP 3163]). *Municipio de La Paz*: Isla San José, Fishing camp Palma Sola, 25°03.091′N 110°40.037′W, 0–50 m, 3.vi.2008, I.G. Nieto and E. González, 1 ♂ (AMCC [LP 8783]); El Pilar, ca. 20 km northeast of Las Pocitas, 24°28.762′N 111°01.125′W, 92 m, 25.vi.2008, H. Montaño and E. González, 1 ♀ (AMCC [LP 8793]).

***Paravaejovis hoffmanni* (Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Misión de San Francisco de San Borja de Adac, 5 km west, 28°44.558′N 113°47.935′W, 380 m, 30.vi.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8797]). *Municipio de Guerrero Negro*: Vizcaino desert, 27°29′54.7″N 114°17′35.6″W, 223 m, 16.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♀ (AMCC [LP 3166]). *Municipio de Mulegé*: Microwave station “El Abulón”, 27°17.483′N 113°01.916′W, 141 m, 12.vii.2005, W.E. Savary and E. González, 1 juv. (AMCC [LP 5096]); Sierra del Placer, 21 km to junction Bahía Tortugas and Bahía Asunción, 98 km east of Vizcaino towards Bahía Tortugas, 27°28.928′N 114°17.093′W, 262 m, 28.vi.2008, H. Montaño and E. González, 1 ♀ (AMCC [LP 8812]).

Paravaejovis pumilis (Williams, 1970): Mexico: Baja California Sur: *Municipio de Comondú*: Ciudad Constitución, 32 km southwest, 24°55′17″N 111°58′05.5″W, 26 m, 11.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♂ (AMCC [LP 3137]); south of El Cayuco “Fish Camp”, 24°34.672′N 111°40.645′W, 23 m, 24.v.2004, R. Mercurio, M. Nishiguchi et al., 1 ♀ (AMCC [LP 3476]); El Cayuco Fish Camp, sand dunes south of, 24°34.666′N 111°40.633′W, 6 m, 11.vii.2005, W.E. Savary, E. González, L. Prendini and R. Mercurio, 1 subad. ♀ (AMCC [LP 4740]).

Paravaejovis puritanus (Gertsch, 1958): Mexico: Baja California: *Municipio de Ensenada*: Cataviña, northwest of El Descanso, 29°46.687′N 114°46.441′W, 635 m, 18.v.2004, R. Mercurio, M. Nishiguchi et al., 1 ♀ (AMCC [LP 3479]); Punta Banda, between El Rincon and La Bufadora, ca. 1 km southeast of Pico Banda off BCN 23, 31°44′N 116°43.025′W, 139 m, 1.vii.2005, E. González, W.E. Savary, L. Prendini and R. Mercurio, 1 ♀ (AMCC [LP 5093]). USA: California: *San Diego Co.*: San Diego Wild Animal Park, USGS pitfall trap sites, 33°06′5.72″N 116°58′21.47″W, 1073 ft, 30.vii.2008, Z. Valois, W.E. Savary, J.P. Montagne and T. Matsuda, 1 subad. ♀ (AMCC [LP 8900]).

Paravaejovis schwenkmeyeri (Williams, 1970): Mexico: Baja California: *Municipio de Ensenada*: Misión de San Francisco de San Borja de Adac, 28°44.607′N 113°45.233′W, 433 m, 13.vii.2005, E. González and W.E. Savary, 1 juv. (AMCC [LP 4413]); Punta Prieta, 37 km north, off Route 1, 29°15.116′N 114°10.10′W, 588 m, 13.vii.2005, L. Prendini and R. Mercurio, 1 juv. (AMCC [LP 4451]); Punta Calamajue, abandoned fishing village, 29°41.119′N 114°09.774′W, 5.4 m, 1.vii.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8821]). *Municipio de Loreto*: Loreto, 25 km south, on gravel road ca. 0.25 km east Route 1, 25°48.666′N 111°19.266′W, 6 m, 7.vii.2005, W.E. Savary, L. Prendini, R. Mercurio and E. González, 1 subad. ♀ (AMCC [LP 4430]).

Paravaejovis spinigerus (Wood, 1863): Mexico: Chihuahua: *Municipio de Batopilas*: Batopilas, military check point, 27°03.502′N 107°43.054′W, 652 m, 2.viii.2005, O. Francke, K. McWest, H. Montaño, J. Ballesteros and L. Jarvis, 1 ♂ (AMCC [LP 5282]). *Municipio de Janos*: Highway MEX 2 km, 75 between Casas Grandes and Agua Prieta, 31°19.067′N 108°43.331′W, 1723 m, 26.vi.2006, P. Berea and E. González, 1 juv. (AMCC [LP 6317]). Sonora: *Municipio de Huatabampo*: Huatabampito coastal sand dunes, 26°41.818′N 109°36.358′W, 0 m, 22.ix.2009, E. González and J.L. Castelo, 1 ♀ (AMCC [LP 9970]). USA: Arizona: *Yavapai Co.*: Kaibab National Forest: Ash Fork, 10 km south on Highway 89 from intersection with I-40, at boat ramp 3262, 35°04′56.5″N 112°24′19.9″W, 1544 m, 8.ix.2007, L. Prendini and J. Huff, 1 juv. (AMCC [LP 7176]). New Mexico: *Hidalgo Co.*: Granite Gap on Highway 80, north of Rodeo, 32°05′34.2″N 108°58′12.1″W, 1367 m, 22.vii.2007, J. Huff, 1 juv. (AMCC [LP 7015]).

Paravaejovis waeringi (Williams, 1970): Mexico: Sonora: *Municipio de Mexicali*: San Felipe, sand dunes 11 km south, 30°57.312′N 114°47.734′W, 11 m, 15.vii.2005, E. González, W.E. Savary, L. Prendini and R. Mercurio, 1 juv. (AMCC [LP 4431]). *Municipio de Puerto Peñasco*: Sand dunes off road to Cerro Lava, 32°02.908′N 113°33.378′W, 230 m, 28.vi.2005, E. González and R. Mercurio, 1 ♂ (AMCC [LP 4433]). USA: California: *Imperial Co.*: Algodones Dunes, at junction of Olgiby Road S34 and Interstate Highway 8, 32°45.454′N 114°50.203′W, 50 m, 31.viii.2005, R. Mercurio and L. Prendini, 1 juv. (AMCC [LP 5029]). *Riverside Co.*: Intersection of Dillon Road and Landfill Road, 33°44′06.3″N 116°09′53.5″W, 16 m, 12.ix.2007, L. Prendini and J. Huff, 1 juv. (AMCC [LP 7119]). Whitewater Canyon, off I10, Whitewater Canyon Road near Whitewater Trout Farm, 33°59′18.2″N 116°39′18.2″W, 665 m, 18.viii.2004, M. McCoy, W.E. Savary, R. Mercurio and K. Bamba, 1 ♂ (AMCC [LP 3226]). *San Diego Co.*: Borrego Springs [33°14.833′N 116°22.317′W], 14.vii.1999, M.E. Soleglad, 1 ♀ (AMCC [LP 1688]).

Syntropis macrura Kraepelin, 1900: Mexico: Baja California Sur: *Municipio de Comondú*: San Miguel de Comondú, 26°02′26.7″N 111°49′55.3″W, 220 m, 12.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♂ (AMCC [LP 3146]); San José de Comondú, 30 km north, between Rosarito and San Isidro, 26°21.252′N 111°50.109′W, 258 m, 27.vi.2008, H. Montaño and E. González, 1 ♀ (AMCC [LP 8709]).

Syntropis williamsi Soleglad, Lowe and Fet, 2007: Mexico: Baja California Sur: *Municipio de La Paz*: El Pilar, ca. 20 km northeast of Las Pocitas, 24°28.762′N 111°01.125′W, 92 m, 25.vi.2008, H. Montaño and E. González, 1 subad. ♀ (AMCC [LP 8706]); Isla San José, Fishing camp Palma Sola, 25°03.091′N 110°40.037′W, 0–50 m, 3.vi.2008, I.G. Nieto and E. González, 1 juv. (AMCC [LP 8707]); San Evaristo, 10–15 km south on dirt road, 24°47.757′N 110°40.502′W, 27–50 m, 12.vii.2008, H. Montaño and E. González, 1 ♂ (AMCC [LP 8826]).

Thorellius cristimanus (Pocock, 1898): Mexico: Colima: *Municipio de Coquimatlán*: road to Coquimatlán, marker km 71, 19°06.775′N 103°51.185′W, 336 m, 26.v.2006, O. Francke, A. Valdez, H. Montaño and A. Ballesteros, 1 juv. (AMCC [LP 6551]). Jalisco: *Municipio de El Grullo*: Puerta de Barro, 2 km north, La Grulla, 19°51.509′N 104°13.420′W, 1059 m, 9.vii.2005, O. Francke, J. Ponce, M. Córdova, A. Jaimes, G. Francke and V. Capovilla, 1 ♂ (AMCC [LP 5323]), 1 juv. (AMCC [LP 5328]). Michoacán: *Municipio de Alvaro Obregón*: Alvaro Obregón, 19°02.310′N 102°58.405′W, 462 m, 11.vii.2005, O. Francke, J. Ponce, M. Córdova, A. Jaimes, G. Francke and V. Capovilla, 1 juv. (AMCC [LP 5325]).

Thorellius intrepidus (Thorell, 1876): Mexico: Colima: *Municipio de Comala*: Comala [19°19.00′N 103°45.00′W], 9.iv.2004, P. Berea, 1 subad. ♀ (AMCC [LP 6377]). *Municipio de Colima*: Los Ortices, 19°06′46.8″N 103°44′22.6″W, 343 m, 9.iv.2004, P. Berea, 1 ♂ (AMCC [LP 6379]). Jalisco: *Municipio de La Huerta*: Estación Biológica Chamela, El Tejon Trail, 19°29.836′N 105°02.491′W, 18.viii.2005, J.L. Castelo, 1 juv. (AMCC [LP 5309]).

Vizcaino viscainensis (Williams, 1970): Mexico: Baja California Sur: *Municipio de Mulegé*: Guerrero Negro, 12 km south, 27°56′05.8″N 113°54′23.1″W, 25 m, 15.vii.2004, O. Francke, W.E. Savary, E. González and A. Valdez, 1 ♂ (AMCC [LP 3174]); Sierra del Placer, 21 km to junction Bahía Tortugas and Bahía Asunción, 98 km east of Vizcaino towards Bahía Tortugas, 27°28.928′N 114°17.093′W, 262 m, 28.vi.2008, H. Montaño and E. González, 1 juv. (AMCC [LP 8809]).

Appendix 2

Material examined for morphological character matrix used in phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905, deposited in the following collections: American Museum of Natural History, New York (AMNH); Colección de Aracnología y Entomología del Centro de Investigaciones Biológicas del Noroeste, Baja California Sur, Mexico (CAECIB); California Academy of Sciences, San Francisco, California (CAS); Colección Nacional de Arácnidos, Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City (IBUNAM); Muséum d’Histoire Naturelle de Genéve, Switzerland (MHNG); Ohio State University, Museum of Biological Diversity, Columbus, Ohio (OSAL). Material at the AMNH, CAS and IBUNAM bearing ARA numbers were collected during a US National Science Foundation-funded “Revisionary Syntheses in Systematics” grant.

Outgroup

***Franckeus kochi* (Sissom, 1991):** Mexico: Hidalgo: *Municipio de Tolantongo*: Grutas de Tolantongo, 29°39.049′N 98°59.927′W, 1256 m, 29.iv.2005, O. Francke, J. Ballesteros, A. Valdez and H. Montaño, 1 ♂, 1 ♀ (AMNH [ARA3161]).

***Pseudouroctonus glimmei* (Hjelle, 1972):** USA: California: *Lake Co.*: Rayhouse Road, ca. 5 miles north, at junction of Davis and Cache Creeks, 900 ft, 15.vi.1969, J.T. Hjelle and M. Bolander, holotype ♂, paratype ♀ (CAS [Type No. 3502]).

***Serradigitus minutus* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de La Paz*: Libramiento to Pichilingue, marker km 4, near Termoelectrica Punta Prieta, 24°12.843′N 110°16.214′W, 105 m, 23.vi.2008, I.G. Nieto and M. Correa, 1 ♂, 1 ♀ (AMNH [ARA2903]).

***Serradigitus* sp.:** Mexico: Sinaloa: *Municipio de La Cruz*: Casas Viejas, 24°02′24.8″N 106°48′54.6″W, 92 m, 13.vii.2006, P. Berea, 1 ♂, 1 ♀ (AMCC [LP 6370]).

***Smeringurus grandis* (Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Punta Bufeo, 4 km south, from road to San Felipe, 29°51.433′N 114°26.500′W, 28 m, 14.vii.2005, E. González, W.E. Savary, R. Mercurio and L. Prendini, 1 ♂, 1 ♀ (AMNH [ARA3025]).

***Stahnkeus deserticola* (Williams, 1970):** USA: California: *San Bernardino Co.*: Death Valley National Park: Saratoga Springs, 35°40.843′N 116°25.264′W, 83 m, 1.ix.2005, R. Mercurio and L. Prendini, 1 ♂, 1 ♀ (AMNH).

***Uroctonites giulianii* Williams and Savary, 1991:** USA: California: *Inyo Co.*: Inyo National Forest: White Mountains, 0.7 miles south Schulman Grove, 3080 m, 4.ix.1988, S.C. Williams and V.F. Lee, paratype ♀ (AMNH); Waucoba Canyon, 6500–7500 ft, 9.vi.1976, paratype ♂ (CAS).

***Vaejovis carolinianus* (Beauvois, 1805):** USA: Georgia: *Rabun Co.*: 5–9.ix.1959, K. Ulmer, 1 ♂, 1 ♀ (AMNH).

***Vaejovis intermedius* Borelli, 1915:** Mexico: Durango: *Municipio de Peñón Blanco*: Peñón Blanco, 8 km north, 24°51.148′N 104°01.989′W, 1667 m, 11.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 ♂, 1 ♀ (AMCC [LP 5289]).

***Vaejovis lapidicola* Stahnke, 1940:** USA: Arizona: *Coconino Co.*: Coconino National Forest: Oak Creek Canyon, 35°01′55.2″N 111°44′01.7″W, 1969 m, 7.ix.2007, L. Prendini and J. Huff, 1 ♂, 1 ♀ (AMNH [ARA3115]).

***Vaejovis mexicanus* C.L. Koch, 1836:** Mexico: Distrito Federal: Pedregal de San Nicolas, northeast side of Cerro Ajusco, 1999, M. Sousa, 1 ♂, 1 ♀ (AMNH).

***Vaejovis pequeno* Hendrixson, 2001:** Mexico: Sonora: *Municipio de Soyopa*: Sierra El Encinal, dirt road between Tonichi and El Encinal, 28°33.628′N 109°20.590′W, 24.vi.2006, P. Berea and E. González, 1 ♂, 1 ♀ (AMNH [ARA3159]); Rio Cuchujaqui, east of Alamos, 14.i.1964, V.E. Roth, 1 ♂, 1 ♀ paratypes (AMNH).

***Vaejovis rossmani* Sissom, 1989:** Mexico: Tamaulipas: *Municipio de Güémez*: Rancho Nuevo, 23°52.050′N 99°27.052′W, surface, 10.iv.1982, P. Sprouse, 1 ♂, 1 ♀ paratypes (IBUNAM).

***Vaejovis* sp.** Mexico: Chiapas: *Municipio de Ocozocuautla de Espinosa*: El Aguacero, 16°45.374′N 93°31.468′W, 764 m, 25.v.2005, O. Francke, A. Jaimes and A. Ballesteros, 1 ♂, 1 ♀ (AMNH).

***Wernerius spicatus* (Haradon, 1974):** USA: California: *Riverside Co.*: Little San Bernardino Mountains, Berdoo Canyon, 6.9 miles northeast of junction with Dillon Road, 31.iii.1972, R.M. Haradon and J.L. Marks, *Vaejovis spicatus* Haradon, 1974 holotype ♀ (CAS [Type No. 12058]).

Ingroup

***Balsateres cisnerosi* (Ponce-Saavedra and Sissom, 2004):** Mexico: Michoacán: *Municipio de La Huacana*: El Vado, 18°48.908′N 101°54.976′W, 198 m, 20.v.2007, O. Francke, J. Ponce, M. Villaseñor and A. Quijano, 1 ♂, 1 ♀ (IBUNAM).

***Chihuahuanus bilineatus* (Pocock, 1898):** Mexico: Tamaulipas: *Municipio de Jaumave*: El Salto, between Palmillas and Jaumave, 23°21.440′N 99°30.941′W, 1115 m, 23.viii.2006, O. Francke, W.D. Sissom, G. Casper, T. Anton, V. Torti, H. Montaño and C. Santibáñez, 1 ♂, 1 ♀ (AMNH [ARA1129]), 1 ♂, 1 ♀ (CAS [ARA1883]).

***Chihuahuanus cazieri* (Williams, 1968):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Cuatro Ciénegas de Carranza, 0.5 km southwest, 740 m, 28.vii.1967, S.C. Williams and W.S. Brown, *Vejovis cazieri* Williams, 1968 holotype ♂ (CAS [Type No. 10169]), 1 ♂, 1 ♀ paratypes (AMNH).

***Chihuahuanus coahuilae* (Williams, 1968):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Cuatro Ciénegas de Carranza, 0.5 km southwest, 740 m, 28.vii.1967, *Vejovis coahuilae* Williams, 1968 holotype ♂ (CAS [Type No. 10170]); Ojo de Agua, Ejido El Oso, 27°00.056′N 102°00.226′W, 1039 m, 19.vii.2006, O. Francke, W.D. Sissom, K. McWest, B. Hendrixson, S. Grant, A. Jaimes and M. Córdova, 2 ♂, 2 ♀ (AMNH [ARA1120]), 2 ♂, 2 ♀ (IBUNAM [ARA0084]).

***Chihuahuanus crassimanus* (Pocock, 1898):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Dunas de Yeso, 26°51.765′N 102°10.47′W, 776 m, 18.vii.2006, O. Francke, W.D. Sissom, M. Córdova, A. Jaimes and A. Ballesteros, 1 ♂ (AMNH [ARA1105]); Sierra San Marcos II, 26°54.780′N 102°08.25′W, 761 m, 18.vii.2006, E. González, B. Hendrixson, K. McWest and S. Grant, 1 ♀ (AMNH [ARA1110]). Durango: *Municipio de Tlahualilo*: Tlahualilo de Zaragoza, ca. 15 km northwest, junction Montes Claros–Tlahualilo de Zaragoza, 26°09.242′N 103°31.28′W, 1107 m, 6.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros and L. Jarvis, 1 ♂ (AMNH [ARA3170]). USA: Texas: *Hudspeth Co.*: Sierra Blanca, 9 miles west, 18.viii.1962, C.A. Triplehorn, 1 ♀ (OSAL).

***Chihuahuanus glabrimanus* (Sissom and Hendrixson, 2005):** Mexico: Guanajuato: *Municipio de San Diego de la Unión*: San Diego de la Unión, 8 km south, 21°23.144′N 100°53.452′W, 2078 m, 28.vii.2006, E. González, M. Córdova, A. Jaimes, A. Ballesteros and O. Francke, 1 ♂ (AMNH). San Luis Potosí: *Municipio de Villa de Arista*: Villa de Arista, 10 km east, 22°30.760′N 100°45.499′W, 30.viii.2006, O. Francke, W.D. Sissom, G. Casper, T. Anton, V. Torti, H. Montaño, C. Santibáñez and A. Ballesteros, 4 ♂, 1 ♀ (CAS [ARA01909]).

***Chihuahuanus globosus* (Borelli, 1915):** Mexico: Coahuila: *Municipio de Cuatro Ciénegas*: Gypsum dunes, 13 km southwest Cuatro Ciénegas de Carranza, 780 m, 27.vii.1967, S.C. Williams and W.S. Brown, *Vejovis gilvus* Williams, 1968 holotype ♂ (CAS [Type No. 10172]); Cuatro Ciénegas, 16 miles southwest, west point of Laguna Grande dunes, 9.viii.1968, S.C. Williams, M. Bentzien, J. Bigelow, and W.L. Minckley, 1 ♂, 1 ♀ (AMNH). *Municipio de Viesca*: Dunas de Bilbao, 25°25.586′N 102°53.654′W, 1098 m, 20.vii.2006, O. Francke, K. McWest, M. Córdova, A. Jaimes and A. Ballesteros, 4 ♂, 1 ♀ (CAS [ARA1879]).

***Chihuahuanus kovariki* (Soleglad and Fet, 2008):** Mexico: Durango: *Municipio de Canatlán*: Highway 137, marker km 4, between Once de Marzo and San Juan del Río, San Francisco de Lajas, 24°51.764′N 104°38.846′W, 1893 m, 10.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 ♂ (AMNH). *Municipio de Peñón Blanco*: Yerbanis, 80 miles northwest Durango, 19.viii.1947, W.J. Gertsch, 1 ♀ (AMNH).

Chihuahuanus russelli **(Williams, 1971):** USA: Arizona: *Cochise Co.*: Portal, 4770 ft, 26.viii.1965, S.C. Wiliams and G. Fernald, *Vaejovis russelli* Williams, 1971 holotype ♂ (CAS [Type No. 11471]). New Mexico: *Hidalgo Co.*: Rodeo, 10 miles north, 22.ix.1963, V. Roth, 1 ♀ (AMNH). Texas: *Brewster Co.*: Big Bend National Park: Pine Canyon Trail, Chisos Mountains, 29°16.08′N 103°14.22′W, 1.viii.2008, W.D. Sissom, G. Casper and T. Anton, 2 ♂ (AMNH).

Kochius barbatus **(Williams, 1971):** Mexico: Baja California Sur: *Municipio de La Paz*: Las Cruces, 25 ft, 29.vii.1968, S.C. Williams and M.A. Cazier, *Vaejovis punctipalpi barbatus* Williams, 1971 holotype ♀ (CAS [Type No. 10469]), paratype ♀ (AMNH); Las Cruces, 4 km northwest, 24°13.511′N 110°07.41′W, 31 m, 24.vi.2008, H. Montaño and E. González, 1 ♂ (AMNH [ARA2884]), 1 ♂ (IBUNAM [ARA2274]).

Kochius bruneus **(Williams, 1971):** Mexico: Baja California: *Municipio de Mulegé*: San Ignacio, 500 ft, 24.vi.1968, S.C. Williams and M.A. Cazier, *Vaejovis bruneus loretoensis* Williams, 1971 holotype ♂, paratype ♀ (CAS [Type No. 10466]). Baja California Sur: *Municipio de Comondú*: San José de Comondú, 5 miles southwest, 1000 ft, 2.vii.1968, S.C. Williams and M.A. Cazier, *Vejovis bruneus* Williams, 1971 holotype ♂ (CAS [Type No. 10410]); San José de Comondú, 30 km north, between Rosarito and San Isidro, 26°21.252′N 111°50.100′W, 258 m, 27.vi.2008, H. Montaño and E. González, 2 ♂, 2 ♀ (AMNH [ARA2854]).

Kochius cerralvensis **(Williams, 1971):** Mexico: Baja California Sur: *Municipio de La Paz*: Isla Cerralvo, Bahia Limoña, 31.v.1969, S.C. Williams, *Vaejovis punctipalpi cerralvensis* Williams, 1971 holotype ♂ (CAS [Type No. 11470]); Isla Cerralvo, Piedras Gordas, 17.v.1970, S.C. Williams and V.F. Lee, *V. p. cerralvensis* paratype ♂, paratype ♀ (AMNH); Isla Cerralvo, southwest side, 24°10.933′N 109°53.233′W, 50 m, 27.v.2008, E. González and I.G. Nieto, 1 ♂, 1 ♀ (AMNH [ARA2880]).

Kochius hirsuticauda **(Banks, 1910):** USA: Arizona: *Yuma Co.*: Palm Canyon, Kofa Mountains, 12.x.1968, M.A. Cazier et al., 1 ♂, 1 ♀ (AMNH). California: *San Diego Co.*: Anza-Borrego Desert State Park: Pinyon Mountain Road, ca. 4.8 km towards Pinyon Mountain Valley from junction with Route S2, 33°03.043′N 116°23.270′W, 870 m, 30.viii.2005, R. Mercurio and L. Prendini, 1 ♂, 1 ♀ (AMNH).

Kochius insularis **(Williams, 1970):** Mexico: Baja California Sur: *Municipio de La Paz*: Isla Espíritu Santo, Playa Bonanza, 24°27.364′N 110°18.47′W, 50 m, 31.v.2008, E. González and I.G. Nieto, 1 ♂, 1 ♀ (AMNH [ARA2875]), ♂, 1 ♀ (IBUNAM [ARA2260]); Isla Partida, Central Valley, 10.vii.1968, S.C. Williams, M. Bentzien and B. Fox, *Vejovis insularis* Williams, 1970 holotype ♂, paratype ♀ (CAS [Type No. 10422]).

Kochius magdalensis **(Williams, 1971):** Mexico: Baja California Sur: *Municipio de La Paz*: La Paz, 75 miles northwest, 200 ft, 4.vii.1968, S.C. Williams and M.A. Cazier, *Vejovis magdalensis* Williams, 1971 holotype ♂ (CAS [Type No. 10468]); El Pilar, ca. 20 km northeast of Las Pocitas, 24°28.762′N 111°01.12′W, 92 m, 25.vi.2008, H. Montaño and E. González, 1 ♂, 1 ♀ (AMNH [ARA2874]), 1 ♂, 1 ♀ (IBUNAM [ARA2259]); La Paz, ca. 5 km north junction Route 1 and road to San Juan de la Costa, 24°08.500′N 110°28.566′W, 30 m, 9.vi.2005, E. González, W.E. Savary, R. Mercurio and L. Prendini, 1 ♂ (AMNH).

Kochius punctipalpi **(Wood, 1863):** Mexico: Baja California Sur: *Municipio de Los Cabos*: Santiago, 23°26.4′N 109°43.567′W, 225 m, 9.vii.2004, O. Francke, E. González and A. Valdez, 1 ♂, 1 ♀ (AMNH [ARA1471]); San José del Cabo, ca. 10 km south off Route 1, 23°01.762′N 109°43.49′W, 50 m, 10.vii.2005, W.E. Savary, E. González and R. Mercurio, 1 ♂, 1 ♀ (AMNH [ARA1473]). *Municipio de La Paz*: La Paz, 15 km southeast, 24°03.733′N 110°10.53′W, 476 m, 8.vii.2004, O. Francke, E. González and A. Valdez, 1 ♂ (AMNH [ARA1472]).

Kochius sonorae **(Williams, 1971):** Mexico: Sonora: *Municipio de Alamos*: Alamos, 11.2 miles west, 23.i.1966, R. Winokur, C. Mays and M.A. Nikerson, *Vaejovis sonorae* Williams, 1971 holotype ♂ (CAS [Type No. 10472]). *Municipio de Navojoa*: Microwave antenna, Cerro Prieto, 15 km east of Navojoa, 27°04.983′N 109°17.450′W, 375 m, 23.viii.2009, E. González and J.L. Castelo, 1 ♂, 1 ♀ (AMNH [ARA3157]); Navojoa, 32 km south, 12.ix.1966, J. and W. Ivie, 1 ♂, 1 ♀ (AMNH). *Municipio de Soyopa*: Sierra el Encinal, 9 km from Highway MEX 16 on dirt road to El Encinal, 28°35.412′N 109°27.148′W, 380 m, 24.vi.2006, E. González and P. Berea, 2 ♂ (AMNH [ARA2539]); Sierra el Encinal, dirt road between El Encinal and Tonichi, 28°33.239′N 109°21.64′W, 645 m, 1.vii.2006, E. González and P. Berea, 2 ♂ (AMNH [ARA3015]).

Kochius villosus **(Williams, 1971):** Mexico: Baja California Sur: *Municipio de Comondú*: San Miguel Comondú, 5–10 miles southwest, 800–1000 ft, 3.vii.1968, S.C. Williams and M.A. Cazier, *Vaejovis bruneus villosus* Williams, 1971 holotype ♂ (CAS [Type No. 10467]), 1 ♂, 1 ♀ paratypes (AMNH). *Municipio de La Paz*: San Evaristo, 10–15 km south on dirt road, 24°47.757′N 110°40.501′W, 50 m, 12.vii.2008, H. Montaño and E. González, 1 ♂ (IBUNAM [ARA2275]). *Municipio de Loreto*: Juncalito, 25°49.891′N 111°19.691′W, 5 m, 20.v.2004, R. Mercurio and M. Nishiguchi, 1 ♂, 1 ♀ (AMNH [ARA3132]). *Municipio de Mulegé*: San Ignacio, 152 m, 24.vi.1968, S.C. Williams and M.A. Cazier, *V. b. villosus*, 1 ♂, 1 ♀ paratypes (AMNH).

Konetontli acapulco **(Armas and Martín-Frías, 2001):** Mexico: Guerrero: *Municipio de Acapulco de Juárez*: Colonia Francisco Villa, Acapulco, 25.v.1999, E. Martín and A. Losoya, *Vaejovis acapulco* Armas and Martín-Frías, 2001 holotype ♂ (IBUNAM). *Municipio de José Azueta*: Colonia Agua de Correa, 17°38.698′N 101°31.093′W, 72 m, 1.viii.2008, O. Francke, H. Montaño, J. Ponce and A. Quijano, 1 ♀ (IBUNAM).

Konetontli chamelaensis **(Williams, 1986):** Mexico: Jalisco: *Municipio de La Huerta*: Estación de Biología de Chamela, UNAM, 10–13.vii.1985, S.C. Williams, *Vaejovis chamelaensis* Williams, 1986 holotype ♂, paratype ♀ (CAS [Type No. 15744]), 31.v.1990, N. Martínez, (IBUNAM), 1.vi.1994, N. Martigera, 1 ♀ (IBUNAM), 19°29.875′N 105°02.608′W, 97 m, 24.x.2005, E. González and J.L. Castelo, 2 ♂ (IBUNAM), 30.viii.2007, O. Francke et al., 1 ♀ (AMCC [LP 7675]); Rincón de Ixtlán, Chamela, 19°32′N 105°04′W, 25.x.2005, E. González, 1 ♀ (IBUNAM).

Konetontli nayarit **(Armas and Martín-Frías, 2001):** Mexico: Nayarit: *Municipio de Compostela*: Felipe Carrillo Puerto, 4 km northeast, 16.vii.1999, J.A. Fernández, *Vaejovis nayarit* Armas and Martín-Frías, 2001 holotype ♂ (IBUNAM). *Municipio de El Nayar*: Río Santiago, 16.v.1996, E. Barrera, 1 ♀ (AMNH).

Konetontli pattersoni **(Williams and Haradon, 1980):** Mexico: Baja California Sur: *Municipio de Los Cabos*: Sierra de la Laguna, 23°14.285′N 109°57.131′W, 782 m, 10.vii.2004, A. Valdez, E. González, O. Francke and W.E. Savary, 1 ♀ (AMNH [ARA3082]), 23°41.167′N 109°56.683′W, 850 m, 9.vii.2004, A. Valdez and E. González, 1 ♀ (AMNH [ARA3083]); Sierra de la Laguna, nucleus zone, 23°33.016′N 109°59.450′W, 1800 m, 20.vii.2006, A. Valdez, E. González, O. Francke and W.E. Savary, 2 ♂ (AMNH [ARA3064]); La Laguna, Sierra de la Laguna, 1–3.viii.1974, R.M. Haradon, V.F. Lee and W.E. Savary, *Vaejovis pattersoni* Williams and Haradon, 1980 holotype ♂, paratype ♀ (CAS [Type No. 12250]).

Kuarapu purhepecha **Francke and Ponce-Saavedra, 2010:** Mexico: Michoacán: *Municipio de La Huacana*: El Vado, km 17 road Zicuaran–Churumuco, 18°48.852′N 101°54.956′W, 248 m, 30.vi.2008, O. Francke, H. Montaño, J. Ponce and A. Quijano, 1 ♂, 1 ♀ paratypes (AMNH).

Maaykuyak vittatus **(Williams, 1970):** Mexico: Baja California Sur: *Municipio de Comondú*: San Miguel Comondú, 5 miles southwest, 1000 ft, 2.vii.1968, S.C. Williams and M.A. Cazier, *Vejovis vittatus* Williams, 1970 holotype ♂ (CAS [Type No. 10430]); San

Miguel Comondú, 8–16 km southwest, 304 m, 3.vii.1968, S.C. Williams and M.A. Cazier, *V. vittatus*, 1 ♂, 1 ♀ paratypes (AMNH).

***Maaykuyak waueri* (Gertsch and Soleglad, 1972):** Mexico: Durango: *Municipio de Tlahualilo*: Highway 49, at deviation Montes Claros–Tlahualilo de Zaragoza, 26°09.242′N 103°31.284′W, 1107 m, 6.viii.2005, O. Francke, W.D. Sissom, K. McWest, C. Lee, H. Montaño, J. Ballesteros, L. Jarvis and C. Durán, 1 ♂ (AMNH). USA: Texas: *Brewster Co.*: Big Bend National Park: The Basin, Chisos Mountains, 28.ix.1950, *Vaejovis waueri* Gertsch and Soleglad, 1972 holotype ♀ (AMNH).

***Mesomexovis atenango* (Francke and González-Santillán, 2007):** Mexico: Guerrero: *Municipio de Copalillo*: Totonimitla, Papalutla, 18°01.470′N 98°53.809′W, 650 m, 28.i.2011, U. Lonjino and J. Mendez, 1 ♂, 1 ♀ (IBUNAM). *Municipio de Tepecoacuilco de Trujano*: Cerro de la Coronilla, 3.4 km northeast Ahuehuepan, 18°00′57″N 99°31′32″W, 857 m, 28.vi.2012, A. Valdez, T. López and A. Quijano, 1 ♀ (IBUNAM); Cerro de la Coronilla, 18°00.976′N 99°31.726′W, 844 m, 27.vi.2008, O. Francke, A. Quijano and C. Santibáñez, 1 ♂, 1 ♀ (AMNH).

***Mesomexovis oaxaca* (Santibáñez-López and Sissom, 2010):** Mexico: Oaxaca: *Municipio de Ocotlán*: Chichicapan, 4.8 km east, 1645 m, 23.viii.1966, C.M. Bogert, 1 ♂, 1 ♀ (AMNH). *Municipio de San Pablo Villa Mitla*: Mitla, 8 km northeast, on ridge ca. 6800–7200 ft, near El Crucero ruins, 27.viii.1963, C.M. Bogert, G. Sludder and N. Bucknall, ♂, 1 ♀ (AMNH). *Municipio de Tlacolula de Matamoros*: Tlacolula, 16.vii.1955, C. and P. Vaurie, *Vaejovis oaxaca* Santibáñez-López and Sissom, 2010 paratype ♂, paratype ♀ (AMNH).

***Mesomexovis occidentalis* (Hoffmann, 1931):** Mexico: Guerrero: *Municipio de Acapulco*: Acapulco, *Vejovis subcristatus occidentalis* Hoffmann, 1931 holotype ♀, paratype ♂, paratype ♀ (AMNH); Cumbres de Llano Largo, 16°49.505′N 99°49.999′W, 371 m, 19.vi.2007, O. Francke, H. Montaño and A. Ballesteros, 1 ♂ (CAS [ARA1975]). *Municipio de Copala*: Microwave antenna, Fogos, east of Copala, 16°33.992′N 98°53.30′W, 103 m, 22.vi.2007, O. Francke, H. Montaño, L. Escalante and A. Ballesteros, 1 ♂, 1 ♀ (IBUNAM).

***Mesomexovis punctatus* (Karsch, 1879):** Mexico: Hidalgo: *Municipio de Zimapán*: Microwave antenna, Zimapán, 20°44.783′N 99°20.900′W, 1900 m, 3.viii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 2 ♂, 2 ♀ (AMNH [ARA1170]).

***Mesomexovis spadix* (Pocock, 1898):** Mexico: Guanajuato: *Municipio de León*: León, iv.2004, P. Berea, 1 ♂, 1 ♀ (IBUNAM).

***Mesomexovis subcristatus* (Pocock, 1898):** Mexico: Oaxaca: *Municipio de Cuicatlán*: Tomellin, 17°45.180′N 96°57.237′W, 605 m, 23.vii.2002, L. Prendini, O. Francke, E. González and J. Ponce, ♂, 1 ♀ (AMCC [LP 2086]). Puebla: *Municipio de Tehuacán*: Tehuacán, 2 km east, 18°24.002′N 97°22.867′W, 1435 m, 25.vii.2002, L. Prendini, O. Francke, E. González and J. Ponce, 1 ♂, 1 ♀ (AMCC [LP 2048]).

***Mesomexovis variegatus* (Pocock, 1898):** Mexico: Guerrero: *Municipio de Buenavista de Cuellar*: El Comal, 18°27.086′N 99°17.139′W, 1749 m, 13.vi.2007, O. Francke et al., 1 ♂, 1 ♀ (AMNH [ARA2623]).

***Paravaejovis confusus* (Stahnke, 1940):** USA: Arizona: *Maricopa Co.*: Wickenburg, 20.iv.1938, A.L. Corbin, *Vejovis confusus* Stahnke, 1940, 2 ♀ syntypes (CAS [Type No. 15170]). *Mohave Co.*: Warm Springs Wash, 4.7 km north of Topock, 34°44.866′N 114°28.900′W, 147 m, 9.ix.2007, L. Prendini and J. Huff, 5 ♂, 2 ♀ (AMNH [ARA3117]).

***Paravaejovis diazi* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de Comondú*: Ciudad Constitución, 34.4 km west (Magdalena Plain, El Crucero, 21.4 miles W), 75 ft, 26.vii.1968, S.C. Williams and M.A. Cazier, *Vejovis diazi* Williams, 1970 holotype ♂ (CAS [Type No. 10413]). *Municipio de La Paz*: Las Cruces, 8 km southwest, 30.vii.1968, S.C. Williams and M.A. Cazier, *V. diazi* paratype ♂, paratype ♀ (AMNH); Punta San Telmo on Gulf coast, 25 ft, 26.v.1969, S.C. Williams, *Vejovis diazi transmontanus* Williams, 1970 holotype ♂ (CAS [Type No. 10414]).

***Paravaejovis eusthenura* (Wood, 1863):** Mexico: Baja California Sur: *Municipio de La Paz*: La Paz, 18 km southeast, 24°2.750′N 110°08.85′W, 626 m, 8.vii.2004, O. Francke, E. González and A. Valdez, 1 ♂, 1 ♀ (AMNH [ARA1192]). *Municipio de Los Cabos*: San José del Cabo, ca. 10 km south off Route 1, 23°01.762′N 109°43.49′W, 50 m, 10.vii.2005, W.E. Savary, E. González and R. Mercurio, 1 ♂, 1 ♀ (AMNH [ARA3177]).

***Paravaejovis gravicaudus* (Williams, 1970):** Mexico: Baja California Sur: Los Aripes, 21.4 miles west, 900 ft, 25.vii.1968, S.C. Williams, J. Bigelow, and M. Bentzien, *Vejovis gravicaudus* Williams, 1970 holotype ♂ (CAS [Type No. 10418]). *Municipio de Comondú*: San Miguel de Comondú, 2 km southwest, 3.vii.1968, M.A. Cazier et al., *V. gravicaudus* paratype ♂, paratype ♀ (AMNH).

***Paravaejovis hoffmanni* (Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Laguna Manuela, 4.8 km north, 152 m, 22.vi.1968, S.C. Williams and M.A. Cazier, *Vejovis hoffmanni* Williams, 1970 paratype ♂, paratype ♀ (AMNH); Manuela, 3 miles north, 500 ft, 22.vi.1968 S.C. Williams and M.A. Cazier, *V. hoffmanni* holotype ♂ (CAS [Type No. 10420]). Baja California Sur: *Municipio de Comondú*: San Jose de Comondú, 24 miles northeast, 900 ft, 15.v.1969, S.C. Williams, *Vejovis hoffmanni fuscus* Williams, 1970 holotype ♂ (CAS [Type No. 10421]).

***Paravaejovis pumilis* (Williams, 1970):** Mexico: Baja California Sur: *Municipio de Comondú*: El Cayuco Fish camp, sand dunes south, 24°34.666′N 111°40.633′W, 6 m, 11.vii.2005, W.E. Savary, E. González, L. Prendini and R. Mercurio, 2 ♀ (AMNH [ARA3173]); Magdalena Plain, El Crucero, 26.8 miles west, 50 m, 26.vii.1968, S.C. Williams and M.A. Cazier, *Vejovis pumilis* Williams, 1970 holotype ♂ (CAS [Type No. 10425]).

***Paravaejovis puritanus* (Gertsch, 1958):** Mexico: Baja California: *Municipio de Ensenada*: Santo Tomas, 8.vii.1953, W.J. and J.W. Gertsch, *Vejovis puritanus* Gertsch, 1958 holotype ♂ (AMNH). Baja California Sur: *Municipio de Loreto*: Rancho Canipolé, 1 miles southwest, 800 ft, 15.v.1969, S.C. Williams, *Vejovis terradomus* Williams, 1970 holotype ♂ (CAS [Type No. 10428]).

***Paravaejovis schwenkmeyeri* (Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Bahia de Los Angeles, 25 ft, 19.vi.1968, S.C. Williams and M.A. Cazier, *Vejovis schwenkmeyeri* Williams, 1970 holotype ♂ (CAS [Type No. 10426]). Baja California Sur: *Municipio de Mulegé*: San Raymundo, 12.9 km northwest, 152 m, 30.vi.1968, M.A. Cazier et al., 1 ♂, 1 ♀ (AMNH).

***Paravaejovis spinigerus* (Wood, 1863):** USA: Arizona: *Maricopa Co.*: Sunflower, turnoff to Bushnell Tanks, 33°52′08.8″N 111°27′54.4″W, 1057 m, 6.iv.2007, J. Huff and L. Prendini, 1 ♂, 1 ♀ (AMNH).

***Paravaejovis waeringi* (Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Oakies Landing, 27 miles [44 km] south of Puertecitos, 12.vi.1968, S.C. Williams and M.A. Cazier, *Vejovis waeringi* Williams, 1970 holotype ♂, paratype ♀ (CAS [Type No. 10431]), paratype ♂ (AMNH); Puertecitos, 11.vi.1968, S.C. Williams and M.A. Cazier, 2 ♂, 1 ♀ (CAS). USA: California: *Imperial Co.*: Algodones Dunes, along Grays Wells Road, south of Interstate Highway 8, west of Imperial Sand Dunes Recreation Area, 32°44.176′N 114°53.43′W, 50 m, 31.viii.2005, R. Mercurio and L. Prendini, 1 ♀ (AMNH [ARA1499]). Andrade, 2 miles west, 6.vii.1969, S.C. Williams and V.F. Lee, *Vejovis coloradensis* Williams, 1970 holotype ♂ (CAS [Type No. 10411]). *San Diego Co.*: Anza-Borrego Desert State Park: Culp Valley Camp, 33°13.412′N 116°27.26′W, 1033 m, 30.viii.2005, R. Mercurio and L. Prendini, 1 ♂, 1 ♀ (AMNH [ARA1497]).

***Syntropis macrura* Kraepelin, 1900:** Mexico: Baja California Sur: *Municipio de Comondú*: San José Comondú, 27.viii.2006, C. Palacios, 1 ♂ (CAECIB). *Municipio de La Paz*: north of Los Aripes, 25.vi.1985, W.R. Lourenco and G.A. Polis, 1 ♂, 1 ♀ (MHNG).

Syntropis williamsi **Soleglad, Lowe and Fet, 2007:** Mexico: Baja California Sur: *Municipio de La Paz*: El Pilar, ca. 20 km northeast of Las Pocitas, 24°28.762′N 111°01.12′W, 92 m, 25.vi.2008, H. Montaño and E. González, 1 ♂ (AMNH [ARA2825]); north of Los Aripes [24°08.533′N 110°18.65′W], 25.vi.1985, W.R. Lourenço and G.A. Polis, holotype ♀ (MHNG).

Thorellius cristimanus **(Pocock, 1898):** Mexico: Colima: *Municipio de Colima*: Colima, in house, *Vejovis intrepidus atrox* Hoffmann, 1931, 2 ♀ syntypes (AMNH). *Municipio de Tonila*: Tonila, 3.2 km south, 28.viii.1965, W.J. Gertsch and R. Hastings, 1 ♂, 1 ♀ (AMNH).

Thorellius intrepidus **(Thorell, 1876):** Mexico: Colima: *Municipio de Armería*: Mina La Salada, northwest of Ixtlahuacan, 19°01.680′N 103°47.036′W, 275 m, mine staff, 1 ♂, 1 ♀ (AMNH). *Municipio de Tecomán*: Tecomán, 18°54′30″N 103°52′28″W, 1 ♂, 1 ♀ (AMNH).

Vizcaino viscainensis **(Williams, 1970):** Mexico: Baja California: *Municipio de Ensenada*: Miller's Landing, 2 miles northwest, 25 ft, 21.vi.1968 S.C. Williams and M.A. Cazier, *Vejovis viscainensis* Williams, 1970 holotype ♂ (CAS [Type No. 10429]). Baja California Sur: *Municipio de Mulegé*: Las Bombas, 3.2 km east, 30 m, 16.iv.1969, S.C. Williams, 2 ♀ (AMNH); Sierra del Placer, 21 km to junction Bahía Tortugas and Bahía Asunción, 98 km east of Vizcaino towards Bahía Tortugas, 27°28.928′N 114°17.093′W, 262 m, 28.vi.2008, H. Montaño and E. González, 8 ♂, 6 ♀ (IBUNAM [ARA2245]).

Appendix 3

Distribution of raw data for quantitative morphological characters 0–44 (Appendix 4) among ingroup and outgroup taxa for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Polymorphisms are indicated as ranges. Material examined is listed in Appendix 2. Numbers following terminal taxon names correspond to samples from which DNA was extracted and sequenced (Appendix 1). Terminals for which meristic data were not recorded, were scored as missing data (?) in analyses of the morphological dataset.

Outgroup

Franckeus kochi **5363**

22–23 19 0 1 1 2 6 3 4 4 4 8 4 5 5 5 2 2 2 2 1.3 1.3 3 3 1 1 3 1 3 1 3 4 4 1 5 2 2 3 3 4 2 3 2 5 1

Pseudouroctonus glimmei **2688**

12 10–11 0 0 0 1 2 2 2 2 2 3 2 3 3 3 0 0 0 0 1.1 1.1 0 1 0 0 4 1 1 0 0 1 1 0 1 0 1 1 1 2 1 2 1 4 0

Serradigitus minutus **1674**

14 13 1 1 1 2 6 3 3 3 3 8 3 3 3 3 1 1 1 1 1.3 1.2 1 2 1 1 4 1 1 0 1 3 3 0 1 1 2 2 2 2 1 2 2 3 1

Serradigitus **sp. 6370**

14 13 1 1 2 2 3 2 2 3 3–4 6 3 3 3 3 0 0 1 1 1.2 1.2 1 1 1 1 4 1 0 0 1 3 3 0 1 1 1 2 2 2 1 2 3 3 1

Smeringurus grandis **8690**

32–33 23 0 0 1 2 4 3 6 6 6 9 5 12 12 11 2 2 2 2 1.1 1.2 1 2 1 0 3 1 1 0 0 3 2 0 2 2 3 2 2 8 1 2 2 6 0

Stahnkeus deserticola **5032**

24–26 21 0 0 1 2 3 2 3 3 3 3 3 3 3 4 0 1 1 1 1.3 1.2 1 2 1 1 4 1 1 0 1 3 3 0 0 2 1 2 2 4 1 2 2 3 1

Uroctonites giulianii **3204**

8 7–8 0 1 1 1 3 2 2 2 2 4 3 3 3 3 2 0 0 0 1.4 1.2 1 2 1 1 4 1 3 0 2 1 1 0 3 3 2 2 3 3 1 2 1 4 1

Vaejovis carolinianus **1576**

14 13 0 1 1 1 3 2 2 2 2 4 3 3 3 3 0 0 0 0 1.4 1.4 1 3 1 1 3 1 1 0 1 1 2 0 5 1 1 2 3 2 1 2 1 3 1

Vaejovis intermedius **2141A**

22 21 0 3 4 7 18 5 9 8 12 36 5 7 5 11 2 2 2 2 1.3 1.3 2 3 1 1 5 1 3 2 3 4 4 1 5 3 3 5 3 6 2 3 2 5 1

Vaejovis lapidicola **1814**

13 12 1 1 1 2 4 2 2 3 3 4 3 4 4 4 0 1 0 0 1.2 1.1 1 2 1 1 3 1 1 1 1 2 2 0 2 1 1 2 1 2 2 2 2 3 1

Vaejovis mexicanus **1825**

19 16–17 0 1 1 2 4 2 2 2 2 3 2 3 3 3 0 0 0 0 1.3 1.3 0 1 1 1 4 1 0 0 1 1 2 0 2 1 1 1 2 2 1 2 3 6 1

Vaejovis pequeno **6308**

14 13 1 1 1 2 5 2 2 2 3 6 3 3 3 3 0 0 0 0 1.3 1.1 1 2 1 1 4 1 0 0 1 3 3 0 2 1 1 2 2 2 1 2 2 3 1

Vaejovis rossmani **2027**

13 11–12 0 0 1 1 3 2 2 2 2 5 3 3 3 3 0 1 1 1 1.2 1.3 1 2 1 0 4 1 3 0 1 2 3 0 2 1 1 2 2 3 1 2 2 4 1

Vaejovis **sp. 5327**

14 13 1 1 1 1 5 2 4 4 4 5–7 2 3 3 3 1 2 2 2 1.2 1.3 1 2 1 1 4 1 0 0 1 3 3 1 2 1 2 2 1 3 2 3 2 4 1

Wernerius spicatus **8968**

12 11 0 1 1 2 4 2 2 2 2–3 4 3 3 3 3 0 0 0 0 1.3 1.4 1 2 1 1 4 1 2 1 1 2 3 0 3 2 2 2 3 2 1 2 2 3 1

Ingroup

Balsateres cisnerosi **2018**

21 21 0 0 0 1 4 1 1 1 1 3 1 1 1 1 0 0 0 0 1.3 1.3 1 1 1 1 4 1 0 0 1 3 3 0 1 0 1 2 1 1 2 2 3 4 1

Chihuahuanus bilineatus **5306**

17–18 17 1 2 2 2 7 3 3 4 4 9 3 3 5 5 2 2 2 2 1.2 1.1 3 2 1 1 4 1 3 2 1 4 4 2 4 3 2 3 3 3 2 3 3 6 1

Chihuahuanus cazieri **7163**

17–19 14–15 0 0 1 1 5 2 2 2 3 4 3 3 3 4 0 0 0 0 1.2 1.2 3 2 1 1 4 1 1 0 1 2 3 0 3 2 2 3 3 4 1 2 2 4 1

Chihuahuanus coahuilae **5353**

18–19 14–15 0 1 3 4 9 3 3 4 4 10 3 4 3 5 1 1 2 1 1.3 1.3 3 4 1 1 6 1 3 4 4 4 4 0 4 4 4 4 3 7 3 3 4 6 1

Chihuahuanus crassimanus **2972**

17 14 0 1 1 1 7 2 2 2 2 8 3 3 3 3 0 0 0 0 1.3 1.2 2 2 1 1 4 1 2 0 1 2 3 0 3 2 2 3 3 4 1 2 2 4 1

Chihuahuanus glabrimanus **6558**

17 14 0 3 3 4 7 3 3–4 3–4 4–5 11 3 3 3 5 0 1 0 0 1.2 1.3 3 4 1 1 4 1 3 2 2 5 5 1 3 1 3 4 3 4 2 3 3 6 1

Chihuahuanus globosus **5281**

16 13 1 3 3 3 6 3 3 3 3 6 3 3 3 5 0 1 1 1 1.3 1.3 3 4 1 1 4 1 3 3 3 5 4 1 4 2 2 4 3 4 2 3 4 6 1

Chihuahuanus kovariki **5299**

16 15 1 2 3 5 11 4 4 4–6 4–6 12–13 3 4 4 5 1 1 1 1 1.3 1.2 5 6 1 1 9 2 3 5 5 6 3 2 7 6 4 7 5 5 3 4 6 8 1

Chihuahuanus russelli **2971**

18 14–15 0 1 1 2 5 2 2 2 3 5 3 3 3 3 0 0 0 0 1.2 1.2 2 2 1 1 4 1 2 1 1 2 3 0 4 2 2 4 3 4 2 2 3 4 1

Kochius barbatus **8803**

19–20 18 0 1 0 1 4 2 2 2 2 4–5 3 3 3 4 0 0 0 0 1.2 1.2 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 2 1 1 1 2 1 4 1

Kochius bruneus **3153**

18 15–16 0 1 1 2 4 2 2 2 2 4 3 3 3 3 0 0 0 0 1.2 1.2 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 1 1 1 1 2 1 4 1

Kochius cerralvensis **8779**

18 17 0 1 1 1 5 2 2 2 2 4–6 2 3 3 3 0 0 0 0 1.2 1.1 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 2 1 1 1 2 1 4 1

Kochius hirsuticauda **5049**

18 16 0 0 1 1 3 2 2 2 2 4 3 3 3 3 0 0 0 0 1.3 1.2 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 1 1 1 1 2 1 4 1

Kochius insularis **8801**

19 16 0 0 0 1 4 2 2 2 2 4–5 3 3 3 3 0 0 0 0 1.1 1.3 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 1 1 1 1 2 1 4 1

Kochius magdalensis **3155**

19 17 0 1 1 1 4 2 2 2 2 4–6 3 3 3 3 0 0 0 0 1.2 1.2 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 1 1 1 1 2 1 4 1

Kochius punctipalpi **1679**

19–20 18 0 1 1 1 4 2 2 2 2 5 3 3 3 3 0 0 0 0 1.1 1.2 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 1 1 1 1 2 1 4 1

Kochius villosus **3477**

18 18 0 0 0 0 3 2 2 2 2 4 3 3 3 3 0 0 0 0 1.2 1.3 0 1 1 1 4 1 0 0 1 1 3 0 0 0 1 1 1 1 1 2 1 4 1

Konetontli acapulco **9520**

15 14 0 1 1 1 6 3 3 –4 3–5 3–5 6–9 3 3 3 4 0 1 1 1 1.3 1.3 1 2 1 1 4 1 2 1 1 4 3 0 2 2 1 3 1 4 2 3 3 4 1

Konetontli chamelaensis **7675**

10–11 10 0 0 0 1 4 3 3 3 3 5 2 3 3 3 0 0 0 0 1.2 1.2 1 2 1 1 4 1 2 0 1 4 3 0 2 2 1 2 1 2 1 2 2 4 1

Konetontli pattersoni **3149**

13 12–13 0 0 1 1 4 2 3 3 3 4 2 3 3 3 0 0 0 0 1.3 1.1 1 2 1 1 4 1 2 0 1 4 3 0 2 2 1 2 1 3 1 2 2 4 1

Kuarapu purhepecha **9517**

18 16–17 0 0 1 1 4 2 2 2 –3 3 4–6 3 3 3 3 0 0 0 0 1.2 1.1 2 1 1 1 4 1 1 0 1 3 3 0 1 1 1 3 1 2 1 3 3 3 1

Maaykuyak vittatus **3180**

20–21 17 0 1 1 2 7 3 4 4 5 12 3 3 3 5 0 1 2 2 1.2 1.1 3 1 1 1 5 1 2 1 4 5 3 0 4 0 2 3 2 4 2 3 2 3 1

Maaykuyak waueri **2973**

14 12 1 2 2 3 7 3 4 4 4 7 3 4 4 5 0 1 2 5 1.2 1.2 2 2 1 1 4 1 2 1 2 4 4 1 4 2 2 3 3 4 2 3 4 4 1

Mesomexovis atenango **2023**

17–18 15–16 0 1 3 3 7 0 2 2 2 7 3 3 3 4 0 0 0 0 1.2 1.2 2 1 1 1 4 1 1 1 2 3 3 1 2 1 2 4 2 4 2 3 3 6 1

Mesomexovis oaxaca **2031**

20–21 17–18 1 3 3 4 13 2 –3 4 4 5–6 11–14 3 4 4 4 0 1 2 3 1.2 1.2 4 3 1 1 5 1 4 4 3 9 6 1 4 3 3 4 3 4 3 3 4 7 1

Mesomexovis occidentalis **3118**

23 19 0 2 2 3 7 0 4 3 3 9 3 3 3 4 0 0 0 0 1.2 1.2 2 3 1 1 5 1 2 3 3 8 3 1 4 2 3 2 3 4 2 3 5 5 1

Mesomexovis punctatus **2080**

19 15–16 1 3 3 4 12 2 4 4 7 14 3 5 5 5 0 0 1 2 1.3 1.2 4 3 1 1 4 2 3 4 4 6 5 1 5 3 2 4 3 6 2 3 3 4 1

***Mesomexovis spadix* 2950**

22 16–17 0 1 2 2 7 2–3 3–4 4 4–5 7–8 3 3 3 3 0 1 1 2 1.3 1.2 2 3 1 1 4 1 2 2 1 4 5 1 4 3 3 2 3 4 2 2 3 6 1

***Mesomexovis subcristatus* 2049**

19 17–18 1 3 3 4 8 3 4 4 4 10 3 4 4 5 0 0 0 0 1.3 1.2 2 1 1 1 5 1 3 2 3 5 5 1 4 2 3 2 3 4 2 3 4 6 1

***Mesomexovis variegatus* 5185**

22 18 0 2 2 3 7 2 4 4 5 10 2 3 3 4 2 2 2 2 1.3 1.3 2 2 1 1 4 1 2 2 2 4 4 1 4 3 2 3 3 4 1 2 3 5 1

***Paravaejovis confusus* 4450**

18–19 15 0 1 1 1 4 2 2 2 2 5 3 3 3 3 0 0 0 0 1.2 1.2 1 2 1 1 4 1 2 0 4 2 2 0 4 3 2 4 2 3 2 3 3 4 1

***Paravaejovis diazi* 3165**

19 15 0 1 3 4 8 2 2 2 2–3 7–9 2 3 3 3 0 0 0 0 1.2 1.2 2 2 1 1 4 1 1 3 3 5 4 0 3 2 2 3 3 4 2 3 3 5 1

***Paravaejovis eusthenura* 1689**

20 15 0 1 3 4 9 3 3 3 3 13 2 3 3 3 0 1 0 0 1.2 1.1 5 4 4 1 6 2 3 5 5 8 8 2 6 5 5 7 7 12 3 4 8 7 1

***Paravaejovis gravicaudus* 3163**

26–27 22–23 0 1 2 2 9 2 3 4 5 11 3 3 3 4 0 1 1 0 1.3 1.1 5 4 2 1 6 2 5 4 4 9 6 2 5 5 4 5 5 7 3 5 6 5 1

***Paravaejovis hoffmanni* 3166**

19–20 16 0 1 3 4 7 2 2 2 2 6 2 3 3 3 0 0 0 0 1.2 1.3 2 3 1 1 5 1 2 3 3 6 5 2 3 2 5 3 3 4 2 3 3 5 1

***Paravaejovis pumilis* 3137**

13 8 1 2 2 2 5 2 2 3 5 11 2 3 3 3 0 0 1 0 1.2 1.2 1 1 1 1 2 1 1 0 1 2 3 0 3 1 1 2 2 0 1 2 2 3 1

***Paravaejovis puritanus* 3479**

19 16 0 1 1 3 5 2 3 3 3 6 3 3 3 4 0 0 0 0 1.2 1.1 3 2 1 1 6 1 3 1 2 4 3 1 4 1 2 4 3 4 2 5 3 5 1

***Paravaejovis schwenkmeyeri* 4413**

18 15–16 0 1 1 2 5 2 2 2 2 6 3 3 3 3 0 0 0 0 1.2 1.1 2 2 1 1 4 1 1 1 2 3 3 1 3 2 2 3 2 4 2 3 4 5 1

***Paravaejovis spinigerus* 7015**

26 21–22 0 1 1 2 5 3 4 4 4 9 4 4 4 5 0 1 1 1 1.3 1.1 4 3 1 1 5 2 3 2 3 5 5 2 3 4 3 4 3 4 1 3 3 5 1

***Paravaejovis waeringi* 1688**

16–17 14 0 0 1 1 3 2 2 2 2–3 6 3 3 3 3 0 0 0 0 1.2 1.2 1 2 1 1 4 1 2 0 4 1 3 0 3 3 2 2 2 3 2 3 3 4 1

***Syntropis macrura* 3146**

27–28 29–30 0 1 2 4 11 3 3 5 5 12 5 5 6 6 0 0 0 0 1.2 1 1 1 1 1 6 1 1 0 3 5 4 0 3 3 1 3 2 6 4 6 7 8 1

***Syntropis williamsi* 8706**

26 26 0 0 1 1 7 2 3 3 4–5 10 3 4 5 5 0 0 0 0 1.3 1 1 1 1 1 4 1 0 0 0 3 3 0 4 0 1 2 2 3 1 2 3 5 1

***Thorellius cristimanus* 5323**

21 20 1 2 2 3 4–5 0 2 2 2 5 2 3 3 3 0 0 0 0 1.4 1.2 2 1 1 1 4 1 1 1 1 3 5 0 2 2 1 3 2 4 3 3 4 6 1

***Thorellius intrepidus* 5309**

22–25 22 1 3 3 3 5 2 3 3 3 8 3 3 3 3 0 0 0 0 1.3 1.3 1 1 1 1 4 1 0 0 1 4 3 0 1 0 1 2 1 1 2 2 3 6 1

***Vizcaino viscainensis* 3174**

17 14–15 0 1 1 2 4 2 3 3 3 6 3 3 3 4 0 1 0 0 1.2 1.1 2 2 1 1 4 1 1 0 1 3 3 0 1 1 2 1 2 2 2 3 2 3 1

Appendix 4

Distribution of scaled data for quantitative morphological characters 0–44 (Appendix 6) among ingroup and outgroup taxa for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Polymorphisms are indicated as ranges. Material examined is listed in Appendix 2. Numbers following terminal taxon names correspond to samples from which DNA was extracted and sequenced (Appendix 1). Terminals for which meristic data were not recorded, were scored as missing data (?) in analyses of the morphological dataset.

Outgroup

***Franckeus kochi* 5363**

1.120–1.200 1.043 0.000 0.400 0.250 0.500 0.380 1.200 0.750 0.857 0.545 0.303 1.500 0.727 0.727 0.800 2.000 1.333 1.333 0.800 1.500 1.649 1.200 0.800 0.500 2.000 0.285 0.000 0.999 0.400 0.857 0.750 0.857 1.000 1.428 0.666 0.500 0.666 0.666 0.666 0.500 0.400 0.285 0.666 2.000

***Pseudouroctonus glimmei* 2688**

0.320 0.260–0.347 0.000 0.000 0.000 0.250 0.000 0.800 0.250 0.285 0.181 0.000 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 0.500 0.947 0.000 0.000 0.000 0.000 0.571 0.000 0.333 0.000 0.000 0.000 0.000 0.000 0.285 0.000 0.000 0.000 0.000 0.333 0.000 0.000 0.000 0.333 0.000

***Serradigitus minutus* 1674**

0.480 0.521 0.500 0.400 0.250 0.500 0.380 1.200 0.500 0.571 0.363 0.303 1.000 0.363 0.363 0.400 1.000 0.666 0.666 0.400 1.500 1.298 0.400 0.400 0.500 2.000 0.571 0.000 0.333 0.000 0.285 0.500 0.571 0.000 0.285 0.333 0.500 0.333 0.333 0.333 0.000 0.000 0.285 0.000 2.000

***Serradigitus* sp. 6370**

0.480 0.521 0.500 0.400 0.500 0.500 0.095 0.800 0.250 0.571 0.363–0.545 0.181 1.000 0.363 0.363 0.400 0.000 0.000 0.666 0.400 1.000 1.298 0.400 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.500 0.571 0.000 0.285 0.333 0.000 0.333 0.333 0.333 0.000 0.000 0.571 0.000 2.000

***Smeringurus grandis* 8690**

1.920–2.000 1.391 0.000 0.000 0.250 0.500 0.190 1.200 1.250 1.428 0.909 0.363 2.000 2.000 2.000 2.000 2.000 1.333 1.333 0.800 0.500 1.298 0.400 0.400 0.500 0.000 0.285 0.000 0.333 0.000 0.000 0.500 0.285 0.000 0.571 0.666 1.000 0.333 0.333 1.333 0.000 0.000 0.285 0.999 0.000

***Stahnkeus deserticola* 5032**

1.280–1.440 1.217 0.000 0.000 0.250 0.500 0.095 0.800 0.500 0.571 0.363 0.000 1.000 0.363 0.363 0.600 0.000 0.666 0.666 0.400 1.500 1.298 0.400 0.400 0.500 2.000 0.571 0.000 0.333 0.000 0.285 0.500 0.571 0.000 0.000 0.666 0.000 0.333 0.333 0.666 0.000 0.000 0.285 0.000 2.000

***Uroctonites giulianii* 3204**

0.000 0.000–0.086 0.000 0.400 0.250 0.250 0.095 0.800 0.250 0.285 0.181 0.060 1.000 0.363 0.363 0.400 2.000 0.000 0.000 0.000 2.000 1.298 0.400 0.400 0.500 2.000 0.571 0.000 0.999 0.000 0.571 0.000 0.000 0.000 0.857 0.999 0.500 0.333 0.666 0.500 0.000 0.000 0.000 0.333 2.000

***Vaejovis carolinianus* 1576**

0.480 0.521 0.000 0.400 0.250 0.250 0.095 0.800 0.250 0.285 0.181 0.060 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 2.000 2.000 0.400 0.800 0.500 2.000 0.285 0.000 0.333 0.000 0.285 0.000 0.285 0.000 1.428 0.333 0.000 0.333 0.666 0.333 0.000 0.000 0.000 0.000 2.000

***Vaejovis intermedius* 2141A**

1.120 1.217 0.000 1.200 1.000 1.750 1.523 2.000 2.000 2.000 2.000 2.000 2.000 1.090 0.727 2.000 2.000 1.333 1.333 0.800 1.500 1.649 0.800 0.800 0.500 2.000 0.857 0.000 0.999 0.800 0.857 0.750 0.857 1.000 1.428 0.999 1.000 1.333 0.666 1.000 0.500 0.400 0.285 0.666 2.000

***Vaejovis lapidicola* 1814**

0.400 0.434 0.500 0.400 0.250 0.500 0.190 0.800 0.250 0.571 0.363 0.060 1.000 0.545 0.545 0.600 0.000 0.666 0.000 0.000 1.000 0.947 0.400 0.400 0.500 2.000 0.285 0.000 0.333 0.400 0.285 0.250 0.285 0.000 0.571 0.333 0.000 0.333 0.000 0.333 0.500 0.000 0.285 0.000 2.000

***Vaejovis mexicanus* 1825**

0.880 0.782–0.869 0.000 0.400 0.250 0.500 0.190 0.800 0.250 0.285 0.181 0.000 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 1.649 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.285 0.000 0.571 0.333 0.000 0.000 0.333 0.333 0.000 0.000 0.571 0.999 2.000

***Vaejovis pequeno* 6308**

0.480 0.521 0.500 0.400 0.250 0.500 0.285 0.800 0.250 0.285 0.363 0.181 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 0.947 0.400 0.400 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.500 0.571 0.000 0.571 0.333 0.000 0.333 0.333 0.333 0.000 0.000 0.285 0.000 2.000

***Vaejovis rossmani* 2027**

0.400 0.347–0.434 0.000 0.000 0.250 0.250 0.095 0.800 0.250 0.285 0.181 0.121 1.000 0.363 0.363 0.400 0.000 0.666 0.666 0.400 1.000 1.649 0.400 0.400 0.500 0.000 0.571 0.000 0.999 0.000 0.285 0.250 0.571 0.000 0.571 0.333 0.000 0.333 0.333 0.500 0.000 0.000 0.285 0.333 2.000

***Vaejovis* sp. 5327**

0.480 0.521 0.500 0.400 0.250 0.250 0.285 0.800 0.750 0.857 0.545 0.121–0.242 0.500 0.363 0.363 0.400 1.000 1.333 1.333 0.800 1.000 1.649 0.400 0.400 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.500 0.571 1.000 0.571 0.333 0.500 0.333 0.000 0.500 0.500 0.400 0.285 0.333 2.000

***Wernerius spicatus* 8968**

0.320 0.347 0.000 0.400 0.250 0.500 0.190 0.800 0.250 0.285 0.181–0.363 0.060 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 2.000 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.400 0.285 0.250 0.571 0.000 0.857 0.666 0.500 0.333 0.666 0.333 0.000 0.000 0.285 0.000 2.000

Ingroup

***Balsateres cisnerosi* 2018**

1.040 1.217 0.000 0.000 0.000 0.250 0.190 0.400 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 1.500 1.649 0.400 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.500 0.571 0.000 0.285 0.000 0.000 0.333 0.000 0.166 0.500 0.000 0.571 0.333 2.000

***Chihuahuanus bilineatus* 5306**

0.720–0.800 0.869 0.500 0.800 0.500 0.500 0.476 1.200 0.500 0.857 0.545 0.363 1.000 0.363 0.727 0.800 2.000 1.333 1.333 0.800 1.000 0.947 1.200 0.400 0.500 2.000 0.571 0.000 0.999 0.800 0.285 0.750 0.857 2.000 1.142 0.999 0.500 0.666 0.666 0.500 0.500 0.400 0.571 0.999 2.000

***Chihuahuanus cazieri* 7163**

0.720–0.880 0.608–0.695 0.000 0.000 0.250 0.250 0.285 0.800 0.250 0.285 0.363 0.060 1.000 0.363 0.363 0.600 0.000 0.000 0.000 0.000 1.000 1.298 1.200 0.400 0.500 2.000 0.571 0.000 0.333 0.000 0.285 0.250 0.571 0.000 0.857 0.666 0.500 0.666 0.666 0.666 0.000 0.000 0.285 0.333 2.000

***Chihuahuanus coahuilae* 5353**

0.720 0.608 0.000 0.400 0.250 0.250 0.476 0.800 0.250 0.285 0.181 0.303 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 1.298 0.800 0.400 0.500 2.000 0.571 0.000 0.666 0.000 0.285 0.250 0.571 0.000 0.857 0.666 0.500 0.666 0.666 0.666 0.000 0.000 0.285 0.333 2.000

***Chihuahuanus crassimanus* 2972**

0.800–0.880 0.608–0.695 0.000 0.400 0.750 1.000 0.666 1.200 0.500 0.857 0.545 0.424 1.000 0.545 0.363 0.800 1.000 0.666 1.333 0.400 1.500 1.649 1.200 1.200 0.500 2.000 1.142 0.000 0.999 1.600 1.142 0.750 0.857 0.000 1.142 1.333 1.500 0.999 0.666 1.166 1.000 0.400 0.857 0.999 2.000

***Chihuahuanus glabrimanus* 6558**

0.720 0.608 0.000 1.200 0.750 1.000 0.476 1.200 0.500–0.750 0.571–0.857 0.545–0.727 0.484 1.000 0.363 0.363 0.800 0.000 0.666 0.000 0.000 1.000 1.649 1.200 1.200 0.500 2.000 0.571 0.000 0.999 0.800 0.571 1.000 1.142 1.000 0.857 0.333 1.000 0.999 0.666 0.666 0.500 0.400 0.571 0.999 2.000

***Chihuahuanus globosus* 5281**

0.640 0.521 0.500 1.200 0.750 0.750 0.380 1.200 0.500 0.571 0.363 0.181 1.000 0.363 0.363 0.800 0.000 0.666 0.666 0.400 1.500 1.649 1.200 1.200 0.500 2.000 0.571 0.000 0.999 1.200 0.857 1.000 0.857 1.000 1.142 0.666 0.500 0.999 0.666 0.666 0.500 0.400 0.857 0.999 2.000

***Chihuahuanus kovariki* 5299**

0.640 0.695 0.500 0.800 0.750 1.250 0.857 1.600 0.750 0.857–1.428 0.545–0.909 0.545–0.606 1.000 0.545 0.545 0.800 1.000 0.666 0.666 0.400 1.500 1.298 2.000 2.000 0.500 2.000 2.000 1.000 0.999 2.000 1.428 1.250 0.571 2.000 2.000 2.000 1.500 2.000 1.333 0.833 1.000 0.800 1.428 1.666 2.000

***Chihuahuanus russelli* 2971**

0.800 0.608–0.695 0.000 0.400 0.250 0.500 0.285 0.800 0.250 0.285 0.363 0.121 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.800 0.400 0.500 2.000 0.571 0.000 0.666 0.400 0.285 0.250 0.571 0.000 1.142 0.666 0.500 0.999 0.666 0.666 0.500 0.000 0.571 0.333 2.000

***Kochius barbatus* 8803**

0.880–0.960 0.956 0.000 0.400 0.000 0.250 0.190 0.800 0.250 0.285 0.181 0.060–0.121 1.000 0.363 0.363 0.600 0.000 0.000 0.000 0.000 1.000 1.298 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.333 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius bruneus* 3153**

0.800 0.695–0.782 0.000 0.400 0.250 0.500 0.190 0.800 0.250 0.285 0.181 0.060 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius cerralvensis* 8779**

0.800 0.869 0.000 0.400 0.250 0.250 0.285 0.800 0.250 0.285 0.181 0.060–0.181 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 0.947 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.333 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius hirsuticauda* 5049**

0.800 0.782 0.000 0.000 0.250 0.250 0.095 0.800 0.250 0.285 0.181 0.060 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 1.298 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius insularis* 8801**

0.880 0.782 0.000 0.000 0.000 0.250 0.190 0.800 0.250 0.285 0.181 0.060–0.121 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 0.500 1.649 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius magdalensis* 3155**

0.880 0.869 0.000 0.400 0.250 0.250 0.190 0.800 0.250 0.285 0.181 0.060–0.181 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius punctipalpi* 1679**

0.880–0.960 0.956 0.000 0.400 0.250 0.250 0.190 0.800 0.250 0.285 0.181 0.121 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 0.500 1.298 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius sonorae* 6301**

0.560 0.608 0.000 0.000 0.000 0.000 0.095 0.800 0.250 0.285 0.181 0.000 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.649 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Kochius villosus* 3477**

0.800 0.956 0.000 0.000 0.000 0.000 0.095 0.800 0.250 0.285 0.181 0.060 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.649 0.000 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.000 0.571 0.000 0.000 0.000 0.000 0.000 0.000 0.166 0.000 0.000 0.000 0.333 2.000

***Konetontli acapulco* 9520**
0.560 0.608 0.000 0.400 0.250 0.250 0.380 1.200 0.500–0.750 0.571–1.142 0.363–0.727 0.181–0.363 1.000 0.363 0.363 0.600 0.000 0.666 0.666 0.400 1.500 1.649 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.400 0.285 0.750 0.571 0.000 0.571 0.666 0.000 0.666 0.000 0.666 0.500 0.400 0.571 0.333 2.000

***Konetontli chamelaensis* 7675**
0.160–0.240 0.260 0.000 0.000 0.000 0.250 0.190 1.200 0.500 0.571 0.363 0.121 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.000 0.285 0.750 0.571 0.000 0.571 0.666 0.000 0.333 0.000 0.333 0.000 0.000 0.285 0.333 2.000

***Konetontli nayarit* 4725**
0.400 0.434 0.000 0.000 0.250 0.250 0.190 0.000 0.250 0.285 0.363 0.060 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 0.596 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.000 0.285 0.500 0.571 0.000 0.571 0.666 0.000 0.333 0.000 0.500 0.000 0.000 0.285 0.333 2.000

***Konetontli pattersoni* 3149**
0.400 0.434–0.521 0.000 0.000 0.250 0.250 0.190 0.800 0.500 0.571 0.363 0.060 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 0.947 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.000 0.285 0.750 0.571 0.000 0.571 0.666 0.000 0.333 0.000 0.500 0.000 0.000 0.285 0.333 2.000

***Kuarapu purhepecha* 9517**
0.800 0.782–0.869 0.000 0.000 0.250 0.250 0.190 0.800 0.250 0.285–0.571 0.363 0.060–0.181 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 0.947 0.800 0.000 0.500 2.000 0.571 0.000 0.333 0.000 0.285 0.500 0.571 0.000 0.285 0.333 0.000 0.666 0.000 0.333 0.000 0.400 0.571 0.000 2.000

***Maaykuyak vittatus* 3180**
0.960–1.040 0.869 0.000 0.400 0.250 0.500 0.476 1.200 0.750 0.857 0.727 0.545 1.000 0.363 0.363 0.800 0.000 0.666 1.333 0.800 1.000 0.947 1.200 0.000 0.500 2.000 0.857 0.000 0.666 0.400 1.142 1.000 0.571 0.000 1.142 0.000 0.500 0.666 0.333 0.666 0.500 0.400 0.285 0.000 2.000

***Maaykuyak waueri* 2973**
0.480 0.434 0.500 0.800 0.500 0.750 0.476 1.200 0.750 0.857 0.545 0.242 1.000 0.545 0.545 0.800 0.000 0.666 1.333 2.000 1.000 1.298 0.800 0.400 0.500 2.000 0.571 0.000 0.666 0.400 0.571 0.750 0.857 1.000 1.142 0.666 0.500 0.666 0.666 0.666 0.500 0.400 0.857 0.333 2.000

***Mesomexovis atenango* 2023**
0.720–0.800 0.695–0.782 0.000 0.400 0.750 0.750 0.476 0.000 0.250 0.285 0.181 0.242 1.000 0.363 0.363 0.600 0.000 0.000 0.000 0.000 1.000 1.298 0.800 0.000 0.500 2.000 0.571 0.000 0.333 0.400 0.571 0.500 0.571 1.000 0.571 0.333 0.500 0.999 0.333 0.666 0.500 0.400 0.571 0.999 2.000

***Mesomexovis oaxaca* 2031**
0.960–1.040 0.869–0.956 0.500 1.200 0.750 1.000 1.047 0.800–1.200 0.750 0.857 0.727–0.909 0.484–0.666 1.000 0.545 0.545 0.600 0.000 0.666 1.333 1.200 1.000 1.298 1.600 0.800 0.500 2.000 0.857 0.000 1.333 1.600 0.857 2.000 1.428 1.000 1.142 0.999 1.000 0.999 0.666 0.666 1.000 0.400 0.857 1.333 2.000

***Mesomexovis occidentalis* 3118**
1.200 1.043 0.000 0.800 0.500 0.750 0.476 0.000 0.750 0.571 0.363 0.363 1.000 0.363 0.363 0.600 0.000 0.000 0.000 0.000 1.000 1.298 0.800 0.800 0.500 2.000 0.857 0.000 0.666 1.200 0.857 1.750 0.571 1.000 1.142 0.666 1.000 0.333 0.666 0.666 0.500 0.400 1.142 0.666 2.000

***Mesomexovis punctatus* 2080**
0.880 0.695–0.782 0.500 1.200 0.750 1.000 0.952 0.800 0.750 0.857 1.090 0.666 1.000 0.727 0.727 0.800 0.000 0.000 0.666 0.800 1.500 1.298 1.600 0.800 0.500 2.000 0.571 1.000 0.999 1.600 1.142 1.250 1.142 1.000 1.428 0.999 0.500 0.999 0.666 1.000 0.500 0.400 0.571 0.333 2.000

***Mesomexovis spadix* 2950**
1.120 0.782–0.869 0.000 0.400 0.500 0.500 0.476 0.800–1.200 0.500–0.750 0.857 0.545–0.727 0.242–0.303 1.000 0.363 0.363 0.400 0.000 0.666 0.666 0.800 1.500 1.298 0.800 0.800 0.500 2.000 0.571 0.000 0.666 0.800 0.285 0.750 1.142 1.000 1.142 0.999 1.000 0.333 0.666 0.666 0.500 0.000 0.571 0.999 2.000

***Mesomexovis subcristatus* 2049**
0.880 0.869–0.956 0.500 1.200 0.750 1.000 0.571 1.200 0.750 0.857 0.545 0.424 1.000 0.545 0.545 0.800 0.000 0.000 0.000 0.000 1.500 1.298 0.800 0.000 0.500 2.000 0.857 0.000 0.999 0.800 0.857 1.000 1.142 1.000 1.142 0.666 1.000 0.333 0.666 0.666 0.500 0.400 0.857 0.999 2.000

***Mesomexovis variegatus* 5185**
1.120 0.956 0.000 0.800 0.500 0.750 0.476 0.800 0.750 0.857 0.727 0.424 0.500 0.363 0.363 0.600 2.000 1.333 1.333 0.800 1.500 1.649 0.800 0.400 0.500 2.000 0.571 0.000 0.666 0.800 0.571 0.750 0.857 1.000 1.142 0.999 0.500 0.666 0.666 0.666 0.000 0.000 0.571 0.666 2.000

***Paravaejovis confusus* 4450**
0.800–0.880 0.695 0.000 0.400 0.250 0.250 0.190 0.800 0.250 0.285 0.181 0.121 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.000 1.142 0.250 0.285 0.000 1.142 0.999 0.500 0.999 0.333 0.500 0.500 0.400 0.571 0.333 2.000

Paravaejovis diazi **3165**
0.880 0.695 0.000 0.400 0.750 1.000 0.571 0.800 0.250 0.285 0.181–0.363 0.242–0.363 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.800 0.400 0.500 2.000 0.571 0.000 0.333 1.200 0.857 1.000 0.857 0.000 0.857 0.666 0.500 0.666 0.666 0.666 0.500 0.400 0.571 0.666 2.000

Paravaejovis eusthenura **1689**
0.960 0.695 0.000 0.400 0.750 1.000 0.666 1.200 0.500 0.571 0.363 0.606 0.500 0.363 0.363 0.400 0.000 0.666 0.000 0.000 1.000 0.947 2.000 1.200 2.000 2.000 1.142 1.000 0.999 2.000 1.428 1.750 2.000 2.000 1.714 1.666 2.000 2.000 2.000 2.000 1.000 0.800 2.000 1.333 2.000

Paravaejovis gravicaudus **3163**
1.440–1.520 1.304–1.391 0.000 0.400 0.500 0.500 0.666 0.800 0.500 0.857 0.727 0.484 1.000 0.363 0.363 0.600 0.000 0.666 0.666 0.000 1.500 0.947 2.000 1.200 1.000 2.000 1.142 1.000 1.666 1.600 1.142 2.000 1.428 2.000 1.428 1.666 1.500 1.333 1.333 1.166 1.000 1.200 1.428 0.666 2.000

Paravaejovis hoffmanni **3166**
0.880–0.960 0.782 0.000 0.400 0.750 1.000 0.476 0.800 0.250 0.285 0.181 0.181 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.649 0.800 0.800 0.500 2.000 0.857 0.000 0.666 1.200 0.857 1.250 1.142 2.000 0.857 0.666 2.000 0.666 0.666 0.666 0.500 0.400 0.571 0.666 2.000

Paravaejovis pumilis **3137**
0.400 0.086 0.500 0.800 0.500 0.500 0.285 0.800 0.250 0.571 0.727 0.484 0.500 0.363 0.363 0.400 0.000 0.000 0.666 0.000 1.000 1.298 0.400 0.000 0.500 2.000 0.000 0.000 0.333 0.000 0.285 0.250 0.571 0.000 0.857 0.333 0.000 0.333 0.333 0.000 0.000 0.000 0.285 0.000 2.000

Paravaejovis puritanus **3479**
0.880 0.782 0.000 0.400 0.250 0.750 0.285 0.800 0.500 0.571 0.363 0.181 1.000 0.363 0.363 0.600 0.000 0.000 0.000 0.000 1.000 0.947 1.200 0.400 0.500 2.000 1.142 0.000 0.999 0.400 0.571 0.750 0.571 1.000 1.142 0.333 0.500 0.999 0.666 0.666 0.500 1.200 0.571 0.666 2.000

Paravaejovis schwenkmeyeri **4413**
0.800 0.695–0.782 0.000 0.400 0.250 0.500 0.285 0.800 0.250 0.285 0.181 0.181 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 0.947 0.800 0.400 0.500 2.000 0.571 0.000 0.333 0.400 0.571 0.500 0.571 1.000 0.857 0.666 0.500 0.666 0.333 0.666 0.500 0.400 0.857 0.666 2.000

Paravaejovis spinigerus **7015**
1.440 1.217–1.304 0.000 0.400 0.250 0.500 0.285 1.200 0.750 0.857 0.545 0.363 1.500 0.545 0.545 0.800 0.000 0.666 0.666 0.400 1.500 0.947 1.600 0.800 0.500 2.000 0.857 1.000 0.999 0.800 0.857 1.000 1.142 2.000 0.857 1.333 1.000 0.999 0.666 0.666 0.000 0.400 0.571 0.666 2.000

Paravaejovis waeringi **1688**
0.640–0.720 0.608 0.000 0.000 0.250 0.250 0.095 0.800 0.250 0.285 0.181–0.363 0.181 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.000 1.298 0.400 0.400 0.500 2.000 0.571 0.000 0.666 0.000 1.142 0.000 0.571 0.000 0.857 0.999 0.500 0.333 0.333 0.500 0.500 0.400 0.571 0.333 2.000

Syntropis macrura **3146**
1.520–1.600 1.913–2.000 0.000 0.400 0.500 1.000 0.857 1.200 0.500 1.142 0.727 0.545 2.000 0.727 0.909 1.000 0.000 0.000 0.000 0.000 1.000 0.596 0.400 0.000 0.500 2.000 1.142 0.000 0.333 0.000 0.857 1.000 0.857 0.000 0.857 0.999 0.000 0.666 0.333 1.000 1.500 1.600 1.714 1.666 2.000

Syntropis williamsi **8706**
1.440 1.652 0.000 0.000 0.250 0.250 0.476 0.800 0.500 0.571 0.545–0.727 0.424 1.000 0.545 0.727 0.800 0.000 0.000 0.000 0.000 1.500 0.596 0.400 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.000 0.500 0.571 0.000 1.142 0.000 0.000 0.333 0.333 0.500 0.000 0.000 0.571 0.666 2.000

Thorellius cristimanus **5323**
1.040 1.130 0.500 0.800 0.500 0.750 0.190–0.285 0.000 0.250 0.285 0.181 0.121 0.500 0.363 0.363 0.400 0.000 0.000 0.000 0.000 2.000 1.298 0.800 0.000 0.500 2.000 0.571 0.000 0.333 0.400 0.285 0.500 1.142 0.000 0.571 0.666 0.000 0.666 0.333 0.666 1.000 0.400 0.857 0.999 2.000

Thorellius intrepidus **5309**
1.120–1.360 1.304 0.500 1.200 0.750 0.750 0.285 0.800 0.500 0.571 0.363 0.303 1.000 0.363 0.363 0.400 0.000 0.000 0.000 0.000 1.500 1.649 0.400 0.000 0.500 2.000 0.571 0.000 0.000 0.000 0.285 0.750 0.571 0.000 0.285 0.000 0.000 0.333 0.000 0.166 0.500 0.000 0.571 0.999 2.000

Vizcaino viscainensis **3174**
0.720 0.608–0.695 0.000 0.400 0.250 0.500 0.190 0.800 0.500 0.571 0.363 0.181 1.000 0.363 0.363 0.600 0.000 0.666 0.000 0.000 1.000 0.947 0.800 0.400 0.500 2.000 0.571 0.000 0.333 0.000 0.285 0.500 0.571 0.000 0.285 0.333 0.500 0.000 0.333 0.333 0.500 0.400 0.285 0.000 2.000

Appendix 5

Distribution of qualitative morphological characters 45–249 (Appendix 6) among ingroup and outgroup taxa for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Character states scored 0–6 or inapplicable (-). Material examined is listed in Appendix 2. Numbers following terminal taxon names correspond to samples from which DNA was extracted and sequenced (Appendix 1).

Outgroup

***Franckeus kochi* 5363**
1100001001 1101021001 1101001010 0101011221 1022331211 1211245000 0000-00000
2221220011 0000101002 1110100002 2311001100 0100110121 2120100011 0100111120
1000211200 1100210000 0110101201 0000100121 0001112010 0001000000 000001

***Pseudouroctonus glimmei* 2688**
0111111000 1000002000 0000101010 0111101111 1211234011 1011211133 4011111032
1041211211 1011111000 0000000102 2211000020 0100110012 3010200011 0111111010
0001211200 1101410011 1110111101 1100100111 0001101011 1111011120 021000

***Serradigitus minutus* 1674**
0000000000 1101001001 1000001010 1101111111 2011100--0 1211000000 0-00-00000
0221201110 0100101000 0000000010 2011001101 0110111130 1450100011 0100101010
0000311200 1111101000 1111101111 1100100111 0001101010 0011011110 000001

***Serradigitus* sp. 6370**
0000000000 0001001100 1111001010 1101001111 2011100--0 1211000030
0-00-00000 0221201111 0100101000 0000000101 2111001121 0100110131 1230100011
0100101010 1000311200 1111101000 1111101101 0100100111 0001111010 0001011110
001001

***Smeringurus grandis* 8690**
0010010000 1100001000 0000100001 1000002222 0112243100 1101123320 3122121132
1141112000 0000101101 1111110102 2301001000 1100000131 1221111111 1101011010
11101010-0 0000010000 0220001200 1000100011 0001101011 1111020000 000001

***Stahnkeus deserticola* 5032**
0111110001 1100002000 1000101010 1101112222 1021211210 1211134220 3101021232
1121210011 1100101010 0000000010 4010101101 0110111240 0560100011 0100101010
0000311200 1111101000 0111101201 0000100111 0001111011 1111011110 001001

***Uroctonites giulianii* 3204**
0111011000 1000002000 0000001000 0111101210 2012234211 0011245133 3111111341
1041211211 2221011000 0000000102 1221000020 0100110002 3010100011 0112122120
00000000-0 0000301001 2110001101 1100100011 0001101011 1111011120 000000

***Vaejovis carolinianus* 1576**
1100001110 1101131111 1101011010 0001012221 1022231210 1211245012 2000-00000
2221221111 1100101000 0000000102 2211001010 0100110112 3120100011 0111222120
2000211200 1100210000 0110101201 0000100111 0001111011 1111011110 000000

***Vaejovis intermedius* 2141A**
1000100001 1100022000 0000001010 0101011221 1122231210 1212245012 2000-00000
2211220011 0000101012 0100100002 2211001100 0100110121 2120100011 0100111010
2000211200 1100210000 0110102201 0000100121 0001112010 0001000000 000001

***Vaejovis lapidicola* 1814**
0000100000 1101002000 0000001010 0101012221 1012231011 1211211200 0100-01000
0221201111 1100101000 0000000102 2211001010 0100110112 2010200011 0100111010
1000211200 1100210111 1110101201 0100100111 0001111011 1111011110 000001

***Vaejovis mexicanus* 1825**
1100001110 1111101211 1100011010 0101002221 1222234011 1211211223 4122011321
2241022211 1220101001 0000000102 2211001010 0100110012 3010200011 0111122022
00012110-0 1000210100 1110101201 1100100111 0001111012 1111011110 020000

***Vaejovis pequeno* 6308**
1100001000 0101001111 1100001010 1101111111 2011100--0 1211000030
0-00-00000 0221201111 0100101000 0000000101 2111001021 0100110131 1230100011
0100101010 1000311200 1111101000 1111101101 0100100111 0001111011 1111011110
001001

***Vaejovis rossmani* 2027**
0100001110 1101121221 1100011010 0101002121 1012201011 1210000000
0-00-00000 0201201111 1100101000 0000001102 2211001010 0100110012 3010200011
0122222122 00002110-1 1000210110 1110101201 0100100111 0001111011 1111011110
020000

***Vaejovis* sp. 3711 5327**
1100001110 0111101111 1100001010 1001002222 2012202011 1211200000
0-00-00000 0241201111 1100101000 0000000102 2211001010 0100110012 3010200011
1111222122 00002110-0 1000210101 1110101211 1100100121 0001111010 0001011110
021100

***Wernerius spicatus* 8968**
0011110000 1100002000 0000101010 1101111111 1010211211 0211200230
0-00-02143 1121210011 0111111011 0000000102 2211000121 0100110142 1220100011
1100101010 0000312200 1111101000 1110101101 0001100111 0001101011 1111011010
001100

Ingroup

Balsateres cisnerosi **2018 5269**
0011110000 1100002000 0000101010 1101000201 1011300--1 1212245330 4000-02443
2132320001 0000101011 0101100101 3211001021 0100110131 1230000000 0100111010
2102311210 1111101000 1110100001 0001011100
1-01110100 0000000000 000000

Chihuahuanus bilineatus **5306 6507 6594**
0000000000 1101001000 1101111010 1101002222 2012000--0 1212200000
0-00-02443 0102320010 0000100011 0000001101 2211001021 0000110112 3231200011
1100101010 0001311210 1111201000 1110101201 0000100111 0001111010 0211000000
010001

Chihuahuanus cazieri **7163 7179**
0010000000 1010002000 1000111010 1101002221 1012200--0 1211134222
4-00-01232 1121221111 0110101010 0000001101 2211001021 0100110121 2231200011
1100101010 0001311210 1111101000 1110101201 0010100111 0001111011 1111000000
010001

Vaejovis lapidicola **1814**
0000100000 1101002000 0000001010 0101012221 1012231011 1211211200 0100-01000
0221201111 1100101000 0000000102 2211001010 0100110112 2010200011 0100111010
1000211200 1100210111 1110101201 0100100111 0001111011 1111011110 000001

Vaejovis mexicanus **1825**
0010000000 1010002000 1000111010 1101002221 1022211211 1211134222
4-00-01232 1121221111 0110101010 0000001101 2[23]11001021 0100110121 2231200011
1100101010 0001311210 1111101000 1110101201 0010100111 0001111011 1111000000
010001

Chihuahuanus glabrimanus **6558 6610 6611**
0011110000 1100002000 0000101010 1101002212 2012300--1 1212202332
0-00-02443 0112320010 0000101011 0100001101 2211001021 0100110122 2231210011
1100101010 0001311210 1111101000 1110100201 0000100111 1011001010 2111000000
010001

Chihuahuanus globosus **5281 6447 6459 8926**
0011110000 1100002000 0000101010 1101002222 2012200--0 1212200332
0-00-02443 2112320010 0000101011 0000001101 2211001021 0100110121 2231211111
1100101010 0001311210 1111101000 1120101201 0000100111 0001111012 2111000000
010001

Chihuahuanus kovariki **5299 5305**
0011110000 1100002000 0000101010 1101002221 1012200--1 1212202332
0-00-01343 2112320010 0000101011 0001001101 2211001021 0100110121 2231210011
1100101010 0001311210 1111101000 1110101201 0000100111 0001111010 0211000000
010001

Chihuahuanus russelli **2971 7017 7266**
0010010000 1010002000 0000101010 1101002221 1022211211 1211134322
4-00-01243 1121221111 0110101012 0101101101 2211001021 0100110121 2231200011
1100101010 0001311210 1111101000 1110101201 0000100111 0001111012 2111000000
010001

Kochius barbatus **8803**
0011110000 1100002000 0000101010 1101002221 1110234011 1211112220 3011111012
1121212211 1111101012 1111101101 2211001021 1100100121 1231200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111011110 100001

Kochius bruneus **3153 3154 4555**
0111101000 1000002000 0000101010 1101002221 1110234011 1211111220 3000-11012
1121212211 1111101000 0000001101 2311001021 1100100121 1230200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111021121 100001

Kochius cerralvensis **8779**
0011110000 1100002000 0000101010 1101002221 1110234011 1211111220 3011111012
1121212211 1111101112 1211201101 2211001021 1100100121 1230200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111011111 100001

Kochius hirsuticauda **5049 7199 8819**
0011110000 1000002000 0000101010 1101002221 1110234011 1211111220 3000-11012
1121212211 1111101000 0000001101 2311001021 1100100121 1230200011 1100101010
0001311210 1111101000 1110111301 2210100111 0001111011 1111011121 100001

Kochius insularis **8801**
0011110000 1100002000 0000101010 1101002221 1110234011 1211111220 3000-11012
1121212211 1111101000 0000001101 2211001021 1100100121 1230200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111011111 100001

Kochius magdalensis **3155 4552 8796**
0011110000 1100002000 0000101010 1101002221 1110234011 1211111220 3011111012
1121212211 1111101012 1111101101 2211001021 1100100121 1230200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111011110 100001

Kochius punctipalpi **1679 3157 8843**
0011110000 1100002000 0000101010 1101002221 1110234011 1211111220 3011111012
1121212211 1111101112 1211201101 2211001021 1100100121 1231200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111011110 000001

***Kochius sonorae* 6301 6304 9974**
0001000000 1101002000 0000101010 1101002221 1110234011 1211111220 3011111012
2121212211 1111101000 0000001101 2211001021 1100100121 1230200011 0100101010
0001311210 1111101000 1110111301 2210100111 0001111011 1111011111 100001

***Kochius villosus* 3477 4544**
0111101000 1000002000 0000101010 1101002221 1110234011 1211111220 3000-11012
1121212211 1111101000 0000001101 2311001021 1100100121 1230200011 0100101010
0001311210 1111101000 1110101301 2210100111 0001111011 1111011111 100001

***Konetontli acapulco* 9520**
0000000000 1101001000 0100001010 1101001311 2012300--1 1211100020
0-00-00043 0112321111 0100101010 0000001102 2311001021 0100110121 0120100011
1110111010 2000311210 1111201000 1110101111 1100100121 0001111100 0000011110
000101

***Konetontli chamelaensis* 7675**
0000000000 1101001111 0000001010 1101001312 1002300--0 1210000000
0-00-00000 0-00001111 0100100010 0000001101 2111001021 0100110122 2120100011
1111111010 2000311210 1111201000 1110101111 1100100111 0001111011 1111011110
001101

***Konetontli nayarit* 4725**
1000000000 1101001111 1100001010 1101001312 2002300--1 1212200030
0-00-00000 2112321111 0100101010 0000001102 2211001021 0100110112 3120100011
1110111010 1000311210 1111201000 1110100111 1100100111 0001111011 1111011110
001110

***Konetontli pattersoni* 3149 3150**
0000000000 1101021111 0100001010 1101001312 1012200--1 1212200030
0-00-00000 0-10002111 0100101011 0000001102 2211001021 0100110112 3120100011
1110111010 2000311210 1111201000 1110101111 1100100111 0011111011 1111011110
001101

***Kuarapu purhepecha* 9517**
1100000000 1111031001 1100111010 1001112221 1011300--1 1210000000
0-00-00000 0-00000011 0100100011 0101100001 2111001021 0100110131 1340100011
1100101010 2101311210 1111201000 0110101201 0010100111 0001111011 1111011110
000001

***Maaykuyak vittatus* 3180 4442**
0001000000 1101001000 0000001010 1101002222 1012300--0 1210000000
0-00-00000 0-00000011 0000100010 0000001102 2311001121 0100110122 3220200011
0100111000 2001311210 1111201000 1110101201 0000100111 0001111010 0111000020
020001

***Maaykuyak waueri* 2973 6544**
0000000001 0101001000 1001001010 1101001122 2002300--0 1210000000
0-00-00000 0-00000011 0100100000 0000001101 2111001021 0100110112 3220200011
1110101000 2000311210 1111201000 1110102101 0000000111 0011110010 0000000020
020001

***Mesomexovis atenango* 2023 7058 9982**
0011010000 1100002000 0000101010 1101002221 1012200--1 1212002000 0000-02443
2112320011 0000101012 1111100101 2311001121 0100110121 1231000001 0100101010
0001311210 1111101000 1110101201 0000100111 0001111011 1111000000 000001

***Mesomexovis oaxaca* 2031 3718 6602**
0000000010 1011001000 0000111010 1101002222 1012300--1 1212002000 4100-02443
2112320011 0000101012 1111100102 2311001021 0100110122 1230000001 0110222120
2101311210 1111001000 1110102201 0000100121 0001112010 0001000020 000001

***Mesomexovis occidentalis* 3118 6559 7056**
0100000010 1011031010 0000101010 1101002222 1012200--1 1212205332 4100-02443
1112320011 0000101012 1111100102 2311001021 0100110121 1230000001 0110222120
2101311210 1111101000 1110101201 0000100111 0001111012 2111022020 000001

***Mesomexovis punctatus* 2080 2241**
0000000000 1101001000 0000101010 1101000222 1012300--0 1212002000 0000-02443
2112320011 0000101012 0101100101 2211001021 0100110121 1230000001 1100101010
2001311210 1111001000 1110100201 0000101121 0001112010 0001000020 000001

***Mesomexovis spadix* 2950 5280 6373**
1100001010 1101031021 1000111010 1101000222 1012300--0 1212002000 0000-02443
2112322211 0000101011 000010010[23] 2211001021 0100110122 2230200001 0100111120
2101311210 1111101000 1110100201 0000100121 0001112010 0001020020 000000

***Mesomexovis subcristatus* 2049 2084 2086**
0000000000 1011001000 0000101010 1101000222 1012300--0 1212002000 0000-02443
2112320010 0000101012 1111100101 2211001021 0100110131 1230000001 1100101010
2101311210 1111101000 1110102201 0000100111 0001112010 0021000000 000001

***Mesomexovis variegatus* 5185 6536 7068**
1200001010 1101031021 1100111010 1101002222 1012300--0 1212202300 0000-02443
2112322211 0000101011 0000100102 2211001021 0100110122 2230200001 0100111010
2101311210 1111101000 1110102201 0000100111 0001112010 0001020020 000000

Paravaejovis confusus **4450 7107 7272 8517**
0011010000 1100002000 0000101010 1101002221 1012222210 1212111332
0-00-02443 2112320011 0100101010 0000001102 2[23]11001121 0110111131 0241200011
1100101010 1101311210 1111101000 1110101201 0000100111 0001111012 1111000000
000001
Paravaejovis diazi **3165 3169 3482 4436 8839**
0011010000 1100002000 0000201010 1101002221 1012300--0 1210000000
0-00-00000 0-00001201 0100100112 1101101102 2211001021 0110110131 1231110011
1100101010 1001311210 1111101000 1120101201 0000100111 0001112010 0221000020
000001
Paravaejovis eusthenura **1689 3168 4448**
0011010000 1100002000 0000001010 1101002221 1012300--0 1210000000
0-00-00000 0-00003201 0100100111 0001001102 2211001021 0110110131 1231110011
1100101010 1001311210 1111101000 1120102201 0000100111 0001112012 2221000020
000001
Paravaejovis gravicaudus **3163 8783 8793**
0000100000 1100021000 0000001010 1101000222 1012300--0 1212202332
0-00-02443 0112323111 0100101010 0000001102 2211001021 0110111131 1231100000
0100101010 2001311210 1111001000 1110102201 0000100121 0001112010 0001000020
000001
Paravaejovis hoffmanni **3166 5096 8797 8812**
0011010000 1100002000 0000001010 1101002221 1012300--0 1210000000
0-00-00000 0-00001001 0100100111 0001001102 2[23]11001021 0110110131 1231110011
1100101010 1001311210 1111101000 1120101201 0000100111 0001112010 0221000000
000001
Paravaejovis pumilis **3137 3476 4740**
0011010000 1100002000 0000201111 2001001311 2002200--0 1210000000
0-00-00000 0-00002111 0100100112 0001001101 2211011021 0101-10112 1001111111
1100101010 0000311210 1111001000 2120101101 0000000011 0001111012 2221000020
000001
Paravaejovis puritanus **3479 5093 8900**
0001100000 1111021001 1000011010 1101002221 1012200--0 1212202032
0-00-02443 2112323211 0100101011 0001101101 2211001021 0110111131 1231110101
0100101010 2101311210 1111101000 1110101201 0000100111 0001111011 1221002020
001001
Paravaejovis schwenkmeyeri **4413 4430 4451 8821**
0011010000 1100002000 0000001010 1101002221 1012300--0 1210202332
0-00-02443 2102323111 0100101012 0101101101 2211001021 0110111131 1231110101
0100101010 0001311210 1111101000 1110101201 0000100111 0001111010 2221000020
000001
Paravaejovis spinigerus **5282 6317 7015 7176 9970**
0000110000 1100001000 0000001010 1101002222 1012200--0 1212202332
0-00-02443 2112323111 0100101010 0000001102 2311001021 0110111121 1231100000
0100101010 2001311210 1111101000 1110102201 0000100121 0001112010 0001000020
000001
Paravaejovis waeringi **1688 3226 4431 4433 5029 7119**
0011000000 1100002000 0000101010 1101002221 1012221210 1212111332
0-00-02443 2112320011 0100101010 0000001102 2211001121 0110111131 0241200011
1100101010 1101311210 1111001000 1110101201 0000100111 0001111012 1111000000
000001
Syntropis macrura **3146 8709**
0011110000 1010002000 0000101010 1001100021 1222222210 1202200330
0-00-01343 0112320000 0000101012 1011100102 3310001121 0100111231 1230000000
0000100010 2101311210 1111201000 0220101201 0020100011 0100101010 0001100000
000001
Syntropis williamsi **8706 8707 8826**
0011110000 1000002000 0000101010 1001100021 1222211210 1201134330
0-00-01343 1111320000 0000101012 1011100102 3310001121 0100111231 1230000000
0000101010 2101311210 1111201000 0220101201 0020100011 0100101010 0001100000
000001
Thorellius cristimanus **5323 5325 5328 6551**
0200001110 1000001001 1000101010 1101002221 1012234011 1211245221 4022111232
1121213211 0100101111 1111100101 2211001021 0100110131 1230100000 0110111010
2102311210 1111201000 1110101201 0000100111 0001111012 2211000000 001001
Thorellius intrepidus **5309 6377 6379**
0201001110 1000031001 1000101010 1101002221 1012200--1 1212245321 4002111212
1121213211 0100101112 1211200101 3210001021 0000110131 1230100000 0111111010
2102311210 1111001000 1110101201 0000100111 0001111012 2211000000 001001
Vizcaino viscainensis **3174 8809**
0011110000 1100002000 0000101010 1001002221 2012200--0 1211134230
0-00-02443 0111320011 0100101011 0000100101 2101001021 0100111231 1341111111
1100101011 2111311210 1111201000 1110101201 0000100111 0001111012 2221011110
000001

Appendix 6

The 45 quantitative morphological characters (Appendices 3 and 4) and 205 qualitative morphological characters (Appendix 5) scored for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Character states are scored 0–6 or inapplicable (-). Characters and terminology from the following matrices that correspond partially or entirely to those listed below are in square brackets: L80 (Lamoral, 1980); S89 (Stockwell, 1989); P00 (Prendini, 2000); FSB01 (Fet et al., 2001); S&S01 (Soleglad and Sissom, 2001); P03 (Prendini, 2003); PCW03 (Prendini et al., 2003); S&F03 (Soleglad and Fet, 2003); P04 (Prendini, 2004); FP08 (Francke and Prendini, 2008); VP08 (Volschenk and Prendini, 2008); PFV10 (Prendini et al., 2010). Morphological terminology follows Vachon (1973) for trichobothria, Sissom (1991a) for hemispermatophore, and Stahnke (1970) for other characters, except where noted. The terms “internal” and “external” are substituted with “prolateral” and “retrolateral”, following Acosta et al. (2008). Pedipalp carination follows a system developed by L. Prendini et al. (in prep.). The pedipalp chela finger dentition of Soleglad and Sissom (2001) is redefined to maintain consistency with the terminology for pedipalp segments. Leg setation and spinules are modified from McWest (2009). Metasomal carination is modified from Ochoa et al. (2010).

Quantitative characters

The utility of quantitative data for phylogenetic analysis has been repeatedly questioned (Pimentel and Riggins, 1987; Cranston and Humphries, 1988; Crowe, 1994; Felsenstein, 1988; Hendrixson and Bond, 2009) due to the difficulty posed by coding such data into discrete characters (Farris, 1990; Prendini, 2000). Quantitative characters have rarely been used in phylogenetic analyses of scorpions (Prendini et al., 2003; Goloboff et al., 2006). Recently, the application of optimization methods (Farris, 1970; Goloboff, 1998) made it possible to analyse quantitative data phylogenetically (Goloboff et al., 2006, 2008). Application of these methods enabled 45 counts of pectinal teeth and macrosetae on the carinae of the pedipalps and metasomal segments to be included in the analyses presented here. Setal counts represented the number of setae situated along selected pedipalp and metasomal carinae, the terminology and homology of which were described by González-Santillán and Prendini (2013) and form part of a more general study, in preparation. Santibáñez-López and Sissom (2010) pointed out a problem with counting macrosetae on the metasomal carinae, especially the ventrosubmedian carinae, specifically whether or not offset setae should be included in the counts for adjacent carinae. In the present study, setae of uncertain position were added to the count for the nearest carina or coded as accessory if situated intermediate between carinae. Variation in the counts of paired carinae was recorded as a range. Coding homologous setae (or setal pairs), following the placeholder approach (Prendini et al., 2010), would be a further improvement, but surpassed the scope of this study.

0. Pectinal tooth count (♂).

1. Pectinal tooth count (♀).

2. Metasomal segment I, dorsolateral carinae, macrosetal count.

3. Metasomal segment II, dorsolateral carinae, macrosetal count.

4. Metasomal segment III, dorsolateral carinae, macrosetal count.

5. Metasomal segment IV, dorsolateral carinae, macrosetal count.

6. Metasomal segment V, dorsolateral carinae, macrosetal count.

7. Metasomal segment I, ventrolateral carinae, macrosetal count.

8. Metasomal segment II, ventrolateral carinae, macrosetal count.

9. Metasomal segment III, ventrolateral carinae, macrosetal count.

10. Metasomal segment IV, ventrolateral carinae, macrosetal count.

11. Metasomal segment V, ventrolateral carinae, macrosetal count.

12. Metasomal segment I, ventrosubmedian carinae, macrosetal count.

13. Metasomal segment II, ventrosubmedian carinae, macrosetal count.

14. Metasomal segment III, ventrosubmedian carinae, macrosetal count.

15. Metasomal segment IV, ventrosubmedian carinae, macrosetal count.

16. Metasomal segment V, ventrosubmedian carinae, macrosetal count.

17. Metasomal segment II, ventral intercarinal surface, (accessory) macrosetal count.

18. Metasomal segment III, ventral intercarinal surface, (accessory) macrosetal count.

19. Metasomal segment IV, ventral intercarinal surface, (accessory) macrosetal count.

20. Metasomal segment I, width : height ratio.

21. Metasomal segment V, width : height ratio.

22. Pedipalp chela, dorsal prolateral (dpl), prolateral dorsal (pld) and dorsal prosubmedian (dps) carinae, macrosetal count.

23. Pedipalp chela, dorsal median (dm) and dorsal retrosubmedian (drs) carinae, macrosetal count.

24. Pedipalp patella, ventral prolateral (vpl) carina, macrosetal count.

25. Pedipalp patella, ventral median (vm) carina, macrosetal count.

26. Pedipalp femur, prolateral ventral (plv) carina, macrosetal count.

27. Pedipalp chela, dorsal retrosubmedian accessory (drsa) carina, macrosetal count.

28. Pedipalp patella, dorsal retrolateral (drl) carina, macrosetal count.

29. Pedipalp patella, dorsal prolateral (dpl) carina, macrosetal count.

30. Pedipalp patella, ventral retrolateral (vrl) carina, macrosetal count.

31. Pedipalp femur, dorsal retrolateral (drl) carina, macrosetal count.

32. Pedipalp femur, dorsal prolateral (dpl) carina, macrosetal count.

33. Pedipalp femur, ventral prolateral (vpl) carina, macrosetal count.

34. Pedipalp chela, dorsal retrolateral (drl) and retrolateral dorsal (rld) carinae, macrosetal count.

35. Pedipalp chela, retrolateral median (rlm) and retrolateral ventrosubmedian (rlvs) carinae, macrosetal count.

36. Pedipalp chela, ventral median (vm) and ventral prosubmedian (vps) carinae, macrosetal count.

37. Pedipalp chela, prolateral median (plm) and prolateral ventrosubmedian (plvs) carinae, macrosetal count.

38. Pedipalp chela, ventral prolateral (vpl) carina and prolateral ventral (plv) carinae, macrosetal count.

39. Pedipalp chela, ventral retrosubmedian (vrs) and ventral retrolateral (vrl) carinae, macrosetal count.

40. Pedipalp patella, prolateral median (plm) carina, setal count.

41. Pedipalp patella, prolateral ventral (plv) carina, macrosetal count.

42. Pedipalp femur, prolateral ventrosubmedian (plvs) carina, macrosetal count.

43. Pedipalp femur, retrolateral dorsosubmedian (rlds) carina, macrosetal count.

44. Pedipalp femur, ventral median (vm) carina, macrosetal count.

Colour and infuscation

Colour and infuscation are plastic in many scorpions, often matching the colour of the substrate (Polis, 1990). Among Syntropinae, psammophilous taxa that inhabit pale substrata, for example, some *Chihuahuanus* and most *Paravaejovis*, tend to be immaculate, with a pale integument. Inhabitants of mesic and subtropical environments, for example, *Konetontli*, *Maaykuyak* and most *Mesomexovis*, possess conspicuous infuscation and/or dark integument that match darker soils. Although clearly adaptive, and thus prone to convergence or parallelism, many patterns of colour and infuscation are phylogenetically informative and offer localized synapomorphies and diagnostic characters. Twenty-six characters were included to represent the patterns observed. Descriptive terminology for carinal infuscation is as follows: carina infuscation: immaculate (no infuscation); infuscate: length (longitudinal development): vestigial: carina restricted to proximal or distal part of segment; partial: carina truncated or becoming gradually weaker distally or proximally, that is, does not extend full length of segment; complete: carina extends full length of segment. As with surface infuscation and ornamentation, carinal infuscation is independent of carinal ornamentation. There are many examples of infuscate carinae without ornamentation and immaculate carinae with ornamentation.

45. Cheliceral manus, dorsal surface, infuscation: immaculate, pale or nearly so (fingers may be slightly infuscate) (0); infuscate (1).

46. Carapace, base colour (irrespective of infuscation): pale yellow or brownish-yellow (0); brown, orange-brown, or reddish-brown (1); dark brown or dark reddish-brown (2).

47. Carapace interocular surface (triangle between median and lateral ocelli), infuscation: partially infuscate (0); immaculate (no infuscation) (1). [FSB01/9–11 (part); FP08/1]

48. Carapace circumocular surfaces, infuscation: infuscation not reaching lateral ocelli (0); immaculate (1). [FSB01/9–11 (part); FP08/2]

49. Carapace anterolateral surfaces, infuscation: infuscate (0); immaculate (1).

50. Carapace posterolateral and posteromedian surfaces, infuscation: infuscate (0); immaculate (1). [FSB01/9–11 (part); FP08/3]

51. Pedipalps, legs, tergites and metasoma, integument base colour: pale (0); dark (1).

52. Pedipalp femur, dorsal intercarinal surfaces, infuscation: immaculate (0); infuscate (1).

53. Pedipalp patella, dorsal intercarinal surfaces, infuscation: immaculate to diffusely infuscate (0); markedly infuscate (1).

54. Pedipalp chela, colour relative to femur and patella: similar (0); darker (1).

55. Pedipalp chela manus, intercarinal surfaces, infuscation: infuscate (0); immaculate (1). [FSB01/12 (part); FP08/5]

56. Pedipalp chela fingers, colour relative to manus: darker (0); similar (pale or dark) (1). [FSB01/8; FP08/4]

57. Pedipalp chela fingers, infuscation: immaculate to diffusely infuscate (0); distinctly infuscate basally (1).

58. Legs, colour and infuscation: pale, immaculate to lightly infuscate (0); moderately infuscate (1); very dark, heavily infuscate (2).

59. Leg coxae, infuscation: immaculate (0); diffuse to moderately infuscate (1).

60. Tergites I–VII, dorsal median (dm) [median] carina, infuscation, length: no difference in infuscation from adjacent intercarinal surfaces (0); infuscation faintly or markedly darker than adjacent intercarinal surfaces: vestigial (1); partial (2); complete (3).

61. Tergites I–VII, intercarinal surfaces, infuscation: entirely infuscate (0); mostly infuscate, lateral and posterior margins immaculate (1); entirely or almost entirely immaculate (2). [FSB01/9 (part); FP08/6]

62. Sternites III–VI, intercarinal surfaces, infuscation: immaculate (0); finely infuscate laterally and around setae only (1); entirely infuscate (2).

63. Sternite VII, intercarinal surfaces, infuscation: immaculate (0); finely infuscate laterally and around setae only (1); entirely infuscate (2).

64. Metasomal segments I–IV, dorsal intercarinal surfaces, between dorsal lateral (dl) carinae, infuscation: immaculate (0); infuscate (1).

65. Metasomal segment V, dorsal intercarinal surfaces, between dl carinae, infuscation: immaculate (0); infuscate (1).

66. Metasomal segments I–IV, ventral intercarinal surfaces, infuscation: immaculate (0); infuscate (1). [FSB01/12 (part), 13; FP08/7]

67. Metasomal segment IV, colour relative to segment III: similar (0); darker (1).

68. Metasomal segment V, colour relative to segment IV: similar (0); darker (1).

69. Telson, colour relative to metasomal segment V: paler (0); similar (1); darker (2).

70. Telson ventral surface, infuscation: immaculate (0); infuscate (1).

Chelicerae

The cheliceral dentition of Syntropinae is typical of Vaejovidae and conforms to one of the patterns described by Vachon (1963). The movable finger dentition offered three characters reflecting differences between outgroup and ingroup taxa. A fourth character, concerning the serrula, was included to test the putatively vestigial condition in Smeringurinae compared with the well-developed serrula of most other vaejovids (Fet et al., 2006; Graham and Fet, 2006).

71. Movable finger, distal denticles [prolateral and retrolateral distal teeth], relative size: subequal, distal external tooth slightly smaller than distal internal tooth [ventral > dorsal] (0); unequal, distal external tooth considerably smaller than distal internal tooth [ventral ≫ dorsal] (1). [L80/21 (part); P00/11; S&S01/1, 6; S&F03/31, 39; FP08/10]

72. Movable finger, distal denticles, alignment: opposable, distal internal tooth completely overlaps distal external tooth in dorsal aspect, creating deep U-shaped notch in anterior aspect (0); not opposable, distal internal tooth does not overlap or at most partially overlaps distal external tooth in dorsal aspect, creating shallow V-shaped notch in anterior aspect (1). [L80/21 (part); P00/11; S&S01/1, 6; S&F03/39; FP08/10; PFV10/4]

73. Movable finger, ventral edge, denticles: crenulate/1–7 small denticles [ventral accessory teeth *sensu* Stockwell, 1989] (0); smooth (1). [S89/34–36; S&S01/4; S&F03/42, 43]

74. Movable finger, ventral edge, serrula: present, well developed (0); present, reduced [vestigial] (1). [S89/37–39; S&S01/7; FP08/12]

Carapace shape and topography

Six characters were included to represent variation in the shape and topography of the carapace, notably the curvature of its anterior margin and the development of the sulci and median ocular tubercle. Characters of the anterior margin were reevaluated and a distinction recognized between the curvature and presence of an anteromedian notch. Sissom (1991a) suggested the obtuse, concave emargination as a diagnostic character for the former *nitidulus* group (species assigned to *Franckeus* and the *nigrescens* group by Soleglad and Fet, 2008). Soleglad and Fet (2008) proposed a difference between *Kochius*, with an anteromedian notch and subtle emargination extending to the lateral ocelli, *Thorellius*, with a less pronounced notch and subtle emargination that does not extend to the lateral ocelli, and the other taxa assigned to Syntropini, with a sublinear anterior margin.

75. Carapace anterior margin, curvature: concave (0); sublinear (1); convex (2). [FP08/14]

76. Carapace anteromedian [frontal] notch [emargination]: obsolete [straight or subtle indentation] (0); present, shallow [shallow to medium indentation] (1). [S&S01/10; P00/3; FP08/14]

77. Carapace anteromedian longitudinal sulcus, anterior furcation: no furcation (0); furcation (1).

78. Carapace, median lateral sulci: pronounced/well developed (0); obsolete/indistinct (1).

79. Carapace, median ocular tubercle: raised (0); shallow (flat) (1).

80. Carapace, median ocular tubercle, superciliary carinae: higher than ocelli (0); lower than ocelli (1).

Carapace ornamentation

Although relatively homogeneous in Syntropinae, carapace surface macrosculpture (texture) provided three characters in support of particular groups. The diverse, distal clades of Syntropinae were relatively similar, presenting shagreened surfaces. A distinctive matte surface was independently derived in *Konetontli*, *M. waueri* and *P. pumilis*. A smooth interocular surface was synapomorphic for *Syntropis*.

81. Carapace interocular surface, texture: glabrous (smooth, shiny) (0); matte (uniformly finely granular) (1); shagreened (coarse granules on smooth or finely granular surface) (2).

82. Carapace interocular surface, texture, distribution: entirely glabrous (0); granular along median longitudinal and anterior furcated sulci only (1); frontal lobes and median surfaces granular, with glabrous areas (2); entirely granular (3).

83. Carapace anterolateral, median lateral, posterolateral, and posteromedian surfaces, texture: glabrous (0); matte (1); shagreened (2).

Pedipalp carination

Although scorpions are generally considered to possess between eight and ten carinae on the pedipalp chela (Vachon, 1952; Stahnke, 1970; Stockwell, 1989; Prendini, 2000; Soleglad and Sissom, 2001), terminology and homology have been inconsistently applied, with different terminology used for serially homologous carinae on the pedipalp patella and femur (e.g. Soleglad and Sissom, 2001; Soleglad and Fet, 2003). Based on work in preparation, additional carinae must be considered on each segment, requiring the revised terminology and homology scheme used here and by González-Santillán and Prendini (2013). Thirty-six characters represent variation in the length, macrosculpture and relative development of the metasomal carinae. Carinae on the prolateral and retrolateral surfaces of the femur and patella, in particular, contain informative characters for relationships among vaejovids, but had not been satisfactorily investigated prior to this study. Descriptive terminology for carinal ornamentation is as follows: carina ornamentation: no difference in height and/or texture from adjacent intercarinal surfaces; difference in height and/or texture: smooth (includes costate); granular (includes costate-granular, i.e. confluent granules, e.g. crenulate, serrate or dentate); length: marginal tubercle: prominent granule (may be spiniform, e.g. "spur") at proximal or distal margin of segment; vestigial: carina restricted to proximal or distal part of segment; partial: carina truncated or becoming gradually weaker distally or proximally, that is, does not extend full length of segment; complete: carina extends full length of segment.

84. Femur, retrolateral dorsosubmedian (rlds) carina, ornamentation, texture and length: granular, partial (0); granular, complete (1); smooth, complete (2).

85. Femur, retrolateral ventral (rlv) carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

86. Femur, ventral retrolateral (vrl) carina, ornamentation, length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: vestigial (1); partial (2).

87. Femur, ventral retrosubmedian (vrs) carina, ornamentation, length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: vestigial (1); partial (2).

88. Femur, prolateral ventral (plv) [internoventral] carina, ornamentation, length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: vestigial (1); partial (2).

89. Patella, dorsal retrolateral (drl) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: smooth, vestigial (1); granular, complete (2); smooth, complete (3).

90. Patella, retrolateral dorsosubmedian (rlds) [(dorsal) externomedian] carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, vestigial (1); smooth, vestigial (2); granular, partial (3); granular, complete (4). [PFV10/44]

91. Patella, retrolateral median (rlm) [(ventral) externomedian] carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, vestigial (1); smooth, vestigial (2); granular, partial (3); granular, complete (4). [PFV10/45]

92. Patella, rlds and rlm carinae, relative development: rlm more strongly developed than rlds (0); rlds more strongly developed than rlm (1); rlm and rlds similarly developed (2).

93. Patella, rlds and rlm carinae, development relative to ventral retrolateral (vrl) carina: as strongly developed (0); less strongly developed (1).

94. Patella, ventral median (vm) carina, length: vestigial, marginal tubercle only (0); partial (1).

95. Patella, prolateral subdorsal (pls) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: marginal tubercle only (1).

96. Patella, prolateral median (plm) [(dorsal) internal median or "dorsal patellar spur"] carina, length: vestigial (0); partial (1); complete (2). [S89/41, 42; S&F03/96; PFV10/43]

97. Patella, prolateral ventral (plv) [(ventral) internomedian or "ventral patellar spur"] carina, landmark macroseta at distal margin, position relative to trichobothrium *i*: absent (-); approximately in line with trichobothrium (0); distal to trichobothrium (1).

98. Chela, dorsal prolateral (dpl) [dorsal marginal (D4)] carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

99. Chela, dorsal median (dm) [dorsal secondary (D3)] carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2). [P00/22; S&S01/24; PFV10/34]

100. Chela, dorsal retrosubmedian (drs) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, vestigial (1); granular, partial (2); granular, complete (3); smooth, complete (4).

101. Chela, dorsal retrosubmedian accessory (drsa) [subdigital (D2)] carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: marginal tubercle only (1); granular, vestigial (2); smooth, vestigial (3). [S89/40; P00/19; S&S01/23; FP08/17 (part)]

102. Chela, dorsal retrolateral (drl) [digital (D1)] carina, ornamentation, texture and length (longitudinal development): no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: smooth, partial (1); granular, complete (2); smooth, complete (3). [PFV10/35]

103. Chela, retrolateral dorsal (rld) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, partial (1); smooth, partial (2); smooth, complete (3).

104. Chela, retrolateral median (rlm) [external secondary (E)] and retrolateral ventrosubmedian (rlvs) carinae, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: smooth, vestigial (1); smooth, partial (2); granular, complete (3); smooth, complete (4). [PFV10/36]

105. Chela, retrolateral median (rlm) [external secondary (E)] carina, development relative to dorsal retrolateral (drl) [digital (D1)] carina and ventral retrolateral (vrl) [ventroexternal (V1)] carina, if difference in height and/or texture from adjacent intercarinal surfaces: no difference in height and/or texture (-); difference in height and/or texture: similarly developed (0); less developed (1).

106. Chela, retrolateral subventral accessory (rlsa) carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

107. Chela, retrolateral subventral (rls) [secondary accessory] carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

108. Chela, retrolateral subventral (rls) [secondary accessory] carina, ornamentation, connection to ventral retrolateral (vrl) [ventroexternal (V1)] carina, if difference in height and/or texture from adjacent intercarinal surfaces: no difference in height and/or texture (-); difference in height and/or texture: rls and vrl carinae connected, continuous to external movable finger condyle (0); rls disconnected from vrl carina, discontinuous (1). [P00/27; S&S01/25].

109. Chela, retrolateral ventral (rlv) carina, ornamentation, length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: vestigial (1); partial (2).

110. Chela, ventral retrolateral (vrl) [ventroexternal (V1)] carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, complete (1); smooth, complete (2).

111. Chela, ventral retrosubmedian (vrs) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, vestigial (1); granular, partial (2); granular, complete (3) smooth, complete (4).

112. Chela, ventral median (vm) [ventrointernal (V2)] carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, vestigial (1); smooth, vestigial (2); granular, complete (3); smooth, complete (4). [P00/28; S&S01/26; FP08/18; PFV10/38, 39]

113. Chela, ventral prosubmedian (vps) [V2] carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: smooth, vestigial (1); granular, complete (2); smooth, complete (3).

114. Chela, ventral prolateral (vpl) carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

115. Chela, ventral prolateral (vpl) + prolateral ventral (plv) [ventral internal (V3/I)] and prolateral ventrosubmedian (plvs) + prolateral median (plm) [dorsal internal (D5)] carinae, relative development: vpl + plv more strongly developed (0); vpl + plv and plvs + plm similarly developed (1); plvs + plm more strongly developed (2).

116. Chela, prolateral dorsal (pld) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: smooth, vestigial (1); granular, partial (2); smooth, partial (3); granular, complete (4).

117. Chela, prolateral median (plm) [dorsointernal (D5)] carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

118. Chela, prolateral ventrosubmedian (plvs) carina, ornamentation, texture and length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular, vestigial (1); granular, complete (2); smooth, complete (3).

119. Chela, prolateral ventral (plv) [internomedian (V3/I)] carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

Pedipalp surface ornamentation

Seven characters were included to represent variation in the macrosculpture of the pedipalps.

120. Femur, dorsal intercarinal surfaces, ornamentation, texture: glabrous (0); matte (1); shagreened (2); unevenly (non-uniform) finely granular (3).

121. Femur, ventral intercarinal surfaces, ornamentation, texture: glabrous (0); matte (1); shagreened (2).

122. Patella, prolateral intercarinal surfaces, ornamentation, texture: glabrous (0); matte (1); shagreened (2).

123. Patella, dorsal intercarinal surfaces, ornamentation, texture: glabrous (0); matte (1).

124. Patella, retrolateral intercarinal surfaces, ornamentation, texture: glabrous (0); matte (1); shagreened (2).

125. Patella, ventral intercarinal surfaces, ornamentation, texture: glabrous (0); matte (1); shagreened (2).

126. Chela, ventral intercarinal surfaces (between “V1” and “V2” carinae), ornamentation, texture: glabrous (0); matte (1); shagreened (2).

Pedipalp shape

Soleglad and Fet (2003) followed Soleglad and Sissom (2001) in presenting characters describing variation in the shape of the pedipalp chela in terms of the relative positions of carinae. Two of these characters were included, with modification, to address outgroup relationships, and two new characters were added to address relationships within Syntropinae.

127. Patella, dorsal intercarinal surface, curvature, relative to dorsal prolateral (dpl) [dorsal marginal (D4)] and dorsal retrolateral (drl) [digital (D1)] carinae: flat, level with or slightly ventral to dpl and drl carinae (0); concave, inclined to medial aspect of segment below dpl and drl carinae (1).

128. Chela manus, shape: flat, angle “D1”:“D3”:“D4” carinae = 180° [flat/hexagonal or vaulted] and angle “V1”:“V2”:“V3” carinae = 180° [flat/hexagonal] (0); obtuse, angle “D1”:“D3”:“D4” carinae > 90° < 180° and angle “V1”:“V2”:“V3” carinae > 90° < 180° [rounded] (1). [S&S01/21, 22; S&F03/93]

129. Chela manus, shape: planes “D1”|“D4” carinae and “V1”|“V3” carinae nonparallel, distance between “D1”|“V1” carinae < “D4”|“V3” carinae (0); planes “D1”|“D4” carinae and “V1”|“V3” carinae parallel, distance between “D1”|“V1” carinae = “D4”|“V3” carinae (1). [S&S01/21; S&F03/93]

130. Chela manus, depression between dorsal prolateral (dpl) + dorsal prosubmedian (dps) [dorsal marginal (D4)] carinae and dorsal median (dm) + dorsal retrosubmedian (drs) [dorsal secondary (D3)] carinae at proximal margin, in prolateral view: absent or very shallow (0); deep (1).

Pedipalp chela finger lobes and notches

Ten characters, some adopted and modified from previous analyses, were included to represent variation in the curvature and closure of the fixed and movable fingers of the pedipalp chela. The terminology and homology of these the lobes and notches of vaejovids were described by González-Santillán and Prendini (2013) and form part of a more general study in preparation.

131. Chela fingers, closure [gap] (♀): fingers fit together evenly, gap absent when closed (0); fingers fit together unevenly, distinct gap evident when closed (1). [PFV10/31]

132. Chela fingers, closure [gap] (♂): fingers fit together evenly, gap absent or minimal when closed (0); fingers fit together unevenly, distinct gap evident when closed (1).

133. Chela fixed finger dentate margin, basal/proximal notch (PN) (♂): sublinear (0); emarginate, shallow notch (1); emarginate, moderate to deep notch (2).

134. Chela fixed finger, dentate margin, PN (♀): sublinear (0); emarginate, shallow notch (1).

135. Chela fixed finger, dentate margin, median lobe (ML) (♂): sublinear (0); weak to moderate lobe (1); strong lobe (2) unknown (?).

136. Chela fixed finger, dentate margin, ML (♀): sublinear (0); weak lobe (1); unknown (?).

137. Chela movable finger dentate margin, PN (♂): sublinear (0); emarginate, moderate to deep notch (1).

138. Chela movable finger, dentate margin, ML (♂): sublinear (0); weak to moderate lobe (1); strong lobe (2); unknown (?). [P00/35; P03/29; PCW03/25 (part); P04/4; VP08/13]

139. Chela movable finger dentate margin, median notch (MN) (♂, ♀): sublinear (0); emarginate, moderate to deep notch (1).

140. Chela fingertips: distinct whitish sensory surface (0); unmodified plain, smooth, elevated area (1).

Pedipalp finger dentition

Eight characters were included to represent variation in the dentition of the fingers of the pedipalp chela. Terminology follows Stahnke (1970), as modified by Soleglad and Sissom (2001), with a further modification consistent with the recommendations of Acosta et al. (2008): external denticles are renamed retrolateral denticles (RD); internal denticles, prolateral denticles (PD); and internal accessory denticles, prolateral accessory denticles (PAD). Vaejovid scorpions possess a single primary denticle row, in which the median denticles and enlarged retrolateral denticles are aligned in a continuous row, with the enlarged prolateral denticles situated on the prolateral side thereof and, rarely among vaejovids (e.g. *Stahnkeus*), with prolateral accessory denticles distributed among them (González-Santillán and Prendini, 2013). In a further departure from previous terminology, the subterminal and enlarged (sometimes hook-like) terminal denticles are considered serial homologs of the prolateral and retrolateral denticles, respectively, and included in the corresponding series.

141. Chela fixed and movable fingers, terminal denticle: considerably larger than preceding denticles, hook-like (0); slightly larger than preceding denticles (1). [PFV10/29]

142. Chela fixed and movable fingers, median denticle row, denticle development: denticles unmodified (0); denticles flat, elongated and pointed, forming serrated cutting edge (*sensu* Soleglad and Sissom, 2001) (1).

143. Chela fixed finger, median denticle row, primary subrows and retrolateral denticles (RD), count: 3 (0); 5 (1); 6 (2).

144. Chela movable finger, prolateral denticles (PD), count: 4 (0); 5 (1); 6 (2); 8 or more (3). [FP08/20; S&S01/33]

145. Chela movable finger, median denticle row, primary subrows and retrolateral denticles (RD), count: 4 (0); 5 (1); 6 (2); 7 (3). [S&S01/33; S&F03/55; P04/6]

146. Chela movable finger, median denticle row, first (terminal) primary subrow: absent (no denticles) (0); one (occasionally two) denticles (1); usually three or more denticles (2). [S&F03/55; P04/6; PFV10/16]

147. Chela movable finger, PD8: present (0); absent (1). [S&S01/33; PFV10/24]

148. Chela movable finger, prolateral accessory denticles (PAD) [supernumerary granules *sensu* Sissom, 1990]: absent (0); numerous, irregularly positioned PAD, variable in number and position (1). [S&S01/29, 33; S&F03/49, 52; FP08/21]

Pedipalp trichobothria

Eighteen characters represented variation in the number and positions of pedipalp trichobothria. The positions of trichobothria on the fixed finger of the pedipalp chela, for example, the prolateral (*ib–it*) and retrolateral (*eb–et*) trichobothria, traditionally determined by reference to the length of the finger, were reinterpreted by reference to the paired pro- and retrolateral denticles and/or their associated macrosetae (González-Santillán and Prendini, 2013). Whereas the positions of denticles may be obscured by the presence of prolateral accessory denticles, for example, in *Stahnkeus*, their associated macrosetae are unmistakable, and provide landmarks in the absence of denticles. Reference to the denticles and/or associated macrosetae permits a more precise assessment of positional homology, on the basis of which it appears that trichobothrial positions are independent of finger elongation, as predicted by the placeholder approach (Prendini et al., 2010) rather than the allometry hypothesis (Francke, 1982). This approach produced novel apomorphies for the diagnoses of *Chihuahuanus*, *Mesomexovis* and *Paravaejovis*.

149. Femur, trichobothrium *d*, position relative to trichobothrium *i*: proximal or aligned (0); distal (1). [S&S01/38; S&F03/5]

150. Patella, external surface, distance trichobothria esb_1–esb_2 relative to distance trichobothria em_1–em_2: less than or equal (0); considerably greater than (1). [S&F03/29]

151. Patella, ventral surface, trichobothrium v_2, position relative to trichobothria v_1 and v_3: approximately equidistant between v_1 and v_3 (0); closer to v_1, distance $v_2 - v_3 >$ distance v_1–v_2 (1). [S&F03/27]

152. Chela manus, trichobothrium *Db*, position relative to drl [D1] carina: ventral (0); on carina (1); dorsal (2). [S89/81, 83–85; P00/51, 52; S&F03/19; FP08/29]

153. Chela manus, trichobothrium *Dt*, position: proximal third (0); medial third (1). [S89/81, 83–85; P00/52; S&F03/19]

154. Chela manus, trichobothrium Eb_1, position: retrolateral surface (0); on vrl [V1] carina (1). [S&S01/45; S&F03/8]

155. Chela manus, external surface, trichobothrium Et_4, position relative to trichobothrium Et_3: aligned (0); distal (1).

156. Chela, trichobothrium Et_5, position: manus, posterior to articulation between fixed and movable fingers, near trichobothrium

Et_4 (0); at base of fixed finger, aligned with or distal to articulation, removed from Et_4 (1). [S&F03/15, 22; FP08/34]

157. Chela manus, ventral surface, trichobothria, count: 4 (no accessory trichobothria) (0); 9 or more (5 or more accessory trichobothria) (1). [L80/14; S89/75, 76; P00/49; FSB01/5; S&S01/57; S&F03/32; FP08/36]

158. Chela, manus, ventral surface, trichobothrium V_3, position: proximal third (0); medial third (1).

159. Chela, manus, trichobothrium V_4, position: ventral surface (0); on vrl [V1] carina or retrolateral surface (1). [S89/80; S&S01/43; S&F03/7]

160. Chela, retrolateral surface, trichobothrium *db*, position: manus or base of fixed finger, not distal to articulation between fixed and movable fingers (0); proximal third of fixed finger, distal to articulation (1). [S&S01/66]

161. Chela fixed finger, retrolateral surface, trichobothrium *eb*, position: base of fixed finger, near articulation between fixed and movable fingers (0); proximal third of fixed finger (1); medial to distal third of fixed finger (2). [P00/61; FP08/43]

162. Chela fixed finger, retrolateral surface, trichobothrium *esb*, position: between RD6 and articulation with movable finger, but closer to articulation (0); midway between RD6 and articulation (1); at or close to RD6 (2); between RD5 and RD6 (3); at or close to RD4 (4). RD numbering starts at terminal denticle; RD refers to denticle and/or associated macroseta.

163. Chela fixed finger, retrolateral surface, trichobothrium *est*, position: between RD3 and RD4 (0); between RD4 and RD5 (1); between RD5 and RD6 (2).

164. Chela fixed finger, retrolateral surface, trichobothrium *et*, position: between RD2 and RD3 (0); between RD3 and RD4, at or closer to RD3 (1); midway between RD3 and RD4 (2); between RD3 and RD4, at or closer to RD4 (3).

165. Chela fixed finger, prolateral surface, trichobothrium *ib*, position: proximal to RD7 (0); at or close to RD7 (1); between RD6 and RD7 (2); at or close to RD6 (3); between RD5 and RD6 (4); at or close to RD5 (5). [S89/71–72; P00/48; S&S01/40, 41; S&F03/10; FP08/44]

166. Chela fixed finger, prolateral surface, trichobothrium *it*, position: proximal to RD7 (0); at or close to RD7 (1); between RD6 and RD7 (2); at or close to RD6 (3); between RD5 and RD6 (4); at or close to RD5 (5); between RD4 and RD5 (6). [S89/70–72; P00/47; S&S01/40, 41; S&F03/11, 14; FP08/45]

Leg proportions and ornamentation

Two characters were included to test the potential elongation of the leg coxae in Syntropinae, and the surface macrosculpture on the prolateral surfaces of the leg femora.

167. Legs II and IV, coxa proportions (anterior lengths IV/II): 1.3–2.0 (0); 2.2–2.9 (1). [S&F03/72]

168. Legs I–IV, femora, prolateral surfaces, texture: glabrous to unevenly (non-uniform) granular (0); matte (1); shagreened (2).

Leg setation

Leg setae and spinules are frequently used in scorpion systematics (Pocock, 1893; Kraepelin, 1899; Gertsch and Soleglad, 1972; Francke, 1975; Lamoral, 1980; Haradon, 1983, 1984a,b, 1985; Sissom, 1990). McWest (2009) presented the most recent attempt to organize this character system in vaejovids, producing an atlas of tarsal setae and spinules, and discussing patterns and putative homologies. Some of McWest's (2009) concepts were implemented in the analyses presented here, although hypotheses of homology and associated terminology were modified to accommodate serial homology. Fourteen informative characters were identified, including seven macrosetal counts along selected carinae. Setal counts represented the number of setae situated along selected carinae, the terminology and homology of which were described by González-Santillán and Prendini (2013) and form part of a more general study in preparation.

169. Legs I and II, basitarsi, setal combs (♀): absent, dorsal and retrodorsal setae arranged into two separate parallel to subparallel rows (0); present, dorsal and retrodorsal setae arranged into single sublinear to linear row (1).

170. Legs I and II, basitarsi, setal combs (♂): absent, dorsal and retrodorsal setae arranged into two separate parallel to subparallel rows ["distal plus proximal subrows" *sensu* Haradon, 1985: 23; Table 1] (0); present, dorsal and retrodorsal setae arranged into single sublinear to linear row ["single continuous row" *sensu* Haradon, 1985: 23; Table 1] (1).

171. Leg III, basitarsus, setal combs (♂, ♀): absent, dorsal and retrodorsal setae arranged into two separate parallel to subparallel rows (0); present, dorsal and retrodorsal setae arranged into single sublinear to linear row (1).

172. Leg III, basitarsus, retroventral series, macroseta 8 [RV series *sensu* McWest, 2009: 8]: present (0); absent (1).

173. Leg III, basitarsus, retroventral series, macroseta 9 [RV series *sensu* McWest, 2009: 8]: present (0); absent (1).

174. Leg III, basitarsus, ventral series, macroseta 5 [DV *sensu* McWest, 2009: 8]: present (0); absent (1).

175. Leg III, basitarsus, ventral series, macroseta 6 [DV *sensu* McWest, 2009: 8]: present (0); absent (1).

176. Leg I, telotarsus, proventral macrosetae, count: 2 (0); 3 (1); 4 (2).

177. Leg I, telotarsus, retroventral macrosetae, count: 2 (0); 3 (1); 4 (2).

178. Legs II and III, telotarsi, proventral macrosetae, count: 2 (0); 3 (1); 4 (2).

179. Leg II, telotarsus, retroventral macrosetae, count: 2 (0); 3 (1); 4 (2).

180. Leg III, telotarsus, retroventral macrosetae, count: 2 (0); 3 (1); 4 (2).

181. Leg IV, telotarsus, proventral macrosetae, count: 3 (0); 4 (1).

182. Leg IV, telotarsus, retroventral macrosetae, count: 2 (0); 3 (1); 4 (2).

Leg spinules

Five characters, included to represent informative variation in the spinules of the legs, were of particular importance for the definition of *Vizcaino*, the telotarsal spinules of which are unique among Syntropinae.

183. Legs I–IV, basitarsi and telotarsi, ventral surfaces, spinules, type: stout (0); very elongate (1); bristle-like (2). [L80/9; S89/93, 94, 97; P00/68, 70; S&S01/83, 84, 88, 89; S&F03/57, 58; FP08/48; PFV10/153]

184. Leg III, basitarsus, retrolateral spinules: distal spinules only (0); short distal row (1); long, partial row (2).

185. Leg IV, basitarsus, retrolateral spinules: distal spinules only (0); row of scattered spinules (1). [S&S01/85]

186. Legs I–IV, telotarsi, ventral surface, spinules, proximal row, configuration: curved/arc-shaped (0); loop or cluster (1). [PFV10/149]

187. Legs I–IV, telotarsi, ventral surface, spinules, ventrodistal pairs [VDS *sensu* McWest, 2009], count: 1 (0); 2 (1); 3 or 4 (2). [S89/97 (part), 100; S&S01/83; S&F03/62; PFV10/151]

Genital operculum

The extent of fusion of the genital opercular sclerites of the female, previously used to differentiate clades and subfamilies of Vaejovidae (Soleglad and Fet, 2003, 2008), was re-evaluated. A distinction was made between the fusion and the hinge, represented as two characters. The sclerites of the genital opercula are fused, such that they open as a single, distinct "flap", in all Syntropinae.

188. Genital operculum, sclerites (♀): separated for most of length, loosely connected at anterior edge (0); partially fused, separated at posterior 20–25% of their length, connected to mesosoma in anterior half (1); partially fused, separated at posterior 20–25% of their length, connected to mesosoma in anterior third (2); fused, strongly connected by membrane entire length, with clear median suture (3). [L80/12 (part); S89/105–107; P00/80; S&F03/82; FP08/52]

189. Genital opercula, hinge of sclerites (♀): sclerites unable to open as a distinct "flap" (0); sclerites able to open as single, distinct "flap" (1).

Hemispermatophore

Sissom (1989a, b, 1991b), Stockwell (1989) and Williams and Savary (1991) presented the first investigations of the microstructure of the hemispermatophore of North American scorpions and its importance for the systematics of Vaejovidae. Thirteen characters, incorporating and refining the observations of these authors and Soleglad and Fet (2008), were included in the analysis.

190. Hemispermatophore, sperm duct, floor: bearing greatly reduced, pouch-like invagination (0); bearing enlarged, pouch-like invagination (1). [S89/116]

191. Hemispermatophore, sclerotized hemi-mating/sperm plug, type I (derived from inner lobe): not developed (0); greatly reduced (inner lobe small) (1); fully developed (inner lobe large, tapered) (2).

192. Hemispermatophore, sclerotized hemi-mating/sperm plug, type I, distal barb margin: smooth (0); spinose (armed with spines, hooks or teeth) (1). [S89/119]

193. Hemispermatophore, sclerotized hemi-mating plug, type II (derived from floor of sperm duct): smooth (0); spinose (1).

194. Hemispermatophore, "dorsal trough margin" (*sensu* Sissom, 1991b) (carina) and "ventral trough margin" (carina), terminal spine-like processes: fused into sclerotized crest or lobe (0); fused into prominent, often bifurcated hook (1). [L80/13; P00/90; S&F03/80]

195. Hemispermatophore, "dorsal trough margin" (carina), shape: short, broad, curving proximally, moderate distance to ventral trough margin (0); long, narrow, curving proximally, large distance to ventral trough margin (1).

196. Hemispermatophore, laminar "hooks", lobes and homologous structures derived from terminal spine-like processes of "dorsal trough margin" (carina) and "ventral trough margin" (carina), position: on dorsal/ectal surface (0); on lamina (ental/dorsal) margin (1).

197. Hemispermatophore, laminar "hooks", lobes and homologous structures derived from terminal spine-like processes of "dorsal trough margin" (carina) and "ventral trough margin" (carina), position on lamina: basal (0); distal ["elevated"] (1).

198. Hemispermatophore, secondary hook created by extension of axial carina (*sensu* Lamoral, 1979): no secondary hook on distal lamina (axial carina completely fused to trough margins, no groove visible, i.e. "intact" *sensu* Soleglad and Fet, 2008) (0); basal on lamina (ental/dorsal) margin or on dorsal/ectal surface, weakly developed hook near primary hook created by fusion of trough margins (axial carina partially fused to trough margins, forming shallow notch with visible "groove") (1); basal on lamina (ental/dorsal) margin or on dorsal/ectal surface, well developed hook near primary hook created by fusion of trough margins (axial carina separated from trough margins, forming deep notch, i.e. "bifurcate") (2); basal on lamina margin, fused with primary hook to create "flange" (3); distal on lamina margin, separated from primary hook or flange (4).

199. Hemispermatophore, distal lamina, dorsal/ental margin: straight (0); curved to ectal/dorsal surface, creating "inflection point" ["internal protuberance" *sensu* Soleglad and Fet, 2008] (1).

200. Hemispermatophore, distal lamina, shape: unconstricted (0); basally constricted (1). [S&S01/76]

201. Hemispermatophore, distal lamina, shape: even width almost to tip (0); broad near base, tapered to tip (1). [S&S01/78; S&F03/79]

202. Hemispermatophore, distal lamina, distal/apical crest (carina): not developed (0); distinct (1).

Pectines

The pectines of Syntropinae are usually unmodified, but may be hypertrophied in psammophilous species. Five characters were included primarily to address outgroup relationships. The basal first to third pairs of teeth are modified in most *Serradigitus* and *Stahnkeus*, providing a potential synapomorphy.

203. Pectines, length relative to length of leg IV coxa (♂): long, distal edge reaching beyond distal edge of coxa (0); moderate, distal edge reaching to, but not beyond, distal edge of coxa (1). [S&F03/103; PFV10/170]

204. Pectines, length relative to length of leg IV coxa (♀): long, distal edge reaching beyond distal edge of coxa (0); moderate, distal edge reaching to, but not beyond, distal edge of coxa (1); short, distal edge not reaching to distal edge of coxa (2). [S&F03/103; PFV10/171]

205. Pectines, first proximal median lamella (scape), angle (♂): acute, < 90° (0); approximately 90° (1); obtuse, > 90° but < 180° (2). [PFV10/169]

206. Pectines, first proximal median lamella (scape), angle (♀): approximately 90° (0); obtuse, > 90° but < 180° (1); straight or shallowly curved, approximately 180° (2).

207. Pectines, first (proximal/basal) pectinal tooth (♀): unmodified, similar to subsequent teeth, sensilla field present (0); modified, usually rounded in shape and often larger than subsequent teeth, sensilla field absent (1). [P04/12]

Mesosomal carination

Carinae of the tergites and sternites were homologized with carinae of the carapace and metasoma as part of a more general study (in preparation), resulting in three informative characters for Syntropinae.

208. Tergites I–VI, dorsal lateral anterior/posterior (dl a/p) [dorsosubmedian] carinae, ornamentation, length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: vestigial (restricted to anterior or posterior margin of segment) (1).

209. Sternite VII, ventral submedian (vsm) carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1).

210. Sternite VII, ventral lateral (vl) carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2). [PFV10/176]

Mesosomal surface ornamentation

Six characters represent variation in the glands and surface macrosculpture of the mesosoma. Among them was a glandular area on the posteromedial surface of sternite VII, with two states (González-

Santillán and Prendini, 2013): a raised, whitish triangular boss, restricted to the posteromedial third of segment in most *Kochius*; and a flat, whitish glandular area between the ventrosubmedian carinae, extending almost the entire length of the segment in *Syntropis*.

211. Tergites I–VII (post-tergites), intercarinal surfaces, texture: glabrous (0); matte (1); sparsely shagreened (2); densely shagreened (3).

212. Sternites III–VI, median surfaces, texture: glabrous (0); matte (1).

213. Sternite V, posteromedian surface, glandular area (♂): unmodified (0); smooth, raised area (1). [PFV10/175]

214. Sternite VII, median intercarinal surface, texture: glabrous (0); matte (1); shagreened (2).

215. Sternite VII, lateral intercarinal surfaces, texture: glabrous (0); matte (1); shagreened (2).

216. Sternite VII, glandular area (♂): unmodified or obsolete (very reduced, flat white spot posteromedially) (0); distinct raised, whitish triangular boss, restricted to posteromedial third of segment (1); distinct flat, whitish glandular area between ventrosubmedian carinae, extending almost entire length of segment (2).

Metasomal carination

Most North American workers use Francke's (1977) terminology for metasomal carinae, although the terminologies of Vachon (1952) and Stahnke (1970) are widely used elsewhere. Ten carinae are usually recognized on metasomal segments I–IV and seven on segment V. Based on work in preparation (also see Ochoa et al., 2010), additional carinae must be considered, requiring the revised terminology and homology scheme used here and by González-Santillán and Prendini (2013). Twenty-two characters represent variation in the length and macrosculpture of the metasomal carinae. Descriptive terminology follows that described above for pedipalp carination.

217. Metasomal segments I–IV, dorsal lateral anterior/posterior (dl a/p) [dorsosubmedian/dorsal] carinae, ornamentation, texture: granular (0); smooth (1). [PFV10/178, 180]

218. Metasomal segment V, dl a/p [dorsolateral] carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1). [PFV10/183]

219. Metasomal segments I–III, lateral median anterior/posterior (lm a/p) [dorsolateral] carinae, ornamentation, texture: granular (0); smooth (1). [PFV10/181]

220. Metasomal segment IV, lm a/p [dorsolateral] carinae, ornamentation, texture: granular (0); smooth (1). [PFV10/182]

221. Metasomal segments I–IV, dl a/p (I–III or I–IV) and lm a/p (I–IV), distal granules, size relative to preceding granules: not noticeably larger (0); significantly larger and spiniform (1). [PFV10/179]

222. Metasomal segment V, lm a/p [median lateral] carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

223. Metasomal segment V, lm a/p carinae, ornamentation, length: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: partial (1). [S&F03/86]

224. Metasomal segment I, lateral inframedian (lim) [median lateral] carinae, ornamentation, texture: granular (0); smooth (1).

225. Metasomal segments II and III, lim carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

226. Metasomal segment IV, lim carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1).

227. Metasomal segment I, lim carinae, ornamentation, length: partial (0); complete (1). [PFV10/186]

228. Metasomal segment II, lim carinae, ornamentation, length: vestigial (0); partial (1). [PFV10/187]

229. Metasomal segment III, lim carinae, ornamentation, length: vestigial (0); partial (1). [PFV10/188]

230. Metasomal segments I–IV, ventral lateral (vl) carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2). [PFV10/189, 190]

231. Metasomal segment V, vl carinae, ornamentation, texture: granular (0); smooth (1). [PFV10/191]

232. Metasomal segment V, vl carinae, ornamentation, length: vestigial (0); complete (1). [PFV10/192]

233. Metasomal segment I, ventral submedian (vsm) carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2).

234. Metasomal segment II, vsm carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2). [S89/132, 133; P00/95; S&S01/12; S&F03/85]

235. Metasomal segment III, vsm carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2). [S89/132, 133; P00/95; S&S01/12; S&F03/85]

236. Metasomal segment IV, vsm carinae, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1); smooth (2). [S89/132, 133; P00/95; S&S01/12; S&F03/85]

237. Metasomal segment V, ventral median (vm) carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: granular (1). [S&F03/84]

238. Metasomal segments I–III, lateral intercarinal surfaces (between dsl and vl carinae), texture: glabrous (0); matte (1); shagreened (2).

239. Metasomal segments I–IV, ventral median (vm) carina, ornamentation, texture: no difference in height and/or texture from adjacent intercarinal surfaces (0); difference in height and/or texture: smooth to crenulate (1). [S89/132, 133; P00/95; S&S01/12; S&F03/85]

Metasomal surface ornamentation

Three characters were included to represent variation in surface macrosculpture on the metasoma.

240. Metasomal segments IV and V, lateral intercarinal surfaces, texture: glabrous (0); matte (1); shagreened (2).

241. Metasomal segments I–IV, ventral intercarinal surfaces (between vl carinae), texture: glabrous (0); matte (1).

242. Metasomal segment V, ventral intercarinal surfaces, texture: glabrous (0); matte (1); shagreened (2).

Telson

Seven characters were included to represent setation, surface macrosculpture, glands and subaculear tubercles of the telson. Telson macrosetae were first used by Williams (1970a, 1971a,b, 1980) to differentiate members of the former *punctipalpi* group, now included in *Kochius*. A dense tuft of long macrosetae is observed on the telson of most species of the genus, for example, *Kochius hirsuticauda* (Banks, 1910). Glandular areas on the dorsal surface of the telson vesicle, for example, the androvestigium of Bothriuridae Simon, 1880 and the subaculear glands of some species of *Hadrurus* Thorell, 1876 (Kraepelin, 1908; Werner, 1934; San Martín, 1965; Williams, 1970d, 1980; Prendini, 2000), were unknown in vaejovids prior to González-Santillán and Prendini (2013), perhaps because they are inconspicuous and visible only in well-preserved specimens. Among vaejovids, a subaculear tubercle occurs in several taxa within Syntropinae, Stahnkeini, and the *mexicanus* group of *Vaejovis*. At least two character states are evident (González-Santillán and Prendini, 2013): a conical tubercle with a sharp tip in *Wernerius* and a laterally compressed tubercle with a rounded tip in *Konetontli* and the *mexicanus* group. These tubercles may be associated with smaller granules, forming a compound subaculear tubercle, in some species of *Konetontli*.

243. Vesicle, macrosetae, length relative to aculeus (♂): moderate, shorter than aculeus (0); elongate, some as long as or longer than aculeus (1).

244. Vesicle, macrosetae, length relative to aculeus (♀): moderate, shorter than aculeus (0); elongate, some as long as or longer than aculeus (1).

245. Vesicle, dorsal surface, glands (♂): absent (surface unmodified) (0); small to moderate fusiform whitish glandular area anterior to base of aculeus (1); moderate oval whitish glandular area medially on dorsal surface (2). [FSB01/14; FP08/61]

246. Vesicle, ventral surfaces, texture: glabrous to matte (0); shagreened (1).

247. Subaculear tubercle: absent (0); present (1). [L80/15; S89/135; P00/106; P04/27; S&F03/90]

248. Compound subaculear tubercle: absent (0); present (1).

249. Aculeus, base, lateral microserration ["spicules" *sensu* Lamoral, 1979; "laterobasal serrations" *sensu* Fet et al., 2006] (♂): absent (surface unmodified) (0); present (1).

Appendix 7

Primers used to amplify DNA sequences of two nuclear and three mitochondrial gene markers for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905

Primer name	Primer sequence (5′ to 3′)	Reference
18S rDNA		
18Sa1.0	GGTGAAATTCTTGGAYCGTC	Whiting et al. (1997)
18Sa2.0	ATGGTTGCAAAGCTGAAAC	Wheeler et al. (1993)
18Sa3.5	TGGTGCATGGCCGYTCTTAGT	Whiting et al. (1997)
18Sai	CCTGAGAAACGGCTACCACATC	Wheeler et al. (1993)
18Sbi	GAGTCTCGTTCGTTATCGGA	Wheeler et al. (1993)
18SB2.9A	TATCTGATCGCCTTCGAACCTCT	Whiting et al. (1997)
18SB3.0	GACGGTCCAACAATTTCACC	Whiting et al. (1997)
18SB3.9	TGCTTTRAGCACTCTAA	Whiting et al. (1997)
18SB5.0	TAACCGCAACAACTTTAAT	Wheeler et al. (1993)
18S1F	TACCTGGTTGATCCTGCCAGTAG	Giribet et al. (1996)
18S3F	GTTCGATTCCGGAGAGGGA	Giribet et al. (1996)
18S5R	CTTGGCAAATGCTTTCGC	Giribet et al. (1996)
18S4R	GAATTACCGCGGCTGCTGG	Giribet et al. (1996)
18S6F	AAACTTAAAGGAAT	Giribet et al. (1996)
18S7F	GCAATAACAGGTCTGTGATGCCC	Whiting (2002)
18S7R	GCATCACAGACCTGTTATTGC	Whiting (2002)
18S8R	ACGGGCGGTGTGTAC	Giribet et al. (1996)
18S9R	GATCCTTCCGCAGGTTCACCTAC	Giribet et al. (1996)
18Sa0.79	TTAGAGTGCTYAAAGC	Whiting et al. (1997)
18Sa0.7	ATTAAAGTTGTTGCGGTT	Whiting et al. (1997)
28S rDNA		
28Sa	GACCCGTCTTGAAGCACG	Nunn et al. (1996)
28Sb	TCGGAAGGAACCAGCTAC	Nunn et al. (1996)
28Sbout	CCCACAGCGCCAGTTCTGCTTACC	Prendini et al. (2005)
12S rDNA		
12Sai	AAACTAGGATTAGATACCCTATTAT	Kocher et al. (1989)
12Sbi	AAGAGCGACGGGCGATGTGT	Kocher et al. (1989)
16S rDNA		
16Sbr	CTCCGGTTTGAACTCAGATCA	Simon et al. (1994)
16Sar	CGCCTGTTTATCAAAAACAT	Simon et al. (1994)
Cytochrome Oxidase I		
HCO	TAAACTTCAGGGTGACCAAAAAATCA	Folmer et al. (1994)
HCOoutout	GTAAATATATGRTGDGCTC	Prendini et al. (2005)
LCO	GGTCAACAAATCATAAAGATATTGG	Folmer et al. (1994)
Nancy (C1-N-2191)	CCCGGTAAAATTAAAATATAAACTTC	Harrison et al. (1987)
C1-J-1718	GGNGGATTTGGAAATTGRTTRGTTCC	Harrison et al. (1987)
C1-N-2776	GGATAATCAGAATANCGNCGAGG	Harrison et al. (1987)
CruzR	CATACCCAAAGARCCAAAAGG	Valdez-Cruz et al. (2004)
HCOEXTa	GAAGTTTATATTTTAATTTTACCTGG	Arango and Wheeler (2007)
HCOEXTb	CCTATTGAWARAACATARTGAAAATG	Arango and Wheeler (2007)

Appendix 8

GenBank accession codes for tissue samples, deposited in the Ambrose Monell Collection for Molecular and Microbial Research (AMCC) at the American Museum of Natural History, New York, from which DNA was extracted and sequenced for phylogenetic analysis of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905. Provenance data are provided in Appendix 1.

Species	Specimen	AMCC	18S	28S	12S	16S	COI
Franckeus kochi	Juv.	LP 5363	KM274428	KM274574	KM274136	KM274282	KM274720
Pseudouroctonus glimmei	Juv.	LP 2688	KM274429	KM274575	KM274137	KM274283	KM274721
Serradigitus minutus	Juv.	LP 1674	KM274430	KM274576	KM274138	KM274284	KM274722
Serradigitus sp.	♂	LP 6370	KM274431	KM274577	KM274139	KM274285	KM274723
Smeringurus grandis	Subad. ♂	LP 8690	KM274432	KM274578	KM274140	KM274286	KM274724
Stahnkeus deserticola	Subad. ♂	LP 5032	KM274433	KM274579	KM274141	KM274287	KM274725
Uroctonites giulianii	Juv.	LP 3204	KM274434	KM274580	KM274142	KM274288	KM274726
Vaejovis carolinianus	♀	LP 1576	KM274435	KM274581	KM274143	KM274289	KM274727
Vaejovis intermedius	♀	LP 2141A	KM274436	KM274582	KM274144	KM274290	KM274728
Vaejovis lapidicola	♂	LP 1814	KM274437	KM274583	KM274145	KM274291	KM274729
Vaejovis mexicanus	♀	LP 1825	KM274438	KM274584	KM274146	KM274292	KM274730
Vaejovis pequeno	♀	LP 6308	KM274439	KM274585	KM274147	KM274293	KM274731
Vaejovis rossmani	♀	LP 2027	KM274440	KM274586	KM274148	KM274294	KM274732
Vaejovis sp.	♀	LP 3711	KM274441	KM274587	KM274149	KM274295	KM274733
	♂	LP 5327	KM274442	KM274588	KM274150	KM274296	KM274734
Wernerius spicatus	♂	LP 8968	KM274443	KM274589	KM274151	KM274297	KM274735
Balsateres cisnerosi	♂	LP 2018	KM274444	KM274590	KM274152	KM274298	KM274736
	Subad. ♂	LP 5269	KM274445	KM274591	KM274153	KM274299	KM274737
Chihuahuanus bilineatus	♀	LP 5306	KM274446	KM274592	KM274154	KM274300	KM274738
	♀	LP 6507	KM274447	KM274593	KM274155	KM274301	KM274739
	♀	LP 6594	KM274448	KM274594	KM274156	KM274302	KM274740
Chihuahuanus cazieri	♂	LP 7163	KM274449	KM274595	KM274157	KM274303	KM274741
	♂	LP 7179	KM274450	KM274596	KM274158	KM274304	KM274742
Chihuahuanus coahuilae	♂	LP 5353	KM274451	KM274597	KM274159	KM274305	KM274743
	♂	LP 6600	KM274452	KM274598	KM274160	KM274306	KM274744
	Juv.	LP 7095	KM274453	KM274599	KM274161	KM274307	KM274745
Chihuahuanus crassimanus	♂	LP 2972	KM274454	KM274600	KM274162	KM274308	KM274746
	Juv.	LP 5365	KM274455	KM274601	KM274163	KM274309	KM274747
	Subad. ♂	LP 7100	KM274456	KM274602	KM274164	KM274310	KM274748
Chihuahuanus glabrimanus	♂	LP 6558	KM274457	KM274603	KM274165	KM274311	KM274749
	Juv.	LP 6610	KM274458	KM274604	KM274166	KM274312	KM274750
	Juv.	LP 6611	KM274459	KM274605	KM274167	KM274313	KM274751
Chihuahuanus globosus	Juv.	LP 5281	KM274460	KM274606	KM274168	KM274314	KM274752
	♀	LP 6447	KM274461	KM274607	KM274169	KM274315	KM274753
	♂	LP 6459	KM274462	KM274608	KM274170	KM274316	KM274754
	♂	LP 8926	KM274463	KM274609	KM274171	KM274317	KM274755
Chihuahuanus kovariki	♂	LP 5299	KM274464	KM274610	KM274172	KM274318	KM274756
	Juv.	LP 5305	KM274465	KM274611	KM274173	KM274319	KM274757
Chihuahuanus russelli	♂	LP 2971	KM274466	KM274612	KM274174	KM274320	KM274758
	♂	LP 7017	KM274467	KM274613	KM274175	KM274321	KM274759
	Juv.	LP 7266	KM274468	KM274614	KM274176	KM274322	KM274760
Kochius barbatus	♂	LP 8803	KM274469	KM274615	KM274177	KM274323	KM274761
Kochius bruneus	Juv.	LP 3153	KM274470	KM274616	KM274178	KM274324	KM274762
	♂	LP 3154	KM274471	KM274617	KM274179	KM274325	KM274763
	♂	LP 4555	KM274472	KM274618	KM274180	KM274326	KM274764
Kochius cerralvensis	♂	LP 8779	KM274473	KM274619	KM274181	KM274327	KM274765
Kochius hirsuticauda	♂	LP 5049	KM274474	KM274620	KM274182	KM274328	KM274766
	Subad. ♂	LP 7199	KM274475	KM274621	KM274183	KM274329	KM274767
	♀	LP 8819	KM274476	KM274622	KM274184	KM274330	KM274768
Kochius insularis	♂	LP 8801	KM274477	KM274623	KM274185	KM274331	KM274769
Kochius magdalensis	♀	LP 3155	KM274478	KM274624	KM274186	KM274332	KM274770
	Juv.	LP 4552	KM274479	KM274625	KM274187	KM274333	KM274771
	♂	LP 8796	KM274480	KM274626	KM274188	KM274334	KM274772
Kochius punctipalpi	♀	LP 1679	KM274481	KM274627	KM274189	KM274335	KM274773
	Juv.	LP 3157	KM274482	KM274628	KM274190	KM274336	KM274774
	♂	LP 8843	KM274483	KM274629	KM274191	KM274337	KM274775

Appendix 8 *(Continued)*

Species	Specimen	AMCC	18S	28S	12S	16S	COI
Kochius sonorae	♂	LP 6301	KM274484	KM274630	KM274192	KM274338	KM274776
	♂	LP 6304	KM274485	KM274631	KM274193	KM274339	KM274777
	Juv.	LP 9974	KM274486	KM274632	KM274194	KM274340	KM274778
Kochius villosus	♂	LP 3477	KM274487	KM274633	KM274195	KM274341	KM274779
	♂	LP 4544	KM274488	KM274634	KM274196	KM274342	KM274780
Konetontli acapulco	♀	LP 9520	KM274490	KM274636	KM274198	KM274344	KM274782
Konetontli chamelaensis	Juv.	LP 7675	KM274491	KM274637	KM274199	KM274345	KM274783
Konetontli nayarit	♀	LP 4725	KM274492	KM274638	KM274200	KM274346	KM274784
Konetontli pattersoni	Juv.	LP 3149	KM274493	KM274639	KM274201	KM274347	KM274785
	♀	LP 3150	KM274494	KM274640	KM274202	KM274348	KM274786
Kuarapu purhepecha	Juv.	LP 9517	KM274495	KM274641	KM274203	KM274349	KM274787
Maaykuyak vittatus	♂	LP 3180	KM274496	KM274642	KM274204	KM274350	KM274788
	♂	LP 4442	KM274497	KM274643	KM274205	KM274351	KM274789
Maaykuyak waueri	Juv.	LP 2973	KM274498	KM274644	KM274206	KM274352	KM274790
	♂	LP 6544	KM274499	KM274645	KM274207	KM274353	KM274791
Mesomexovis atenango	Juv.	LP 2023	KM274500	KM274646	KM274208	KM274354	KM274792
	Subad. ♂	LP 7058	KM274501	KM274647	KM274209	KM274355	KM274793
	Subad. ♀	LP 9982	KM274502	KM274648	KM274210	KM274356	KM274794
Mesomexovis oaxaca	♂	LP 2031	KM274503	KM274649	KM274211	KM274357	KM274795
	♂	LP 3718	KM274504	KM274650	KM274212	KM274358	KM274796
	Juv.	LP 6602	KM274505	KM274651	KM274213	KM274359	KM274797
Mesomexovis occidentalis	♂	LP 3118	KM274506	KM274652	KM274214	KM274360	KM274798
	♂	LP 6559	KM274507	KM274653	KM274215	KM274361	KM274799
	Juv.	LP 7056	KM274508	KM274654	KM274216	KM274362	KM274800
Mesomexovis punctatus	♂	LP 2080	KM274509	KM274655	KM274217	KM274363	KM274801
	♀	LP 2241	KM274510	KM274656	KM274218	KM274364	KM274802
Mesomexovis spadix	♀	LP 2950	KM274511	KM274657	KM274219	KM274365	KM274803
	♀	LP 5280	KM274512	KM274658	KM274220	KM274366	KM274804
	Juv.	LP 6373	KM274513	KM274659	KM274221	KM274367	KM274805
Mesomexovis subcristatus	♀	LP 2049	KM274514	KM274660	KM274222	KM274368	KM274806
	♂	LP 2084	KM274515	KM274661	KM274223	KM274369	KM274807
	♂	LP 2086	KM274516	KM274662	KM274224	KM274370	KM274808
Mesomexovis variegatus	♂	LP 5185	KM274517	KM274663	KM274225	KM274371	KM274809
	Subad. ♂	LP 6536	KM274518	KM274664	KM274226	KM274372	KM274810
	Juv.	LP 7068	KM274519	KM274665	KM274227	KM274373	KM274811
Paravaejovis confusus	♂	LP 4450	KM274520	KM274666	KM274228	KM274374	KM274812
	Juv.	LP 7107	KM274521	KM274667	KM274229	KM274375	KM274813
	Juv.	LP 7272	KM274522	KM274668	KM274230	KM274376	KM274814
	♀	LP 8517	KM274523	KM274669	KM274231	KM274377	KM274815
Paravaejovis diazi	♀	LP 3165	KM274524	KM274670	KM274232	KM274378	KM274816
	♂	LP 3169	KM274525	KM274671	KM274233	KM274379	KM274817
	Juv.	LP 3482	KM274526	KM274672	KM274234	KM274380	KM274818
	♀	LP 4436	KM274527	KM274673	KM274235	KM274381	KM274819
	♂	LP 8839	KM274528	KM274674	KM274236	KM274382	KM274820
Paravaejovis eusthenura	♀	LP 1689	KM274529	KM274675	KM274237	KM274383	KM274821
	♀	LP 3168	KM274530	KM274676	KM274238	KM274384	KM274822
	Juv.	LP 4448	KM274531	KM274677	KM274239	KM274385	KM274823
Paravaejovis gravicaudus	Juv.	LP 3163	KM274532	KM274678	KM274240	KM274386	KM274824
	♂	LP 8783	KM274533	KM274679	KM274241	KM274387	KM274825
	♀	LP 8793	KM274534	KM274680	KM274242	KM274388	KM274826
Paravaejovis hoffmanni	♀	LP 3166	KM274535	KM274681	KM274243	KM274389	KM274827
	Juv.	LP 5096	KM274536	KM274682	KM274244	KM274390	KM274828
	♂	LP 8797	KM274537	KM274683	KM274245	KM274391	KM274829
	♀	LP 8812	KM274538	KM274684	KM274246	KM274392	KM274830
Paravaejovis pumilis	♂	LP 3137	KM274539	KM274685	KM274247	KM274393	KM274831
	♀	LP 3476	KM274540	KM274686	KM274248	KM274394	KM274832
	Subad. ♀	LP 4740	KM274541	KM274687	KM274249	KM274395	KM274833
Paravaejovis puritanus	♀	LP 3479	KM274542	KM274688	KM274250	KM274396	KM274834
	♀	LP 5093	KM274543	KM274689	KM274251	KM274397	KM274835
	Subad. ♀	LP 8900	KM274544	KM274690	KM274252	KM274398	KM274836

Appendix 8 *(Continued)*

Species	Specimen	AMCC	18S	28S	12S	16S	COI
Paravaejovis schwenkmeyeri	Juv.	LP 4413	KM274545	KM274691	KM274253	KM274399	KM274837
	Subad. ♀	LP 4430	KM274546	KM274692	KM274254	KM274400	KM274838
	Juv.	LP 4451	KM274547	KM274693	KM274255	KM274401	KM274839
	♂	LP 8821	KM274548	KM274694	KM274256	KM274402	KM274840
Paravaejovis spinigerus	♂	LP 5282	KM274549	KM274695	KM274257	KM274403	KM274841
	Juv.	LP 6317	KM274550	KM274696	KM274258	KM274404	KM274842
	Juv.	LP 7015	KM274551	KM274697	KM274259	KM274405	KM274843
	Juv.	LP 7176	KM274552	KM274698	KM274260	KM274406	KM274844
	♀	LP 9970	KM274553	KM274699	KM274261	KM274407	KM274845
Paravaejovis waeringi	♀	LP 1688	KM274554	KM274700	KM274262	KM274408	KM274846
	♂	LP 3226	KM274555	KM274701	KM274263	KM274409	KM274847
	Juv.	LP 4431	KM274556	KM274702	KM274264	KM274410	KM274848
	♂	LP 4433	KM274557	KM274703	KM274265	KM274411	KM274849
	Juv.	LP 5029	KM274558	KM274704	KM274266	KM274412	KM274850
	Juv.	LP 7119	KM274559	KM274705	KM274267	KM274413	KM274851
Syntropis macrura	♂	LP 3146	KM274560	KM274706	KM274268	KM274414	KM274852
	♀	LP 8709	KM274561	KM274707	KM274269	KM274415	KM274853
Syntropis williamsi	Subad. ♀	LP 8706	KM274562	KM274708	KM274270	KM274416	KM274854
	Juv.	LP 8707	KM274563	KM274709	KM274271	KM274417	KM274855
	♂	LP 8826	KM274564	KM274710	KM274272	KM274418	KM274856
Thorellius cristimanus	♂	LP 5323	KM274565	KM274711	KM274273	KM274419	KM274857
	Juv.	LP 5325	KM274566	KM274712	KM274274	KM274420	KM274858
	Juv.	LP 5328	KM274567	KM274713	KM274275	KM274421	KM274859
	Juv.	LP 6551	KM274568	KM274714	KM274276	KM274422	KM274860
Thorellius intrepidus	Juv.	LP 5309	KM274569	KM274715	KM274277	KM274423	KM274861
	Subad. ♀	LP 6377	KM274570	KM274716	KM274278	KM274424	KM274862
	♂	LP 6379	KM274571	KM274717	KM274279	KM274425	KM274863
Vizcaino viscainensis	♂	LP 3174	KM274572	KM274718	KM274280	KM274426	KM274864
	Juv.	LP 8809	KM274573	KM274719	KM274281	KM274427	KM274865

Appendix 9

Morphological apomorphies, relative Bremer support (RBS), symmetric resampling GF (group frequency) values above 50% and GC values (group frequency difference, i.e. supported/contradicted) for selected clades in preferred phylogeny of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905, based on simultaneous analysis of 250 morphological characters and 4221 aligned DNA nucleotides from two nuclear and three mitochondrial gene markers under implied weighting with $k = 18$ and gaps treated as a fifth character state. Node numbers and names of terminals refer to Fig. 6; ancestral and derived character states are separated by arrows, followed by the count of molecular apomorphies and the RBS/GF/GC values.

((*Vaejovis intermedius* (*Franckeus kochi* + *V. carolinianus*)) ((*V. lapidicola* ((*Pseudouroctonus glimmei* + *Uroctonites giulianii*) (*V. rossmani* (*V. mexicanus* + *Vaejovis* sp.)))) (Syntropinae (*Wernerius* + *Stahnkeus*) (*Serradigitus* + *V. pequeno*)))) [Node 151]: 54/79/58.

(*Vaejovis intermedius* (*Franckeus kochi* + *V. carolinianus*)) [Node 155]: Char. 20: 1.000→1.500; 21: 1.298→1.649; 22: 0.333→0.666; 32: 0.400→0.800; 40: 0.571→1.428; 45: 0→1; 60: 0→2; 87: 1→2; 106: 1→0; 111: 1→0; 164: 3→2; 167: 2→1; and 40 molecular apomorphies; 69/100/100.

***Vaejovis intermedius* [2141A]:** Char. 3: 0.400→1.200; 4: 0.250→1.000; 5: 0.500→1.750; 6: 0.190–0.380→1.523; 7: 1.200→2.000; 8: 0.750–1.250→2.000; 9: 0.857–1.428→2.000; 10: 0.545–0.909→2.000; 11: 0.303–0.363→2.000; 27: 0.333–0.666→1.333; 28: 0.000–0.400→0.800; 41: 0.666→0.999; 44: 0.285–0.571→0.857; 49: 0→1; 98: 1→2; 117: 2→1; 133: 0→1; 212: 1→2; and 58 molecular apomorphies.

(*Franckeus kochi* + *Vaejovis carolinianus*) [Node 156]: Char. 46: 0→1; 51: 0→1; 58: 0→1; 64: 0→1; 65: 0→1; 66: 0→1; 68: 0→1; 183: 0→1; 184: 1→2; and 28 molecular apomorphies; 48/77/57.

***Franckeus kochi* [5363]:** Char. 31: 0.400–0.800→1.200; 94: 1→2; 134: 0→1; 136: 0→1; 145: 2→3; and 48 molecular apomorphies.

***Vaejovis carolinianus* [1576]:** Char. 0: 1.120→0.480; 1: 1.043→0.521; 5: 0.500→0.250; 6: 0.190–0.380→0.095; 7: 1.200→0.800; 8: 0.750→0.250; 9: 0.857→0.285; 10: 0.545→0.181; 11: 0.303→0.060; 12: 1.500→1.000; 13: 0.727→0.363; 14: 0.727→0.363; 15: 0.800→0.400; 16: 2.000→0.000; 17: 1.333→0.000; 18: 1.333→0.000; 19: 0.800→0.000; 20: 1.500→2.000; 21: 1.649→2.000; 23: 0.666→0.333; 24: 0.500–0.750→0.000; 34: 0.500→0.000; 38: 0.666→0.000; 39: 0.285→0.000; 41: 0.666→0.333; 52: 0→1; 53: 0→1; 59: 0→1; 60: 2→3; 62: 0→1; 63: 0→2; 70: 0→1; 76: 1→0; 121: 0→1; 122: 0→1; 125: 0→1; 126: 0→1; 136: 1→0; 139: 1→0; 154: 0→1; 164: 2→1; 165: 1→2; 166: 2→3; 178: 0→1; 179: 0→1; 180: 1→2; 181: 1→2; 182: 1→2; 242: 0→1; 243: 0→1; 244: 0→1; 251: 1→0; and 38 molecular apomorphies.

((*Vaejovis lapidicola* ((*Pseudouroctonus glimmei* + *Uroctonites giulianii*) (*V. rossmani* (*V. mexicanus* + *Vaejovis* sp.)))) (Syntropinae (*Wernerius* + *Stahnkeus*) (*Serradigitus* + *V. pequeno*)))) [Node 150]: Char. 0: 1.120→0.480–0.560; 1: 1.043–1.217→0.521–0.608; 7: 1.200→0.800; 8: 0.750–1.250→0.250–0.500; 9: 0.857–1.428→0.571; 10: 0.545–0.909→0.363; 11: 0.303–0.363→0.060–0.181; 12: 1.500–2.000→1.000; 13: 0.727–1.090→0.363–0.545; 14: 0.727→0.363–0.545; 15: 0.800–2.000→0.600; 16: 2.000→0.000; 17: 1.333→0.666; 18: 1.333→0.000–0.666; 19: 0.800→0.000–0.400; 23: 0.666–1.000→0.500; 34: 0.500–1.000→0.000; 38: 0.666→0.333; 126: 0→1; 136: 1→0; 139: 1→0; 206: 0→1; 242: 0→1; 243: 0→1; 244: 0→1; and 14 molecular apomorphies; 100/100/100.

(*Vaejovis lapidicola* ((*Pseudouroctonus glimmei* + *Uroctonites giulianii*) (*V. rossmani* (*V. mexicanus* + *Vaejovis* sp.)))) [Node 149]: Char. 0: 0.480–0.560→0.400; 1: 0.521–0.608→0.434; 11: 0.181→0.060–0.121; 24: 0.500→0.250; 92: 2→0; 94: 0→1; 121: 0→1; 122: 0→1; 125: 0→1; 164: 23→1; 167: 2→0; 168: 2→1; 170: 1→2; 217: 0→1; and 11 molecular apomorphies; 36/77/57.

***Vaejovis lapidicola* [1814]:** Char. 2: 0.000→0.500; 21: 1.298→0.947; 22: 0.333→0.000; 23: 0.500→0.333; Char. 28: 0.000→0.400; 38: 0.333→0.000; 49: 0→1; 102: 0→2; and 147 molecular apomorphies.

((*Pseudouroctonus glimmei* + *Uroctonites giulianii*) (*Vaejovis rossmani* (*V. mexicanus* + *Vaejovis* sp.))) [Node 148]: Char. 5: 0.500→0.250; 9: 0.571→0.285; 10: 0.363→0.181; 15: 0.600→0.400; 46: 0→1; 51: 0→1; 117: 2→4; 163: 1→0; 178: 0→1; 179: 0→12; 186: 1→0; 251: 1→0; and 10 molecular apomorphies; 17/51/31.

(*Pseudouroctonus glimmei* + *Uroctonites giulianii*) [Node 147]: Char. 0: 0.400→0.320; 1: 0.434→0.260–0.347; 17: 0.666→0.000; 24: 0.250→0.000; 25: 0.285–0.571→0.000; 39: 0.285→0.000; 47: 0→1; 48: 0→1; 50: 0→1; 56: 1→0; 77: 0→1; 79: 0→1; 83: 2→1; 96: 2→0; 102: 0→1; 103: 0→3; 104: 0→3; 107: 0→1; 108: 0→1; 110: 0→1; 115: 0→1; 116: 2→0; 120: 0→1; 122: 1→2; 128: 0→1; 130: 0→1; 152: 1→0; 213: 2→1; 231: 1→0; 244: 1→2; and 22 molecular apomorphies; 32/88/79.

***Pseudouroctonus glimmei* [2688]:** Char. 3: 0.400→0.000; 4: 0.250→0.000; 6: 0.095→0.000; 11: 0.060→0.000; 12: 1.000→0.500; 20: 1.000→0.500; 21: 1.298→0.947; 22: 0.333→0.000; 23: 0.500→0.333; 27: 0.333→0.000; 29: 0.285→0.000; 31: 0.400→0.000; 32: 0.400→0.000; 33: 2.000→0.000; 37: 2.000→0.000; 40: 0.571→0.285; 41: 0.333→0.000; 43: 0.500→0.000; 49: 0→1; 69: 0→1; 82: 2→1; 86: 0→2; 88: 2→1; 106: 1→0; 189: 0→1; 199: 0→1; 211: 0→1; 248: 0→1; and 120 molecular apomorphies.

***Uroctonites giulianii* [3204]:** Char. 0: 0.320→0.000; 1: 0.260–0.347→0.000–0.086; 16: 0.000→2.000; 20: 1.000→2.000; 22: 0.333→0.666; 29: 0.285→0.571; 34: 0.000→0.500; 40: 0.571→0.857; 41: 0.333→0.999; 42: 0.333→0.999; 73: 1→0; 84: 1→2; 85: 1→2; 92: 0→2; 95: 1→0; 112: 0→3; 125: 1→2; 129: 0→1; 145: 2→1; 147: 1→2; 164: 1→0; 170: 2→1; 190: 2→0; 191: 1→0; 192: 1→0; 196: 1→0; 201: 1→0; 202: 0→1; 206: 1→2; 210: 1→0; 223: 1→0; and 117 molecular apomorphies.

(*Vaejovis rossmani* (*V. mexicanus* + *Vaejovis* sp.)) [Node 153]: Char. 21: 1.298→1.649; 52: 0→1; 53: 0→1; 59: 0→1; 62: 0→2; 64: 0→1; 65: 0→1; 66: 0→1; 185: 0→2; and 21 molecular apomorphies; 77/100/100.

***Vaejovis rossmani* [2027]:** Char. 3: 0.400→0.000; 33: 2.000→0.000; 42: 0.333→0.999; 60: 0→2; 82: 2→1; 98: 1→0; 99: 2→0; 116: 4→0; 140: 0→1; 177: 1→2; 194: 0→1; and 94 molecular apomorphies.

(*Vaejovis mexicanus* + *Vaejovis* sp.) [Node 152]: Char. 0: 0.400→0.480; 1: 0.434→0.521; 12: 1.000→0.500; 42: 0.333→0.000; 45: 0→1; 57: 0→1; and 56 molecular apomorphies; 81/100/100.

***Vaejovis mexicanus* [1825]:** Char. 0: 0.480→0.880; 1: 0.521→0.782–0.869; 5: 0.250→0.500; 11: 0.060–0.121→0.000; 17: 0.666→0.000; 20: 1.000→1.500; 23: 0.500→0.333; 24: 0.250→0.000; 27: 0.333→0.000; 31: 0.400→0.000; 32: 0.400→0.000; 38: 0.333→0.999; 39: 0.285→0.571; 86: 0→2; 87: 1→2; 102: 0→2; 103: 0→2; 104: 0→3; 105: 0→4; 107: 0→2; 108: 0→2; 110: 0→1; 112: 0→3; 113: 0→2; 114: 0→3; 115: 0→2; 119: 2→0; 120: 0→2; 121: 1→2; 122: 1→2; 126: 1→2; 127: 0→2; 134: 0→1; 189: 0→1; and 62 molecular apomorphies.

***Vaejovis* sp. [Node 154]:** Char. 55: 1→0; 62: 2→1; 75: 0→1; 76: 1→0; 84: 1→2; 85: 1→2; 175: 0→1; 214: 0→1; 224: 1→2; 236: 1→0; 237: 1→0; 238: 1→0; 248: 0→1; 249: 0→1; and 59 molecular apomorphies; 100/100/100.

(Syntropinae (*Stahnkeus* + *Wernerius*) (*Serradigitus* + *Vaejovis pequeno*)) [Node 160]: Char. 90: 3→0; 154: 0→1; 189: 2→3; 197: 0→1; 198: 0→1; 200: 1→0; 201: 0→1; and 9 molecular apomorphies; 65/100/100.

((*Stahnkeus* + *Wernerius*) (*Serradigitus* + *Vaejovis pequeno*)) [Stahnkeini Node 159]: Char. 20: 1.000→1.500; 38: 0.333→0.000; 79: 0→1; 88: 2→1; 103: 0→3; 200: 2→1; 248: 0→1; and 25 molecular apomorphies; 75/99/99.

***Wernerius spicatus* [8968]:** Char. 0: 0.480–0.560→0.320; 1: 0.521–0.608→0.347; 9: 0.571→0.285; 21: 1.298→2.000; 22: 0.333→0.666; 24: 0.500→0.250; 28: 0.000→0.400; 34: 0.000→0.500; 40: 0.571→0.857; 42: 0.333→0.666; 88: 1→0; 89: 2→3; 94: 0→1; 95: 1→0; 111: 1→2; 127: 0→1; 128: 0→1; 130: 0→1; 134: 0→1; 152: 1→0; 176: 0→1; 192: 1→2; 219: 0→1; 231: 1→0; 243: 1→0; 249: 0→1; 251: 1→0; and 93 molecular apomorphies.

(*Stahnkeus* + *Wernerius*) [Node 161]: Char. 11: 0.181→0.060; 47: 0→1; 48: 0→1; 49: 0→1; 50: 0→1; 69: 0→1; 90: 0→1; 102: 0→2; 115: 0→1; 120: 0→1; 164: 3→4; 186: 1→0; and 10 molecular apomorphies.

(*Serradigitus* + *Vaejovis pequeno*) [Node 158]: Char. 2: 0.000→0.500; 85: 1→0; 89: 2→1; 110: 1→0; 120: 0→1; 121: 0→1; 143: 2→1; 167: 2→3; 216: 0→1; and 5 molecular apomorphies; 52/88/81.

***Stahnkeus deserticola* [5032]:** Char. 0: 0.480–0.560→1.280–1.440; 1: 0.521–0.608→1.217; 3: 0.400→0.000; 6: 0.190→0.095; 11: 0.060–0.181→0.000; 23: 0.333–0.500→0.666; 40: 0.285–0.571→0.000; 46: 0→1; 54: 0→1; 84: 1→2; 87: 1→2; 101: 0→3; 103: 3→2; 105: 0→3; 108: 0→1; 110: 0→2; 112: 0→2; 113: 0→3; 114: 0→2; 125: 0→1; 142: 1→0; 143: 0→1; 145: 2→4; 149: 1→0; 150: 0→1; 154: 2→0; 156: 0→1; 160: 0→1; 163: 1→2; 166: 1→0; 167: 2→5; 168: 2→6; 206: 1→0; and 48 molecular apomorphies.

***Vaejovis pequeno* [6308]:** Char. 9: 0.571→0.285; 21: 1.298→0.947; 45: 0→1; 46: 0→1; 51: 0→1; 63: 0→2; and 54 molecular apomorphies.

***Serradigitus* [Node 157]:** Char. 40: 0.571→0.285; 235: 1→0; 236: 1→0; 237: 1→0; and 27 molecular apomorphies; 50/95/91.

***Serradigitus minutus* [1674]:** Char. 6: 0.190–0.285→0.380; 7: 0.800→1.200; 11: 0.181→0.303; 16: 0.000→1.000; 34: 0.000→0.500; 103: 3→0; 124: 1→0; 142: 1→0; 143: 0→1; 146: 1→0; 154: 2→0; 158: 0→1; 162: 0→1; 165: 1→0; 167: 2→4; 168: 3→5; 186: 1→0; 214: 0→1; 216: 0→1; 231: 1→0; 248: 1→0; and 63 molecular apomorphies.

***Serradigitus* sp. [6370]:** Char. 4: 0.250→0.500; 6: 0.190-0.285→0.095; 20: 1.500→1.000; 32: 0.400→0.000; 39: 0.285→0.571; 56: 1→0; 67: 0→1; 68: 0→1; 79: 1→0; 80: 1→0; 238: 1→0; and 45 molecular apomorphies.

Syntropinae [Node 165]: Char. 36: 0.000→0.400; 117: 2→1; 186: 1→2; 194: 0→1; and 30 molecular apomorphies; 70/100/100.

(*Konetontli* + *Maaykuyak*) [Node 172]: Char. 7: 0.800→1.200; 24: 0.500→0.750; 42: 0.333→0.666; 89: 2→3; 111: 1→0; 118: 1→0; 141: 0→1; 164: 3→2; 166: 1→3; and 4 molecular apomorphies; 47/48/11.

***Konetontli* [Node 175]:** Char. 5: 0.500→0.250; 22: 0.333→0.000; 82: 2→3; 83: 2→1; 120: 0→1; 121: 0→1; 167: 2→1; 214: 0→1; 216: 0→1; 217: 0→1; 249: 0→1; and 3 molecular apomorphy; 39/79/62.

***Konetontli acapulco* [9520]:** Char. 21: 1.298→1.649; 85: 1→2; 103: 0→2; 113: 0→4; 114: 0→3; 118: 0→2; 120: 0→2; 166: 3→0; 224: 1→2; 233: 0→1; 234: 1→0; 237: 1→0; 238: 1→0; 239: 1→0; and 75 molecular apomorphies.

(*Konetontli chamelaensis* (*K. nayarit* + *K. pattersoni*)) [Node 174]: Char. 0: 0.480–0.560→0.400; 1: 0.521–0.608→0.434; 3: 0.400→0.000; 11: 0.181→0.121; 12: 1.000→0.500; 15: 0.600→0.400; 35: 0.500→0.000; 36: 0.400→0.000; 62: 0→1; 63: 0→2; 64: 0→1; 248: 0→1; and 18 molecular apomorphies; 64/100/100.

***Konetontli chamelaensis* [7675]:** Char. 0: 0.400→0.160–0.240; 1: 0.434→0.260; 4: 0.250→0.000; 23: 0.500→0.333; 117: 1→0; 131: 1→0; 144: 2→1; 166: 3→2; 179: 0→1; and 68 molecular apomorphies.

(*Konetontli nayarit* + *K. pattersoni*) [Node 176]: Char. 7: 1.200→0.800; 11: 0.121→0.060; 21: 1.298→0.947; 103: 0→3; 164: 2→1; and 15 molecular apomorphies; 19/69/48.

***Konetontli nayarit* [4725]:** Char. 7: 0.800→0.000; 8: 0.500→0.250; 9: 0.571→0.285; 21: 0.947→0.596; 24: 0.750→0.500; 45: 0→1; 65:

0→1; 85: 1→2; 118: 0→2; 120: 0→2; 186 2→1; 212: 1→0; 250: 0→1; 251: 1→0; and 79 molecular apomorphies.

***Konetontli pattersoni* [Node 177]:** Char. 60: 0→2; 89: 3→2; 121: 1→2; 134: 0→1; 228: 0→1; and 52 molecular apomorphies; 95/100/100.

***Maaykuyak* [Node 171]:** Char. 6: 0.190–0.380→0.476; 8: 0.500→0.750; 9: 0.571→0.857; 10: 0.363→0.545; 11: 0.181→0.242; 15: 0.600→0.800; 18: 0.000–0.666→1.333; 19: 0.000–0.400→0.800; 29: 0.285→0.571; 34: 0.000→0.500; 40: 0.571→1.142; 117: 1→0; 131: 1→0; 170: 1→2; 184: 1→0; 241: 1→0; 242: 1→0; 243: 1→0; 244: 1→2; 247: 0→2; and 12 molecular apomorphies; 94/100/100.

***Maaykuyak vittatus* [Node 170]:** Char. 48: 01→2; 126: 1→0; 153: 0→1; 189: 0→1; and 54 molecular apomorphies; 98/100/100.

***Maaykuyak waueri* [Node 173]:** Char. 54: 0→1; 55: 1→0; 65: 0→1; 68: 0→1; 82: 2→1; 85: 1→2; 87: 1→0; 133: 1→0; 144: 2→1; 164: 2→1; 212: 1→2; 220: 1→0; 228: 0→1; 232: 1→0; 237: 1→0; 238: 1→0; 239: 1→0; and 46 molecular apomorphies; 94/100/100.

((*Syntropis* + *Vizcaino*) ((*Kuarapu* (*Balsateres* (*Kochius* + *Thorellius*))) (*Mesomexovis* (*Chihuahuanus* + *Paravaejovis*)))) [Node 164]: Char. 0: 0.480–0.560→0.720–0.800; 1: 0.521–0.608→0.695–0.782; 47: 0→1; 69: 0→1; 134: 0→1; 139: 0→1; 168: 2→3; 189: 0→1; and 7 molecular apomorphies; 22/49/24.

(*Syntropis* + *Vizcaino*) [Node 163]: Char. 21: 1.298→0.947; 49: 0→1; 50: 0→1; 76: 1→0; 103: 0→3; 162: 0→1; 163: 1→2; and 12 molecular apomorphies; 30/53/30.

***Vizcaino* [Node 162]:** Char. 85: 1→2; 111: 1→2; 147: 1→0; 167: 2→3; 168: 3→4; 169: 0→1; 171: 0→1; 172: 0→1; 173: 0→1; 185: 0→1; 188: 0→1; and 53 molecular apomorphies; 97/100/100.

***Syntropis* [Node 167]:** Char. 0: 0.720–0.800→1.440; 1: 0.695–0.782→1.652; 6: 0.190–0.285→0.476; 10: 0.363→0.545–0.727; 11: 0.181→0.424; 13: 0.363→0.545; 14: 0.363→0.727; 15: 0.600→0.800; 21: 0.947→0.596; 32: 0.400→0.000; 38: 0.333→0.666; 40: 0.571→0.857; 56: 1→0; 79: 0→1; 81: 2→0; 82: 2→0; 86: 0→2; 87: 1→2; 97: 1→0; 123: 1→0; 124: 1→0; 126: 1→0; 134: 1→2; 135: 0→1; 137: 0→1; 145: 2→3; 147: 1→0; 153: 0→1; 170: 1→0; 174: 1→0; 175: 1→0; 177: 1→0; 206: 1→0; 207: 1→2; 208: 1→2; 218: 0→2; 223: 1→0; 227: 0→1; 229: 1→0; 231: 1→0; 240: 1→0; 241: 1→0; 242: 1→0; 243: 1→0; 244: 1→0; and 53 molecular apomorphies; 98/100/100.

***Syntropis macrura* [Node 166]:** Char. 57: 0→1; 98: 1→2; 118: 1→2; 182: 1→0; and 10 molecular apomorphies; 85/100/100.

***Syntropis williamsi* [Node 169]:** Char. 0→1; 11 molecular apomorphies; 91/100/100.

((*Kuarapu* (*Balsateres* (*Kochius* + *Thorellius*))) (*Mesomexovis* (*Chihuahuanus* + *Paravaejovis*))) [Node 184]: 10 molecular apomorphies; 45/37/21.

(*Kuarapu* (*Balsateres* (*Kochius* + *Thorellius*))) [*Kochius* clade, node 222]: Char. 5: 0.500→0.250; 15: 0.600→0.400; 22: 0.333→0.000; 23: 0.500→0.333; 32: 0.400→0.000; 40: 0.571→0.285; 94: 0→1; and 4 molecular apomorphies; 64/38/22.

***Kuarapu purhepecha* [9517]:** Char. 21: 1.298→0.947; 38: 0.333→0.000; 45: 0→1; 46: 0→1; 47: 1→0; 57: 0→1; 58: 0→1; 60: 0→3; 61: 2→1; 64: 0→1; 65: 0→1; 66: 0→1; 70: 0→1; 76: 1→0; 79: 0→1; 80: 0→1; 89: 2→3; 98: 12→0; 111: 1→0; 118: 1→0; 131: 1→0; 142: 1→0; 167: 2→3; 168: 3→4; 206: 1→0; and 75 molecular apomorphies.

(*Balsateres* (*Kochius* + *Thorellius*)) [Node 225]: Char. 10: 0.363→0.181; 23: 0.333→0.166; 36: 0.400→0.000; 41: 0.333→0.000; 42: 0.333→0.000; 103: 0→2; and 10 molecular apomorphies; 41/73/58.

(*Balsateres* (*Thorellius cristimanus* + *T. intrepidus*)) [Node 224]: Char. 0: 0.800-0.880→1.040; 1: 0.782-0.869→1.130-1.217; 20: 1.000→1.500; 174: 1→0; 173: 1→0; 181: 0→1; 189: 1→2; 241: 1→0; 242: 1→0; 243: 1→0; 244: 1→0; and 5 molecular apomorphies; 65/78/57.

***Balsateres* [Node 223]:** Char. 50: 0→1; 81: 2→0; 83: 2→0; 89: 2→3; 103: 2→3; 111: 1→2; 117: 2→3; 118: 1→2; 123: 1→0; 125: 1→0; 170: 1→0; 212: 1→0; 213: 2→0; 219: 0→1; 220: 1→0; 221: 0→1; 222: 0→1; 224: 1→0; 225: 1→0; 226: 0→1; 232: 1→0; 233: 0→1; 234: 1→0; 238: 1→0; 239: 1→0; 251: 1→0; and 43 molecular apomorphies; 100/100/100.

***Thorellius* [Node 228]:** Char. 2: 0.000→0.500; 3: 0.000-0.400→0.800; 4: 0.250→0.500; 5: 0.250→0.750; 38: 0.333→0.999; 46: 0→2; 47: 1→0; 51: 0→1; 52: 0→1; 53: 0→1; 56: 1→0; 61: 2→1; 64: 0→1; 65: 0→1; 104: 0→1; 108: 0→2; 121: 0→3; 132: 0→1; 135: 0→1; 137: 0→1; 178: 0→1; 200: 1→0; 248: 0→1; and 5 molecular apomorphies; 84/100/100.

***Thorellius cristimanus* [Node 227]:** 48: 0→1; 90: 0→3; 91: 0→4; 107: 0→2; and 16 molecular apomorphies; 83/45/-10.

***Thorellius intrepidus* [Node 231]:** 60: 0→3; 134: 1→2; 136: 1→2; 139: 1→2; 149: 1→2; 48: 0→1; 157: 1→0; 179: 0→1; 30 molecular apomorphies; 92/100/100.

***Kochius* [Node 235]:** Char. 24: 0.500→0.000; 27: 0.333→0.000; 31: 0.400→0.000; 39: 0.571→0.000; 40: 0.285→0.000; 86: 0→1; 88: 12→0; 90: 0→3; 91: 0→4; 121: 0→2; 125: 0→1; 127: 0→1; 128: 0→1; 139: 0→1; 156: 0→1; 161: 1→0; 164: 3→2: 170: 1→2; 186: 2→0; 213: 2→3; 216: 0→2; 217: 0→2; and 5 molecular apomorphies; 83/100/100.

(*Kochius punctipalpi* (*K. magdalensis* (*K. barbatus* + *K. cerralvensis*))) [Node 234]: Char. 50: 0→1; 135: 0→1; 137: 0→1; and 11 molecular apomorphies; 59/82/68.

***Kochius punctipalpi* [Node 247]:** Char. 132: 0→1; 136: 1→2; 139: 1→2; 169: 0→1; and 44 molecular apomorphies.

(*Kochius magdalensis* (*K. barbatus* + *K. cerralvensis*)) [Node 233]: 26 molecular apomorphies; 75/100/100.

***Kochius magdalensis* [Node 245]:** 16 molecular apomorphies; 79/100/100.

(*Kochius barbatus* + *K. cerralvensis*) [Node 232]: Char. 27: 0.000→0.333; and 25 molecular apomorphies; 86/100/100.

***Kochius barbatus* [8803]:** Char. 1: 0.869→0.956; 4: 0.250→0.000; 15: 0.400→0.600; 101: 1→2; 169: 0→1; and 11 molecular apomorphies.

***Kochius cerralvensis* [8779]:** Char. 0: 0.880→0.800; 6: 0.190→0.285; 12: 1.000→0.500; 21: 1.298→0.947; 132: 0→1; 136: 1→2; 139: 1→2; 245: 0→1; and 19 molecular apomorphies.

(*Kochius sonorae* ((*K. insularis* + *K. villosus*) (*K. bruneus* + *K. hirsuticauda*))) [Node 239]: Char. 11: 0.121→0.060; 133: 1→0; 136: 1→0; 138: 1→0; 139: 1→0; 245: 0→1; and 2 molecular apomorphies; 57/59/40.

***Kochius sonorae* [Node 249]:** Char. 47: 1→0; 58: 0→1; 115: 1→2; 211: 0→1; and 35 molecular apomorphies.

((*Kochius insularis* + *K. villosus*) (*K. bruneus* + *K. hirsuticauda*)) [Node 238]: 8 molecular apomorphies; 58/86/57.

(*Kochius insularis* + *K. villosus*) [Node 243]: 11 molecular apomorphies; 51/81/70.

***Kochius insularis* [8801]:** Char. 0: 0.800→0.880; 20: 1.000→0.500; 50: 0→1; and 37 molecular apomorphies.

***Kochius villosus* [Node 250]:** Char. 46: 0→1; 51: 0→1; and 42 molecular apomorphies; 100/100/100.

(*Kochius bruneus* + *K. hirsuticauda*) [Node 237]: Char, 244: 1→2; and 10 molecular apomorphies; 52/95/94.

***Kochius hirsuticauda* [Node 242]:** Char. 50: 0→1; 176: 0→1; and 15 molecular apomorphies.

***Kochius bruneus* [Node 236]:** Char. 46: 0→1; 51: 0→1; 241: 1→2; and 18 molecular apomorphies; 90/100/100.

(*Mesomexovis* (*Chihuahuanus* + *Paravaejovis*)) [Node 183]: Char. 23: 0.500→0.666; 29: 0.285→0.571–0.857; 34: 0.000→0.500; 111: 1→2; 118: 1→2; 241: 1→0; 242: 1→0; 243: 1→0; 244: 1→0; and 5 molecular apomorphies; 51/18/2.

***Mesomexovis* [Node 204]:** Char. 4: 0.250→0.500–0.750; 5: 0.500→0.750; 6: 0.285→0.476; 126: 1→0; 134: 1→2; 174: 1→0; and 6 molecular apomorphies; 39/54/38.

***Mesomexovis atenango* [Node 203]:** Char. 50: 0→1; 94: 0→1; 146: 2→3; 153: 0→1; and 55 molecular apomorphies; 98/100/100.

((*Mesomexovis punctatus* + *M. subcristatus*) ((*M. oaxaca* + *M. occidentalis*) (*M. spadix* + *M. variegatus*)) [Node 210]: Char. 0: 0.800→0.880; 3: 0.400→0.800; 8: 0.250→0.750; 9: 0.285–0.571→0.857; 10: 0.363→0.545–0.727; 11: 0.242→0.363–0.424; 24: 0.500→0.750–1.000; 25: 0.571→0.857–1.142; 28: 0.400→0.800; 40: 0.571-0.857→1.142; 47: 1→0; 58: 0→1; 61: 2→1; 84: 1→2; 89: 2→3; 212: 1→2; 232: 1→2; 236: 1→0; 237: 1→0; 238: 1→0; and 1 molecular apomorphies; 45/82/75.

(*Mesomexovis punctatus* + *M. subcristatus*) [Node 217]: Char. 2: 0.000→0.500; 3: 0.800→1.200; 5: 0.750→1.000; 6: 0.476→0.571; 13: 0.363→0.545; 14: 0.363→0.545; 15: 0.600→0.800; 42: 0.666→0.999; 81: 2→0; and 6 molecular apomorphies; 63/100/100.

***Mesomexovis punctatus* [Node 216]:** Char. 200: 1→0; 212: 2→0; 222: 0→1; 224: 1→2; and 39 molecular apomorphies; 98/100/100.

***Mesomexovis subcristatus* [Node 218]:** Char. 56: 1→0; 57: 0→1; 124: 1→0; 164: 2→3; 238: 0→2; and 47 molecular apomorphies; 96/100/100.

(*Mesomexovis oaxaca* + *M. occidentalis*) (*M. spadix* + *M. variegatus*) [Node 209]: Char. 0: 0.880→1.040–1.120; 53: 0→1; 144: 1→2; and 3 molecular apomorphies; 45/37/3.

(*Mesomexovis spadix* + *M. variegatus*) [Node 208]: Char. 36: 0.400→0.000; 45: 0→1; 51: 0→1; 63: 0→3; 64: 0→1; 65: 0→1; 121: 0→2; 122: 0→2; 134: 2→1; 136: 1→0; 138: 1→0; 166: 1→2; 170: 0→2; 251: 1→0; and 20 molecular apomorphies.

***Mesomexovis spadix* [Node 207]:** Char. 81: 2→0; 212: 2→0; 224: 1→2; and 44 molecular apomorphies; 92/100/100.

***Mesomexovis variegatus* [Node 221]:** Char. 66: 0→1; 99: 0→2; 102: 0→3; and 23 molecular apomorphies; 89/100/100.

(*Mesomexovis oaxaca* + *M. occidentalis*)) [Node 213]: Char. 24: 0.750-1.000→1.750; 28: 0.800→1.200; 39: 0.571→0.857; 44: 0.571→0.857; 56: 1→0; 57: 0→1; 94: 0→1; 105: 0→4; 106: 0→1; 146: 2→3; 178: 0→1; 180: 1→2; 182: 1→2; and 15 molecular apomorphies; 79/100/100.

(*Mesomexovis oaxaca* [Node 212]: Char. 200: 1→0; 224: 1→2; and 12 molecular apomorphies; 52/97/95.

***Mesomexovis occidentalis* [Node 215]:** Char. 63: 0→2; 89: 3→2; 99: 0→2; 101: 0→3; 102: 0→3; 103: 0→2; 212: 2→1; 232: 2→1; 235: 0→2; 236: 0→2; 237: 0→1; 238: 0→1; 242: 0→2; and 1 molecular apomorphy; 58/98/97.

(*Chihuahuanus* + *Paravaejovis*) [Node 182]: Char. 104: 0→2; 139: 1→0; 141: 0→1; and 3 molecular apomorphies; 37/41/30.

***Chihuahuanus* [Node 181]:** Char. 166: 1→2; 247: 0→1; and 10 molecular apomorphies; 60/80/70.

(*Chihuahuanus cazieri* (*C. crassimanus* + *C. russelli*)) [Node 187]: Char. 24: 0.500→0.250; 29: 0.571–0.857→0.285; 36: 0.400→0.000; 56: 1→0; 57: 0→1; 98: 2→1; 101: 0→3; 103: 03→2; 105: 0→4; 111: 2→1; 112: 4→2; 117: 1→2; 118: 2→1; 119: 3→2; 121: 0→1; 122: 0→1; 127: 0→1; and 5 molecular apomorphies; 70/93/86.

***Chihuahuanus russelli* [Node 202]:** Char. 50: 0→1; 134: 0→2; 136: 0→1; 138: 0→1; 139: 0→1; 235: 1→2; 236: 1→2; and 29 molecular apomorphies; 95/100/100.

***Chihuahuanus cazieri* [Node 186]:** 66 molecular apomorphies; 99/100/100.

(*Chihuahuanus crassimanus* + *C. russelli*) [Node 190]: Char. 15: 0.600→0.400; 87: 1→2; 90: 0→1; 91: 0→1; 94: 0→1; and 17 molecular apomorphies; 74/68/36.

***Chihuahuanus crassimanus* [Node 189]:** 47 molecular apomorphies; 98/100/100.

((*Chihuahuanus bilineatus* + *C. coahuilae*) (*C. globosus* (*C. glabrimanus* + *C. kovariki*))) [Node 180]: Char. 4: 0.250→0.500–0.750; 6: 0.285→0.380–0.476; 7: 0.800→1.200; 8: 0.250→0.500; 15: 0.600→0.800; 17: 0.000→0.666; 18: 0.000→0.666; 19: 0.000→0.400; 24: 0.500→0.750; 25: 0.571→0.857; 28: 0.000–0.400→0.800–1.200; 38: 0.333–0.666→0.999; 40: 0.857→1.142; 42: 0.666→0.999; 84: 1→2; 85: 1→2; 89: 2→3; 124: 1→0; 126: 1→0; and 2 molecular apomorphies; 58/75/65.

(*Chihuahuanus bilineatus* + *C. coahuilae*) [Node 179]: Char. 16: 0.000→1.000; 18: 0.666→1.333; 41: 0.666→0.999; 47: 1→0; 58: 0→1; 61: 2→1; 104: 2→0; 165: 1→2; 200: 1→2; 237: 1→2; and 12 molecular apomorphies; 54/90/83.

***Chihuahuanus bilineatus* [Node 178]:** Char. 66: 0→1; 68: 0→1; 89: 3→0; 115: 2→0; 117: 1→0; 131: 1→0; 157: 1→0; 164: 2→1; 166: 2→3; and 39 molecular apomorphies; 100/100/100.

***Chihuahuanus coahuilae* [Node 192]:** 54 molecular apomorphies; 96/100/100.

(*Chihuahuanus globosus* (*C. glabrimanus* + *C. kovariki*)) [Node 195]: Char. 0: 0.800→0.640–0.720; 24: 0.750→1.000; 49: 0→1; 50: 0→1; and 12 molecular apomorphies; 80/93/90.

***Chihuahuanus globosus* [Node 199]:** Char. 172: 0→1; 173: 0→1; 208: 1→2; 235: 0→2; and 41 molecular apomorphies; 98/100/100.

(*Chihuahuanus glabrimanus* + *C. kovariki*) [Node 194]: Char. 5: 0.750→1.000; 11: 0.181–0.363→0.484; 34: 0.500→1.000; 94: 1→2; and 12 molecular apomorphies.

***Chihuahuanus glabrimanus* [Node 193]:** Char. 83: 2→1; 89: 2→3; 115: 2→0; 136: 0→1; 165: 1→2; 212: 1→0; 226: 0→1; 228: 0→1; 230: 1→0; 231: 1→0; and 3 molecular apomorphies; 91/100/100.

***Chihuahuanus kovariki* [Node 200]:** Char. 84: 2→1: 85: 2→1: 111: 2→1; 112: 4→3; 138: 0→1; 237: 1→2; and 12 molecular apomorphies; 66/98/97.

***Paravaejovis* [Node 255]:** 158: 0→1; and 13 molecular apomorphies; 23/74/63.

(*Paravaejovis confusus* + *P. waeringi*)) [Node 254]: Char. 10: 0.363→0.181; 23: 0.666→0.500; 29: 0.571-0.857→1.142; 31: 0.800→0.400; 41: 0.666→0.999; 90: 0→2; 100: 0→1; 101: 02→1; 134: 1→0; 153: 0→1; 166: 1→0; 168: 3→4; and 11 molecular apomorphies; 76/100/100.

***Paravaejovis waeringi* [Node 253]:** Char. 27: 0.666–0.999→0.333; 200: 1→0; and 9 molecular apomorphies; 59/90/82.

***Paravaejovis confusus* [Node 257]:** 23 molecular apomorphies; 95/100/100.

((*Paravaejovis puritanus* + *P. schwenkmeyeri*) ((*P. gravicaudus* + *P. spinigerus*) (*P. pumilis* (*P. eusthenura* (*P. diazi* + *P. hoffmanni*))))) [Node 264]: Char. 69: 1→0; 121: 0→3; 122: 0→1; 237: 1→2; 238: 1→2; 244: 0→2; and 7 molecular apomorphies; 23/53/19.

((*Paravaejovis puritanus* + *P. schwenkmeyeri*) (*P. gravicaudus* + *P. spinigerus*)) [Node 272]: Char. 1: 0.695→ 0.782; 21: 1.298→0.947; 174: 1→0; 176: 1→0; and 2 molecular apomorphies; 49/52/28.

(*Paravaejovis puritanus* + *P. schwenkmeyeri*) [Node 279]: Char. 139: 0→1; 173: 0→1; and 18 molecular apomorphies; 83/99/98.

***Paravaejovis puritanus* [Node 278]:** Char. 57: 0→1; 58: 0→1; 60: 0→2; 64: 0→1; 65: 0→1; 70: 0→1; 122: 1→2; 187: 0→1; 235: 0→1; 242: 0→2; 248: 0→1; and 11 molecular apomorphies; 86/100/100.

***Paravaejovis schwenkmeyeri* [Node 283]:** Char. 89: 2→3; 98: 2→0; 117: 1→0; 136: 0→1; and 5 molecular apomorphies; 55/100/100.

(*Paravaejovis gravicaudus* + *P. spinigerus*) [Node 271]: Char. 0: 0.800–0.880→1.440; 1: 0.782→1.217–1.304; 9: 0.571→0.857; 10: 0.363→0.545; 17: 0.000→0.666; 18: 0.000→0.666; 20: 1.000→1.500; 24: 0.500–0.750→1.000; 25: 0.571→1.142; 26: 0.000→1.000; 28: 0.400→0.800; 30: 1.000→2.000; 31: 0.800–1.200→1.600; 32: 0.400→0.800; 34: 0.500→1.000; 41: 0.666→1.333; 48: 1→0; 84: 1→2; 134: 1→0; 175: 1→0; 212: 1→2; 224: 1→2; 232: 1→2; 236: 12→0; 237: 2→0; 238: 2→0; and 11 molecular apomorphies; 94/100/100.

***Paravaejovis gravicaudus* [Node 270]:** Char. 60: 0→2; 81: 2→0; 89: 2→3; 115: 2→0; 200: 1→0; and 24 molecular apomorphies; 90/100/100.

***Paravaejovis spinigerus* [Node 285]:** Char. 146: 2→3; 164: 3→2; and 13 molecular apomorphies; 96/100/100.

(*Paravaejovis pumilis* (*P. eusthenura* (*P. diazi* + *P. hoffmanni*))) [Node 263]: Char. 4: 0.250→0.500; 12: 1.000→0.500; 98: 2→0; 104: 2→0; 111: 2→0; 112: 4→0; 113: 4→0; 114: 3→0; 117: 1→0; 118: 2→0; 119: 3→0; 120: 2→0; 131: 1→0; 132: 0→1; 208: 1→2; and 3 molecular apomorphies; 23/89/81.

***Paravaejovis pumilis* [Node 276]:** Char. 69: 0→2; 72: 0→1; 74: 0→1; 75: 1→2; 76: 1→0; 81: 2→1; 82: 2→3; 83: 2→1; 85: 1→2; 87: 1→0; 121: 3→2; 134: 1→2; 151: 0→1; 158: 1→0; 159: 0→1; 164: 3→1; 165: 1→2; 167: 2→0; 168: 3→0; 172: 0→1; 173: 0→1; 189: 1→0; 200: 1→0; 206: 1→2; 213: 2→1; 220: 1→0; 223: 1→0; and 52 molecular apomorphies; 69/100/100.

(*Paravaejovis eusthenura* (*P. diazi* + *P. hoffmanni*)) [Node 262]: Char. 4: 0.500→0.750; 5: 0.500→1.000; 6: 0.285→0.571; 24: 0.500-0.750→1.000; 25: 0.571→0.857-1.142; 28: 0.000-0.400→1.200; 89: 2→3; 122: 1→2; 123: 1→0; 232: 1→2; and 4 molecular apomorphies; 45/84/71.

***Paravaejovis eusthenura* [Node 268]:** Char. 212: 1→2; and 38 molecular apomorphies.

(*Paravaejovis diazi* + *P. hoffmanni*) [Node 261]: Char. 9: 0.571→0.85; 221: 3→1; 236: 2→0; and 6 molecular apomorphies; 69/79/59.

***Paravaejovis diazi* [Node 260]:** Char. 69: 0→2; 134: 0→1; 135: 0→1; 136: 0→1; 139: 0→1; and 11 molecular apomorphies; 82/98/97.

***Paravaejovis hoffmanni* [Node 275]:** Char. 122: 2→0; 244: 2→0 and; and 27 molecular apomorphies 79/100/100.