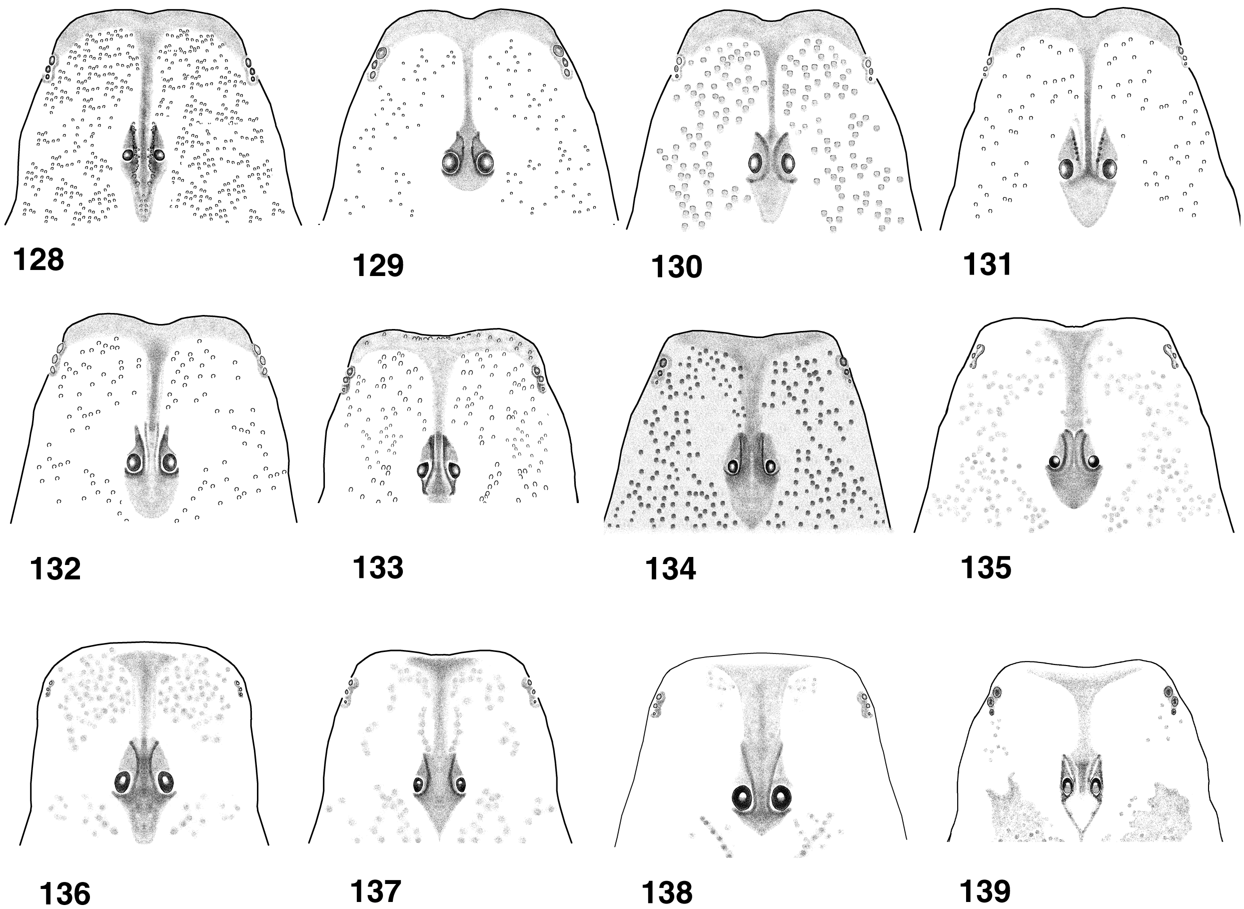
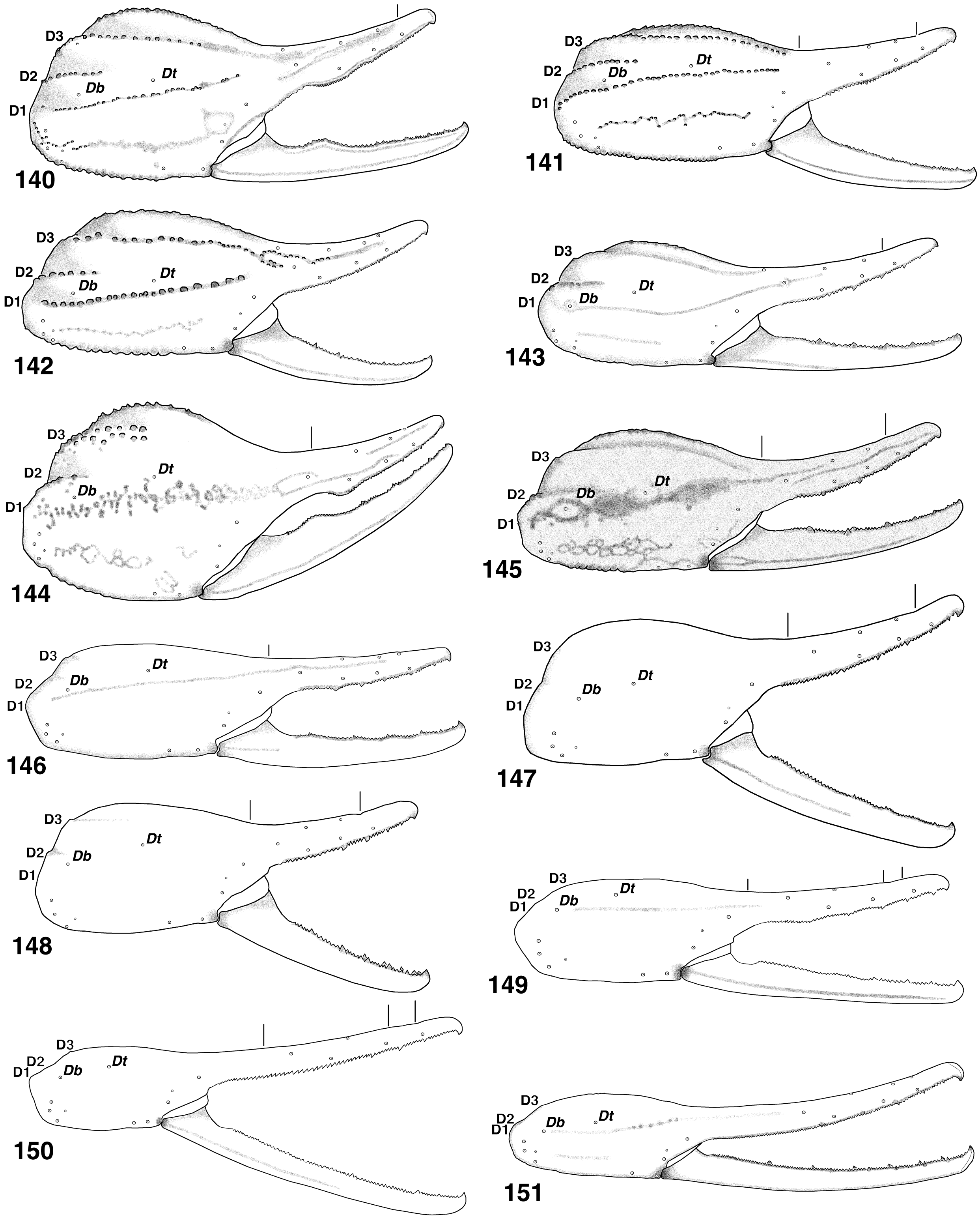


Figures 128–139: Carapace, anterior half, of representative Syntropini species, emphasizing differences in the *anterior emargination* and *median indentation*. **128.** *K. punctipalpi punctipalpi*, female, Cabo San Lucas, Baja California Sur, Mexico. **129.** *K. bruneus loretoensis*, male, Loreto, Baja California Sur, Mexico. **130.** *K. hirsuticauda*, female, Indian Gorge Canyon, ABDSP, California, USA. **131.** *K. cazieri*, male, Cuatro Ciénegas, Coahuila, Mexico. **132.** *K russelli*, female, Deming, New Mexico, USA. **133.** *K. kovariki*, female holotype, Durango, Durango, Mexico. **134.** *T. atrox*, female, Colima, Colima, Mexico. **135.** *T. cristimanus*, male, Autlán, Jalisco, Mexico. **136.** *H. eusthenura*, male, Cabo San Lucas, Baja California Sur, Mexico. **137.** *H. gravicaudus*, female, Santa Rosalia, Baja California Sur, Mexico. **138.** *H. globosus*, female, Zacatecas, Zacatecas, Mexico. **139.** *Syntropis aalbui*, holotype female, Cataviña, Baja California, Mexico (after Soleglad et al., 2007: fig. 17, in part).

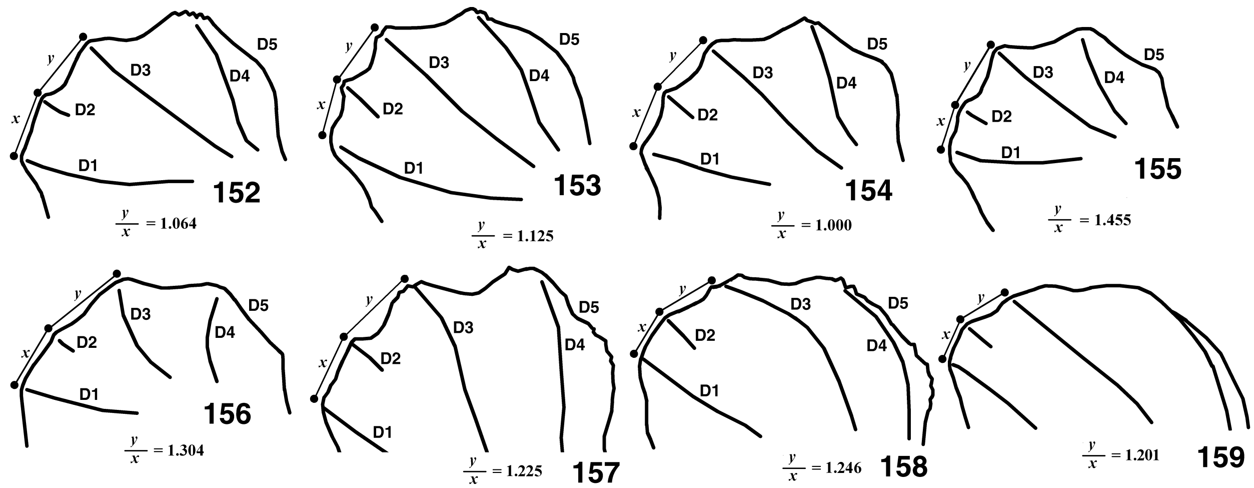
Smeringurinae. Haradon (1983) defined a new subgenus *Smeringurus* comprised of five species and subspecies, with the type species *S. vachoni* (Stahnke, 1961). This subgenus was differentiated from *Paruroctonus* by the numerous irregularly placed setae occurring between the ventral median (*VM*) carinae of metasomal segments I–IV and having a significantly more slender metasoma. Stockwell (1992) established *Smeringurus* as a genus.

The slender metasoma found in *Smeringurus* is significant, in our opinion, and represents a valid diagnostic character. This is clear from the histograms presented in Fig. 191 showing morphometrics of metasomal segments I–IV (width-to-length ratios). In these data, where all genera and all species are represented, males and females are *combined*. This further illustrates the very slender metasoma of *Smeringurus* as compared to the other three genera in Smeringurinae. Not only do we see complete separation of the standard deviation ranges, but the absolute ranges are separate as well. Mean value differences range from 150 to 300 % and resulting p-values from variance analysis are negligible exhibiting 13–14 fractional digits of significance. These data also show that genera *Vejovoidus* and *Paravaejovis* in general have the stockiest metasoma.

For genera *Smeringurus*, *Vejovoidus*, and *Paravaejovis*, additional specimens were measured, albeit most of the ratios were calculated from published data. In additional to material examined, the following references were used: Gertsch & Allred (1965), Gertsch & Soleglad (1966), Williams (1968b, 1969, 1970a, 1970b, 1972, 1980, 1987), Williams & Hadley (1967), Soleglad (1972), Sissom & Francke (1981), Hjelle



Figures 140–151: Chela, external view, of representative *Kochius*, *Thorellius*, *Hoffmannius*, and *Syntropis* species, showing carination and trichobothria pattern. In particular note the well developed subdigital (*D2*) carina, the mid-palm position of trichobothrium *Dt*, and location of *Db* dorsal of the digital (*D1*) carina. **140.** *Kochius punctipalpi punctipalpi*, female, Cabo San Lucas, Baja California Sur, Mexico. **141.** *K. hirsuticauda*, female, Indian Gorge Canyon, ABDSP, California, USA. **142.** *K. bruneus loretoensis*, male, Loreto, Baja California Sur, Mexico. **143.** *K russelli*, female, Deming, New Mexico, USA. **144.** *Thorellius intrepidus*, male, Mexico. **145.** *T. atrox*, female, Colima, Colima, Mexico. **146.** *Hoffmannius eusthenura*, male, Cabo San Lucas, Baja California Sur, Mexico. **147.** *H. gravicaudus*, female, Santa Rosalia, Baja California Sur, Mexico. **148.** *H. globosus*, female, Zacatecas, Zacatecas, Mexico. **149.** *H. puritanus*, male, Jasper Trail, ABDSP, California, USA. **150.** *H. viscainensis*, female, Las Bombas, Baja California Sur, Mexico. **151.** *Syntropis williamsi*, male paratype, Los Aripes, Baja California Sur, Mexico (after Soleglad et al., 2007: fig. 13, in part).



Figures 152–159: Diagrammatic view of chelal palm, proximal aspect, showing digital carinae (*D1–D5*). In particular, this perspective shows the profiled development of the subdigital (*D2*) carina and its relative position with respect to *D1* and *D3*. See Figs. 140–145 for lateral view of *D2* carina showing its relative length as compared to chelal palm length. **152.** *Kochius punctipalpi punctipalpi*, female, Cabo San Lucas, Baja California Sur, Mexico. **153.** *K. bruneus loretoensis*, male, Loreto, Baja California Sur, Mexico. **154.** *K. hirsuticauda*, female, Indian Gorge Canyon, ABDSP, California, USA. **155.** *K. cazieri*, male, Cuatro Ciénegas, Coahuila, Mexico. **156.** *K. russelli*, female, Deming, New Mexico, USA. **157.** *Thorellius intrepidus*, male, Mexico. **158.** *T. cristimanus*, male, Autlán, Jalisco, Mexico. **159.** *T. atrox*, female, Colima, Colima, Mexico. *D1* = digital carina, *D2* = subdigital carina, *D3* = dorsosecondary carina, *D4* = dorsomarginal carina, *D5* = dorsointernal carina.

(1982), Haradon (1984a, 1984b, 1985), Sissom & Henson (1998).

Tribe Syntropini. Williams (1980: 49–55), in his key to the species groups of genus *Vaejovis* found in Baja California, Mexico, contrasts the heavily developed chela found in *Kochius* (referred to as the "punctipalpi" group) to the more slender chela found in *Hoffmannius* (referred to as the "eusthenura" group):

> "… 16 (1). Pedipalp palm greatly swollen, ratio of movable-finger length to palm width 1.8 or less ---------- 17
>
> Pedipalp palm not greatly swollen, ratio of movable-finger length to palm greater than 1.8 ---------- 30 [this isolates Williams's "eusthenura" group which now is genus *Hoffmannius*] …".

In addition, Williams (1980) uses the relatively thin metasoma found in *Kochius* to differentiate it from another, also heavy chelate group now placed in genus *Pseudouroctonus*:

> "…17 (16). Pectine teeth 15 or fewer in males, 14 or fewer in females; ratio of metasoma length to width of metasomal segment V equal to or less than 7.5; metasomal segment II as wide as or wider than long; metasomal segment IV with ratio of length to width 1.5 or less --------- 18 [this isolates species now placed in genus *Pseudouroctonus*]
>
> Pectine teeth 16 or more in males, 15 or more in females; ratio of metasoma length to width of metasomal segment V greater than 7.5; metasomal segment II longer than wide; metasomal segment IV with ratio of length to width greater than 1.5 --------- 22 [this isolates Williams's "punctipalpi" group now placed in genus *Kochius*] …".

Although we agree in general with Williams's (1980) characterizations of these two assemblages of species, it is difficult to quantify these differences across all species to be used as "discrete" characters in a cladistic analysis. In order to fully understand these characterizations and others that may be present, we studied all morphometrics of these two genera along with genus *Thorellius*, the sister genus of *Kochius*.

Maximized ratios. We extracted a full set of measurements for a subset of species in genera *Hoffmannius* and *Kochius* where all possible morphometric ratios were compared: 300 resulting ratios based on 25 morphometrics. Each component of a ratio (i.e., its numerator and denominator) was analyzed as to its effect on the comparison between the two species sets. The measurements having the most effect across all ratio comparisons are considered measurements of potential diagnostic importance. To fully realize this, measurements having the most effect from *both* species sets must be combined in a ratio in order to *maximize* the ratio's effect as diagnostic (see Fet & Soleglad, 2002: 5, for an explanation of this technique).

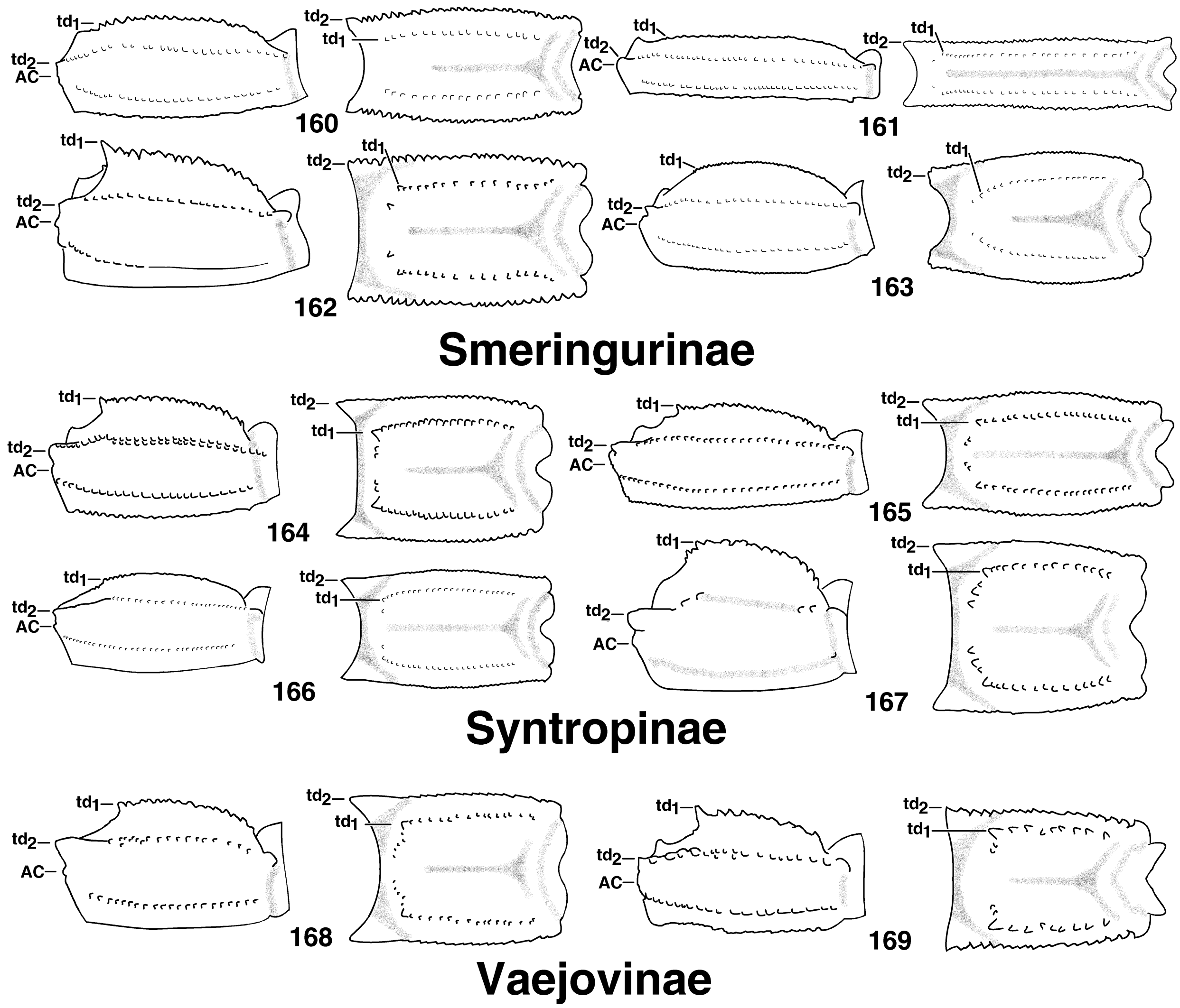
For genus *Kochius* two morphometrics dominated the ratio comparisons, the chelal palm depth and palm width. The palm depth dominated in all ratios (24 in all) and the palm width dominated in 23 ratios. For genus *Hoffmannius* five morphometrics dominated in most of

<table>
<tr><th></th><th></th><th colspan="5">Metasoma (L/W)</th><th>PD/</th><th>PD/</th><th>PD/</th><th>PD/</th><th>PW/</th><th>*VM* (I-IV)</th><th>Chela</th></tr>
<tr><th></th><th></th><th>I</th><th>II</th><th>III</th><th>IV</th><th>V</th><th>V_W</th><th>IV_W</th><th>TelW</th><th>TelD</th><th>V_W</th><th>Carinae</th><th>Carinae *</th></tr>
<tr><td>*K. sonorae*</td><td>♂</td><td>0.947</td><td>1.176</td><td>1.375</td><td>1.800</td><td>2.400</td><td>1.333</td><td>1.333</td><td>1.818</td><td>2.222</td><td>1.133</td><td>**8,8,8,8**</td><td>**4,4,4,4,4**|x,x,x|x</td></tr>
<tr><td></td><td>♀</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td></td></tr>
<tr><td>*K. russelli*</td><td>♂</td><td>0.960</td><td>1.130</td><td>1.217</td><td>1.682</td><td>2.429</td><td>1.000</td><td>0.955</td><td>1.313</td><td>1.500</td><td>0.905</td><td>2,2,**6,6**</td><td>3,3,**4,4,4**|**6**,x,x|1</td></tr>
<tr><td></td><td>♀</td><td>0.960</td><td>1.122</td><td>1.229</td><td>1.583</td><td>2.298</td><td>1.000</td><td>0.979</td><td>1.306</td><td>1.621</td><td>0.787</td><td>2,2,**6,6**</td><td>-</td></tr>
<tr><td>*K. kovariki*</td><td>♂</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td></td><td>♀</td><td>0.925</td><td>1.109</td><td>1.190</td><td>1.607</td><td>2.483</td><td>0.983</td><td>0.934</td><td>1.118</td><td>1.425</td><td>0.879</td><td>0,0,2,**4**</td><td>2,2,2,2,2|2,2,2|2</td></tr>
<tr><td>*K. crassimanus*</td><td>♂</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td></td><td>♀</td><td>1.000</td><td>1.194</td><td>1.257</td><td>1.706</td><td>2.625</td><td>1.188</td><td>1.118</td><td>1.357</td><td>1.462</td><td>1.125</td><td>3,**7,7,7**</td><td>3,3,3,3,3|3,3,3|3</td></tr>
<tr><td>*K. punctipalpi*</td><td>♂</td><td>1.000</td><td>1.226</td><td>1.333</td><td>1.893</td><td>2.643</td><td>1.464</td><td>1.464</td><td>2.050</td><td>2.412</td><td>1.179</td><td>2,3,**6,7**</td><td>**6,6,6,6,6**|**6**,x,x|3</td></tr>
<tr><td></td><td>♀</td><td>0.923</td><td>1.108</td><td>1.286</td><td>1.875</td><td>2.594</td><td>1.531</td><td>1.531</td><td>2.227</td><td>2.579</td><td>1.188</td><td>2,3,**6,7**</td><td>-</td></tr>
<tr><td>*K. atenango*</td><td>♂</td><td>1.000</td><td>1.206</td><td>1.375</td><td>1.871</td><td>2.759</td><td>1.069</td><td>1.000</td><td>0.969</td><td>1.632</td><td>1.000</td><td>1,3,3,**7**</td><td>**4**,?,**4,4,4**|?,**4,4**|**4**</td></tr>
<tr><td></td><td>♀</td><td>0.944</td><td>1.083</td><td>1.294</td><td>1.844</td><td>2.594</td><td>0.938</td><td>0.938</td><td>1.034</td><td>1.364</td><td>1.000</td><td>-</td><td>**-**</td></tr>
<tr><td>*K. cazieri*</td><td>♂</td><td>1.000</td><td>1.259</td><td>1.462</td><td>2.000</td><td>2.917</td><td>1.250</td><td>1.250</td><td>1.500</td><td>1.667</td><td>1.208</td><td>**6,6,6,6**</td><td>**5,5,5,5,5**|**6**,x,x|3</td></tr>
<tr><td></td><td>♀</td><td>1.000</td><td>1.242</td><td>1.303</td><td>1.781</td><td>2.677</td><td>1.290</td><td>1.250</td><td>1.429</td><td>1.819</td><td>1.226</td><td>**6,6,6,6**</td><td>-</td></tr>
<tr><td>*K. bruneus*</td><td>♂</td><td>0.963</td><td>1.160</td><td>1.250</td><td>1.909</td><td>2.714</td><td>1.429</td><td>1.364</td><td>1.875</td><td>2.308</td><td>1.333</td><td>**7,7,7,7**</td><td>**6,6,6,6,6**|**6**,x,x|**4**</td></tr>
<tr><td></td><td>♀</td><td>1.000</td><td>1.226</td><td>1.379</td><td>1.926</td><td>2.920</td><td>1.440</td><td>1.333</td><td>1.800</td><td>2.250</td><td>1.360</td><td>**7,7,7,7**</td><td>-</td></tr>
<tr><td>*K. insularis*</td><td>♂</td><td>1.000</td><td>1.250</td><td>1.391</td><td>1.818</td><td>2.750</td><td>1.350</td><td>1.227</td><td>1.688</td><td>2.250</td><td>1.250</td><td>**8,8,8,8**</td><td>**4,4,4,4,4**|x,x,x|x</td></tr>
<tr><td></td><td>♀</td><td>0.933</td><td>1.286</td><td>1.357</td><td>1.846</td><td>2.792</td><td>1.417</td><td>1.308</td><td>1.889</td><td>2.429</td><td>1.250</td><td>**8,8,8,8**</td><td>-</td></tr>
<tr><td>*K. magdalensis*</td><td>♂</td><td>1.000</td><td>1.292</td><td>1.391</td><td>1.955</td><td>2.762</td><td>1.333</td><td>1.273</td><td>2.000</td><td>2.333</td><td>1.143</td><td>3,3,3,**7**</td><td>**5,5,5,5,5**|x,x,x|x</td></tr>
<tr><td></td><td>♀</td><td>0.929</td><td>1.231</td><td>1.360</td><td>1.875</td><td>2.773</td><td>1.364</td><td>1.250</td><td>2.000</td><td>2.500</td><td>1.182</td><td>3,3,3,**7**</td><td>-</td></tr>
<tr><td>*K. hirsuticauda*</td><td>♂</td><td>1.136</td><td>1.500</td><td>1.722</td><td>2.235</td><td>3.333</td><td>1.867</td><td>1.647</td><td>2.800</td><td>2.800</td><td>1.800</td><td>**8,8,8,8**</td><td>-</td></tr>
<tr><td></td><td>♀</td><td>1.100</td><td>1.444</td><td>1.706</td><td>2.333</td><td>3.462</td><td>1.769</td><td>1.533</td><td>2.556</td><td>2.556</td><td>1.538</td><td>**8,8,8,8**</td><td>**6,6,6,6,6**|**6**,x,x|**4**</td></tr>
<tr><td>*T. atrox*</td><td>♂</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td></td><td>♀</td><td>0.776</td><td>0.933</td><td>1.056</td><td>1.444</td><td>2.056</td><td>0.913</td><td>0.824</td><td>1.135</td><td>1.355</td><td>0.826</td><td>2,2,3,**6**</td><td>**b,b,b,b,b|b,b,b|b**</td></tr>
<tr><td>*T. cristimanus*</td><td>♂</td><td>0.771</td><td>0.928</td><td>1.023</td><td>1.395</td><td>1.978</td><td>1.026</td><td>1.000</td><td>1.290</td><td>1.481</td><td>0.872</td><td>2,2,3,3</td><td>**b,b,b,4,4|b,b,4|b**</td></tr>
<tr><td></td><td>♀</td><td>0.717</td><td>0.846</td><td>0.953</td><td>1.313</td><td>1.913</td><td>1.318</td><td>1.261</td><td>1.526</td><td>1.871</td><td>0.909</td><td>1,1,3,**6**</td><td>**-**</td></tr>
<tr><td>*T. intrepidus*</td><td>♂</td><td>0.990</td><td>1.173</td><td>1.245</td><td>1.734</td><td>2.250</td><td>1.383</td><td>1.327</td><td>1.625</td><td>1.711</td><td>1.064</td><td>2,2,2,3</td><td>**b,4,4,4,4|b,b,4|b**</td></tr>
<tr><td></td><td>♀</td><td>0.840</td><td>1.093</td><td>1.191</td><td>1.637</td><td>2.397</td><td>1.400</td><td>1.373</td><td>1.667</td><td>1.750</td><td>1.000</td><td>2,2,3,**6**</td><td>**-**</td></tr>
<tr><td>*T. cisnerosi*</td><td>♂</td><td>0.986</td><td>1.192</td><td>1.222</td><td>1.586</td><td>2.197</td><td>1.091</td><td>1.029</td><td>1.469</td><td>1.714</td><td>0.848</td><td>0,0,0,0</td><td>1,1,1,1,1|1,1,1|1</td></tr>
<tr><td></td><td>♀</td><td>0.956</td><td>1.191</td><td>1.233</td><td>1.524</td><td>2.115</td><td>1.038</td><td>0.964</td><td>1.209</td><td>1.421</td><td>0.846</td><td>0,0,0,0</td><td>-</td></tr>
<tr><td>*T. occidentalis*</td><td>♂</td><td>0.674</td><td>0.864</td><td>0.911</td><td>1.364</td><td>1.841</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>1,2,2,**6**</td><td>2,x,1,1,1|21,1|1</td></tr>
<tr><td></td><td>♀</td><td>0.833</td><td>0.957</td><td>1.014</td><td>1.296</td><td>1.912</td><td>0.743</td><td>0.703</td><td>1.040</td><td>1.238</td><td>0.629</td><td>2,2,2,**5**</td><td>2,1,2,2,2|**b**,2,2|1</td></tr>
<tr><td>*T. subcristatus*</td><td>♂</td><td>0.906</td><td>1.094</td><td>1.194</td><td>1.600</td><td>2.333</td><td>1.067</td><td>1.067</td><td>1.280</td><td>1.524</td><td>0.917</td><td>1,1,1,2</td><td>1,1,1,1,1|1,1,1|1</td></tr>
<tr><td></td><td>♀</td><td>0.824</td><td>1.000</td><td>1.097</td><td>1.500</td><td>2.200</td><td>0.900</td><td>0.900</td><td>0.964</td><td>1.227</td><td>0.733</td><td>-</td><td>-</td></tr>
</table>

Table 4: Select characters of genera *Kochius* and *Thorellius*. Ratios calculated from measurements taken from specimens examined, Gertsch & Allred (1965), Williams (1968, 1970, 1971a, 1971b), Stahnke (1973), Sissom (1989), Ponce Saavedra & Sissom (2004), Francke & González Santillán (2006). Order of species based on gross metasomal proportions, the more stocky metasoma first. Carinae codes: x = information not available, 0 = obsolete, 1 = vestigial-smooth, 2 = smooth, 3 = smooth-granular, **4 = granular, 5 = granular-crenulate, 6 = crenulate, 7 = crenulate-serrate, 8 = serrate, a = weak-marbled, b = strong marbled.** * *D1–D5|V1–V3|E*.

		Metasoma (L/W)					PD/ V_W	PD/ IV_W	PD/ TelW	PD/ TelD	PW/ V_W	*VM* (I-IV) Carinae	Chela Carinae *
		I	II	III	IV	V							
H. waueri	♂	-	-	-	-	-	-	-	-	-	-	0,0,0,0	1,1,1,1,1|1,1,1|1
	♀	0.818	0.818	0.864	1.238	1.714	0.524	0.524	0.733	0.917	0.476	-	-
H. bilineatus	♂	0.667	0.833	1.000	1.304	2.000	0.864	0.826	1.188	1.356	0.727	0,0,0,0	1,1,1,1,1|1,1,1|1
	♀	0.667	0.767	0.800	1.069	1.786	0.714	0.690	0.800	1.000	0.643	-	-
H. gravicaudus	♂	0.804	0.933	0.978	1.261	1.783	0.674	0.674	0.838	1.107	0.652	0,0,0,0	0,0,0,0,0|0,0,0|0
	♀	0.725	0.860	0.900	1.151	1.625	0.500	0.528	0.609	0.848	0.482	-	-
H. punctatus	♂	0.742	0.900	0.967	1.279	1.869	0.885	0.885	1.350	1.742	0.721	0,0,0,0	0,0,0,0,0|0,0,0|0
	♀	0.700	0.838	0.925	1.235	1.818	0.848	0.824	0.982	1.333	0.697	-	-
H. spinigerus	♂	0.772	0.945	1.000	1.327	1.982	0.655	0.655	0.857	1.091	0.582	-	-
	♀	0.743	0.882	0.955	1.265	1.826	0.725	0.735	0.943	1.136	0.667	0,0,0,0	0,0,0,0,0|0,0,0|0
H. vittatus	♂	0.769	0.885	0.962	1.346	1.923	0.731	0.731	0.950	1.267	0.654	0,0,0,1	0,0,0,0,0|0,0,0|0
	♀	0.667	0.828	0.929	1.250	1.852	0.630	0.607	0.810	1.133	0.556	-	-
H. eusthenura	♂	0.882	1.045	1.119	1.485	1.984	0.635	0.606	0.833	0.952	0.571	0,0,1,2	0,0,0,0,0|1,0,0|0
	♀	0.865	1.014	1.113	1.443	1.892	0.622	0.657	0.708	0.852	0.581	-	-
H. diazi	♂	0.938	1.031	1.063	1.438	1.969	0.688	0.688	0.957	1.158	0.625	0,0,0,0	0,0,0,0,0|0,0,0|0
	♀	0.800	0.931	1.036	1.321	2.000	0.679	0.679	0.864	1.056	0.607	-	-
H. hoffmanni	♂	0.917	1.087	1.174	1.565	2.083	0.583	0.609	0.778	1.000	0.542	0,0,0,0	0,0,0,0,0|0,0,0|0
	♀	0.815	0.962	1.080	1.400	2.000	0.615	0.640	0.727	0.889	0.577	-	-
H. coahuilae	♂	0.833	0.933	1.034	1.379	2.214	0.923	0.897	1.300	1.529	0.857	0,3,3,**7**	1,1,1,1,1|1,1,1|1
	♀	0.811	0.971	1.029	1.343	2.088	0.824	0.800	1.000	1.217	0.794	-	-
H. waeringi	♂	0.941	1.088	1.152	1.529	2.094	0.531	0.500	0.630	0.810	0.438	2,2,2,3	2,1,3,3,3|2,2,2|1
	♀	0.868	1.000	1.108	1.368	1.789	0.579	0.579	0.647	0.786	0.526	-	-
H. globosus	♂	0.880	1.083	1.125	1.565	2.500	0.818	0.783	0.947	1.125	0.818	3,3,**6**,**7**	1,1,1,1,1|1,1,1|1
	♀	0.833	0.958	1.043	1.455	2.318	0.818	0.818	0.818	1.000	0.727	-	-
H. confusus	♂	1.080	1.200	1.200	1.538	2.115	0.577	0.577	0.652	0.789	0.538	1,2,3,**6**	1,1,1,1,1|1,1,1|1
	♀	0.882	0.970	1.061	1.371	1.800	0.629	0.629	0.688	0.957	0.571		-
H. galbus	♂	0.958	1.125	1.167	1.565	2.125	0.667	0.696	0.842	1.067	0.583	1,1,1,1	0,0,0,0,0|0,0,0|0
	♀	0.885	1.038	1.120	1.440	2.080	0.840	0.840	0.913	1.167	0.720	-	-
H. glabrimanus	♂	0.944	1.151	1.226	1.608	2.365	0.942	0.961	1.000	1.167	0.923	1,1,1,3	1,1,1,1,1|1,1,1|1
	♀	-	-	-	-	-	-	-	-	-	-	-	-
H. puritanus	♂	1.029	1.265	1.364	1.813	2.406	0.813	0.813	0.897	1.083	0.719	1,1,1,2	1,1,1,1,1|1,1,1|1
	♀	0.895	1.053	1.167	1.571	2.364	0.636	0.600	0.636	0.808	0.606	-	-
H. viscainensis	♂	1.071	1.308	1.423	1.920	2.792	0.583	0.560	0.778	0.933	0.500	2,2,3,**4**	1,1,1,1,1|1,1,1|1
	♀	1.034	1.286	1.407	1.885	2.833	0.667	0.615	0.727	0.889	0.583	-	-

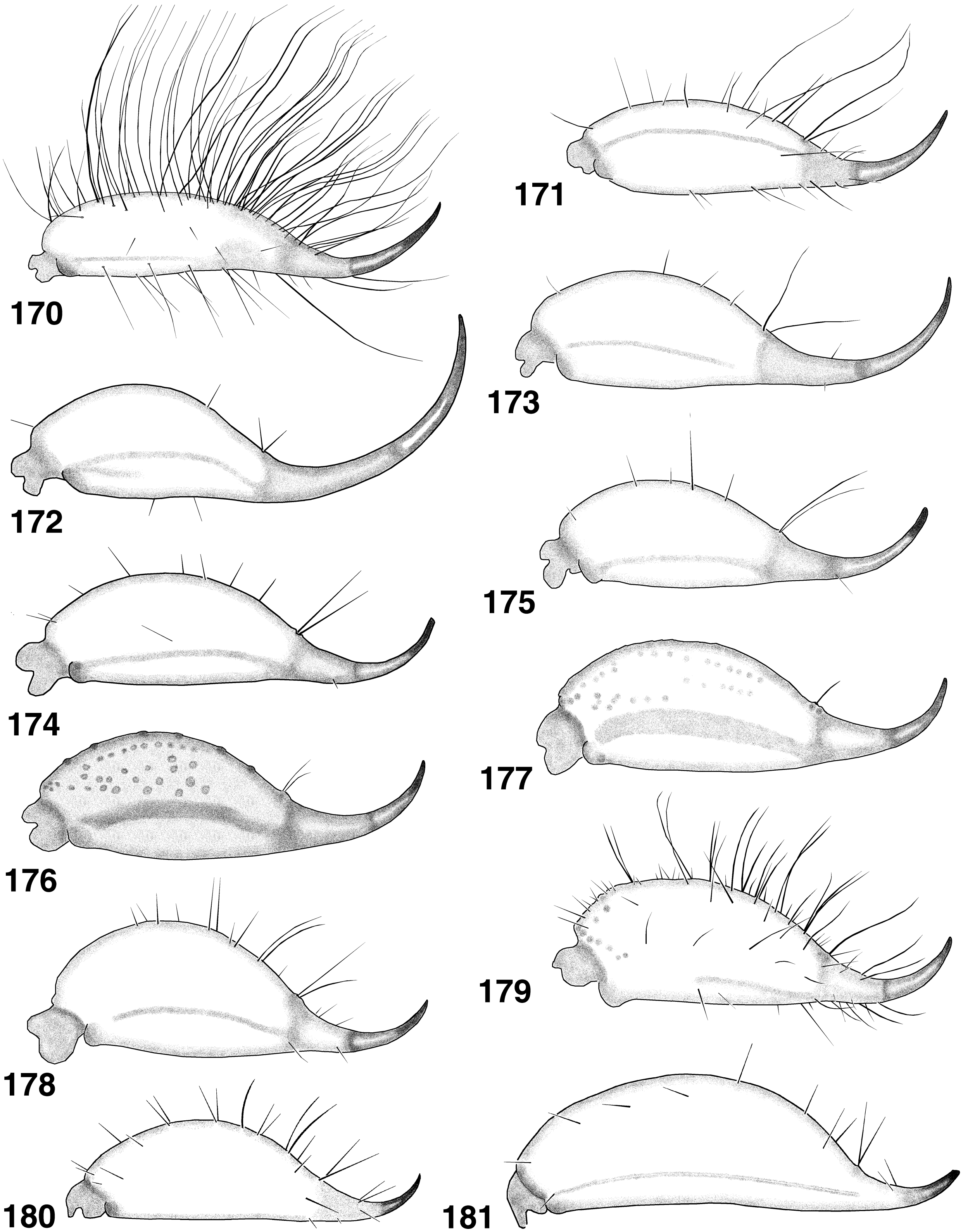
Table 5: Select characters of genus *Hoffmannius*. Ratios calculated from measurements taken from specimens examined, Hoffmann (1931), Gertsch (1958), Gertsch & Allred (1965), Gertsch & Soleglad (1972), Williams (1970c, 1970d, 1986), Yahia & Sissom (1996), Sissom & Hendrixson (2005). Order of species based on gross metasomal proportions, the more stocky metasoma first. Carinae codes: x = information not available, 0 = obsolete, 1 = vestigial-smooth, 2 = smooth, 3 = smooth-granular, **4 = granular, 5 = granular-crenulate, 6 = crenulate, 7 = crenulate-serrate, 8 = serrate.** * *D1–D5|V1–V3|E*.



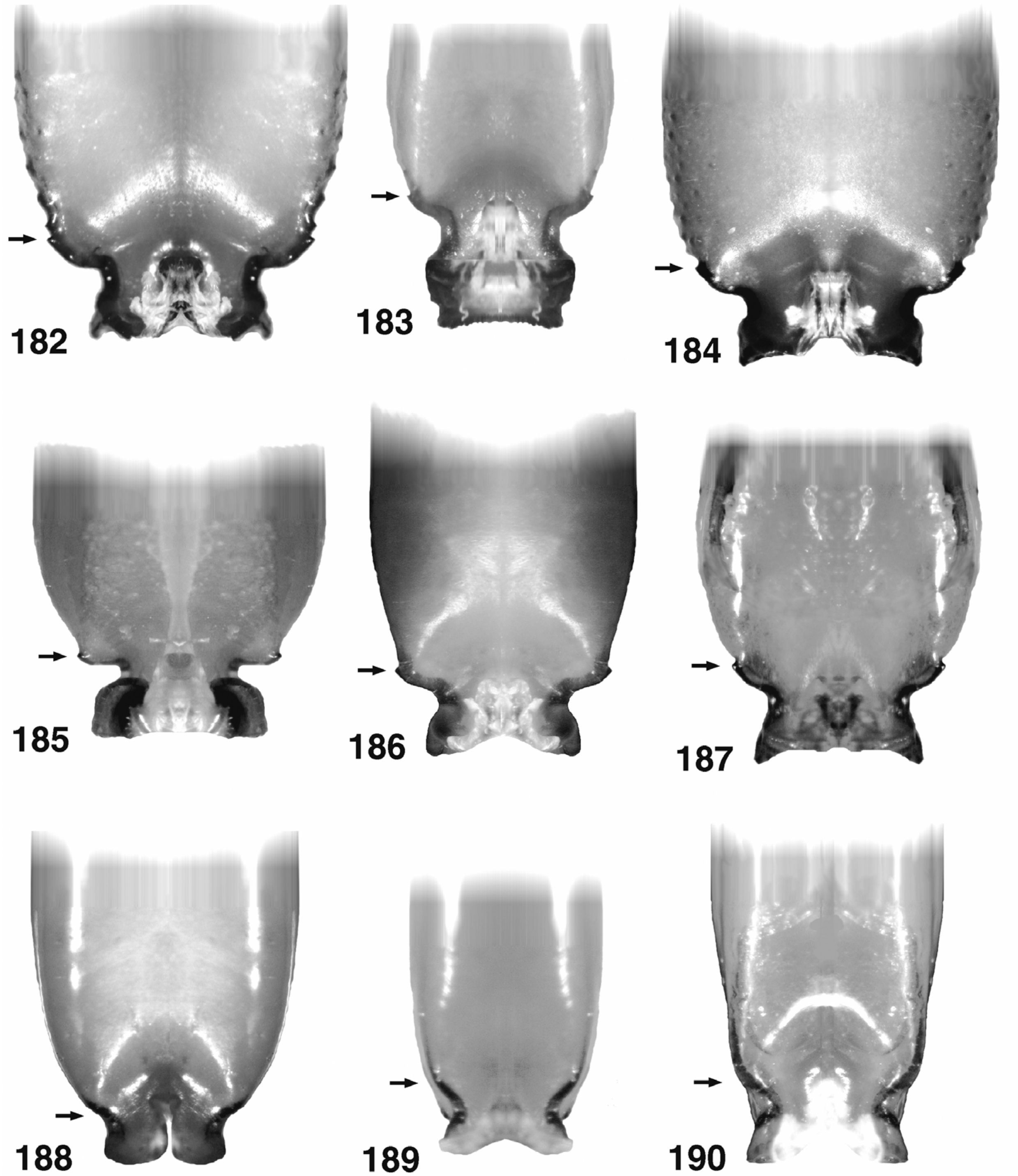
Figures 160–169: Metasomal segment IV, lateral and dorsal views, showing development of the terminus of the dorsal (*D*) and dorsolateral (*DL*) carinae for the three subfamilies of Vaejovidae. Subfamily **Smeringurinae**: **160.** *Paruroctonus stahnkei*, male, Mesa, Arizona, USA. **161.** *Smeringurus aridus*, male, ABDSP, California, USA. **162.** *Vejovoidus longiunguis*, male, Las Bombas, Baja California Sur, Mexico. **163.** *Paravaejovis pumilis*, male, Ciudad Constitución, Baja California Sur, Mexico. Subfamily **Syntropinae**: **164.** *Stahnkeus subtilimanus*, ABDSP, California, USA. **165.** *Kochius punctipalpi punctipalpi*, female, Cabo San Lucas, Baja California Sur, Mexico. **166.** *Hoffmannius viscainensis*, male, Las Bombas, Baja California Sur, Mexico. **167.** *Hoffmannius gravicaudus*, female, Santa Rosalia, Baja California Sur, Mexico. Subfamily **Vaejovinae**: **168.** *Vaejovis solegladi*, female, Cuicatlan, Oaxaca, Mexico. **169.** *Pseudouroctonus reddelli*, male, Comal Co., Texas, USA. AC = articulation condyle, td_1 = terminal denticle of dorsal carina, td_2 = terminal denticle of dorsolateral carina. After Soleglad & Fet (2003b), in part.

the ratios in which they were involved: the width of metasomal segment V (all 24 ratios) and segment IV (21 ratios), and the telson vesicle width (23 ratios), depth (22 ratios) and telson length (19 ratios). These results, in part, are not surprising, when reflecting on diagnostic descriptions and keys of Williams (1970d, 1980) discussing the "punctipalpi" and "eusthenura" groups, in particular, the large robust chela in *Kochius* and the heavy metasoma in *Hoffmannius*. Our results did, however, uncover the relatively large telson exhibited in *Hoffmannius* as compared to *Kochius* (and *Thorellius*, see below), a character not previously disclosed.

Interestingly, the other three metasomal segment widths in *Hoffmannius* also dominated in the majority of the ratios in which they were involved but not as significantly as in segments V and IV: segment III, 18 out of 24 ratios, segment II, 17 ratios, and segment I, 16 ratios. This dominance of the metasoma segment's width definitely implies that the metasoma in *Hoffmannius* is significantly wider than in *Kochius*. Similarly, consistent with the heavy chelal palm, the chela length in *Kochius* also dominated in its ratios, 22 out of 24. To further emphasize a thinner metasoma in *Kochius*, ratio comparisons for segment II–V *lengths* dominated in this



Figures 170–181: Telson, lateral view, of representative Syntropini species. **170.** *Kochius hirsuticauda*, female, Indian Gorge Canyon, ABDSP, California, USA. **171.** *K. bruneus loretoensis*, male, Loreto, Baja California Sur, Mexico. **172.** *K. punctipalpi punctipalpi*, female, Cabo San Lucas, Baja California Sur, Mexico. **173.** *K. punctipalpi punctipalpi*, male, Los Aripes, Baja California Sur, Mexico. Note the significant sexual dimorphism in this species. **174.** *K. cazieri*, male, Cuatro Ciénegas, Coahuila, Mexico. **175.** *K. russelli* female, Deming, New Mexico, USA. **176.** *Thorellius atrox*, female, Colima, Colima, Mexico. **177.** *T. cristimanus*, male, Autlán, Jalisco, Mexico. **178.** *Hoffmannius globosus*, female, Zacatecas, Zacatecas, Mexico. **179.** *H. eusthenura*, male, Cabo San Lucas, Baja California Sur, Mexico. **180.** *Syntropis williamsi*, female holotype, Los Aripes, Baja California Sur, Mexico. **181.** *S. macrura*, female, Isla Carmen, Baja California Sur, Mexico. (Figs. 180, 181 after Soleglad et al., 2007, in part).



Figures 182–190: Base of telson vesicle, dorsal view, showing development of vesicular "tabs" (pointed to by *arrow*) in subfamilies Syntropinae and Smeringurinae. Note the reduced tabs, the sharp granules essentially obsolete, in *Smeringurus*, *Paravaejovis*, and *Vejovoidus*, whereas in *Paruroctonus* and subfamily Syntropinae, the spine is distinct and well developed. **182.** *Hoffmannius waeringi*, male, Indian Gorge Canyon, ABDSP, California, USA. **183.** *Kochius punctipalpi punctipalpi*, female, Cabo San Lucas, Baja California Sur, Mexico. **184.** *Stahnkeus subtilimanus*, female, Split Mountain, ABDSP, California, USA. **185.** *Paruroctonus becki*, male, Cottonwood Springs, Joshua Tree National Monument, California, USA. **186.** *Paruroctonus silvestrii*, Chihuahua Road, ABDSP, California, USA. **187.** *Paruroctonus luteolus*, male, Palo Verde Wash, ABDSP, California, USA. **188.** *Smeringurus mesaensis*, female, Palo Verde Wash, ABDSP, California, USA. **189.** *Paravaejovis pumilis*, male, Ciudad Constitución, Baja California Sur, Mexico. **190.** *Vejovoidus longiunguis*, female, Las Bombas, Baja California Sur, Mexico.

genus (whereas *widths* dominated in *Hoffmannius*) ranging from 13 to 17 ratios out of 24.

Based on this analysis, we constructed ten morphometric ratios for all species, including both

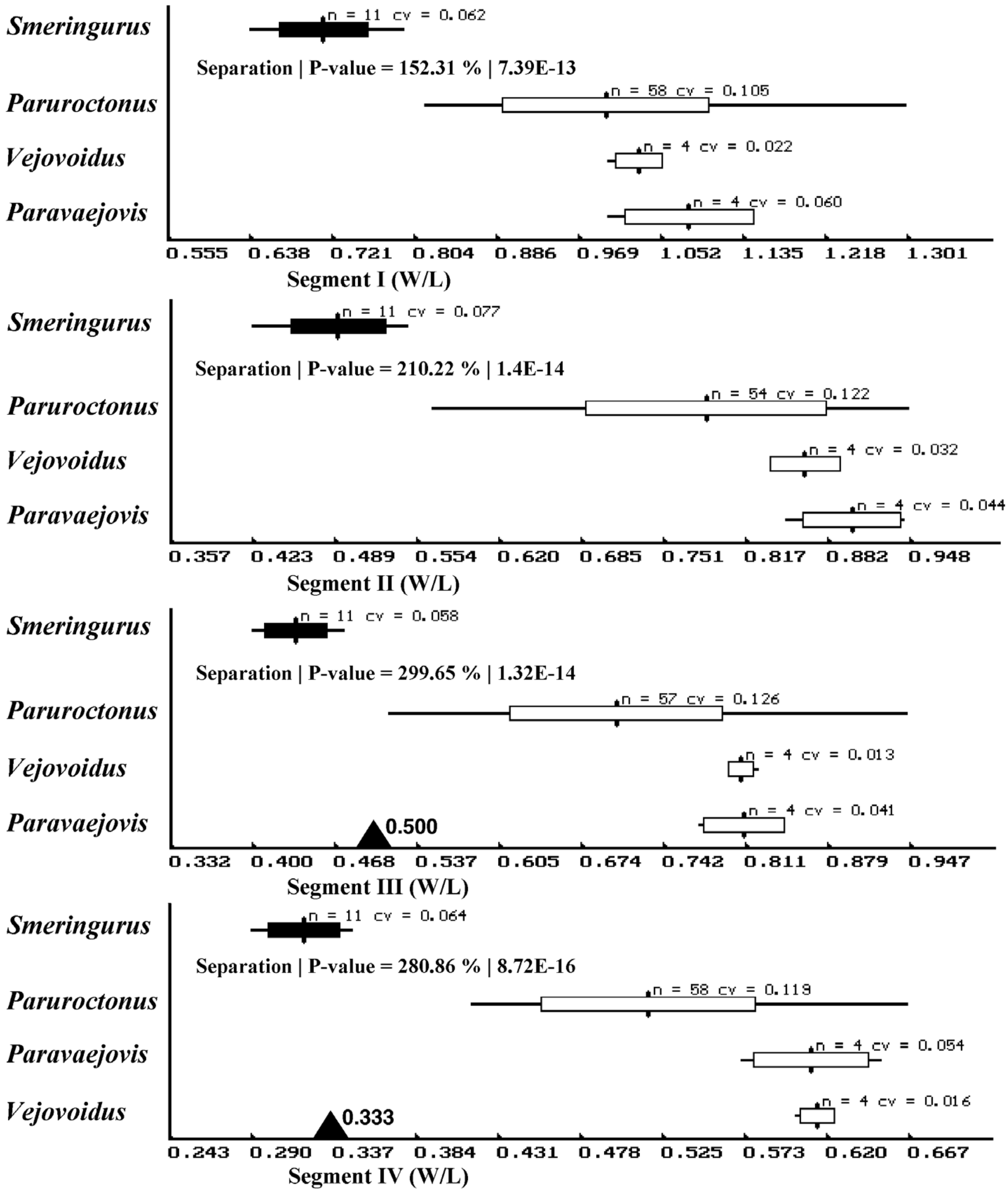


Figure 191: Metasomal segment (I–IV) proportions for subfamily Smeringurinae (ratios = segment width / segment length). Data include both adult males and females *combined*. These data show that *Smeringurus* segments are significantly thinner than in the other three genera, not only showing complete separation between standard error ranges, but for *all* data points. Statistical difference between *Smeringurus* and *Paruroctonus* is indicated by significant standard error separation and the negligible variance analysis value (p-value). In addition, segment III is at least twice as long as wide (indicated by 0.500 triangle marker) and segment IV is in general three times as long as wide (indicated by 0.333 triangle marker). The other genera cluster together, with *Vejovoidus* and *Paravaejovis* exhibiting the most stocky metasoma. The data, which encompass all species currently defined in Smeringurinae, were gathered from measurements calculated in this study as well as published measurements, primarily from those sources where the species were originally described (i.e., most measurements are from type specimens). See Fig. 1 for explanation of histogram components.

		Kochius	*Thorellius*	*Hoffmannius*
PD/ V_W	♂	1.00 – 1.87 (1.344) (±0.249) [9]	1.03 – 1.38 (1.142) (±0.163) [4]	0.53 – 0.94 (0.723) (±0.134) [16]
	♀	0.94 – 1.77 (1.292) (±0.268) [10]	0.74 – 1.40 (1.052) (±0.257) [6]	0.50 – 0.85 (0.678) (±0.109) [16]
PD/ IV_W	♂	0.95 – 1.65 (1.279) (±0.214) [9]	1.00 – 1.33 (1.105) (±0.150) [4]	0.50 – 0.96 (0.716) (±0.134) [16]
	♀	0.93 – 1.53 (1.217) (±0.223) [10]	0.70 – 1.37 (1.004) (±0.260) [6]	0.52 – 0.84 (0.673) (±0.103) [16]
PD/ TelW	♂	0.97 – 2.80 (1.779) (±0.517) [9]	1.28 – 1.62 (1.416) (±0.164) [4]	0.63 – 1.35 (0.925) (±0.205) [16]
	♀	1.03 – 2.56 (1.672) (±0.502) [10]	0.96 – 1.67 (1.257) (±0.279) [6]	0.61 – 1.00 (0.788) (±0.124) [16]
PD/ TelD	♂	1.50 – 2.80 (2.125) (±0.431) [9]	1.48 – 1.71 (1.608) (±0.122) [4]	0.79 – 1.74 (1.136) (±0.248) [16]
	♀	1.36 – 2.58 (2.000) (±0.510) [10]	1.23 – 1.87 (1.477) (±0.271) [6]	0.79 – 1.33 (0.999) (±0.161) [16]
PD/ TelL	♂	0.42 – 0.93 (0.650) (±0.172) [9]	0.47 – 0.59 (0.520) (±0.057) [4]	0.23 – 0.52 (0.359) (±0.078) [16]
	♀	0.39 – 0.70 (0.532) (±0.088) [10]	0.40 – 0.64 (0.499) (±0.099) [6]	0.25 – 0.47 (0.344) (±0.060) [15]
PW/ V_W	♂	0.90 – 1.80 (1.217) (±0.253) [9]	0.85 – 1.06 (0.925) (±0.097) [4]	0.44 – 0.92 (0.653) (±0.134) [16]
	♀	0.79 – 1.54 (1.154) (±0.221) [10]	0.63 – 1.00 (0.824) (±0.130) [6]	0.48 – 0.79 (0.613) (±0.089) [16]
PW/ IV_W	♂	0.86 – 1.59 (1.156) (±0.207) [9]	0.80 – 1.02 (0.897) (±0.095) [4]	0.41 – 0.94 (0.647) (±0.134) [16]
	♀	0.77 – 1.33 (1.087) (±0.178) [10]	0.59 – 0.98 (0.785) (±0.131) [6]	0.48 – 0.77 (0.609) (±0.085) [16]
PW/ TelW	♂	0.91 – 2.70 (1.607) (±0.491) [9]	1.10 – 1.25 (1.147) (±0.072) [4]	0.52 – 1.20 (0.832) (±0.179) [16]
	♀	1.00 – 2.22 (1.482) (±0.393) [10]	0.79 – 1.19 (0.987) (±0.141) [6]	0.59 – 0.96 (0.713) (±0.105) [16]
PW/ TelD	♂	1.36 – 2.70 (1.918) (±0.398) [9]	1.26 – 1.33 (1.304) (±0.032) [4]	0.67 – 1.42 (1.022) (±0.212) [16]
	♀	1.27 – 2.22 (1.777) (±0.397) [10]	1.00 – 1.29 (1.162) (±0.116) [6]	0.71 – 1.17 (0.904) (±0.129) [16]
PW/ TelL	♂	0.39 – 0.90 (0.588) (±0.165) [9]	0.40 – 0.45 (0.422) (±0.024) [4]	0.20 – 0.44 (0.323) (±0.068) [16]
	♀	0.37 – 0.57 (0.475) (±0.065) [10]	0.32 – 0.45 (0.393) (±0.046) [6]	0.22 – 0.39 (0.311) (±0.048) [15]

Table 6: Statistical data for genera *Hoffmannius*, *Kochius*, and *Thorellius* based on maximized morphometric ratios. The data show that genus *Kochius* exhibits the larger mean value in all cases as does *Hoffmannius* the smallest, showing differences ranging from 53.3 % to 112.4 % between the two. *Thorellius* is always intermediate. Shaded data denote complete absolute separation of ranges. See Figures 192–193 for histograms of these data and variance analysis p-values. Data = minimum–maximum (mean) (± standard deviation) [number of samples]. PD = palm depth; PW = palm width; V_W = metasomal segment V width; IV_W = metasomal segment IV width; TelL = telson length; TelW = telson width; TelD = telson depth.

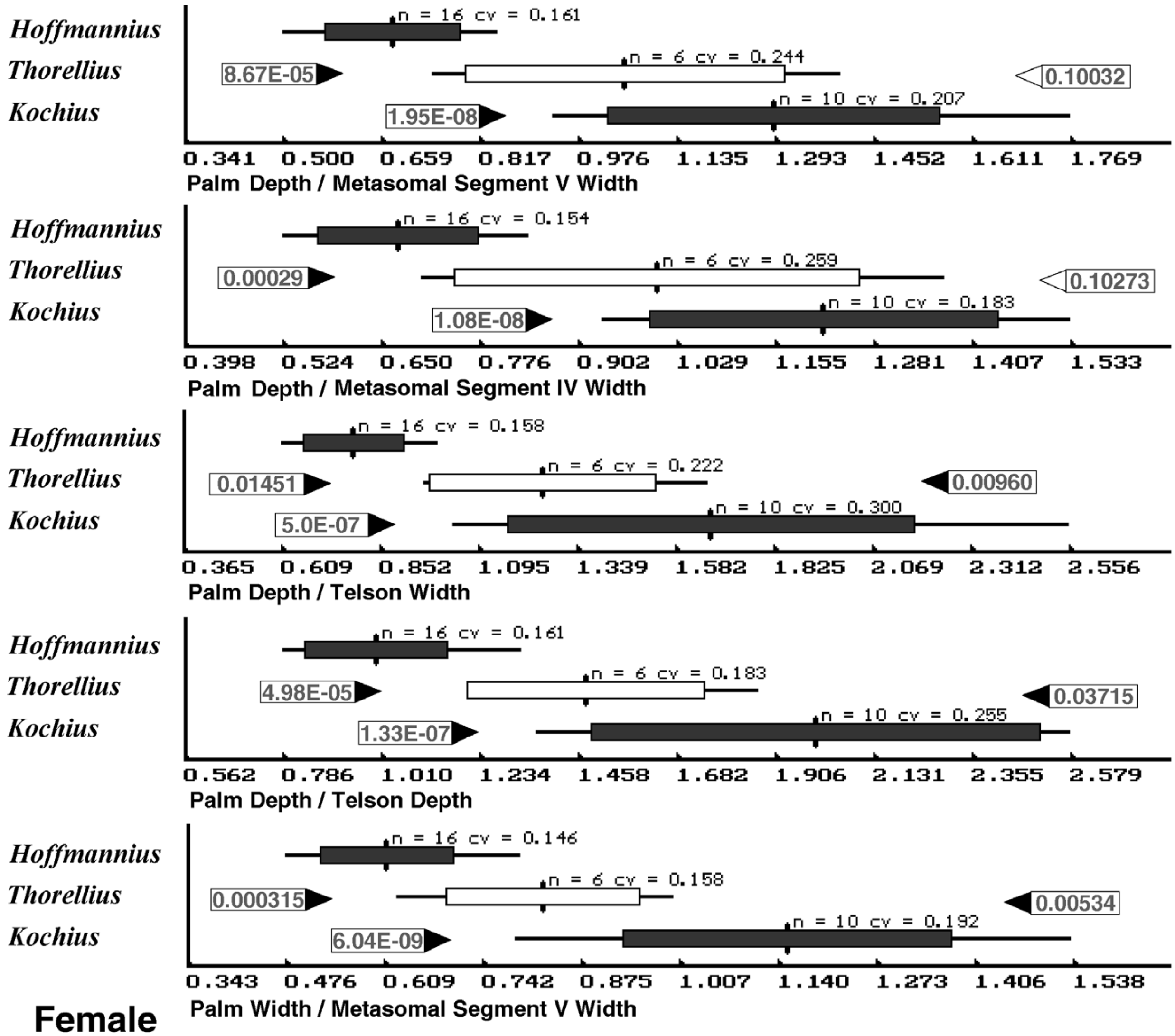


Figure 192: Histogram showing maximized morphometric ratios of species (female) in genera *Hoffmannius*, *Kochius*, and *Thorellius*. See Figure 193 for data on male, and Table 6 for additional data. Variance analysis p-values depicted in rectangles, *Hoffmannius* as compared to *Thorellius* and *Kochius* on left, and *Kochius* as compared to *Thorellius* on right. Statistically significant p-values (i.e., very small) indicated with black arrow. See Fig. 1 for explanation of histogram components.

genders, in the genera *Hoffmannius*, *Kochius*, and *Thorellius* utilizing the seven morphometrics isolated above:

1) palm depth / metasomal segment V width
2) palm depth / metasomal segment IV width
3) palm depth / telson width
4) palm depth / telson depth
5) palm depth / telson length
6–10) palm width / as above

Note that all ten ratios combine predominant morphometrics across both species sets, the large chelal palm in *Kochius* divided by the wide metasoma and large telson vesicle in *Hoffmannius*. Table 6 provides statistical data for these ten ratios across the three genera for both genders. Of these ten ratios, we concentrated on five which are highlighted in Tables 4–5, which show specific ratio values by species and gender, and Figures 192–195, which provide histograms and further statistical data.

The five histograms per gender presented in Figures 192–193 illustrate the significance of maximizing these morphometric ratios. It is apparent from these histograms that there is a significant standard error separation for all ratios between *Hoffmannius* and *Kochius*, and separation for eight out of ten ratios between *Hoffmannius* and *Thorellius*. In all cases, *Thorellius* is intermediate between *Hoffmannius* and *Kochius*. Of great significance is the absolute separation

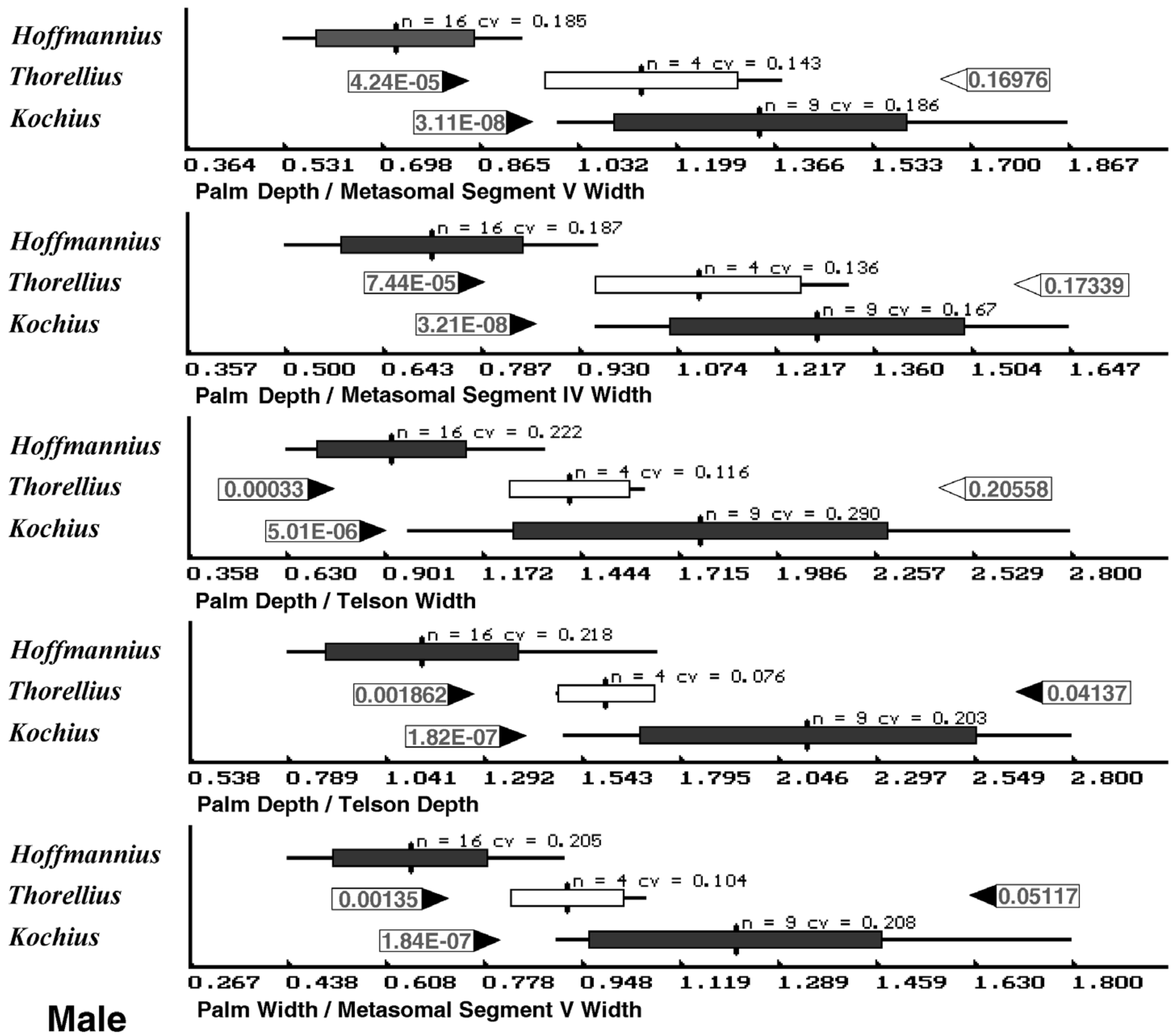


Figure 193: Histogram showing maximized morphometric ratios of species (male) in genera *Hoffmannius*, *Kochius*, and *Thorellius*. See Figure 192 for data on female and Table 6 for additional data. Variance analysis p-values depicted in rectangles, *Hoffmannius* as compared to *Thorellius* and *Kochius* on left, and *Kochius* as compared to *Thorellius* on right. Statistically significant p-values (i.e., very small) indicated with black arrow. See Fig. 1 for explanation of histogram components.

of both *Thorellius* and *Kochius* from *Hoffmannius* for males when the chelal depth is compared to the width of metasomal segment V. Note that this involves almost all species assigned to the three genera. Stated p-values for these comparisons are also quite small, implying a “statistical significance” when the variance is analyzed. For the just mentioned ratio, when *Hoffmannius* is compared to *Kochius*, we see considerably small p-values, 3.11E-08 and 1.95E-08, for males and females respectively.

Species discussion. Although we observe separation between *Hoffmannius* and the two genera *Kochius* and *Thorellius*, there is a lot of variability within the three genera with respect to these morphometric ratios. Tables 4–5 provide specific ratio values for all species, male and female. It is interesting to see which species in a genus is the closest to a “typical species” as defined by these ratios.

For genus *Kochius*, species *K. hirsuticauda*, *K. punctipalpi*, *K. bruneus*, *K. insularis*, and *K. magdalensis* in general have the highest ratio values across the genus. [Note that, since the dominant *Kochius* morphometrics, palm depth and width, form the numerator of the ratio, their effect will make the ratio larger]. These species are all primarily found in Baja California, Mexico. The species with the lower ratio values are *K. russelli*, *K. kovariki*, and *K. atenango*. These species normally exhibit a somewhat thinner chela. It is also interesting to point out that these species are found in western Mexico from Sonora and Durango,

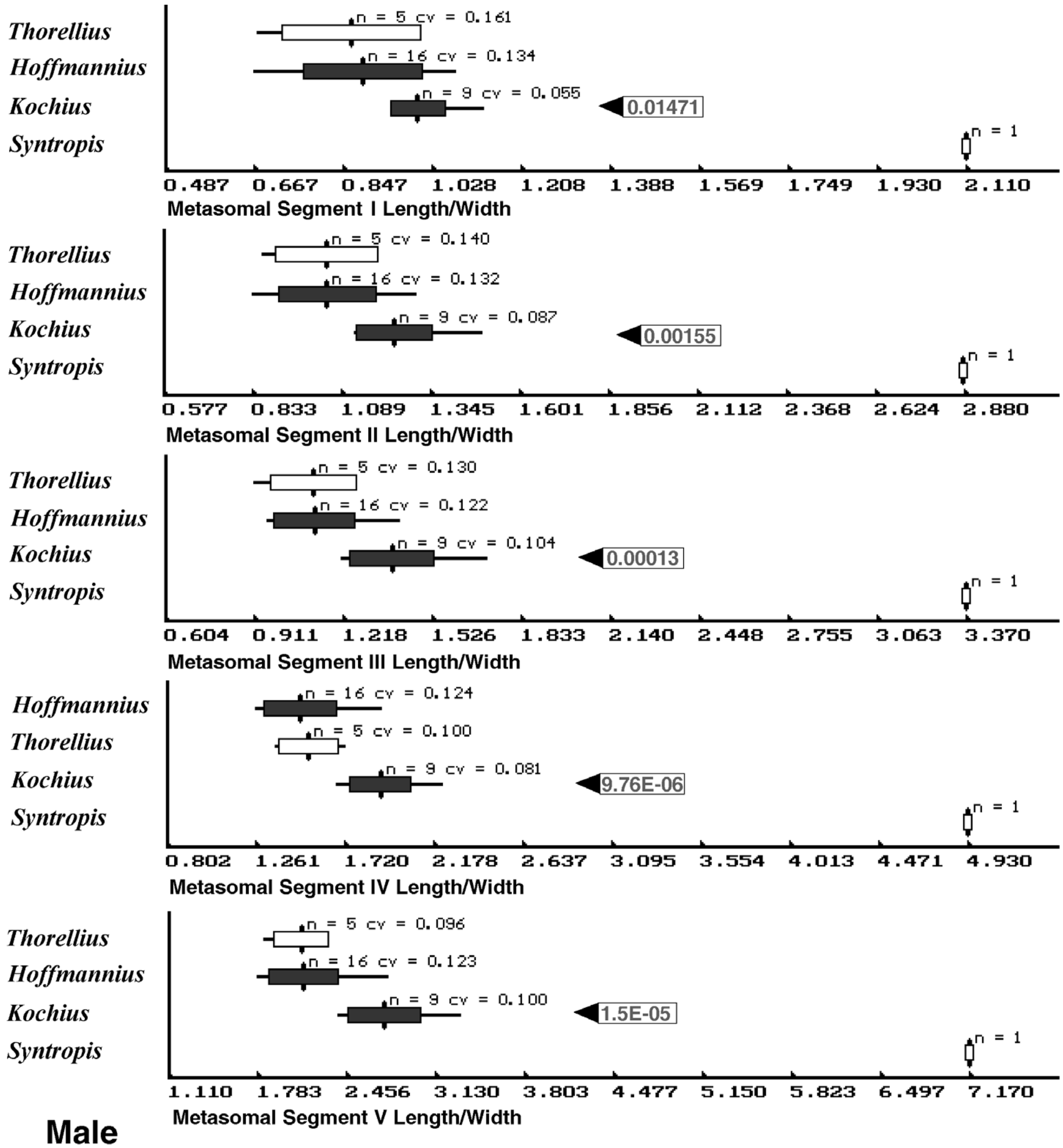


Figure 194: Morphometric ratios contrasting metasomal segments (length/width) for species in tribe Syntropini (male). Variance analysis p-values depicted in rectangles, *Hoffmannius* as compared to *Kochius*. Statistically significant p-values (i.e., very small) indicated with black arrow. See Fig. 1 for explanation of histogram components.

to Guerrero. Species *K. cazieri*, from Coahuila, Mexico, and *K. crassimanus* from southern Texas, are intermediate in these ratios.

In genus *Thorellius*, the species with generally the higher ratio values are *T. intrepidus* and *T. cristimanus*. Both of these species have very robust chelae. Species *T. subcristatus* and *T. occidentalis* exhibit less robust chelae and therefore show lower ratio values. *T. cisnerosi* and *T. atrox* are intermediate. It is interesting to point out that the ratio values for *T. intrepidus* and *T. cristimanus* are lower than those that dominate in *Kochius* species, such as *K. hirsuticauda*. This is due to the heavier metasoma (see below) and larger telson found in genus *Thorellius*.

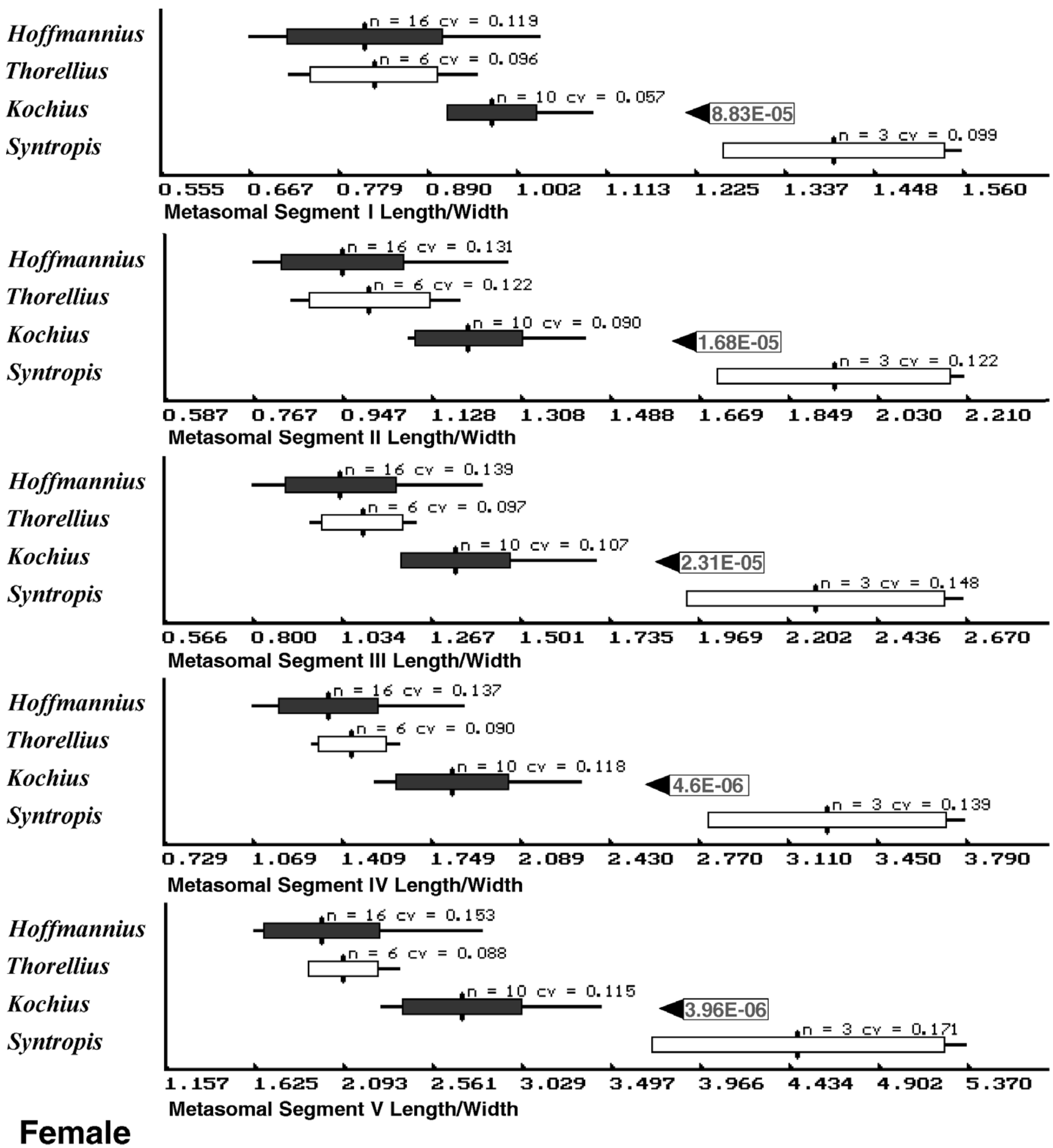


Figure 195: Morphometric ratios contrasting metasomal segments (length/width) for species in tribe Syntropini (female). Variance analysis p-values depicted in rectangles, *Hoffmannius* as compared to *Kochius*. Statistically significant p-values (i.e., very small) indicated with black arrow. See Fig. 1 for explanation of histogram components.

For genus *Hoffmannius*, there is a great variability in these ratio values, caused in most part by several species exhibiting somewhat heavy chelae, whereas others have longer and thinner chelae; all, however, have wide robust metasomas and telsons. Since dominant morphometrics for *Hoffmannius* form the denominator in the ratios, species with the smallest ratio values are typical of this genus. These species include *H. waeringi*, *H. gravicaudus*, and *H. waueri*. In *H. puritanus*, *H. glabrimanus*, and *H. coahuilae*, ratio values are somewhat large due to their relatively thin metasoma (see below).

Metasoma ratios. We also analyzed the relative heaviness of the metasomal segments where we formed ratios for each segment, length divided by its width. Tables 4–5 show these data on a species and gender basis, and Figures 194–195 show histograms for both genders of all four genera comprising tribe Syntropini.

The proportional differences in the metasoma for tribe Syntropini provide excellent diagnostic characters for its four genera. Figures 194–195 shows histograms of all five metasomal segments for the four genera. First and foremost, genus *Syntropis* has a very slender metasoma for both genders. All five segments are longer than wide, segment five, on average, is well over four times longer than wide, whereas in the other genera, the average is well under three times longer. Genus *Kochius* exhibits the next most slender metasoma, showing significant standard error differences in segments III–V, exhibiting very small p-values as compared to *Hoffmannius*, ranging from 0.00013 to 3.96E-06. The mean value difference between segments III–V for the two genera with the most slender metasomas, *Syntropis* and *Kochius*, are very significant: 71–166 %, 78–159 %, and 65–161 % percentage of difference (includes both male and female), thus further emphasizing a very slender metasoma of *Syntropis*. Genera *Hoffmannius* and *Thorellius* metasomal morphometrics are essentially the same, as seen in the histograms, standard deviation ranges essentially overlapped.

Of particular interest is a comparison between genera *Kochius* and *Hoffmannius*. Although we observe essential separation of standard deviation ranges for segments III–V, exhibiting a 24–29 %, 28–34 %, and 28–37 % percentage of difference between the mean values (includes both male and female), the two genera do overlap in some “end-point” species (i.e., an overlap between the most slender *Hoffmannius* and the most stocky *Kochius*). In Tables 4–5 (where the taxa are roughly ordered from the stockiest to thinnest metasomas), *H. puritanus* and *H. viscainensis*, the species with the thinnest metasoma in *Hoffmannius*, overlap with *Kochius sonorae* and *K. russelli*, the more stocky members of *Kochius*. At the other extreme, if we compare the mean value difference between the thinnest male *Kochius* (*K. hirsuticauda*) and the stockiest *Hoffmannius* (*H. gravicaudus*), we see a 87 % percent difference for segment V. Therefore, with the significant mean value differences exhibited and the standard error separation, we consider these differences in metasomal segment morphometrics to be significant and therefore a legitimate diagnostic character. Although we see these trends for all five metasomal segments, we only establish segments III–V as significant since they exhibit standard error range separation. It must be pointed out, however, that, although the metasomal segments III–V provide important diagnostic characters, they do not show the absolute range separation as exhibited in some of the maximized ratios discussed above.

The morphometrics presented in this effort were gathered primarily from literature but several specimens were measured when necessary. The following references provided morphometric data: Hoffmann (1931), Gertsch & Allred (1965), Gertsch & Soleglad (1972), Williams (1968a, 1970a, 1970b, 1971a, 1971b, 1980, 1986), Stahnke (1973), Sissom (1989b), Ponce Saavedra & Sissom (2004), Sissom & Hendrixson (2005), and Francke & González Santillán (2006).

Pectines

Diagnostic value: Pectinal tooth counts are used to differentiate tribes in subfamily Syntropinae.

Syntropinae. Soleglad & Fet (2003b: 61–65, figs. 110–113) discussed the number of pectinal teeth as it related to the mature size of the scorpion species, in particular, contrasting the four chactoid families, Chactidae, Euscorpiidae, Superstitioniidae, and Vaejovidae. In is interesting to point out here that this analysis by Soleglad & Fet (2003b) was based on the original observation of Soleglad (1973b: figs. 13–14) that within closely related species sets (e.g., a genus) the number of pectinal teeth is proportional to the scorpion species adult size; that is, larger species in a related species set will exhibit a larger pectinal tooth count than a smaller species in that same set. And, important to taxonomic analysis, the ratios derived from these comparisons differ across different species sets, thus providing a gross diagnostic indicator at the genus level or higher. In their analysis, based primarily on published data, Soleglad & Fet (2003b) demonstrated that pectinal tooth numbers in the family Vaejovidae is considerably higher than that found in the other three chactoid families, exhibiting, on average, an increase exceeding well over 100 % (i.e., as it relates to the species mature size). Consequently, a character was established in their cladistic analysis (character 103), where the more developed pectines was shown to be a synapomorphy for family Vaejovidae. See Soleglad & Fet (2003b: appendix D) for details and assumptions used in their analysis.

In this analysis, the data were recalculated to include all vaejovid species where the information was available (149 species). In particular, we use this metric to establish a significant difference in pectinal tooth numbers between the two tribes of subfamily Syntropinae, with that of tribe Stahnkeini being considerably higher (i.e., the ratio value is smaller) than that found in Syntropini. This was also discussed in Soleglad & Fet (2006).

The Total Length (TL)/Pectinal Tooth Count (PTC) ratios (female only) by genus are as follows (min–max (mean) (sdev) (sdev-range) [n]):

Gertschius = 1.517–1.923 (1.720) [2]
Serradigitus = 1.429–2.484 (1.942) [15]