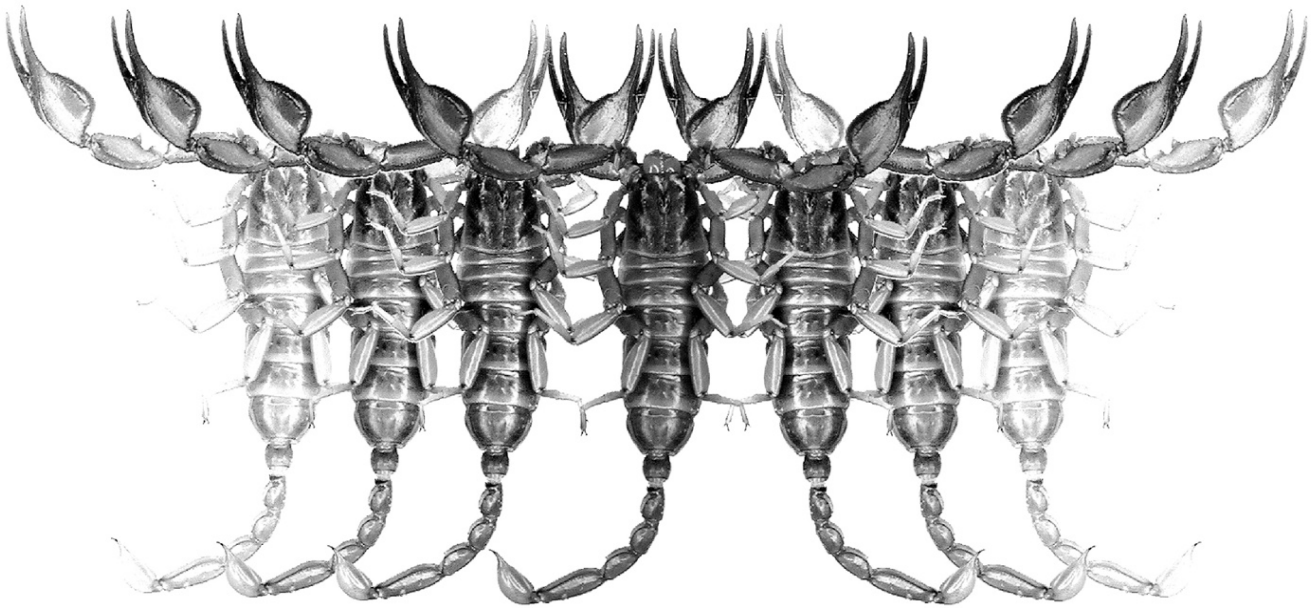# Euscorpius

Occasional Publications in Scorpiology

Revision of genus-group taxa in
the family Scorpiopidae Kraepelin, 1905,
with description of 15 new species
(Arachnida: Scorpiones)

František Kovařík, Graeme Lowe, Mark Stockmann & František Šťáhlavský

Euscorpius

Occasional Publications in Scorpiology

Euscorpius is the first research publication completely devoted to scorpions (Arachnida: Scorpiones). *Euscorpius* takes advantage of the rapidly evolving medium of quick online publication, at the same time maintaining high research standards for the burgeoning field of scorpion science (scorpiology). *Euscorpius* is an expedient and viable medium for the publication of serious papers in scorpiology, including (but not limited to): systematics, evolution, ecology, biogeography, and general biology of scorpions. Review papers, descriptions of new taxa, faunistic surveys, lists of museum collections, and book reviews are welcome.

Derivatio Nominis

The name *Euscorpius* Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpiidae).

Euscorpius is located at: https://mds.marshall.edu/euscorpius/
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ICZN COMPLIANCE OF ELECTRONIC PUBLICATIONS:

Revision of genus-group taxa in the family Scorpiopidae Kraepelin, 1905, with description of 15 new species (Arachnida: Scorpiones)

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Summary

The scorpiopids comprise a large scorpion family, distributed widely across the Oriental region, that currently encompasses 85 species placed under 8 genera and one subgenus. A variety of morphological characters have been used in the diagnoses of these genera or subgenera. Some characters were introduced by Vachon (1980) and Soleglad & Sissom (2001) when less than a few dozen species were known, while other more recent characters have not been fully evaluated. We critically review all characters that have been applied to generic or subgeneric taxonomy of the family, as well as several others hitherto neglected. We analyze their variation in the context of currently known species, including new species described herein. They are: 1) placement of trichobothrium Eb_3 with respect to Db and Dt on the pedipalp chela manus; 2) annular ring on the telson, at juncture between vesicle and aculeus; 3) alignment of trichobothria *db* and *eb* on the chela fixed finger; 4) neobothriotaxy on ventral chela manus; 5) number of inner accessory denticles (IAD) on pedipalp chela movable finger; 6) neobothriotaxy on external surface of pedipalp patella; 7) neobothriotaxy on ventral surface of pedipalp patella; 8) apophysis on movable finger of pedipalp chela; 9) sexual dimorphism; 10) number and size of lateral eyes; 11) spination of leg tarsus; 12) pectine morphology; and 13) hemispermatophore morphology. Genera *Alloscorpiops* Vachon, 1980, *Dasyscorpiops* Vachon, 1974, *Euscorpiops* Vachon, 1980, *Neoscorpiops* Vachon, 1980, *Plethoscorpiops* Lourenço, 2017, and *Vietscorpiops* Lourenço & Pham, 2015, and subgenus *Alloscorpiops* (*Laoscorpiops*) Lourenço, 2013, are all synonymized under *Scorpiops* Peters, 1861, **syn. n**. We describe 15 new species from Laos, Myanmar, Thailand, and Vietnam: *Scorpiops bastawadei* **sp. n**., *S. birulai* **sp. n**., *S. ciki* **sp. n**., *S. dii* **sp**. **n**., *S. dunlopi* **sp. n**., *S. kautti* **sp. n**., *S. krabiensis* **sp. n**., *S. pakseensis* **sp. n**., *S. phatoensis* **sp. n**., *S. prasiti* **sp. n**., *S. scheibeae* **sp**. **n**., *S. schumacheri* **sp. n**., *S. sherwoodae* **sp. n**., *S. soleglади* **sp. n**., and *S. thailandus* **sp. n**. Descriptions are complemented with color photographs of both live and preserved specimens, as well as their habitats. In addition to analysis of morphology, we also summarize known data about the cytogenetic characteristics of the Scorpiopidae. Moreover, we supplement this information with the karyograms of 16 species whose karyotypes were previously described without direct visualization. New synonymies proposed at the species level are: *Scorpiops* (*Vietscorpiops*) *dentidactylus* Lourenço & Pham, 2015 = *Scorpiops farkaci* Kovařík, 1993, **syn. n**.; *Euscorpiops karschi* Lourenço, Zhu & Qi, 2005 = *Scorpiops novaki* (Kovařík, 2005), **comb. n**., **syn. n**.; *Scorpiops atomatus* Qi, Zhu & Lourenço, 2005 = *Scorpiops tibetanus* Hirst, 1911, **syn. n**.; *Scorpiops pococki* Zhu, Qi & Lourenço, 2005 = *Scorpiops tibetanus* Hirst, 1911, **syn. n**.; *Euscorpiops validus* Di et al., 2010 = *Scorpiops vachoni* (Zhu et al., 2005), **comb. n**., **syn. n**. A distribution map of Scorpiopidae (95 species) is included.

Introduction

The main aim of this paper is to revise the genus-group taxonomy of the family Scorpiopidae. This large, complex assemblage of scorpions ranges from Afghanistan, across the Himalayas and peninsular India, to large parts of Southeast Asia, and currently includes nine genera or subgenera. We critically review all characters that were previously applied to diagnose these taxa, as well as several other characters, and revise the generic status of all known species. We also describe 15 new species.

The taxonomic rank and position of the group have shifted over the years. Early genera *Scorpiops* Peters, 1861 and *Parascorpiops* Banks, 1928 were placed in the subfamily Scorpiopsinae Kraepelin, 1905, under the family Vaejovidae. Later, these and four additional genera (*Dasyscorpiops* Vachon, 1974; and *Alloscorpiops*, *Euscorpiops*, and *Neoscorpiops*, originally defined as subgenera of *Scorpiops* by Vachon, 1980) were elevated to their own family 'Scorpiopsidae' (Stockwell, 1989, 1992; Lourenço, 1998) or Scorpiopidae (Fet, 2000; corrected spelling) and were associated with the

Figures 1–2. *Scorpiops hardwickii*, India, Uttaranchal State, ca. 30 km N of Bageshwar, SE of Dhakuri, 2600-2800 m a. s. l., FKCP, ♀, dorsal (1) and ventral (2) views. Scale bar: 10 mm.

Euscorpiinae and Megacorminae, rather than the vaejovids. In their phylogenetic analysis, Soleglad & Sissom (2001) downgraded this group of six genera to a tribe Scorpiopini of subfamily Scorpiopinae, under family Euscorpiidae. The other tribe included under Scorpiopinae was Troglocormini, containing the Mexican cave genus, *Troglocormus* Francke, 1982, originally described as a Megacormine. Prendini & Wheeler (2005), objecting to the methods of Soleglad & Sissom (2001), reinstated the family Scorpiopidae without further analysis. This was rejected by Fet & Soleglad (2005). More recently, the group was restored again to family status by checklist declaration without further analysis (Prendini, 2011; Lourenço, 2015). While we recognize the existence of morphological (Soleglad & Sissom, 2001; Monod et al., 2017) and molecular (Sharma et al., 2018; Santibáñez-López et al., 2019, 2020) evidence supporting an affinity of scorpiopids with euscorpiids, it is outside the scope of this paper to address the higher relationships of scorpiopids and the issue of familial vs. subfamilial rank. We use the family group name here only to be consistent with its most recent usage in the literature.

Monophyly of the scorpiopids was supported by cladistic analysis of morphological characters by Sissom & Soleglad

(2001) and Soleglad & Fet (2003a), but has not been tested further. We have independently confirmed monophyly by DNA analysis, the results of which will be published elsewhere (Šťáhlavský et al., in press). Below, we cite general results of that analysis in our discussions of generic characters.

Methods, Material & Abbreviations

Nomenclature and measurements follow Stahnke (1971), Soleglad & Sissom (2001), Kovařík (2009), and Kovařík & Ojanguren Affilastro (2013), except for trichobothriotaxy (Vachon, 1974), hemispermatophore structure (Monod et al., 2017) and sternum (Soleglad & Fet, 2003a).

Specimen Depositories: AMNH (American Museum of Natural History, New York, USA); BMNH (The Natural History Museum, London, United Kingdom); FKCP (František Kovařík, private collection, Prague, Czech Republic; will in future be merged with the collections of the National Museum of Natural History, Prague, Czech Republic); MHBU (Museum of the College of Life Sciences, Hebei University, China); MNHN (Muséum National d´Histoire Naturelle, Paris, France); NMPC (National Museum of Natural History, Prague, Czech Republic); ZISP (Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia); ZMHB (Museum für Naturkunde der Humboldt-Universität, Berlin, Germany); and ZMUH (Centrum für Naturkunde (CeNak), Center of Natural History Universität Hamburg, Zoological Museum, Hamburg, Germany).

Morphometrics: D, depth; L, length; W, width.

Movable finger dentition: ID, inner denticles; IAD, inner accessory denticles; MD, median denticles; OD, Outer denticles. Specimen locality coordinates cited without parentheses were provided by collectors (or were cited in the original descriptions), while coordinates in parentheses were estimated or inferred from online resources (e.g. Google Earth™).

Herein, the genera (or subgenera) *Alloscorpiops* Vachon, 1980, *Alloscorpiops* (*Laoscorpiops*) Lourenço, 2013, *Dasyscorpiops* Vachon, 1974, *Euscorpiops* Vachon, 1980, *Neoscorpiops* Vachon, 1980, *Plethoscorpiops* Lourenço, 2017, and *Vietscorpiops* Lourenço & Pham, 2015, are all synonymized under *Scorpiops* Peters, 1861. However, we repeatedly refer to these names below in the context of analysis and discussion of taxonomic characters that have been used to define the genera.

Cytogenetic methods follow the protocols already described in previous articles characterizing karyotypes of scorpiopid species (Kovařík et al., 2013a, 2015a, 2015c, Šťáhlavský et al., in press). In this study we supplemented the previously published data with karyograms. These were derived from photographs of male postpachytene chromosomes obtained with an ORCA-AG monochromatic camera (Hamamatsu) on an Olympus IX81 microscope operated by Cell^R. The karyotypes show also the location of nucleolus organizer regions (NORs) using FISH with 18S rDNA probe (red signal) (see Šťáhlavský et al., in press) on the same chromosome as in the karyogram (ppach) and additionally, in some species also on chromosomes during pachytene (pach) or metaphase II (met II).

Brief taxonomic history of genus-group taxa in Scorpiopidae

The first genus of the family, *Scorpiops*, was described by Peters (1861: 510) with type species *Scorpio hardwickii* Gervais, 1843 (Figs. 1–2). Subsequently, Banks (1928: 505–506) added the monotypic genus *Parascorpiops* with type species *P. montanus*, differentiated by the possession of two pairs of lateral eyes (all species of *Scorpiops* then known were thought to have three pairs). Francke (1976: 78–80) challenged the validity of lateral eye counts as generic character, as have other authors (e.g., Stockwell, 1989). Vachon (1974) described three fundamental trichobothrial patterns of scorpions (orthobothriotaxic types A, B and C) and categorized *Scorpiops* as type C, but with additional ('accessory') trichobothria present on the patella or chela manus, i.e., additive neobothriotaxy, which actually occurs on the patella of all scorpiopids. In the same publication, Vachon erected the monotypic genus *Dasyscorpiops* (p. 952–953, figs. 142, 147, 160–162) with type species *D. grandjeani*, based on numerous accessory trichobothria on the pedipalp patella. The holotype, and only specimen then known, had 59–60 external and 23 ventral trichobothria on the patella, a much higher neobothriotaxic number than *Scorpiops*. However, Francke (1976: 82) questioned the logic of separating *Dasyscorpiops* from *Scorpiops* by neobothriotaxy alone. He argued that the two (then) congeneric species, *Euscorpius germanus* and *E. italicus* also bore accessory patellar trichobothria, with counts of the latter exceeding counts of the former in a proportion similar to those of *Dasyscorpiops* vs. *Scorpiops*.

Vachon (1980: 143–160, figs. 1–40) revised the genus *Scorpiops* and introduced the three subgenera *Alloscorpiops*, *Euscorpiops*, and *Neoscorpiops*, diagnosed by different numbers of accessory trichobothria and relative positions of certain trichobothria on the pedipalp chela manus and fixed finger. In particular, *Alloscorpiops* was characterized by the presence of accessory trichobothria on the ventral surface of the pedipalp manus (i.e., more than the orthobothriotaxic count of 4), and both *Euscorpiops* and *Neoscorpiops* by the presence of higher numbers of accessory trichobothria on the external surface of the patella. Nominotypic subgenus *Scorpiops* was characterized as having lower additive neobothriotaxy on the external patellar surface, with 17 trichobothria (vs. orthobothriotaxic count of 13), whereas the range was 18–20 in *Euscorpiops*, and 22–26 in *Neoscorpiops*. All three subgenera were elevated to generic status by Lourenço (1998: 246) as a formality, without any further study of the species. Kovařík (2000) was the first to revise the scorpiopids, and synonymized *Euscorpiops* under *Scorpiops*, arguing that a mimimal difference of only a single accessory trichobothrium on the external patella (17 vs. 18) was not a stable character. As an example, he cited the holotype of *Scorpiops kraepelini* (= *Euscorpiops lindbergi*) as having an external patellar count of 17 on one side, and 18 on the other side (see Kovařík, 2000: 164, 186–188), showing that the difference fell within the range of individual variation.

Soleglad & Sissom (2001: 96) concurred that a single extra accessory trichobothrium was not a reliable character for separating *Euscorpiops* from *Scorpiops*, but they resurrected *Euscorpiops* on the basis of other characters. The primary character was placement of trichobothrium Eb_3 with respect to *Db* and *Dt* on the chela manus. In *Scorpiops*, Eb_3 was between *Db* and *Dt*, and in *Euscorpiops* it was distal to *Dt*. A secondary character concerned a modification of the telson, i.e., an annular ring-like constriction at the juncture between the vesicle and aculeus. The ring was absent in *Scorpiops* and present in at least the males of *Euscorpiops*. On the basis of these characters, Soleglad & Sissom (2001: 96) transferred *Euscorpiops lindbergi* to *Scorpiops*, and 8 species of *Scorpiops* were transferred to *Euscorpiops* (i.e., *E. asthenurus*, *E. bhutanensis*, *E. binghamii*, *E. kaftani*, *E. longimanus*, *E. montanus*, *E. problematicus*, and *E. sejnai*).

Lourenço (2013a) described a new species, *Alloscorpiops calmonti*, and created for it the subgenus, *Alloscorpiops* (*Laoscorpiops*). The subgenus was differentiated from other *Alloscorpiops* by the presence of two accessory trichobothria on the proximal external surface of the chela manus, that were labelled as part of the '*Eb*' series. Kovařík et al., (2013b) argued that this was unjustified and synonymized the subgenus under the nominotypic genus. However, Lourenço & Pham (2015b) reinstated *Alloscorpiops* (*Laoscorpiops*) without further analysis. Lourenço & Pham (2015a) also described a new species, *Scorpiops dentidactylus*, and created for it a subgenus, *Scorpiops* (*Vietscorpiops*). This subgenus was differentiated from other *Scorpiops* by having only 2 pairs of lateral eyes and an internal apophysis on the movable finger of the pedipalp chela. Pham et al. (2017) elevated this subgenus to the rank of a genus, *Vietscorpiops*, by checklist declaration without analysis or justification. Most recently, Lourenço (2017) created another genus, *Plethoscorpiops*, for a new species *P. profusus*. The genus was diagnosed by high additive neobothriotaxy on the pedipalp chela manus, with 19 accessory trichobothria on the external surface and 37–39 on the ventral surface.

Taxonomic characters

Soleglad & Sissom (2001: 95) relied on seven characters to diagnose six genera referred to the tribe Scorpiopini (= Scorpiopidae, in the current sense). At the time, only about 30 species were known. Today, including new taxa described herein, the number of species has more than tripled to 95. More material is also available representing some older taxa. A thorough review of generic characters is thus warranted to test if they still support the division of scorpiopids into the currently recognized genera. In numbered sections below (§1–§7), we address the corresponding numbered characters of Soleglad & Sissom (2001: 95) that were listed in order of presumed importance.

Since 2001, additional generic or subgeneric names have been introduced: *Alloscorpiops* (*Laoscorpiops*) Lourenço, 2013; *Vietscorpiops* Lourenço & Pham, 2015;

and *Plethoscorpiops* Lourenço, 2017. *Alloscorpiops* (*Laoscorpiops*) and *Plethoscorpiops* were based solely on neobothriotaxic characters (reviewed in §4). *Vietscorpiops* was based in part on an unusual modification of the pedipalp movable finger, presumed to be a secondary sexual characteristic (reviewed in §8). We also critically evaluate the following five additional characters: §9, sexual dimorphism; §10, number and size of lateral eyes; §11, spination of leg tarsi (see also Soleglad & Sissom, 2001: 61, figs. 161–164); §12, pectine morphology (see also Soleglad & Sissom, 2001: 69, figs. 192–203); and §13, hemispermatophore morphology.

The need for a critical review of generic characters is illustrated by cases of uncertain application. For example, Lourenço & Pham (2014) described *Euscorpiops dakrong* from Vietnam. Diagnostic characters for placement in *Euscorpiops* were not stated, only that it "exhibits the general characteristics of the genus *Euscorpiops*". This seemed inconsistent with their fig. 3h (Lourenço & Pham, 2014: 539) showing the chela manus trichobothrium Eb_3 proximal to *Dt*, a diagnostic character for *Scorpiops* (Vachon, 1980; Soleglad & Fet, 2001). Subsequently, Lourenço & Pham (2015a) mentioned a conflict in generic diagnoses of Soleglad & Sissom (2001) when applied to *E. dakrong* and another species, *Scorpiops oligotrichus*. Both have Eb_3 proximal to *Dt* (diagnostic for *Scorpiops*), but also have a telson with an annular constriction at the base of the aculeus (diagnostic for *Euscorpiops*). Faced with this conundrum, they transferred *E. dakrong* to the genus *Scorpiops*, granting precedence to trichobothrial position as the more stable character. On the other hand, the species appears to bear a rather large number of inner accessory denticles (IAD) on the movable pedipalp finger (Lourenço & Pham, 2014: 538, fig. 2f), which is more typical for *Euscorpiops* (cf. Soleglad & Sissom, 2001: 95). We discuss these characters in detail below (§1, §2 and §5).

§1. Placement of trichobothrium Eb_3 with respect to *Db* and *Dt* on the pedipalp chela manus

In scorpiopids, placement of the dorsal and external trichobothria on the chela manus generally complies with the orthobothriotaxic type C pattern (Vachon, 1974). Trichobothria *Dt* and *Db* are situated in the proximal 3/5 of the manus, with *Dt* dorsal to, and *Db* external to the digital carina. Trichobothria Eb_1, Eb_2 and petite *Esb* form a relatively compact triad in the ventro-proximal corner of the external surface. Along the proximal-distal axis, Eb_3 is level with or distal to *Db*, and its position in different species varies widely over the proximal 1/5 to 2/3 of the manus. *Dt* is also quite variable between species in its axial position. The position of Eb_3 relative to *Dt* has been applied as a character to separate scorpiopids into two major subdivisions: *Scorpiops* and *Neoscorpiops* were diagnosed as having Eb_3 either proximal to, or level with *Dt* ($Eb_3 \leq Dt$; e.g., Figs. 11–15, 17, 92; Soleglad & Sissom, 2001: 52, figs. 113–114; Vachon, 1980: 149, 152;
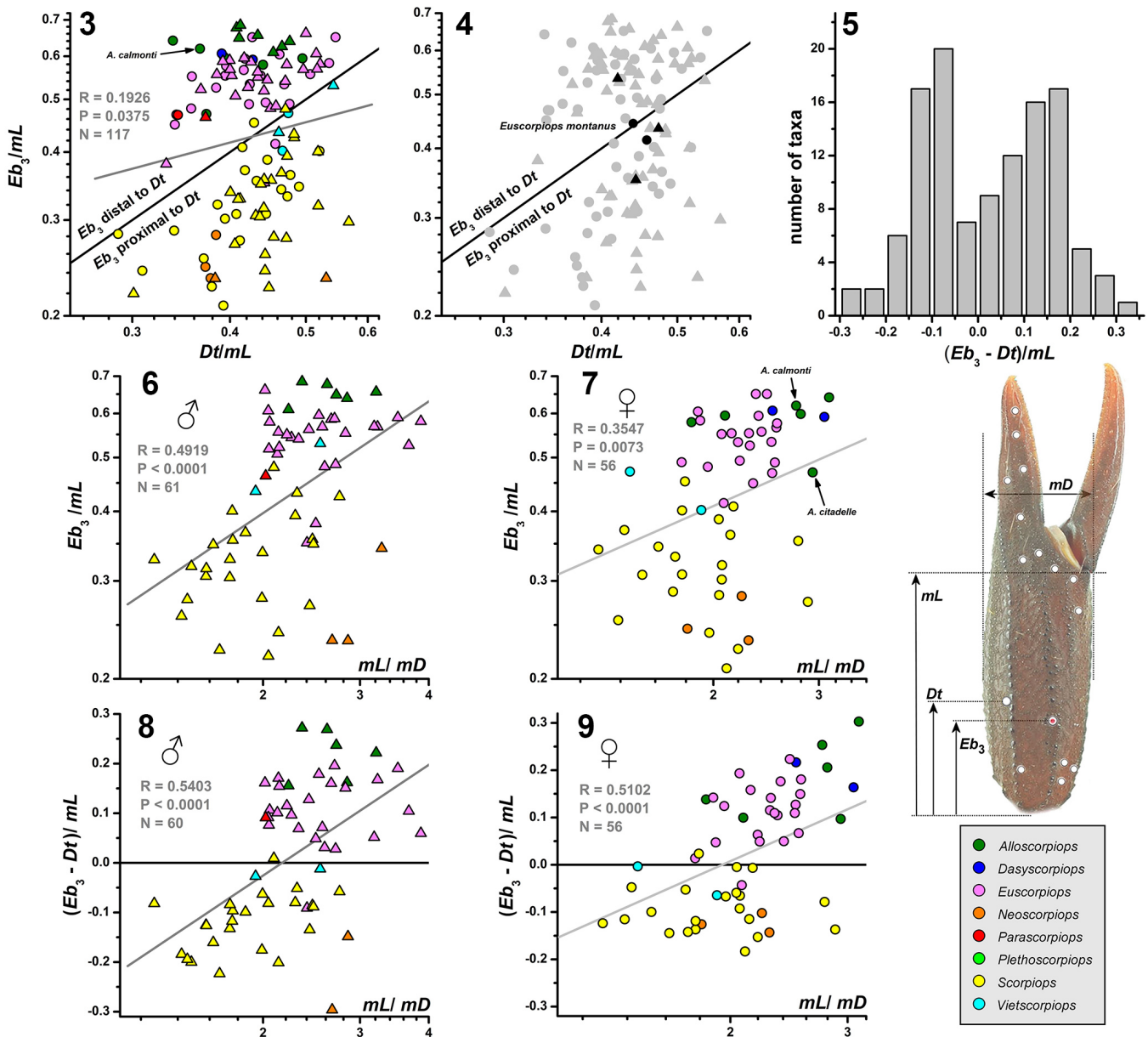
Figures 3–9: Variation in positions of trichobothria Eb_3 and Dt on the manus of the pedipalp chela of scorpiopids. **Figure 3**. Bivariate logarithmic scatter plot of normalized positions of Eb_3 vs. Dt along the proximal-distal axis of the manus (normalized by manus length, mL), for males (triangles, 61 species) and females (circles, 56 species). Biometrics defined in right page inset. Data compiled from published trichobothrial maps, and study of our own material. Each symbol represents one species with a total of 84 species (= 90% of the 93 known scorpiopids). For illustrative purposes, symbols are color-coded (color key in lower right page inset) by old generic assignments determined by trichobothriotaxic scheme of Soleglad & Sissom (2001), including new species described herein under *Scorpiops*. Eb_3 is level with Dt along the black diagonal line, distal to it above the line, and proximal to it below the line. Gray line is least squares regression fit to all 117 points, showing weak or insignificant correlation between Eb_3 and Dt position. "*Alloscorpiops*" *calmonti* (indicated arrow) clusters high with other "*Alloscorpiops*", assuming homology of mid-manus trichobothrium with Eb_3. **Figure 4**. Scatter plot of Fig. 3, with 5 specimens of *S. montanus* highlighted in black symbols. Intraspecific variation encompasses cases with Eb_3 distal to, level with, or proximal to Dt, invalidating the use of the relative positions of these two trichobothria as a taxonomic character. **Figure 5**. Histogram showing distribution of position of Eb_3 relative to Dt. Vertical separation from the diagonal of each point in Fig. 3 was calculated and binned at intervals of 0.05. Zero value on abscissa corresponds to Eb_3 level with Dt. **Figures 6–7**. Logarithmic scatter plots of normalized position of Eb_3 along proximal-distal axis vs. L/D ratio of manus for 61 male (6) and 56 female (7) scorpiopids. Female "*A.*" *calmonti* (7, upper arrow) clusters with other "*Alloscorpiops*" and with "*Euscorpiops*" having elongated manus, if we interpret the mid-manus trichobothrium as Eb_3. Female "*A.*" *citadelle* (7, lower arrow) is separated from other "*Alloscorpiops*" by having less distal Eb_3, although it has an elongated manus. Gray lines are least squares regressions, showing significant positive correlation between distal placement of Eb_3 and manus elongation. **Figures 8–9**. Scatter plots of position of Eb_3 relative to Dt along proximal-distal axis vs. L/D ratio of manus for 60 male (8) and 56 female (9) scorpiopids. Abscissa scale is logarithmic. Gray lines are least squares regressions, showing significant positive correlation between distal placement of Eb_3 relative to Dt and manus elongation. R=Pearson´s correlation coefficient.

figs. 3, 11); *Alloscorpiops*, *Dasyscorpiops*, *Euscorpiops* and *Parascorpiops* were diagnosed as having Eb_3 distal to Dt ($Eb_3 > Dt$; e.g., Figs. 10, 16, 94; Soleglad & Sissom, 2001: 52, figs. 115, 117; Vachon, 1980: 153–154, figs. 19, 27). This dichotomy was used in the first couplet of the scorpiopid key of Soleglad & Sissom (2001: 96).

The position of Eb_3 is a continuously distributed variable, and if Dt is an independent landmark that arbitrarily splits this distribution then artificial categories will result. Conversely, if Eb_3 is linked with Dt such that the distance between them has a disjunct bimodal distribution, then discrete categories would emerge. To test this, we compared axial positions of Eb_3 and Dt for a majority of scorpiopid species. In Figure 3, Eb_3 position is plotted against Dt position (both normalized to manus ventral length, *mL*) for 61 male and 56 female scorpiopids. We found that species points were widely scattered, and Eb_3 and Dt were only weakly correlated (P = 0.0375). Dt position can vary widely, almost independent of Eb_3, and vice versa. The black diagonal line marks the boundary between Eb_3 being distal vs. proximal to Dt. Species that were placed in *Scorpiops* and *Neoscorpiops* (yellow and orange symbols) fall below the diagonal, and those in *Alloscorpiops*, *Dasyscorpiops*, *Euscorpiops*, and *Parascorpiops* (olive, dark blue, magenta, and red symbols) sit above it. This merely reflects the fact that taxonomists mostly followed the prescription of Soleglad & Sissom (2001) in their generic assignments of new taxa. An exception is *Euscorpiops montanus* (sub-diagonal magenta symbols), which is discussed below. For illustrative purposes, the new species described herein are also plotted with the old generic assignments according to Soleglad & Sissom (2001). Genus *Alloscorpiops*, diagnosed by ventral neobothriotaxy on the chela manus, clusters in the upper region of the plot, with more distal Eb_3 locations (olive symbols). Grouped together in this cluster is *A. calmonti* Lourenço, 2013, whose Eb_3 homology and position have been disputed (Kovařík et al., 2013; Lourenço, 2017). In our plot, we took the most parsimonious interpretation and identified the mid-manus trichobothrium straddling the external secondary carina as Eb_3, matching the patterns of Eb_{1-3} and *Esb* in other species of *Alloscorpiops* and *Euscorpiops*. The original description relabeled as Eb_3 what we interpret here as Eb_1 (Lourenço, 2013a). That would place *A. calmonti* below the diagonal near the bottom of the plot, very far from all other *Alloscorpiops*. This issue is further discussed below (**§4**).

In Fig. 3, the distribution of taxa in bivariate space is non-uniform. When $Dt < \sim 0.4$, the local distribution of Eb_3 exhibits a gap between above and below diagonal points, consistent with a division into two categories. However, when $Dt > \sim 0.4$, Eb_3 is continuously distributed without distinct gaps. A number of species are located either on the diagonal, or close to it (slightly above or below it). Thus, the condition $Eb_3 \leq Dt$ inclusive of diagonal points, is an arbitrary, ambiguous diagnostic character. Most species plotted in Fig. 3 are represented by single specimens, and we expect intraspecific variation to further blur the distinction

between above- and below-diagonal groups. Indeed, the plot of Fig. 4 shows 5 individuals belonging to a single species, *Euscorpiops montanus*, that are positioned above, directly on, and below the diagonal line (see also Figs. 10–14). Also, species formally referable to the genus *Vietscorpiops* based on the presence of an apophysis on the movable pedipalp finger (Fig. 3, cyan symbols) locate both below and slightly above diagonal. The histogram in Fig. 5 shows that the distance between Eb_3 and Dt does have a bimodal distribution, with above- and below-diagonal peaks. However, this distribution is continuous and non-zero across the origin ($Eb_3 – Dt = 0$), with no gap to naturally separate species into disjoint categories. Furthermore, the character state of Eb_3 being level with Dt is ill-defined categorically, as there is no isolated sharp peak at the origin.

Taxonomic instability of the Eb_3 vs. Dt character is also evident for species that should be closely related to each other according to other morphological features, but differ markedly in relative positions of Eb_3 and Dt. For example, *Scorpiops petersi* and *Scorpiops vonwicki* (originally described as subspecies, *Scorpiops petersii vonwicki*) are very similar. Both have Eb_3 at approximately the same axial position. However, Dt is level with Eb_3 in *S. vonwicki*, and distal to Eb_3 in *S. petersii* (cf. Figs. 19–20 vs. Figs. 17–18).

We applied DNA analysis to reconstruct phylogenetic relationships of 21 scorpiopid species (Šťáhlavský et al., in press). We found that higher level classification based on position of Eb_3 relative to Dt was polyphyletic and incongruent with the retrieved molecular phylogeny. Taking $Eb_3 \leq Dt$ as plesiomorphic, and $Eb_3 > Dt$ as derived (Eb_3 is proximal to Dt in most orthobothriotaxic type C outgroup taxa), this character scored low consistency and retention indices (both 0.25), indicating high homoplasy. Apparently, Eb_3 placement distal to Dt has evolved independently in at least 4 major clades. This derived state is related to elongation of the pedipalp chela. Species with more proximal Eb_3 have more robust chelae, while those with Eb_3 in more distal locations near mid-manus have more elongated, flattened chelae. This was shown by our finding of a positive correlation between normalized Eb_3 position and chela manus L/D ratio in both sexes (Figs. 6–7). We also found that Eb_3 position relative to Dt was positively correlated with manus L/D (Figs. 8–9), i.e., as the chela becomes more elongated, Eb_3 shifts from proximal to distal, passing Dt. On the other hand, there was no significant positive correlation between Dt position and manus L/D (P > 0.05 for both sexes; data not shown). This is consistent with statistical independence of Eb_3 and Dt positions. Morphometric stretching of pedipalps and other appendages is often associated with lithophilic adaptation (Polis, 1990; Prendini, 2001). We hypothesize that lithophilic ecomorphotypes evolved independently in several different scorpiopid lineages, leading to homoplasy of the character $Eb_3 > Dt$.

For the purposes of descriptive taxonomy at the species level, we define the following empirical combinations of Eb_3 vs. Dt position (cf. Table 9):

Figures 10–20: *Scorpiops* spp., pedipalp chela external (10–16, 18 and 20) and dorsal (17 and 19) views. Trichobothria Dt and Eb_3 are indicated by white open circles. **Figures 10–14**. *S. montanus*, juvenile, holotype, ZMHB (10), female (11) and male reared from litter of female 11 (12), India, Uttarakhand State, Dhika forest, 29.65°N 78.94°E, FKCP, female (13) and male (14) from India, Uttarakhand State, Rishikesh, 30.13°N 78.32°E, FKCP. In the juvenile holotype, Eb_3 is located distal to Dt (Fig. 10); in the female from Dhika forest, Eb_3 is located slightly distal to Dt (Fig. 11) but the male from her litter has Eb_3 proximal to Dt (Fig. 12); in both specimens from Rishikesh, Eb_3 is proximal to Dt but its relative position differs between individuals (Figs. 13–14). **Figure 15**. *S. hardwickii*, female, India, Uttaranchal State, ca. 30 km of Bageshwar, SE of Dhakuri vill., 2600–2800 m a. s. l., FKCP. **Figure 16**. *S. asthenurus*, male, India, Meghalaya State, Nong Poh env., FKCP. **Figures 17–18**. *S. petersii*, male, India, Himachal Pradesh State, Molta, FKCP. **Figures 19–20**. *S. vonwicki*, female, holotype, ZISP.

A. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est* (Fig. 16).

B. Chelal trichobothrium Eb_3 located in middle of manus at same level as *Dt* (Fig. 527–528).

C. Chelal trichobothrium Eb_3 located in middle of manus between trichobothria *Dt* and *Est* (Fig. 364–365).

D. Chelal trichobothrium Eb_3 located in proximal half of manus between trichobothria *Dt* and *Db* (Figs. 17–18).

E. Chelal trichobothrium Eb_3 located in proximal half of manus at same level as *Dt* (Figs. 19–20).

§2. Annular ring on telson at juncture between vesicle and aculeus

An annular ring-like constriction of the telson, separating vesicle and aculeus, was first reported by Vachon (1980). According to his diagnoses, it was present in *Alloscorpiops* (1 sp.), 'more or less' present in *Euscorpiops* (4 spp.) and absent in *Scorpiops* (12 spp.) and *Neoscorpiops* (3 spp.). Soleglad & Sissom (2001) confirmed its presence in both sexes of *Alloscorpiops* (1 sp.) and "generally in both sexes" of *Euscorpiops* (3 spp.). They noted that it was well expressed in males, and suggested that its development may exhibit sexual dimorphism. According to their key, the ring was absent in *Scorpiops* (4 spp.), *Neoscorpiops* (1 sp.), *Dasyscorpiops* (1 sp.), and *Parascorpiops* (1 sp.). The species they examined were a subset of those listed by Vachon (1980). Tikader & Bastawade (1983) reported a ring in *Euscorpiops* (4 spp.), but not in *Scorpiops* (8 spp.) and *Neoscorpiops* (3 spp.). Their species were also a subset of those listed by Vachon (1980), except for *E. bhutanensis*. Overall, the character state was scored for 21 species by various authors. Stockwell (1989) referred to it as the "suturiform groove" and postulated that it was a shared derived character in *Alloscorpiops*, *Euscorpiops*, and *Troglocormus*. Soleglad & Sissom (2001) proposed this as a generic character in their key, although they could examine only a small sample of individuals and species, and knew that it needed further testing (personal communication). We have reviewed this character in 70 scorpiopid species and found that most have a ring present, at least in males (see Figs. 21–76). A ring was undetected in only 2 species (i.e., *Neoscorpiops satarensis*, *N. tenuicauda*). We cannot exclude the possibility of intraspecific variation in these species, in particular sexual dimorphism. Soleglad & Sissom (2001: 33, fig. 183) illustrated the telson of a female *S. leptochirus* without the ring. However, we show here an annular ring is present in a male of *S. leptochirus* (Fig. 37). Importantly, a ring is also present in the male holotype of *S. hardwickii* (Fig. 30), the type species of genus *Scorpiops*. This invalidates the diagnosis of *Scorpiops* as lacking a ring. Our finding of widespread expression of the ring, and the occurrence of sexual dimorphism in at least some species, shows that this is not a reliable character for either genus or species level taxonomy.

§3. Alignment of trichobothria *db* and *eb* on the chela fixed finger

Vachon (1980) proposed that axial alignment of trichobothria *db* and *eb*, at the base of the pedipalp chela fixed finger, was diagnostic for the genus *Scorpiops*. In contrast, *Neoscorpiops* was diagnosed as having *db* slightly distal to *eb*, although still located proximally on the finger. *Euscorpiops* was characterized as having *db* level with *eb*, in contrast to *Alloscorpiops* with *db* near mid-finger and distant from *eb*. Soleglad & Sissom (2001: 95) used similar characters in their key. They stipulated that *db* was distal to *eb* in *Euscorpiops*, and "extremely" so in *Alloscorpiops*.

In our survey of a much larger sample of species, we found considerable variability in relative positioning of *db* and *eb*. The plot in Fig. 77 compares metrics of distal positioning of *db* and *eb* for 57 male and 57 female scorpiopids. Manus trichobothrium Et_5 is a relatively stable landmark near the base of the fixed finger, so we used its chord distance to finger terminus as a proxy for fixed finger length. On this plot, ordinate (or abscissa) axis is the difference between the fixed finger terminus chord distance of *db* (or *eb*), and that of Et_5 (normalized to chord distance of the latter). The black diagonal line marks the boundary between *db* being distal vs. proximal to *eb*. It can be seen that almost all points are located on or above the diagonal, showing that *db* is normally level with or distal to *eb*. In this plot, generic assignments were based on the Eb_3 vs. *Dt* character (cf. **§1**). The plot reveals much scatter in *db* and *eb* distal positioning. Although *Euscorpiops* tends to have *db* more distal to *eb* than *Scorpiops*, their bivariate distributions are broadly overlapping. Genera *Alloscorpiops*, *Dasyscorpiops*, and *Plethoscorpiops* have *db* most distal to *eb*, so their data points group together in the upper region of the plot. However, this grouping encroaches on the upper end of the *Euscorpiops* distribution. The wide variation in relative positioning of *db* vs. *eb*, and its conflict with genera previously defined by positions of Eb_3 vs. *Dt*, prevents its use as a reliable diagnostic character to differentiate genera.

In **§1** we showed that distal positioning of manus Eb_3 was correlated with chela manus elongation. A similar trend is seen for distal positioning of *db* on the fixed finger (see fig. 114 vs. figs. 113, 115–118 in Soleglad & Sissom, 2001: 5). Approximate axial alignment of *db* and *eb* occurs in species with a stout chela and short fixed finger, whereas *db* is more distal to *eb* in species with an elongated chela and long fixed finger. Plots in Figs. 78–79 show positive correlations between a normalized metric of distal position of *db* relative to *eb*, and manus L/D. The correlation was weaker for males ($0.01 < P < 0.05$) than for females ($P < 0.01$), a difference that may be related to secondary sexual modification of pedipalp fingers in adult males. Since there appears to be a common link to chela elongation, we tested whether distal positioning of *db* was directly correlated with distal positioning of Eb_3 or *Dt* on the manus. For *Dt* position, we found no positive correlation with our normalized *db* vs. *eb* metric (Fig. 80).

Figures 21–52: *Scorpiops* spp., telson lateral. **Figure 21**. *S. affinis*, male, lectotype. **Figure 22**. *S. afghanus*, female, holotype. **Figure 23**. *S. braunwalderi*, male, holotype. **Figure 24**. *S. dastychi*, female, paratype. **Figure 25**. *S. demisi*, female, holotype. **Figure 26**. *S. farkaci*, male, holotype. **Figure 27**. *S. feti*, male, paratype. **Figure 28**. *S. furai*, female, holotype. **Figure 29**. *S. grosseri*, female, holotype. **Figure 30**. *S. hardwickii*, male, holotype. **Figure 31**. *S. harmsi*, female, holotype. **Figure 32**. *S. hofereki*, female, holotype. **Figure 33**. *S. irenae*, female, holotype. **Figure 34**. *S. jendeki*, male, holotype. **Figure 35**. *S. kejvali*, male, holotype. **Figure 36**. *S. langxian*, male, China, Tibet, W. Kangtissu Shan Mts., Nakaeh Cushul, 4200 m a. s. l., FKCP. **Figure 37**. *S. leptochirus*, male (306), India, Meghalaya State, Nong Poh env., FKCP. **Figure 38**. *S. lhasa*, female, topotype, China, Tibet, Lhasa, 3700 m a. s. l., FKCP. **Figure 39**. *S. lindbergi*, male, holotype of *S. kraepelini*. **Figure 40**. *S. margerisonae*, male, holotype. **Figure 41**. *S. oligotrichus*, male (508), Laos, Xieng Khouang Province, Tham Xang Caves, Phone Savan, near Muang Khoun, FKCP. **Figure 42**. *S. pakistanus*, male, holotype. **Figure 43**. *S. petersii*, male, India, Himachal Pradesh State, Molta, FKCP. **Figure 44**. *S. pseudomontanus*, male, holotype. **Figure 45**. *S. solidus*, male, holotype. **Figure 46**. *S. tibetanus*, male, topotype of *S. pococki*, China, Tibet, Gyaca district, 29°08'N 92°43'E, FKCP. **Figure 47**. *S. tryznai*, female, holotype. **Figure 48**. *S. vonwicki*, female, holotype. **Figure 49**. *S. wrzecionkoi*, female, holotype. **Figure 50**. *S. yagmuri*, male, holotype. **Figure 51**. *S. zubairahmedi*, male, holotype. **Figure 52**. *S. zubairi*, male, holotype.
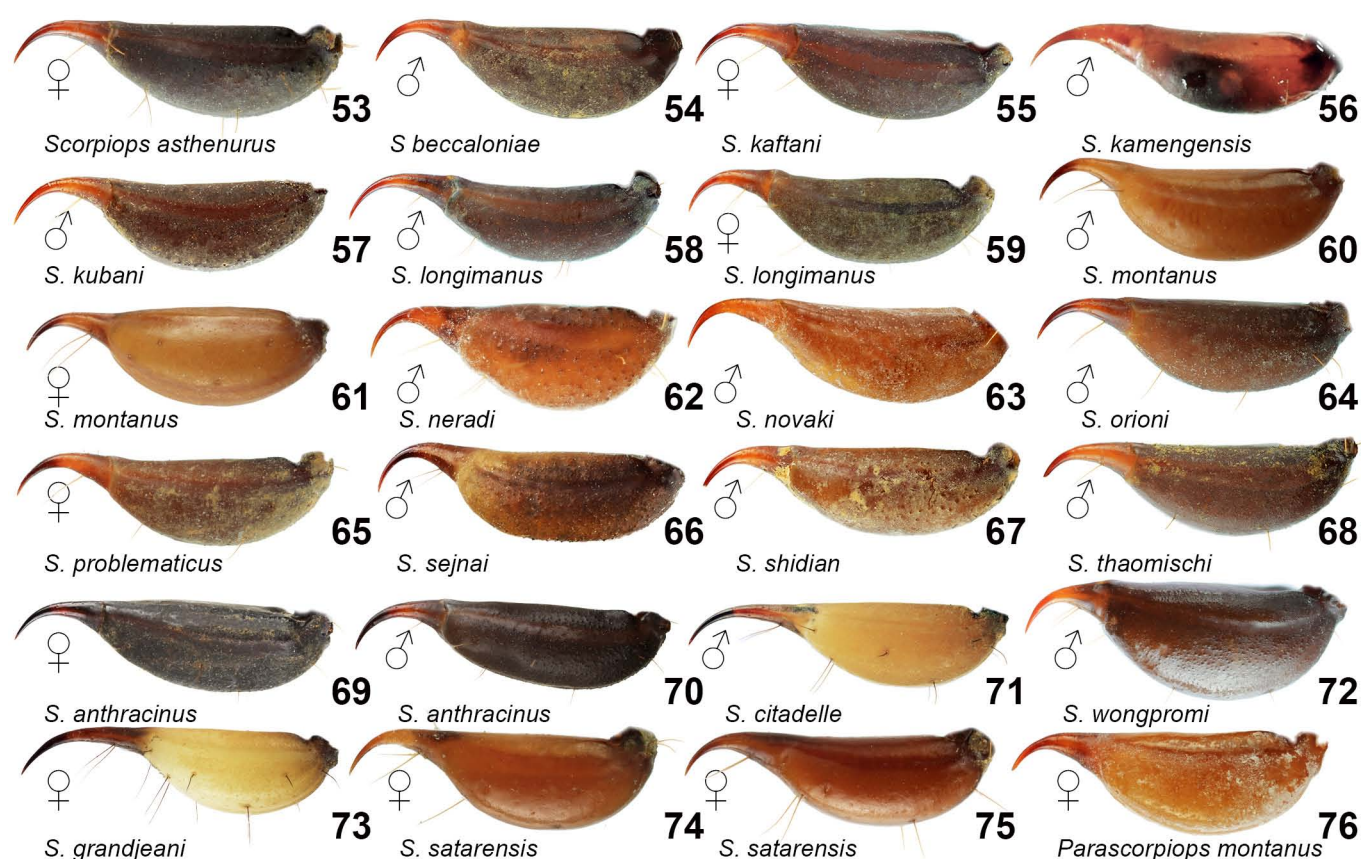
Figures 53–76: *Scorpiops* spp., telson lateral. **Figures 53–68**: Species previously placed in genus *Euscorpiops*. **Figure 53**. *S. asthenurus*, female, India, Meghalaya State, Nong Poh env., FKCP. **Figure 54**. *S. beccaloniae*, male, holotype. **Figure 55**. *S. kaftani*, female, holotype. **Figure 56**. *S. kamengensis*, male, India, Arunachal Pradesh State, Hunli vicinity, 28°19'32"N 95°57'31"E, FKCP. **Figure 57**. *S. kubani*, male, paratype. **Figure 58–59**. *S. longimanus*, male (59), India, Assam State, 50 km E of Tezpur, 1800 m a. s. l., FKCP and female (59), India, Maghalaya State, West Garo-Hills, FKCP. **Figures 60–61**. *S. montanus*, male (60), and female (61), India, Uttarakhand State, Dhika forest 29.65°N 78.94°E, FKCP. **Figure 62**. *S. neradi*, male, holotype. **Figure 63**. *S. novaki*, male, holotype. **Figure 64**. *S. orioni*, male, holotype. **Figure 65**. *S. problematicus*, male (1265) topotype, Thailand, Chiang Mai Province, Doi Poi mt., FKCP. **Figure 66**. *S. sejnai*, male, holotype. **Figure 67**. *S. shidian*, male, topotype, China, Yunnan Province, Shidian district, Jiucheng town, 24.43°N 99.09°E, FKCP. **Figure 68**. S. *thaomischi*, male, holotype. **Figures 69–72**: Species previously placed in genus *Alloscorpiops*. **Figures 69–70**. *S. anthracinus*, female (69) and male (70), Thailand, Phetchaburi Province, Kaeng Krachan, 450 m a. s. l., FKCP. **Figure 71**. *S. citadelle*, male (1632) topotype. **Figure 72**. *S. wongpromi*, male, holotype. **Figure 73**. *S. grandjeani* (previously placed in genus *Dasyscorpiops*), female (1823), Thailand, Kapang, 8.004608°N 99.744415°E, FKCP. **Figures 74–75**: *S. satarensis* (previously placed in genus *Neoscorpiops*), female (74), India, Maharashtra State, Panrel env., FKCP and female (75), topotype, India, Maharashtra State, Mahabaleshwar, FKCP. **Figure 76**. *Parascorpiops montanus*, female, Malaysia, Borneo, Sarawak, Matang, ca. 20 km W of Kuching, FKCP.

This is consistent with the lack of an effect of elongation on *Dt* location (cf. **§1**). For Eb_3 position, there was a significant positive correlation with *db* vs. *eb* distal position in females (P << 0.01), consistent with chela elongation being a common factor in distal placement of both trichobothria (Figs. 7, 81). Males lacked a significant positive correlation, which may also be attributed to variability in secondary sexual modification of male fingers.

A prominent outlier was *Alloscorpiops citadelle*, in which *db* was much more proximal on the fixed finger than in other *Alloscorpiops* (Figs. 77, 79, 81). In the others, greater elongation of the chela correlates with *db* being more distal relative to *eb*, but this was not true for *A. citadelle* (Fig. 79). This species also has Eb_3 more proximal on the manus (Figs. 7, 81). This separation corroborates our DNA analysis, which

places *A. citadelle* in a lineage apart from other "*Alloscorpiops*" (Šťáhlavský et al., in press).

Taking *db* $\simeq$ *eb* as the plesiomorphic state, and *db* > *eb* as derived (*db* is approximately level with or proximal to *eb* in most orthobothriotaxic type C outgroup taxa), this character scored low consistency and retention indices (both 0.20) when mapped onto a cladogram of 21 taxa obtained by DNA analysis (Šťáhlavský et al., in press). This indicated a high homoplasy, wherein distal placement of *db* on the fixed finger occurred in five separate clades. As in the case of distal Eb_3 on the manus, we suggest that distal displacement of *db* is associated with independent elongation of chela fingers as lithophilic adaptations in multiple lineages. The conclusion is that genera diagnosed by distal *db* positioning will be polyphyletic.
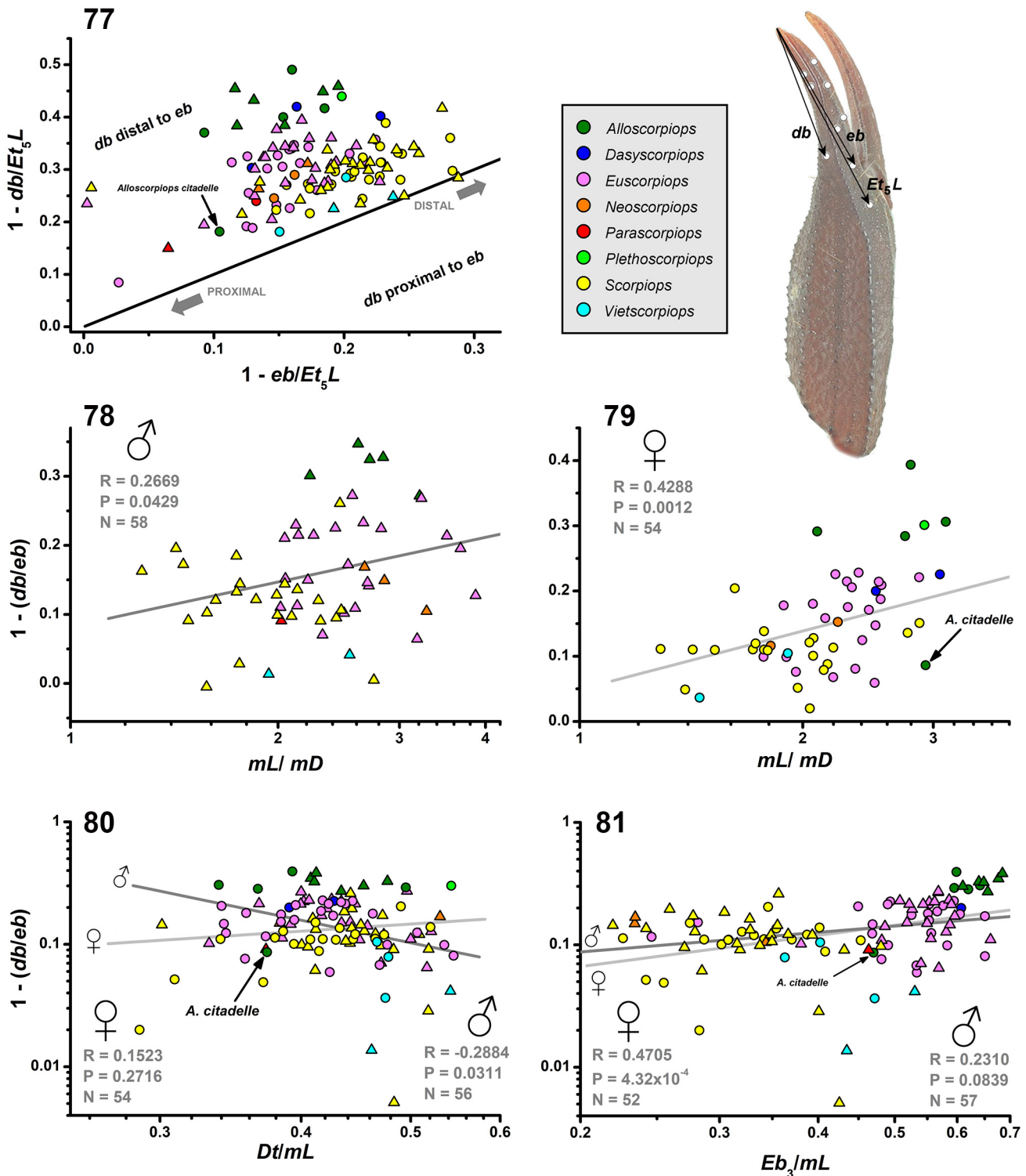
Figures 77–81: Variation in positions of trichobothria *db* and *eb* on the fixed finger of the pedipalp chela of scorpiopids. **Figure 77**. Bivariate scatter plot of normalized distal positions of *db* vs. *eb* referred to trichobothrium *Et₅* on the distal chela manus (a proxy landmark for base of fixed finger) for males (triangles, 57 species) and females (circles, 57 species). Biometrics and symbol color indicating trichobothrial generic assignments according to old trichobothrial diagnoses, in upper right page inset. Trichobothrium *db* is level with *eb* along the black diagonal line, distal to it above the line, and proximal to it below the line. **Figures 78–79**. Relation of distal positioning of *db* vs. *eb* to manus elongation. Scatter plots of distal position of *db* relative to *eb* vs. L/D ratio of manus for 58 male (78) and 54 female (79) adult scorpiopids. Abscissa scale is logarithmic. Gray lines are least squares regressions, showing correlation is weak for males and strong for females. **Figures 80–81**. Relation of distal positioning of *db* vs. *eb* to positions of trichobothria *Dt* and *Eb₃* on manus. Scatter plots of distal position of *db* relative to *eb* vs. normalized position of *Dt* (80) and *Eb₃* (81) for males (triangles, 56 and 57 species) and females (circles, 54 and 52 species). Least squares regression lines are shown for each sex (males, dark gray; females, light gray). Arrows in Figs. 77, 79–81 indicate "*Alloscorpiops*" *citadelle* with more proximal *db* and *Eb₃*, separated from other "*Alloscorpiops*s" with distal *db*. R=Pearson´s correlation coefficient.

§4. Neobothriotaxy on ventral chela manus

Background. Vachon (1974) discovered 3 fundamental trichobothrial patterns (Types A, B and C) on the pedipalps that are conserved across many scorpion taxa. Additional patterns were later described for pseudochactids (Type D) and fossil taxa (e.g., Soleglad & Fet, 2001). The basic types are diagnostic at the family level or above, while finer details of trichobothrial arrangements are routinely used in genus and species level taxonomy. The scorpiopids comply with the Type C pattern, but all species have various numbers of accessory trichobothria ('additive neobothriotaxy') in addition to the basic orthobothriotaxic Type C counts of: femur 3, patella 19, chela manus 16, and chela fixed finger 10. Accessory trichobothria, often numerous, occur on the external or ventral surfaces of the patella, and the chela manus (cf. Soleglad & Sissom, 2001: 56, tab. 5). Patterns with accessory trichobothria are presumably derived from the basic Type C pattern, so they offer potential synapomorphies for defining monophyletic groups such as genera. However, these patterns can be quite complex and their analysis and interpretation controversial (e.g., Soleglad & Fet, 2001, 2005; Prendini & Wheeler, 2005; Ochoa et al., 2013).

Vachon (1974) devised a nomenclature for each pedipalp segment, designating a unique alphanumeric label for each trichobothrium in orthobothriotaxic cases. Label letters were acronyms reflecting typical positions of trichobothria on a segment, and label numbers identified individual trichobothria within arbitrary labelled groups ('series' or 'territories'). 'Series' were subsets of trichobothria, usually on oriented surfaces (e.g., dorsal, external, ventral, internal), and 'territories' were localized clusters segregated from neighboring groups. Boundaries of territories were drawn to indicate ranges of intraspecific variation of the spatial locations of trichobothria in each cluster. Implicit in this scheme was a hypothesis of homology of trichobothria with unique labels across different taxa. These homologies are inferred by parsimonious interpretations of overall patterns, rather than exact spatial locations of individual trichobothria, which can vary with respect to segment shape, orientation axes or structural landmarks. Numbers and patterns confined to oriented surfaces are usually sufficiently stable for local assignment of labels. In particular, a minor subset of 'petite' trichobothria, with smaller areolae and shafts, are more clearly identifiable (in Type C these are usually, but not always: patella esb_2; chela Esb, Et_4 and V_2). Vachon (1974: 894–895) hinted at a neural basis for his groupings into series and territories, but no neuroanatomical, histological, or ultrastructural evidence was provided, and none exists to date. Although repeatedly mentioning his "théorique" interpretation, there was no theory behind the groupings, which he admitted were the product of "vue de l'esprit", devised as convenient book-keeping aids. Other authors visualized different groupings of trichobothria (e.g., Bonacina, 1980; Gertsch & Soleglad, 1972; Stahnke, 1973, 1974; Valle, 1975).

The problem of homology determination is compounded by additive neobothriotaxy, where extra trichobothria can obscure orthobothriotaxic patterns. It is often difficult, if not impossible,

to discriminate accessory vs. orthobothriotaxic trichobothria (Prendini & Wheeler, 2005: 477–478). In orthobothriotaxic Type C patterns, Vachon (1974) assigned trichobothria on the external patella to five "facilement réparties" territories, anchored to landmark trichobothria et_1, est_1, esb_1, and petite esb_2 ("trichobothries-pilotes"). Trichobothria within territories were joined into linear graphs with vertices numbered in ascending order, in roughly dorso-ventral directions, except for the *eb* series which could follow more circuitous trajectories (Vachon, 1974: 918, 920; figs. 76–90, 98–102). In neobothriotaxic Type C patterns, accessory trichobothria on the external patella were assigned to one of the five territories and their corresponding linear graphs (Vachon, 1974: 920, 926; figs. 103–107, 139, 143, 174–181). Territorial assignments and labeling of ortho- vs. neobothriotaxies appeared arbitrary, the reader being instructed "d'imaginer quelles sont les trichobothries accessoires" (like how ancient Greeks imagined seeing constellation Scorpius in the sky). In some cases, hypothesized accessory trichobothria were appended to orthobothriotaxic linear graphs as higher numbered vertices. In others, they were interpolated into orthobothriotaxic sequences, although the interpolation rules were not defined. This resulted in confusing notations, in which, e.g., 'et_2' was orthobothriotaxic in some species, but neobothriotaxic in others, so that et_2 no longer labelled a structure presumed homologous across all Type C scorpions.

Vachon (1980) applied his labeling scheme to neobothriotaxy on the external patella of scorpiopids. As before, his linear graphs of territories roughly followed a dorso-ventral ordering of labels, but could also trace zig-zag or tortuous serpentine paths meandering up and down the proximo-distal axis of the patella. In this paper, he did not indicate which trichobothria he thought were accessory vs. orthobothriotaxic. Accessory numeric labels were simply appended to orthobothriotaxic sequences in his graph vertices, and due to variable neobothriotaxy, these could have different numeric ranges. Therefore, accessory trichobothria with the same label could occupy different locations in different species or even individuals, and hence were unlikely to be homologous. The result was again an inconsistent hybrid nomenclature, where some labels (in orthobothriotaxic territories) presumably signified homology, while others (in neobothriotaxic territories) did not. This practice has caused some confusion (see below). Soleglad & Sissom (2001: 50–51, figs. 100–111) reproduced Vachon's (1980) linear graphs, adding their own interpretations of vertices representing accessory trichobothria, without explaining the assignments. We here take a conservative approach to trichobothrial homology. We generally accept homologies implied by the basic orthobothriotaxic Type C pattern. In neobothriotaxic cases, where possible we assume the most parsimonious homology compatible with orthobothriotaxic patterns of related taxa. Otherwise, we do not make arbitrary subjective assignments of orthobothriotaxic vs. neobothriotaxic labels, in order to avoid confusion about implied homologies.

Neobothriotaxy of the chela manus. The ventral surface of the chela manus in the majority of scorpiopids (83/95) has an orthobothriotaxic series of 4 trichobothria, designated V_1–V_4 in

Euscorpius yagmuri   *Euscorpius naupliensis*   *Megacormus granosus*   *Troglocormus ciego*

○ chelal trichobothria   ● chelal trichobothria *V1-V3*   ● chelal trichobothria *V4*
◉ chelal trichobothria *Eb3*   • additional accesory trichobothria

Euscorpiidae
Scorpiopidae

Parascorpiops montanus   "*Neoscorpiops*" *satarensis*   "*Alloscorpiops*" *anthracinus*   *Scorpiops kautti* **sp**. **n**.

Figures 82–97: Trichobothrial pattern of pedipalp chela external (82, 84, 86, 88, 90, 92, 94, 96) and ventral (83, 85, 87, 89, 91, 93, 95, 97) views. **Figures 82–89**: Euscorpiidae. **Figure 82–83**. *Euscorpius yagmuri* Kovařík et al., 2014, male paratype, FKCP. **Figure 84–85**. *Euscorpius naupliensis* (C. L. Koch, 1837), male, Greece, Zakynthos Island, Kampi, FKCP. **Figure 86–87**. *Megacormus granosus* (Gervais, 1843), male, Mexico, Veracruz, Atotonilco, pine forest, 19°08'86"N 97°11'83"W, 2180 m a. s. l., FKCP. **Figure 88–89**. *Troglocormus ciego* Francke, 1981, male, holotype, AMNH. **Figures 90–97**: Scorpiopidae. **Figure 90–91**. *Parascorpiops montanus*, female, Malaysia, Borneo, Sarawak, Matang, ca. 20 km W of Kuching, FKCP. **Figure 92–93**. *Scorpiops* (previously *Neoscorpiops*) *satarensis*, female, topotype, India, Maharashtra State, Mahabaleshwar, FKCP. **Figure 94–95**. *Scorpiops* (previously *Alloscorpiops*) *anthracinus*, female, Thailand, Phetchaburi Province, Kaeng Krachan, 450 m a. s. l., FKCP. **Figure 96–97**. *Scorpiops kautti* **sp. n**., female, paratype, FKCP.

distal to proximal order. A minority of species (11/95) exhibit additive neobothriotaxy, with totals of 8–25 trichobothria on the ventral surface. Vachon (1980) created the subgenus *Alloscorpiops* to include then known species with ventral neobothriotaxy, i.e., *S. anthracinus* and *S. lindstroemi* (= *S. anthracinus*) with 10–11 ventral trichobothria. In his graph, the two most distal trichobothria were labeled V_1–V_2. Homology of V_1–V_2 with their orthobothriotaxic counterparts is supported by the internal angling of the line joining them and the identity of V_2 as a petite trichobothrium. Which trichobothria, if any, can be considered homologous to orthobothriotaxic V_3 and

V_4 is unclear. They were not explicitly labeled, although the most proximal of the series was labeled V_{11}. Stockwell (1989: 82) treated *Alloscorpiops* as a genus, a rank formalized by Lourenço (1998: 246). This was accepted by Kovařík (2000: 155) and Soleglad & Sissom (2001), with a generic diagnosis of 9–12 ventral trichobothria on the chela.

Lourenço (2013a) described *A. calmonti* and created for it the subgenus *Alloscorpiops* (*Laoscorpiops*), diagnosed by neobothriotaxy: chela manus with 11–12 trichobothria (7–8 accessory) on ventral surface, 14 on dorsal and external surfaces (2 accessory); patella with 18 ventral trichobothria

(15 accessory) and a high number of 30 trichobothria (17 accessory) on external surface. In fact, the sole differential diagnostic character is neobothriotaxy on the external manus, because the other neobothriotaxies occur in the nominotypic subgenus *Alloscorpiops* (see below). Two additional external trichobothria are present on the proximal manus, close to the petite landmark *Esb* (Lourenço, 2013a: 54, fig. 3C). They were assigned to the *Eb* territory, increasing its membership from 3 to 5 trichobothria, numbered in ascending ventral-to-dorsal order as Eb_{1-5}. These labels were not a homology statement, as is evident from the discussion speculating about potential homology of 'Eb_5' with orthobothriotaxic Eb_3 (Lourenço, 2013a: 52). This hybrid of homologous ortho- and non-homologous neobothriotaxic labels caused misunderstanding and dispute. The neobothriotaxic labels were interpreted by Kovařík et al. (2013b) as statements of homology, which they rejected, and this led them to synonymize the subgenus. Lourenço & Pham (2015b) rejected the homology argument and reinstated *Alloscorpiops* (*Laoscorpiops*). Lourenço (2017) further elaborated that Vachon was uncertain about how to interpret complex neobothriotaxic Type C patterns and had not proposed explicit homologies for his accessory labels.

Our interpretation of the homology of chelal trichobothria of *A. calmonti* is similar to what was articulated by Kovařík et al. (2013b). Trichobothria labelled as 'Eb_{3-5}' by Lourenço (2013a) we interpret as orthobothriotaxic Eb_{1-3}. This is supported by their relative geometric configuration, which matches the relative positions of Eb_{1-3} seen in many other scorpiopids with a distally positioned Eb_3 near mid-manus. Our Eb_{1-2} together with petite *Esb* form a compact triad similar to those of other scorpiopids. Homology of 'Eb_5' with orthobothriotaxic Eb_3 is further supported their shared position straddling the external secondary carina, and by distal placement of 'Eb_5' correlating with an elongated manus, consistent with other scorpiopids (Fig. 7). This leaves the two trichobothria labeled 'Eb_{1-2}' by Lourenço (2013a), as the accessory trichobothria. These could be either separate neobothriotaxic elements of the external surface, or part of the neobothriotaxy of the ventral surface which includes a series of 12 trichobothria (8 accessory). The first scenario posits two independent neobothriotaxic gains (on external and ventral surfaces), and the second scenario a single neobothriotaxic gain (on the ventral surface) that happens to extend across the ventroexternal carina. We consider the latter scenario to be the more parsimonious. It is supported by the positions of the two external accessory trichobothria at the proximal end of the long ventral series, forming part of a continuous linear sequence crossing the ventroexternal carina. There is precedent for this interpretation in related taxa (see below). A reassignment of these accessory trichobothria to the neobothriotaxic ventral series would leave the subgenus *Alloscorpiops* (*Laoscorpiops*) without any diagnostic characters to separate it from the nominotypic subgenus. In speculating about homology of 'Eb_5' with orthobothriotaxic Eb_3, Lourenço (2013a) proposed "that the presence of only three *Eb* trichobothria in most taxa is due to one or more losses during the evolutionary history of the group." In other words, 5 *Eb* is not the apomorphic, but the plesiomorphic state, and 3 *Eb* is a

derived neobothriotaxic condition resulting from loss of 2 *Eb*. Phylogenetically, this would put *A. calmonti* in a basal position with respect to the majority of Type C scorpions, that have only 3 *Eb*. We find this implausible because no other characters of *A. calmonti* have been identified as putative basal states relative to all Type C scorpions (bothriurids, chactoids, scorpionoids). On the contrary, even among scorpiopids, we consider *A. calmonti* to express several derived characters: i.e., high neobothriotaxy on the ventral chela, external and ventral patella, distal position of manus Eb_5, high denticle counts on pedipalp fingers, and relatively elongate pedipalp chelae. We further note that the proximal-most trichobothria of neobothriotaxic *V* series also traverse the ventroexternal carina in *Scorpiops kautti* **sp. n.**, *S. krabiensis* **sp. n.** and *S. scheibeae* **sp. n.** (see descriptions below), species that differ markedly from *Alloscorpiops* in possessing an additional derived character, i.e., high neobothriotaxy on the external patella (diagnostic character of *Dasyscorpiops*).

Carinae are useful landmark features for defining the limits of oriented surfaces (e.g., dorsal, ventral, external, internal surfaces of the chela; Sissom & Soleglad, 2001: 41, fig. 43). Trichobothrial patterns often respect these boundaries, but there are many exceptions. For example, in euscorpiids, a family with close affinity to the scorpiopids (Sharma et al., 2018; Santibáñez-López et al., 2020), the orthobothriotaxic chelae of *Megacormus* and *Troglocormus* have V_4 located external to the ventroexternal carina (Figs. 86–89). Similarly, in *Euscorpius/ Alpiscorpius* species with orthobothriotaxic chelae, V_4 is located on or slightly external to the carina (Fig. 83). At first, Vachon (1963: 351–352, figs. 4–5) depicted only three trichobothria in the *V* series of these species (*E. carpathicus* and *A. germanus*), and labeled the fourth as 'Eb_1'. Later, after studying many more taxa with Type C patterns, Vachon (1974: 942, figs. 229–230; 1975: 635: figs. 3–4, 6–7) relabeled the carinal trichobothrium as 'V_4', an interpretation that is consistent with the 4 *V* and 3 *Eb* territories in most other Type C patterns. In neobothriotaxic euscorpiids (e.g., *Tetratrichobothrius flavicaudis*, *Euscorpius italicus*, and *E. naupliensis*) neobothriotaxy on the chela ventral surface is considered to traverse the ventroexternal carina (Hadži, 1929; Vachon, 1981; Bonacina, 1982; Gantenbein et al., 2002). The 2–3 most proximal accessory trichobothria in the ventral series are located slightly external to the ventroexternal carina, near the *Esb* and *Eb* territories, and one of the accessories is closely associated with, or straddles the carina (Figs. 84–85). This is very similar to the configuration illustrated for *A. calmonti*. Vachon (1963: 352–353, figs. 6–7) labelled these accessory trichobothria as part of the *Eb* territory and restricted the *V* series to only those on the internal side of the carina. Indices of *Eb* trichobothria were shifted up by 2–3, incrementing the indices of normally orthobothriotaxic Eb_{1-3} as 'Eb_{3-5}', or as 'Eb_{4-6}'. This same method was applied by Lourenço (2013a) to *A. calmonti*. Subsequently, Vachon (1975: 638, figs. 8, 11, 13–14) relabeled the accessory trichobothria external to the carina as extensions of the *V* series. External *V* series trichobothria were characterized as having "migrated" across the carina, a term with mechanistic connotations that has been controversial. Prendini & Wheeler (2005: 466–470) criticized the concept of "migration" as apparent shifts
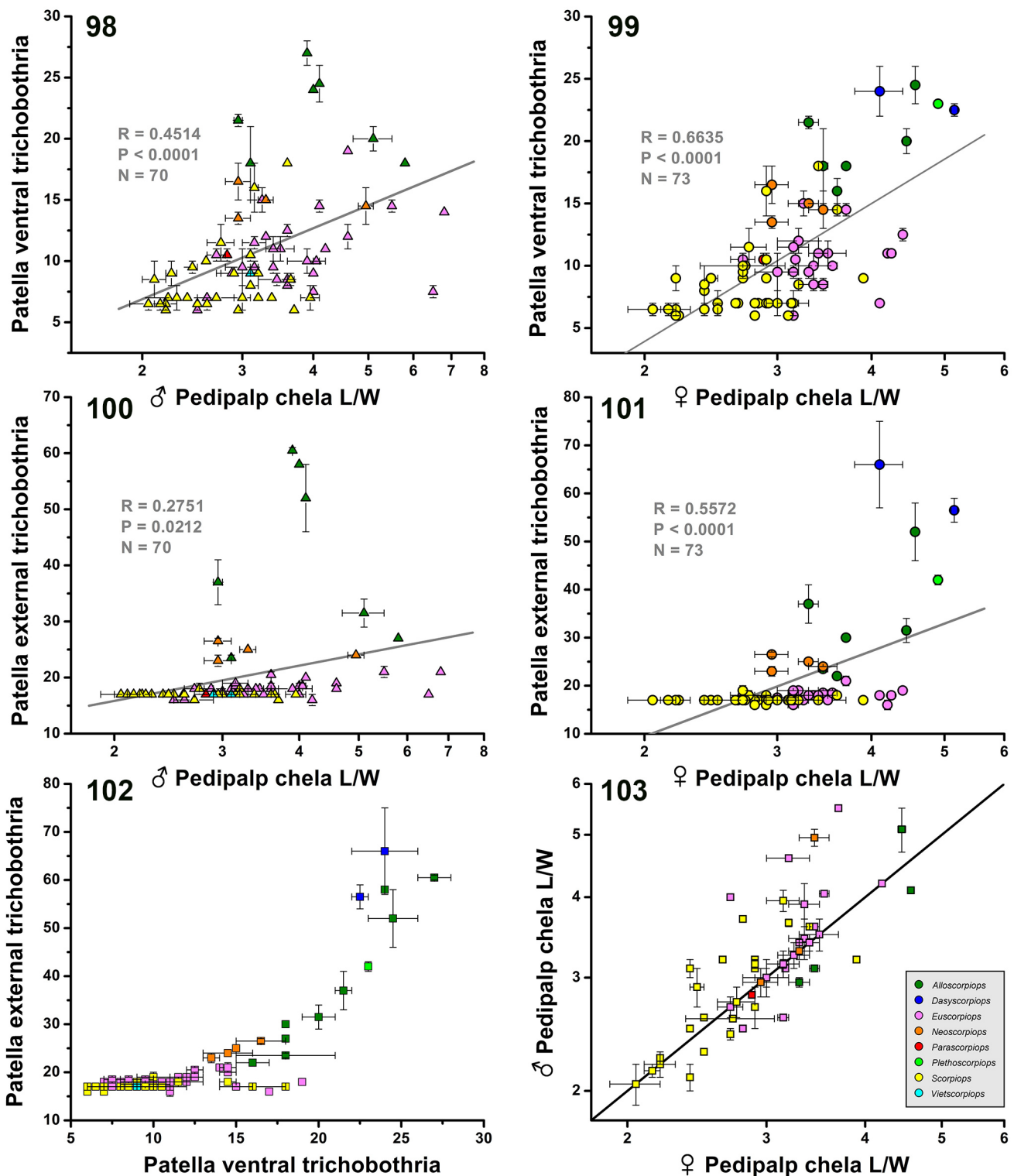
Figures 98–103: Variation in patellar trichobothrial counts and pedipalp chela morphometrics of scorpiopids. **Figures 98–101**. Bivariate scatter plots of numbers of trichobothria on ventral (98–99) and external (100–101) surfaces of patella vs. adult pedipalp chela L/W ratio of 70 male (98, 100) and 73 female (99, 101) scorpiopids. Counts for a species, including both male and female, are plotted against L/W ratios for one sex (male or female) of that species. Abscissa scales are logarithmic. Gray lines are least squares regressions, showing significant positive correlations. **Figure 102**. Bivariate scatter plot of numbers of trichobothria on external vs. ventral surface of patella in 92 scorpiopids (male or female). **Figure 103**. Bivariate logarithmic scatter plot of male vs. female pedipalp chela L/W ratio of 53 adult scorpiopids. Lower right inset: symbol colors indicating generic assignments according to old trichobothrial diagnoses, for all plots including males (triangles), females (circles) or either sex (squares). In all plots, symbols are located at range midpoints for each variable, and error bars indicate the ranges (minimum to maximum). R=Pearson´s correlation coefficient.

in position of homologous trichobothria relative to other trichobothria or landmarks. They proposed an alternative model in which a standard trichobothrium in one territory is lost, and an accessory trichobothrium is independently gained in another territory. They argued that this was the preferred explanation of large apparent shifts in position that greatly distorted overall patterning (see also Ochoa et al., 2013). However, we regard the independent gain of external accessory trichobothria to be a less parsimonious interpretation of the neobothriotaxy on the chela manus of *A. calmonti*.

Four other species have also been described under the genus *Alloscorpiops*: *A. citadelle* Kovařík, 2013, *A. wongpromi* Kovařík et al., 2013, *A. troglodytes* Lourenço & Pham, 2015, and *A. viktoriae* Lourenço & Košulič, 2018. All exhibit ventral neobothriotaxy on the chela manus, with counts of 9–13, in agreement with the diagnosis of *Alloscorpiops*. None of them have accessory trichobothria on the external manus. Lourenço (2017) created the monotypic genus *Plethoscorpiops* for the species *P. profusus*. The generic diagnosis was based solely on high additive neobothriotaxy on the pedipalp chela and patella: chela manus with 25 *V* (21 accessory), 3 *Est* (2 accessory), 6 *Et* (1 accessory), 19 *Eb* (16 accessory); patella ventral surface with 23 *V* (20 accessory), external surface with 41–43 (37–39 accessory) trichobothria. Assignment of the majority of external accessory trichobothria on manus to '*Eb*' territory is, as we have discussed, an arbitrary choice. An alternative is to categorize them as members of the *V* series that traverse the ventroexternal carina, a convention applied for example to *Urodacus yashenkoi* by Vachon (1974: 924, fig. 132). Another option is to avoid uncertain assignments to orthobothriotaxic territories or series, and simply label them as external accessory (*Ea*) (Volschenk et al., 2000). Likewise, Lourenço (2017) did not attempt to fit the numerous external patellar trichobothria of *P. profusus* to Vachon's template of five territories.

Neobothriotaxy as a generic character. Diagnoses of most scorpiopid genera, or subgenera, are either partly or completely dependent on neobothriotaxic characters. Criteria are based on the presence or absence of accessory trichobothria, and on their counts: *Neoscorpiops* is differentiated from *Scorpiops* in part by the patella bearing 7–10 *est* (6–9 accessory) and 5–7 *et* (2–4 accessory), vs. 4–5 *est* (3–4 accessory) and 4–5 *et* (1–2 accessory); *Alloscorpiops* is differentiated from *Euscorpiops* by the chela bearing 9–12 *V* (5–8 accessory), and patella bearing 7–10 *est* (6–9 accessory) and 5–7 *et* (2–4 accessory), vs. 4 *V* (0 accessory), 4–5 *est* (3–4 accessory) and 4–5 *et* (1–2 accessory); *Alloscorpiops* (*Laoscorpiops*) is differentiated from the nominotypic subgenus by the chela bearing 5 *Eb* (2 accessory) (but see above discussion); *Dasyscorpiops* is differentiated from other genera by high neobothriotaxy of the patella, bearing 59–60 external (46–47 accessory) and 22–23 *V* (19–20 accessory); and *Plethoscorpiops* is differentiated from other genera by exceptionally high neobothriotaxy on the chela and patella (see above).

We regard use of these neobothriotaxic characters as primary characters in genus level systematics to be problematic for several reasons. Firstly, the cited range

differences of *est/ et* accessory trichobothrial counts used to differentiate *Neoscorpiops* from *Scorpiops*, or *Alloscorpiops* from *Euscorpiops*, are not large and may not have disjunct distributions when greater variation is taken into account. Accessory trichobothrial counts can be subject to intraspecific variation (Tab. 9), and counts may even vary among siblings reared from the same parent (e.g., *Euscorpius naupliensis*, *E. italicus* and *Scorpiops kautti* **sp. n.**).

Secondly, purely phenetic taxonomy based on combinations of ortho- or neobothriotaxy in different trichobothrial series or territories is non-phylogenetic and risks producing polyphyletic or paraphyletic groupings. It can spawn monotypic genera defined by autapomorphies, as new taxa are discovered that do not fit into existing character state combinations. Thus, *Plethoscorpiops* was created to accommodate a species whose chela has numerous accessory trichobothria on the ventral surface (a diagnostic character for *Alloscorpiops*) as well as on the external surface (where accessory trichobothria are absent in *Alloscorpiops*). Another example is *S. kautti* **sp. n.**, a new species described below, which shares neobothriotaxic characters with both *Dasyscorpiops* and *Alloscorpiops*. The genus *Dasyscorpiops* was created to accommodate a species with a high number of patellar trichobothria on the external surface (59–60 in the holotype; range of 54–65 in material studied here) and ventral surface (23), combined with an orthobothriotaxic chela (4 trichobothria in the *V* series). The genus *Alloscorpiops* differs from *Dasyscorpiops* in having neobothriotaxic chela with accessory trichobothria in the *V* series, and fewer accessory trichobothria on the patella external surface (21–37; extended range 21–58 in material studied here). The species *S. kautti* **sp. n.**, combines a high number of patellar trichobothria on the external surface (46–58; diagnostic for *Dasyscorpiops*) with a neobothriotaxic chela (*V* series with 13–16 trichobothria, i.e., 9–12 accessory; diagnostic for *Alloscorpiops*). This neobothriotaxic pattern shows some similarity to that of *Plethoscorpiops* except that there are more trichobothria on the external patella, fewer on the ventral manus, and a lack of numerous accessory trichobothria on external manus. Similar neobothriotaxy occurs in two other species: *S. krabiensis* **sp. n.** and *S. scheibeae* **sp. n.** However, we avoided creating another new genus for these species based entirely on different neobothriotaxy, without comparative analysis of other morphological characters or support from molecular data.

Thirdly, in scorpiopids neobothriotaxy is ubiquitous, variable and complex, suggesting multiple derivations in the evolutionary history of the family. We argue that neobothriotaxy is intrinsically susceptible to convergence and homoplasy. Trichobothria are mechanosensory organs functioning as ultra-sensitive air current detectors (Reißland & Görner, 1978; Barth et al., 1993; Bathellier et al., 2012; Zhang et al., 2020). The array of trichobothria on the pedipalps of scorpions responds in a direction-sensitive manner to small aerodynamic disturbances generated by nearby moving objects, and can play an essential role in prey capture (Krapf, 1988; Müllan, 2011; Ashford et al., 2018). The increased numbers of trichobothria in taxa with additive neobothriotaxy are likely to improve sensory

performance relative to an orthobothriotaxic array. If additional trichobothria had a preferred plane of oscillation, it could enhance signal-to-noise ratio for detection of airflow vectors in that plane, if the collective sensory input were integrated by central neural circuits. If they had different planes of oscillation, it could increase angular resolution of directional airflow mapping. We suggest that neobothriotaxy confers significant adaptive advantage through increased detection sensitivity and orientation response to both prey and predators of scorpions. We may therefore expect positive selection pressure to act on mutations that increase trichobothrial count in unrelated scorpion lineages. This is analogous to the independent development, in unrelated psammophilous scorpions, of dense tarsal setation as an adaptation for locomotion on soft sand, i.e., the tarsal bristle comb is also a taxonomic character with high homoplasy.

A majority of scorpions, mostly buthids (Type A pattern), have retained orthobothriotaxic phenotypes, whereas Type C taxa have a greater predisposition for additive neobothriotaxy. Even in orthobothriotaxic scorpions, there may be wide variation in the reliance on trichobothria for critical sensory functions such as prey detection. Trichobothrial ablation negatively affected prey capture in *Androctonus australis* and *Buthus occitanus* (Krapf, 1988), but not in *Tityus serrulatus* (Murayama & Willemart, 2019) which relies on substrate vibrations (Mineo & Del-Claro, 2006). We hypothesize that air current sensing by trichobothria is more likely to be important for lithophilic scorpions, because the high velocity and small amplitude of wave conduction in hard rock surfaces may preclude using substrate-borne vibrations as reliable sensory cues. In **§1**, we suggested that the elongation of pedipalp chelae in scorpiopids may be an ecomorphotype that is correlated with lithophilic adaptation. Some lithophilic scorpions forage by a sit-and-wait strategy, with their body protected in a rock fissure, and their pedipalps extended outside the fissure to monitor external stimuli. In this situation, heightened sensitivity of large numbers of accessory trichobothria should enable more efficient capture of passing prey, or detection of approaching predators. Our hypothesis therefore predicts that scorpiopids with more elongated chelae will tend to have greater numbers of accessory trichobothria. To test this, we surveyed neobothriotaxy and chela morphometrics across the entire family. We found significant positive correlations between trichobothrial counts on ventral or external patellar surfaces, and chela length/ width ratios in both sexes (Figs. 98–101). Patellar counts were, on average, higher in species with more elongated chelae, and were lower in species with more robust chelae. As chelae become more elongated, ventral counts tended to increase steadily across all species, whereas external counts rose sharply for a minor subset of species. The plot in Fig. 102 tracks how external counts vary with ventral counts. As ventral counts increase from 6 to 13, external counts remain nearly constant. When ventral counts exceed 13, there is an abrupt non-linear elevation in numbers of external accessory trichobothria within a subset of taxa, initially in the genus *Neoscorpiops*, rising to the highest values in the genus *Dasyscorpiops*. The curve bifurcates at 13 ventral

trichobothria, with a second subset of taxa maintaining constant external counts as ventral counts exceed 13.

High counts of accessory trichobothria evolved independently in several other unrelated groups of lithophilic scorpions, e.g., Hormuridae (*Hadogenes*), Euscorpiidae (*Euscorpius*, *Alpiscorpius*, *Tetratrichobothrius*), Heteroscorpionidae (*Heteroscorpion*, which is also corticolous) and Hemiscorpiidae (*Hemiscorpius enischnochela* Monod & Lourenço, 2005; *H. gaillardi* Vachon, 1974; *H. shahii* Kovařík et al., 2017). In the latter family, Vachon (1974) originally described *H. gaillardi* under the monotypic genus *Habibiella*, distinguishing it from *Hemiscorpius* only on the basis of patellar neobothriotaxy. In their revision of hemiscorpiids of Iran, Monod & Lourenço (2005) argued that if the totality of morphological characters is considered together, *Habibiella* appears more closely related to the type species of *Hemiscorpius* (*H. lepturus*), than to several other *Hemiscorpius* species from Arabia and Africa. Their logical conclusion was that *Habibiella* must be a junior synonym of *Hemiscorpius*, and hence the neobothriotaxy of *H. gaillardi* is an autapomorphy that is uninformative about its phylogenetic position. They also described a similar neobothriotaxic species, *H. enischnochela*, under the genus *Hemiscorpius*. Lourenço (2013a, 2017) subsequently reverted to the practice of Vachon, creating monotypic genera (or subgenera) of scorpiopids solely on the basis of neobothriotaxy. We do not accept genera of scorpiopids that have been diagnosed primarily or exclusively by neobothriotaxy, a view that is confirmed by our DNA analysis (Šťáhlavský et al., in press). In that analysis, multiple species that would have been diagnosed by neobothriotaxic characters as members of *Euscorpiops*, *Alloscorpiops*, or *Dasyscorpiops* were instead partitioned across different clades, rendering these genera incongruent with the retrieved molecular phylogeny.

§5. Number of inner accessory denticles (IAD) on pedipalp chela movable finger

Soleglad & Sissom (2001) characterized patterns of pedipalp finger dentition of chactoid scorpions in terms of several structures. The basic hypothetical basic pattern was comprised of a small, dense longitudinal row of median denticles (MD), accompanied by series of large, regularly-spaced outer and inner denticles (OD and ID). In addition, various numbers of inner and outer accessory denticles (IAD and OAD) arranged along internal and external sides of the MD, are present in different taxa. They characterized scorpiopid dentition as a continuous, linear MD row flanked by regular series of OD and opposing ID, with OAD alternating with OD. The numbers of IAD varied widely: *Scorpiops* 6–30+; *Parascorpiops* 35–45+, *Neoscorpiops* 45+, *Dasyscorpiops* 50+, *Euscorpiops* 40–60+, and *Alloscorpiops* 60–65 (cf. Soleglad & Sissom, 2001: 95, also 33–38, figs. 1–21, tab. 2).

We have studied this character in detail in many more species and found a range of IAD+ID count of 12–80+. For comparative purposes, we pooled IAD and ID numbers because in some species with low numbers of IAD, it was
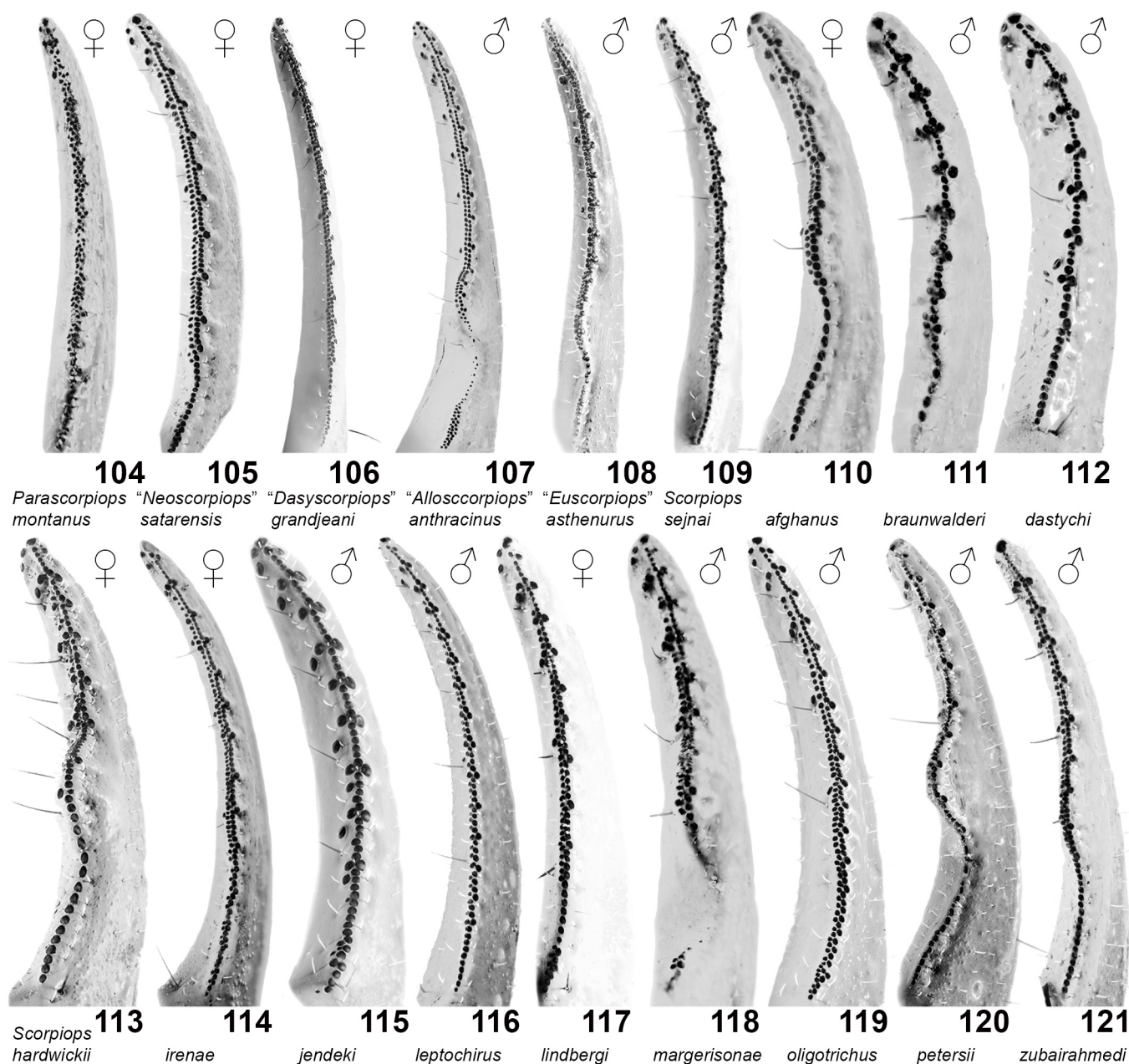
Figures 104–121: Pedipalp movable finger dentition under UV light. **Figure 104**. *Parascorpiops montanus*, female, Malaysia, Borneo, Sarawak, Matang, ca. 20 km W of Kuching, FKCP. **Figures 105–121**: *Scorpiops* spp. **Figure 105**. *S. satarensis*, female, topotype, India, Maharashtra State, Mahabaleshwar, FKCP. **Figure 106**. *S. grandjeani*, female (1823), Thailand, Kapang, 8.004608°N 99.744415°E, FKCP. **Figure 107**. *S. anthracinus*, male (885), Thailand, Phetchaburi Province, Kaeng Krachan, 450 m a. s. l., FKCP. **Figure 108**. *S. asthenurus*, male, India, Meghalaya State, Nong Poh env., FKCP. **Figure 109**. *S. sejnai*, male, holotype. **Figure 110**. *S. afghanus*, female, holotype. **Figure 111**. *S. braunwalderi*, male, holotype. **Figure 112**. *S. dastychi*, male, paratype. **Figure 113**. *S. hardwickii*, female, India, Uttaranchal State, ca. 30 km N of Bageshwar, SE of Dhakuri vill., 2600-2800 m a. s. l., FKCP. **Figure 114**. *S. irenae*, female, holotype. **Figure 115**. *S. jendeki*, male, holotype. **Figure 116**. *S. leptochirus*, male (306), India, Meghalaya State, Nong Poh env., FKCP. **Figure 117**. *S. lindbergi*, female, Pakistan, northern Balochistan, Ziarat, FKCP. **Figure 118**. *S. margerisonae*, male, holotype. **Figure 119**. *S. oligotrichus*, male (508), Laos, Xieng Khouang Province, Tham Xang Caves, Phong Savan, near Muang Khoun, FKCP. **Figure 120**. *S. petersii*, male, India, Himachal Pradesh State, Molta, FKCP. **Figure 121**. *S. zubairahmedi*, male, holotype.

difficult or impossible to clearly distinguish between ID and IAD. In genera previously diagnosed by neobothriotaxy, ranges of IAD+ID were: *Scorpiops* 12–65+ (< 45 in most), *Euscorpiops* ~40–75+ (as low as 11–28 in some), and *Alloscorpiops* 65–80. This overlapping variation precludes using IAD counts to diagnose these genera. In *Scorpiops*, the

IAD were heterogeneous, some being about the same size as, or smaller than MD, while others were larger than MD. Several species had only larger IAD (e.g. Fig. 115, *S. jendeki*), while others had both larger and smaller IAD (e.g. Figs. 113, 120, *S. hardwickii*, *S. petersi*). We observed a trend in which higher IAD+ID counts tended to occur in species with more elongate
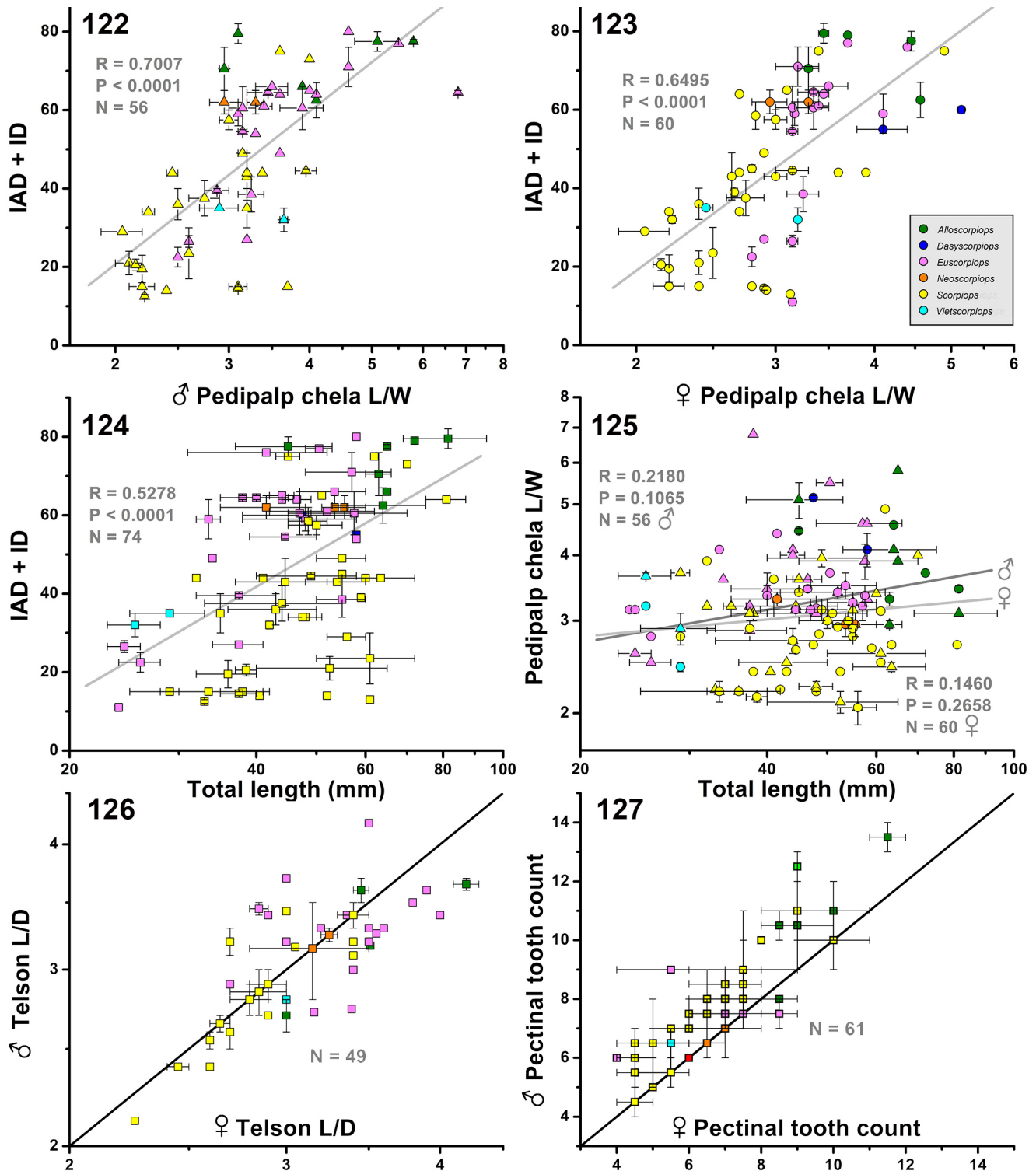
Figures 122–127: Morphometric trends and sexual dimorphism in scorpiopids. **Figures 122–123**. Bivariate scatter plots of total numbers of internal accessory denticles and internal denticles (IAD + ID) vs. adult pedipalp chela L/W ratio of 56 male (122) and 60 female (123) scorpiopids. Denticle counts for a species, including both male and female, are plotted against L/W ratios for one sex (male or female) of that species. **Figure 124**. Bivariate scatter plot of IAD + ID vs. total length of 74 scorpiopids (male and female). **Figure 125**. Bivariate scatter plot of adult pedipalp chela L/W ratio vs. total length of 56 male (triangles) and 60 female (circles) scorpiopids. In Figs. 122–125, gray lines are least squares regressions. Significant positive correlations were detected in 122–124, but not in 125. **Figure 126**. Bivariate scatter plot of adult telson L/D ratios of males vs. females of 49 scorpiopids. Black line is diagonal. **Figure 127**. Bivariate scatter plot of pectinal tooth counts of males vs. females of 61 scorpiopids. Not all points are visible as many are overlaid at the same coordinates. Black line is diagonal. In all plots, symbols are located at range midpoints for each variable, and error bars indicate the ranges (minimum to maximum). Abscissa scales of all plots and ordinate scales of 125–126 are logarithmic. Upper right inset (123): symbol colors indicating generic assignments according to old trichobothrial diagnoses, for all plots including males (triangles), females (circles) or either sex (squares).

pedipalps (Figs. 122–123). The counts were also roughly correlated with body size, although many larger species had lower counts (Fig. 124). Overall, pedipalp chela elongation was not well correlated with body size, as many smaller taxa had elongated chelae, and many larger taxa had robust chelae (Fig. 125). Higher IAD+ID counts (55–82) were characteristic of one particular clade resolved by DNA analysis (cf. box 4 in Fig. 186), but other clades contained species with both low and high counts. We conclude that although there are major differences in IAD and ID numbers in scorpiopids (see Figs. 105–121), this character cannot be used to diagnose genera, and is useful only for species level taxonomy.

§6. Neobothriotaxy on external surface of pedipalp patella

The genera *Scorpiops*, *Euscorpiops*, and *Neoscorpiops* are diagnosed in part by different degrees of neobothriotaxy on the external patella. According to Vachon (1980) there are 17 external trichobothria in *Scorpiops* (4 *est*, 4 *et*), 18–20 in *Euscorpiops* (4–6 *est*, 5–6 *et*), and 22–26 in *Neoscorpiops* (7–10 *est*, 5–7 *et*). Kovařík (2000) synonymized genera *Scorpiops* and *Euscorpiops*, arguing that the difference of a single external trichobothrium was insufficient for generic diagnosis (see above under taxonomic history). Soleglad & Sissom (2001) slightly expanded the numeric ranges for *Scorpiops* (4–5 *est*, 4–5 *et*), allowing for up to 19 externals, which overlaps *Euscorpiops* counts. They emphasized the low external counts of *est* and *et* in *Scorpiops* and *Euscorpiops*, and stated that "considerably larger numbers of accessory trichobothria" were good diagnostic characters for *Neoscorpiops* and *Alloscorpiops*. However, data that we compiled from a much larger number of species described after 2001 revealed considerable interspecific and intraspecific variability in accessory trichobothrial counts, with contiguous or overlapping ranges between genera (Table 9). For example, the patellar ranges of *Neoscorpiops* are 22–27 external, 13–18 ventral, those of *E. binghamii* 20–21 external, 12–13 ventral. The plot in Fig. 102 shows ranges of external and ventral counts for all known scorpiopid species, color-coded by assignments to genera according to currently accepted diagnoses. In all genera, the ranges of both variables partially overlap with ranges of other genera, or are separated from them by only a single accessory trichobothrium. Distributions of these variables lack gaps or disjunctions that would allow unambiguous definition of supraspecific categories. As discussed in **§4**, contiguous or overlapping ranges of accessory trichobothrial counts have dubious value as characters for defining genera.

Significant intraspecific variation in accessory trichobothrial counts of patellar *est* and *et* is not confined to Scorpiopidae. In the related Euscorpiidae, such variation is well known in *Alpiscorpius*, *Euscorpius*, and *Tetratrichobothrius* (e.g., Hadži, 1929; Vachon & Jaques, 1977; Bonacina, 1980, 1982; Bonacina & Rivellini, 1986; Fet, 1993; Fet & Soleglad, 2002) and also occurs in *Megacormus* (González-Santillán et al. 2017; Kovařík, 2019). We conclude that numbers of accessory trichobothria on the external patella are not a reliable generic character in scorpiopids. In particular, it cannot differentiate between *Euscorpiops* and *Neoscorpiops*. As there no other diagnostic characters that can separate these two genera, they must be placed in synonymy.

§7. Neobothriotaxy on ventral surface of pedipalp patella

Soleglad & Sissom (2001) concluded that the number of accessory trichobothria on the ventral surface of the patella was not useful for diagnosis of genera. They found considerable overlap in the ranges of counts obtained for the existing scorpiopid genera, even within their limited sample of species. In our much larger sample, we found even greater intergeneric overlaps in a broad distribution of ventral counts, that did not fall into discrete groups (Fig. 102). We concur that the ventral counts have no utility for genus level taxonomy. However, counts could be applied to species level diagnostics, once statistics of variation have been quantified.

§8. Apophysis on movable pedipalp chela finger

Lourenço & Pham (2015a) described *Scorpiops dentidactylus*, a species bearing a dentate apophysis on the internal aspect of the pedipalp chela movable finger. The species was placed in its own subgenus, *Scorpiops* (*Vietscorpiops*), diagnosed by the presence of the apophysis, and two pairs of lateral eyes (discussed in §10 below). It was later elevated to a monotypic genus by Pham et al. (2017). The holotype male was the only available specimen, so it was not known if females exhibited this character. Lourenço & Pham (2015a: 215) did suggest, however, that this was a secondary sexual character, perhaps analogous to similar apophyses found on the chela manus of bothriurids that play a role in courtship. Below, we describe a similar species, *Scorpiops thailandus* **sp. n.**, which also has an apophysis, smaller in size, in the exact same position on the movable finger. We confirm that the character is sexually dimorphic and absent in the female. This new species is a member of *Scorpiops* and is most closely related to *S. oligotrichus* according to our DNA analysis (Šťáhlavský et al., in press). Moreover, we show below that *S. dentidactylus* is a synonym of *S. farkaci* Kovařík, 1993, a species with the same apophysis present only in males, and not in females. As a secondary sexual character found only in these two closely related species, we consider this apophysis to be a specialized autapomorphy that does not by itself merit creation of a new genus. Doing so would render all remaining *Scorpiops* paraphyletic. We therefore synonymize *Vietscorpiops* Lourenço & Pham, 2015 with *Scorpiops* Peters, 1861, **syn. n.**

§9. Sexual dimorphism

In addition to the apophysis cited in §8, we registered four other main types of sexual dimorphism in scorpiopids that can have taxonomic importance.

A. Larger pectines and pectine teeth in males (Figs. 136–137, 139–140). This character is probably valid for all scorpiopid species. We also found that, like many other scorpions, males generally possess more pectine teeth than females (Fig. 127, Table 9).

B. More bulbous telson in males. This character is often reported in species traditionally included in the genus *Scorpiops*, but it is not observed in e.g. *S. pakistanus* and *S. oligotrichus*. In species traditionally included in the genus *Alloscorpiops* it was found only in *A. wongpromi*. We tested this character in 49 species and found either male (e.g., Figs. 73–74) or female (e.g., Figs. 58–61), could have a more bulbous telson (cf. plot in Fig. 126, below and above diagonal points, respectively). Our DNA analysis further confirmed that this character is not valid at the genus level.

C. Fingers of pedipalp chela with stronger undulations on the proximal dentate margins in males, or margins undulate in both sexes, or straight. In our survey, we found that if undulation is present in the female of a species, then it is always also present in the male. This character has utility for species level taxonomy.

D. Pedipalp chela narrower in males (frequently in *Dasyscorpiops*, *Alloscorpiops*, and *Euscorpiops*, but also in *Scorpiops dastychi* and *S. leptochirus*) (cf. above diagonal points in Fig. 103) or, conversely, wider in males (often the case in *Scorpiops*) (Table 9) (cf. below diagonal points in Fig. 103). This character has utility for species level taxonomy.

§10. Number and size of lateral eyes

Scorpiopids were generally regarded as having three pairs of lateral eyes (e.g., Stanhke, 1974), with the exception of *Parascorpiops*, a monotypic genus diagnosed with two pairs of lateral eyes. Francke (1976: 78–80) questioned the stability of lateral eye number and its application to *Parascorpiops*, pointing out variations in eye counts among other genera. Stockwell (1989: 164) expressed the same doubts about this character. Loria & Prendini (2014) established the main types of lateral eye pattern in scorpions, interpreted as reductions or losses from a fundamental six-eye model. They found that scorpiopid genera *Scorpiops* (1 sp.), *Euscorpiops* (2 sp.) and *Alloscorpiops* (1 sp.) actually have 4 pairs: 3 large ocelli plus a smaller posterior ocellus that was previously overlooked (Type 4B). Two specimens (lectotype, and paralectotype) of *Parascorpiops montanus* had 2 pairs, and 3 pairs (one small) (Types 3A, and 2A, respectively). Patterns of reduction in lateral eye count varied across taxa, but were sufficiently consistent to be suggested as useful systematic characters. Figures 128–133 show that within the scorpiopids, some species have three pairs of equally large lateral eyes (Figs. 131–132), others have two pairs of normal-sized and a pair of rather reduced-sized eyes in a different position (Figs. 129–130, 133), and others only two pairs of lateral eyes (Fig. 128; *P. montanus*). The first two may fit pattern Type 4B, the last either Type 3A or 2A, in the model of Loria & Prendini (2014). The holotype male of *Vietscorpiops dentidactylus*

was reported to have only 2 pairs of lateral eyes as a generic character (Lourenço & Pham, 2015a), but we find that *S. farkaci* Kovařík, 1993, a senior synonym of *V. dentidactylus* (see below), can have 3 pairs (two pairs plus a reduced pair). Moreover, the closely related species *S. thailandus* **sp. n.** also has either two pairs, or two pairs plus a reduced pair. This invalidates the character of two lateral eyes as diagnostic for genus *Vietscorpiops*. According to our DNA analysis *S. thailandus* **sp. n.** is a member of *Scorpiops*. We conclude that the genus *Vietscorpiops* cannot be justified on the basis of this character, and that lateral eye number in this case is not even stable for species level diagnosis.

§11. Spination of leg tarsus

In the legs of all scorpiopids, tarsomere II has a row of 3–11 stout spinules on the ventral surface. Soleglad & Sissom (2001: 61, figs. 163–164, table 6) enumerated these spinules as a potential taxonomic character, but only examined a small sample of specimens (personal communication). We counted these tarsal spinules in all examined specimens and found large intraspecific variation that precludes using their numbers in either generic or species level taxonomy. Their exact numbers are not cited in most published descriptions, so we invoke it here only as a character for diagnosis of the family.

§12. Pectine morphology

Soleglad & Sissom (2001: 67, figs. 192–203) noted a strong tendency for the loss of pectinal fulcra in euscorpiids and scorpiopids. The presence or absence of fulcra is considered an important high-level taxonomic character in other scorpion groups, but within Scorpiopidae these differences are only important at the species level, and even there it exhibits much intraspecific variability. Figures 134–148 also show unusual variability in the formation of the lamellae of the pectines. Stahnke (1970: 307) observed that scorpion pectines generally include 3 marginal lamellae, median lamellae, fulcra and teeth. He mentioned that only the median lamellae "vary in shape and number". We evaluated the unusual variability in both marginal and median lamellae in scorpiopids and have defined four basic types of pectine morphology, which are probably stable at the species level:

P1. Pectines form a single compact unit with an incomplete furrow between areas of marginal and middle lamellae, or the furrow can delimit marginal lamella I (basal) (Figs. 134–137).

P2. Pectines with marginal lamellae I (basal) and III present, marginal lamella II not delimited, but connected with middle lamella forming a single compact unit. Although marginal lamellae III is always developed, marginal lamellae I may be only indicated (Figs. 138–140).

P3. Pectines with two marginal and 1–4 middle lamellae present (Figs. 141–144).

P4. Pectines with 3 marginal and 1–5 middle lamellae present (Figs. 145–148).
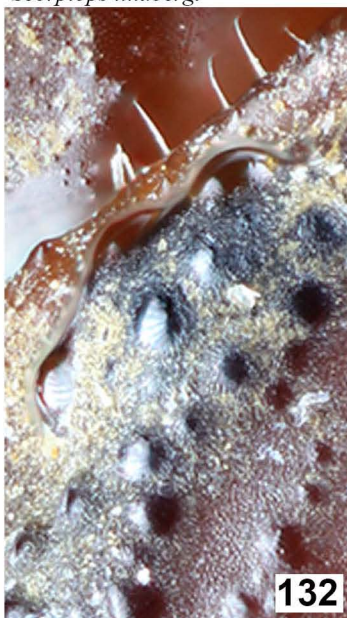
Figures 128–133: Part of carapace with lateral eyes. **Figure 128**. *Parascorpiops montanus*, female, Malaysia, Borneo, Sarawak, Matang, ca. 20 km W of Kuching, FKCP. **Figure 129**. *Scorpiops solegladi* **sp. n.**, female, holotype. **Figure 130**. *S. lindbergi*, male, holotype of *S. kraepelini*. **Figure 131**. *S. grosseri*, female, holotype. **Figure 132**. *S. tryznai*, female, holotype. **Figure 133**. *S. sherwoodae* **sp. n.**, male holotype.
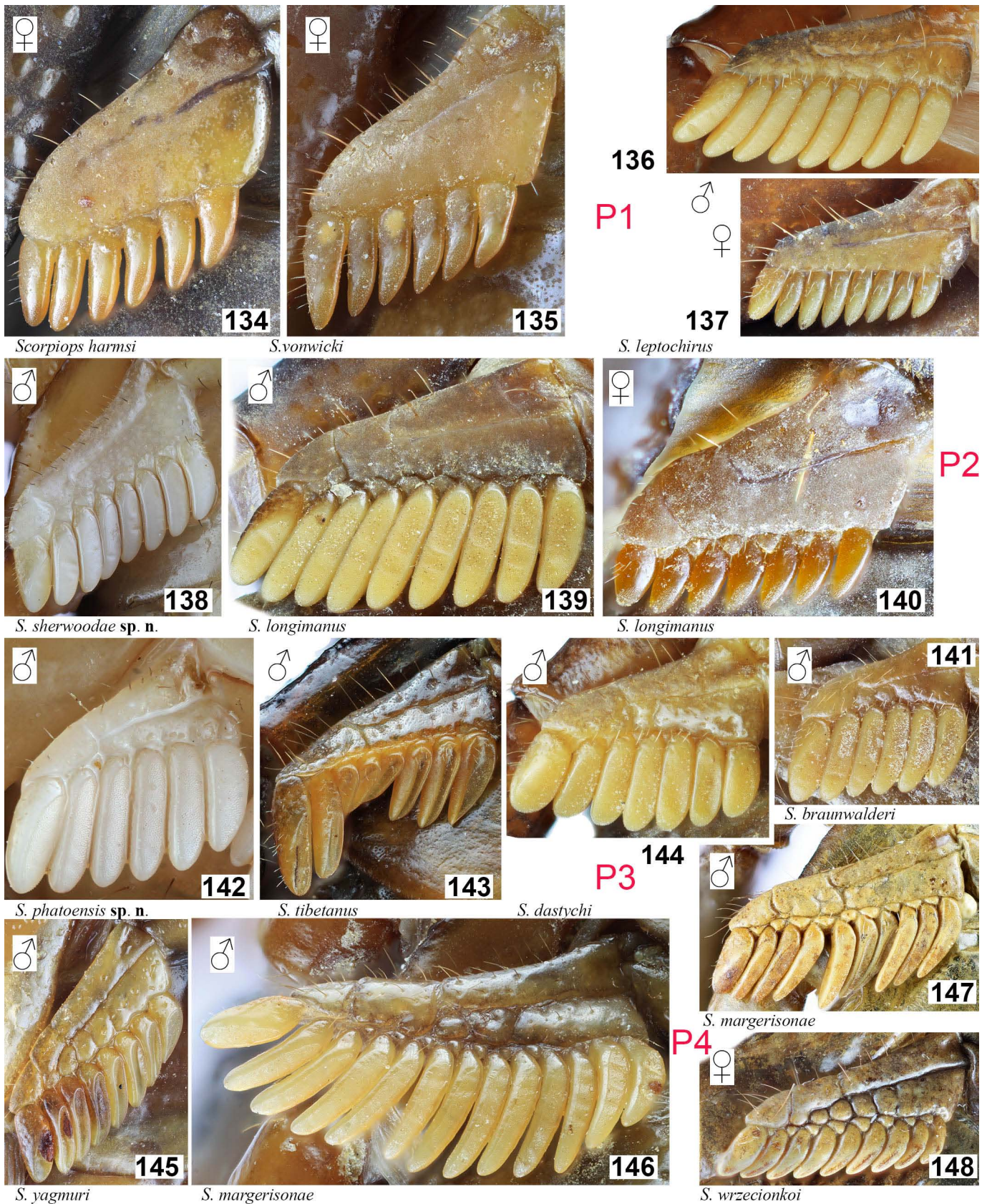
Figures 134–148: *Scorpiops* spp., right pectines. **Figure 134**. *S. harmsi*, female, holotype. **Figure 135**. *S. vonwicki*, female, holotype. **Figure 137**. *S. leptochirus*, male and female, India, Meghalaya State, Nong Poh, FKCP. **Figure 138**. *S. sherwoodae* **sp. n.**, male holotype. **Figure 139**. *S. longimanus*, male, India, Assam State, 50 km E of Tezpur, FKCP. **Figure 140**. *S. longimanus*, female, India, Maghalaya State, West Garo-Hills, FKCP. **Figure 141**. *S. braunwalderi*, male, holotype. **Figure 142**. *S. phatoensis* **sp. n.**, male, holotype. **Figure 143**. *S. tibetanus*, male, topotype of *S. pococki*, FKCP. **Figure 144**. *S. dastychi*, male, paratype. **Figure 145**. *S. yagmuri*, male, holotype. **Figure 146**. *S. margerisonae*, male, holotype. **Figure 147**. *S. margerisonae*, male, China, 100 km S of Lhasa, FKCP. **Figure 148**. *S. wrzecionkoi*, female, holotype.

§13. Hemispermatophore morphology

Hemispermatophores of scorpiopids were seldom described in the literature. The first report was for *Scorpiops montanus* by Stockwell (1989: 379, figs. 206–207). A lamelliform hemispermatophore was illustrated with an elongate but relatively short trunk and a rather long, narrow distal lamina with weak basal constriction and sharply bent, tapered apex. The capsule region bore three lobe-like processes (terminology according to Monod et al., 2017): (i) a longer, inwardly twisted *distal posterior lobe* (*dpl*) closest to the distal lamina, with truncate, finely denticulate distal margin; (ii) a shorter, pointed *lateral hook* (*lh*); and (iii) a broad *basal carina* (*bc*) with smooth distal margin, whose internal surface is attached to an inverted *terminal membrane of the sperm duct* (*tmsd*) bearing numerous spicules. Not shown was a truncal flexure, taken here to denote a transverse groove or fold at the juncture of trunk and distal lamina (*median transverse cleavage* (*mtc*) of Lamoral, 1979), an intrinsic structural feature whose biomechanical function is to localize the point of bending of a formed spermatophore during sperm transfer. Absence of a truncal flexure in the scorpiopid hemispermatophore was noted by Stockwell (1989: 129).

Bastawade (1994) described and illustrated the hemispermatophore of *Scorpiops hardwickii*. He depicted a lamelliform type with a narrow distal lamina that was apically bent and slightly shorter than the trunk. The capsule region bore sclerotized carinae and there appeared to be at least two lobes, although the configuration was not specified and described only as "complicated". In contrast to Stockwell (1989), a "prominent" truncal flexure was indicated at a notch on the posterior margin between trunk and distal lamina. It is unclear if this refers to a structural fold as we interpret it here, because the author also claims a truncal flexure in *Chaerilus tricostatus*. However, both Stockwell (1989: 129) and Monod et al. (2017) reported the absence of a truncal flexure in chaerilids, and none is visible in other species that have been illustrated: e.g., *C. truncatus* and *C. annapurna* (Lourenço & Duhem, 2010); *C. granulatus* and *C. hofereki* (Kovařík et al., 2015); and *C. phami* (Monod et al., 2017). Confusion may arise from introduction of the terminology by Francke (1979a: 24, "the trunk … connects to the lamella at the *truncal flexure*") without definition, leaving ambiguity about whether it means the point where trunk and distal lamina join and bend, or a permanent structural specialization at this point.

Soleglad & Sissom (2001) illustrated hemispermatophores of *Parascorpiops montanus* and *Neoscorpiops tenuicauda*. Capsules of both bore three lobe-like structures and a spicule-coated *tmsd*. The lobes of *N. tenuicauda* were similar to those of *S. montanus*: *dpl* twisted with denticulate apical margin (= "upward process"), *lh* hook-like, and *bc* broad and robust. The *bc* distal margin differed in being strongly sclerotized and armed with a regular row of at least 5 denticles, termed the *crown-like structure* (*cls*). The lobes of *P. montanus* exhibited several differences: *dpl* broad and serrate along one edge; *lh* apically bifid; and *bc* weaker without dentate distal margin.

The truncal flexure was remarked to be absent, in agreement with Stockwell (1989).

Since then, only a few authors included the hemispermatophore in species descriptions. Di & Zhu (2009b) illustrated the hemispermatophore of *Scorpiops lhasa*, showing a twisted *dpl* with denticulate distal margin, dark sclerotized *lh*, broad *bc* that seems to bear a smooth or finely dentate distal margin (*cls*?), and spiculate *tmsd*. Di et al. (2010b) illustrated the hemispermatophore capsule of *Euscorpiops puerensis*, showing a twisted *dpl* (= 'lc', undefined abbreviation), short *lh* (= 'cl', capsular lobe complex), *bc* without clearly indicated *cls*, and spiculate *tmsd* (= 'cs', mislabeled as crown-like structure). Kovařík et al. (2015b) described the hemispermatophore of *Alloscorpiops wongpromi*, showing a slender, twisted *dpl* (= 'del', distal external lobe), sharply bent *lh* (= 'bl', basal lobe), and *bc* with multi-pronged *cls* bearing 8 tines serially graded in size. However, the structures were incompletely developed with weak sclerotization and a fragmented *tmsd* bearing few spicules. All three of these described species exhibited capsule structures similar to those of *S. montanus* and *N. tenuicauda*: *dpl*, *lh*, *bc* with or without *cls*, and spiculate *tmsd*. In addition, Di et al. (2010a) illustrated a formed spermatophore of *Euscorpiops validus* in which paired *lh* and *cls* appear to be present on the fused capsule.

Monod et al. (2017: 18, figs. 12e, f, g) illustrated a hemispermatophore from an undetermined *Scorpiops* sp. (Myanmar) with the same elements as described above. They observed that the layout of scorpiopid hemispermatophores follows a two-folds bauplan (Monod et al., 2017: 10, fig. 4c) with an invaginated tectum that is extended distally to form the *dpl*. The *lh* corresponds to the sclerotized distal carina of the capsule, and the *bc* has a crest-like expansion (*bcr*) on its posterior margin. The distal margin of the *bc + bcr* has dentition that forms the *cls*. They found that several scorpiopid capsule features are shared with related taxa: elongation and torsion of the sperm duct also in *Brotheas* and allied genera; expanded spiculate *tmsd* also in *Chactopsis* and allied genera, and in *Euscorpius* and *Megacormus*; and a dentate *cls* also in *Chactas*, *Euscorpius* and *Megacormus* (cf. Soleglad & Sissom, 2001). Structural parallels with *Euscorpius* suggest likely functions of scorpiopid capsule components in sperm delivery (Jacob et al., 2004a). Backward leverage of the distal lamina pulls the *dpl* and *lh* apart from the *cls*, an action hypothesized pry open female genital opercula. The coating of spicules on the everted *tmsd* probably help secure contact of the sperm duct to the lining of the female genital tract, ensuring safe sperm transfer.

Soleglad & Sissom (2001) excluded hemispermatophores from their analysis, only having data from 3 species of ca. 30 known scorpiopids. Since then, hemispermatophores were described for only 3 of 46 new scorpiopids. Here we studied and compared hemispermatophores of 16 species that trichobothrial diagnoses place in 4 different genera (*Scorpiops*, *Euscorpiops*, *Alloscorpiops*, and *Dasyscorpiops*) (Figs. 149–185). All were lamelliform with a large capsule, a broad trunk and foot, and a distal lamina at least as long as the trunk but narrower. The

distal lamina was slightly or moderately constricted at its base, coiled apically and tapered to a fine tip. A prominent mid-axial rib extended along the length of the trunk, dividing it into a lightly sclerotized posterior half, and a moderately sclerotized anterior half. At the distal end of the axial rib was a narrow junction connecting to the sclerotized distal carina of the capsule. This point likely acts as a fulcrum when the distal lamina pivots to evert the capsule during sperm expulsion. The hemispermatophore was bent sharply in the posterior direction at this point, with an angle of 70°–140° between trunk axis and axis of proximal distal lamina (Figs. 149–163). However, there was no intrinsic structural fold or groove that could be identified as the 'truncal flexure' found in other lamelliform hemispermatophores. The junction point probably serves a similar biomechanical function as that of the truncal flexure. Capsule architectures were well conserved across species and consistent with previous descriptions. All conformed to the two-folds bauplan, and the same basic structures were identifiable, when present: *dpl*, *lh*, *bc*, and a spiculate *tmsd*.

The following characters were interspecifically variable and of potential taxonomic significance: distal lamina width, trunk length, development and length of the distal posterior lobe (*dpl*), sclerotization of the basal carina *(bc)* and development and armature of the crown-like structure (*cls*). Relative to capsule size, the distal lamina was most broad in *Scorpiops leptochirus*, being nearly as wide proximally as the trunk, and gradually tapering distally (Fig. 154**)**. In other species the distal lamina was narrower than the trunk, and more gradually tapered. The trunk was shortest in *S. wongpromi* and *S. kautti* **sp**. **n**. (Figs. 157–158) and longest in *S. problematicus* (Fig. 163) (Tab. 1). The *dpl* was absent in *S. leptochirus*, and varied in length in the other species. It was shorter in *S. oligotrichus*, *S. phatoensis* **sp**. **n**., *S. schumacheri* **sp**. **n**., *S. thaomischi*, and *S. dii* **sp**. **n**., longer in *S. citadelle*, *S. sherwoodae* **sp**. **n**., *S. wongpromi*, *S. kautti* **sp**. **n**., *S. krabiensis* **sp**. **n**., and *S. anthracinus*, and of intermediate length in *S. montanus*, *S. birulai* **sp**. **n**., and *S. problematicus* (Figs. 170–185, Tab. 1). Denticulation of the distal margin of the *dpl* varied widely even within the same species (Fig. 186), and thus was not a stable taxonomic character.

The basal carina was strongly sclerotized distally in most species, forming a plate-like structure with a concave surface facing the outer (convex) side of the capsule. This formed a shield covering the *tmsd* on the inner (concave) side of the capsule. In the majority of species examined, the *bc* apical margin was heavily sclerotized and formed a *cls* bearing multiple denticles or tines. Exceptions were: (i) *S. phatoensis* **sp**. **n**. and *S. schumacheri* **sp**. **n**., in which the margin was only weakly sclerotized with slight crenulations instead of denticles (Figs. 176–177); (ii) *S. montanus*, in which the margin was unsclerotized and smooth (Figs. 166, 173); and (iii) *S. leptochirus*, in which a sclerotized plate was absent, exposing the *tmsd* (Figs. 165, 175).

In the species examined, development and dentition of the *cls* segregated according to the four major clades resolved by DNA analysis (Šťáhlavský et al., in press) (Fig. 186):

Group 1. Distal *bc* plate present, *cls* present, margin oligodentate, with 5–7 denticles: *S. oligotrichus*, *A. citadelle*, *S. sherwoodae* **sp**. **n**. Dentition was very similar in the pair (*A. citadelle* + *S. sherwoodae* **sp**. **n**.) with *cls* margin terminating anteriorly in two enlarged hook-like denticles that were opposed like a pincer.

Group 2. Distal *bc* plate present, margin either smooth, without denticles (*S. montanus*, in agreement with Stockwell, 1989), or polydentate with 8–9 denticles (*S. pakseensis* **sp**. **n**.).

Group 3. Distal *bc* plate either present or absent (*S. leptochirus*); when present, *cls* absent and margin weakly sclerotized, crenulate (ca. 4 crenulations): *S. phatoensis* **sp**. **n**., *S. schumacheri* **sp**. **n**.

Group 4. Distal *bc* plate present, *cls* present, margin polydentate, with 7–11 denticles: *S. wongpromi*, *S. kautti* **sp**. **n**., *S. birulai* **sp**. **n**., *S. anthracinus*, *S. thaomischi* **sp**. **n**., *S. dii* **sp**. **n**., *S. problematicus*; denticles were uniformly spaced and tend to decrease in size from anterior to posterior.

The homogeneity of *cls* phenotypes within Groups 1 (oligodentate), 3 (reduced or absent) and 4 (polydentate) matches the main clades resolved in the DNA phylogeny, whilst the heterogeneity within Group 2 (both smooth and polydentate) implies a strong divergence between the two included taxa, *S. pakseensis* **sp**. **n**. and *S. montanus*. Interestingly, these two species are also widely separated geographically. Our findings provide good support for the phylogeny as the hemispermatophores represent 76% (16/21) of the terminal taxa sampled by DNA analysis, including all 4 major clades in the tree.

Which types of *cls* armature are plesiomorphic and which are derived? A possible outgroup for polarizing the character are the Euscorpiidae (genera *Euscorpius* Thorell, 1876, *Alpiscorpius* Gantenbein et al., 1999, *Tetratrichobothrius* Birula, 1917, and *Megacormus* Karsch, 1881), which were resolved as sister groups to scorpiopids in morphological (Soleglad & Sissom, 2001) and phylogenomic (Sharma et al., 2015, 2018) analyses. In these genera, the basal carina of the capsule terminates in a sclerotized distal process bearing tines or denticles (Vachon, 1948; Francke, 1979b; Stockwell, 1989; Sissom, 1994). This process was variously termed crown-like structure (Jacob et al., 2004a; Monod et al., 2017), crown-like process (González-Santillán & Alvarez-Padilla, 2015; González-Santillán et al., 2017), 'couronne de dents' (Vachon, 1948), 'dornenkranzes' (Scherabon, 1987), and 'spinose distal ental channel' (Fet & Soleglad, 2002). The *cls* is quite similar among the various euscorpiid genera, being composed of a non-contiguous series of long, digitate hooks arrayed more or less uniformly along the distal rim of the basal carina. The rim is bent into an arc or semicircle (hence the analogy to a crown), whose convex aspect faces the outer (convex) surface of the hemispermatophore capsule. The basal carina is narrow, weakly sclerotized, with a convex surface, and lacks a crest. In contrast, the scorpiopid *cls* arises from a well sclerotized basal carina, distally broadened by *bcr* expansion to form a plate with a concave surface. The distal rim is essentially straight, not arcuate, and has a row of nearly contiguous, short,
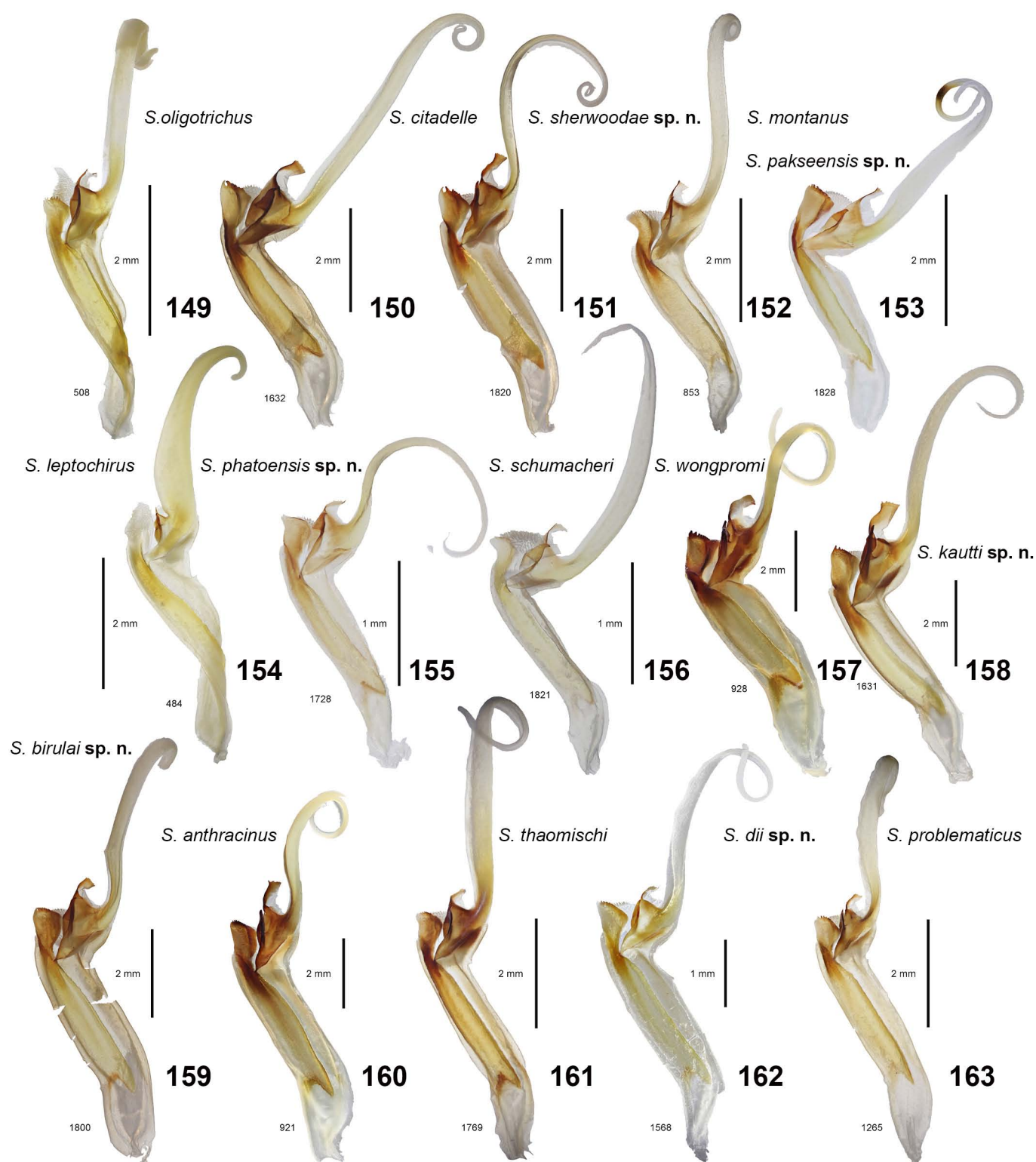
Figures 149–163: Whole hemispermatophores of 15 scorpiopids. Convex (external) aspect of hemispermatophores of: *Scorpiops oligotrichus* (149), *S. citadelle* (150), *S. sherwoodae* **sp. n.** (151), *S. montanus* (152), *S. pakseensis* **sp. n.** (153), *S. leptochirus* (154), *S. phatoensis* **sp. n.** (155), *S. schumacheri* (156), *S. wongpromi* (157), *S. kautti* **sp. n.** (158), *S. birulai* **sp. n.** (159), *S. anthracinus* (160), *S. thaomischi* (161), *S. dii* **sp. n.** (162) and *S. problematicus* (163). Specimen numbers indicated. Scale bars: 2 mm (149–154, 157–161, 163), 1 mm (155–156, 162).
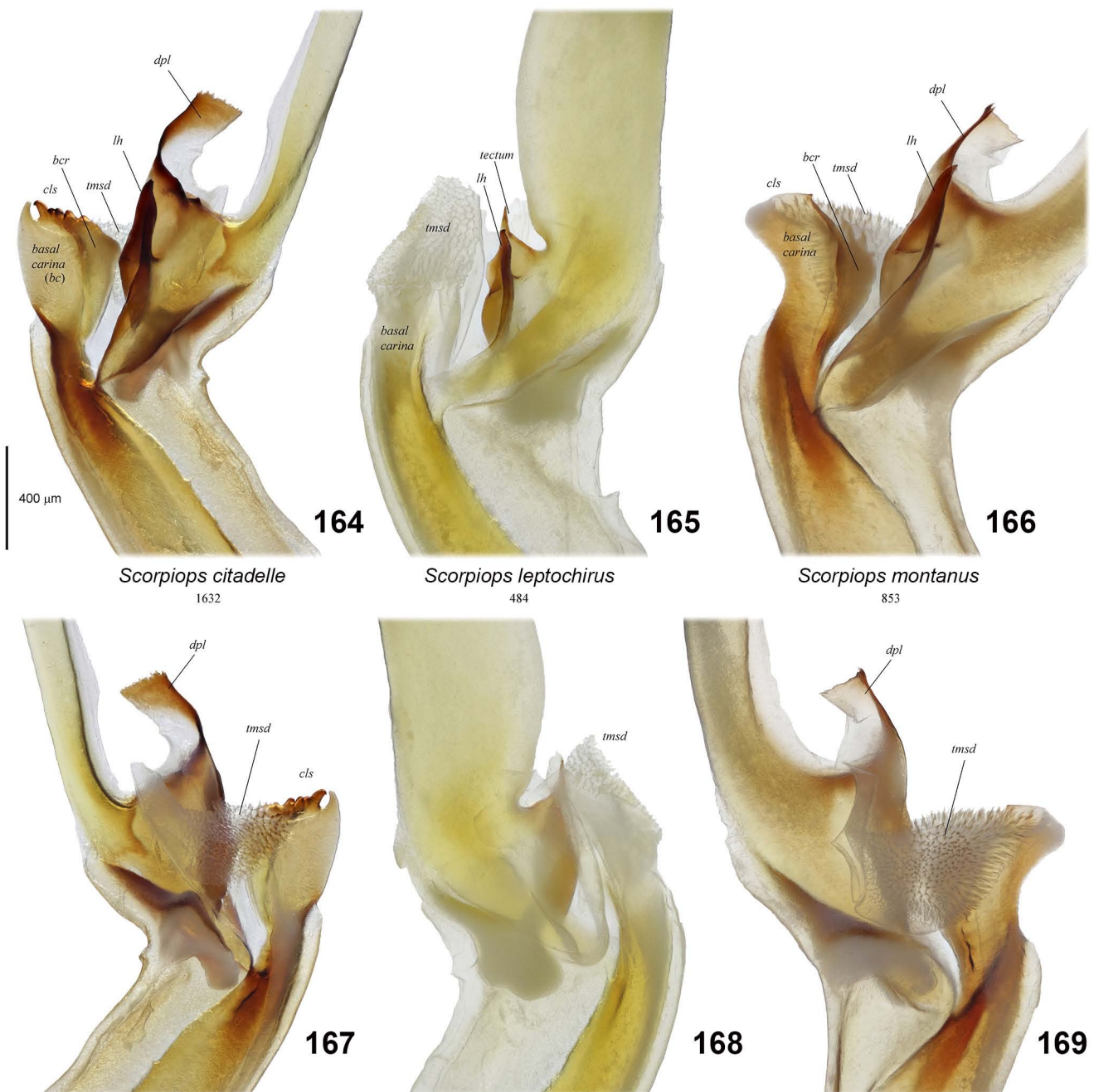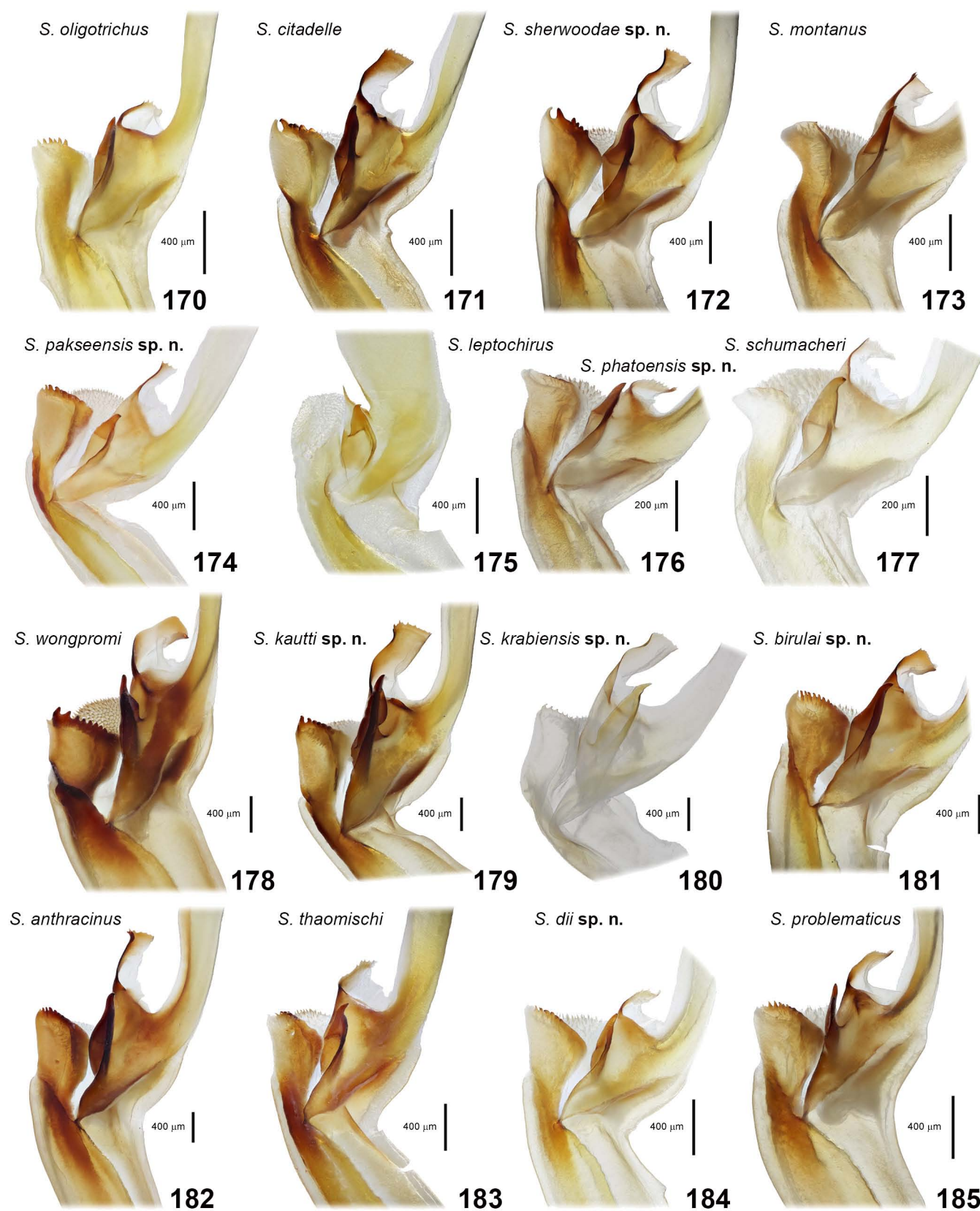
Figures 164–169: Types of hemispermatophore capsule architecture in scorpiopids, showing main structures and nomenclature. **Figures 164**, **167**. *Scorpiops citadelle* capsule in convex (164) and concave (167) views, showing distal *bc* expanded into a plate with basal crest bearing oligodentate *cls*, strongly spiculate *tmsd*, and long *dpl* with denticulate apical margin. **Figures 165**, **168**. *S. leptochirus* capsule in convex (165) and concave (168) views, showing a *bc* without distal plate or basal crest, no *cls*, weakly spiculate or fenestrate *tmsd*, and tectum not extended into a *dpl*. **Figures 166**, **169**. *S. montanus* capsule in convex (166) and concave (169) views, showing distal *bc* expanded into a plate with basal crest with smooth distal margin lacking *cls* denticles, strongly spiculate *tmsd*, and intermediate length *dpl* with weakly denticulate apical margin. Abbreviations: *bc*, basal carina; *bcr*, basal crest; *cls*, crown-like structure; *dpl*, distal posterior lobe; *lh*, lateral hook; *tmsd*, terminal membrane of sperm duct. Specimen numbers indicated. Scale bar: 400 μm.

robust, hooked denticles. In form it appears more pectinate or serrulate, than coronate, and '*cls*' may be better understood to mean 'comb-like structure'. These fundamental structural differences suggest that the *cls* of scorpiopids and euscorpiids are not necessarily homologous, but possibly evolved independently to serve similar functions.

Even assuming homology, the degree of development of the *cls* varies widely across different euscorpiid taxa, which complicates the choice of an appropriate primitive character state for outgroup comparison to scorpiopids. In *Euscorpius* and *Alpiscorpius*, the *cls* can be oligodentate (4–9 tines), e.g., *Alpiscorpius alpha* (Caporiacco, 1950), *A. gamma* Caporiacco,

Figures 170–185: Hemispermatophore capsules of 16 scorpiopids. Convex aspect of capsules of: *Scorpiops oligotrichus* (170), *S. citadelle* (171), *S. sherwoodae* **sp. n.** (172), *S. montanus* (173), *S. pakseensis* **sp. n.** (174), *S. leptochirus* (175), *S. phatoensis* **sp. n.** (176), *S. schumacheri* (177), *S. wongpromi* (178), *S. kautti* **sp. n.** (179), *S. krabiensis* **sp. n.** (180), *S. birulai* **sp. n.** (181), *S. anthracinus* (182), *S. thaomischi* (183), *S. dii* **sp. n.** (184) and *S. problematicus* (185). Specimen number of *S. krabiensis* 1829, of others as indicated in Figs. 149–163. Scale bars: 400 µm (170–175, 178–185), 200 µm (176–177).
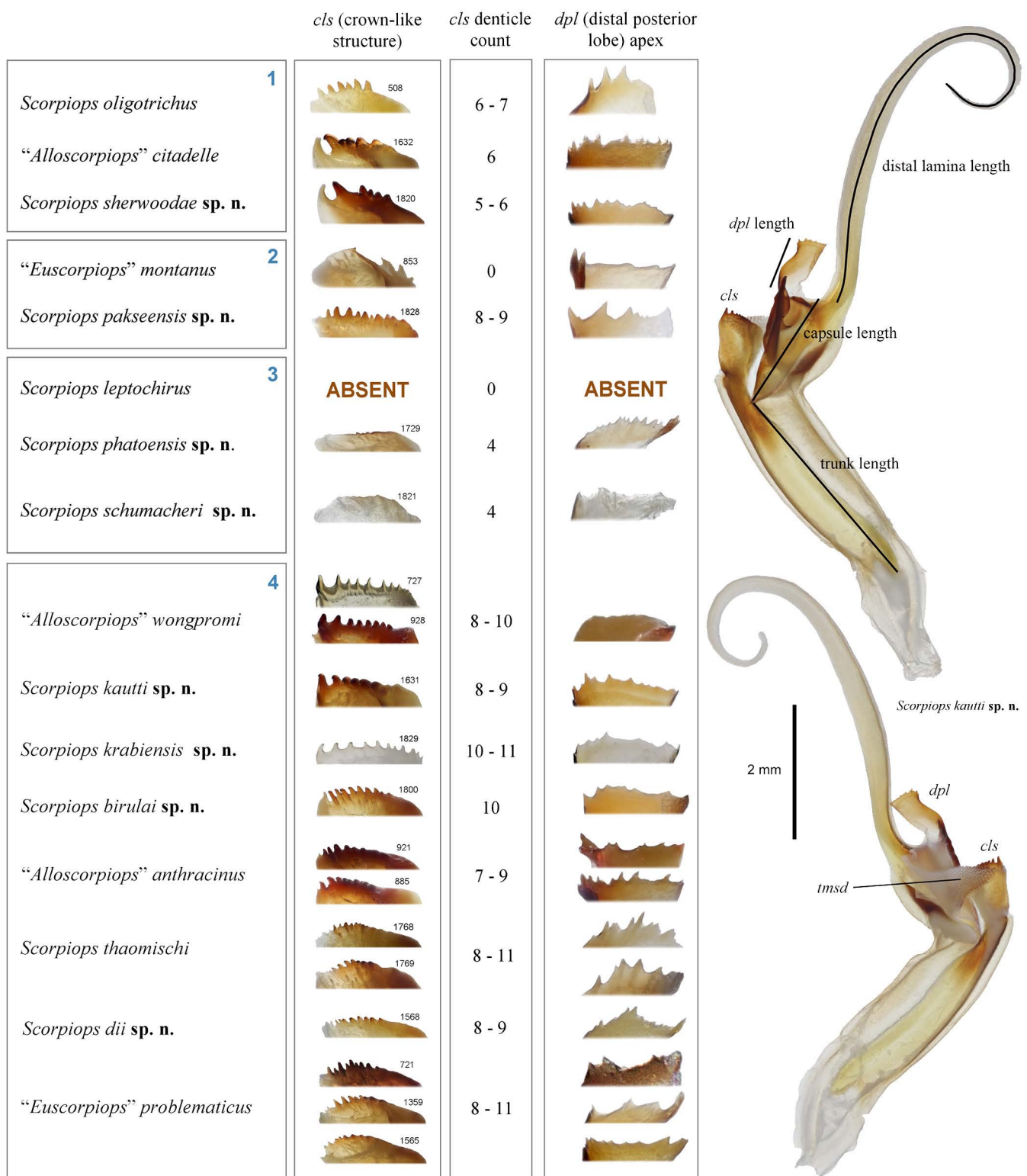
Figure 186: Dentition of crown-like structures (*cls*) and distal posterior lobe (*dpl*) apex of 16 scorpiopids. Species are grouped according to four major clades resolved by DNA analysis (Šťáhlavský et al., in press). To highlight inconsistency of the trichobothrial classification with molecular phylogeny, previously described species are listed under genera (in quotes) where they were originally placed according to trichobothriotaxic characters of Soleglad & Fet (2001). Cited ranges of *cls* denticle counts for each species represent data from both left and right hemispermatophores extracted from all available specimens: N =1, except for "*Alloscorpiops*" *wongpromi* (N = 2), "*A.*" *anthracinus* (N = 2), *Scorpiops thaomischi* (N = 2), and "*Euscorpiops*" *problematicus* (N = 3). Data with N > 1 reveal intraspecific stability of *cls* dentition patterns, and intraspecific variability of *dpl* denticulation patterns. Right insets: convex (upper inset) and concave (lower inset) views of whole hemispermatophore of *Scorpiops kautti* **sp. n**. Anatomical structures and measurements are indicated. Scale bar: 2 mm.

Clade	Species	No.	Capsule L (μm)	*dpl* L (μm)	Trunk L (μm)	distal lamina L (μm)	*dpl* Capsule L/ L	distal lamina Capsule L/ L	Trunk Capsule L/ L	distal lamina Trunk L/ L
1	*S. oligotrichus* Fage, 1933	508	766	227	1870	3434	0.296	4.48	2.44	1.84
1	*S. citadelle* (Kovařík, 2013)	1632	1335	564	2706	6657	0.422	4.99	2.03	2.46
1	*S. sherwoodae* **sp. n.**	1820	1324	590	2901	6842	0.446	5.17	2.19	2.36
2	*S montanus* Karsch, 1879	853	1056	249	2142	4216	0.236	3.99	2.03	1.97
2	*S. pakseensis* **sp. n.**	1828	1206	260	2181	5216	0.216	4.33	1.81	2.39
3	*S. leptochirus* Pocock, 1893	484	661	-	2570	3591	-	5.43	3.89	1.40
3	*S. phatoensis* **sp. n.**	1729	534	110	1169	2516	0.206	4.71	2.19	2.15
3	*S. schumacheri* **sp. n.**	1821	479	150	1181	2669	0.313	5.57	2.47	2.26
4	*S. wongpromi* (Kovařík et al., 2013)	928	1742	637	3410	7302	0.366	4.19	1.96	2.14
4	*S. kautti* **sp. n.**	1631	1743	880	3337	7332	0.505	4.24	1.91	2.20
4	*S. krabiensis* **sp. n.**	1829	1752	763	-	-	0.436	-	-	-
4	*S. birulai* **sp. n.**	1800	1521	423	3486	5115	0.278	3.36	2.29	1.47
4	*S. anthracinus* Simon, 1887	921	1774	754	4203	7011	0.425	3.95	2.37	1.67
4	*S. thaomischi* (Kovařík, 2012)	1769	1125	292	2833	6526	0.260	5.80	2.52	2.30
4	*S. dii* **sp. n.**	1568	906	255	2343	4844	0.281	5.35	2.59	2.07
4	*S. problematicus* Kovařík, 2000	1359	848	243	2619	3801	0.287	4.48	3.09	1.45

Table 1. Hemispermatophore measurements of 16 scorpiopids. Measured parameters are defined in Fig. 186 (upper right photo): capsule length, distal posterior lobe (*dpl*) length, trunk length, and distal lamina length. Computed biometric ratios: *dpl* length/ capsule length, distal lamina length/ capsule length, trunk length/ capsule length, distal lamina length/ trunk length. Clade = grouping in Fig. 186; No. = specimen number.

1950, *A. uludagensis* Lacroix, 1995, *Euscorpius avcii* Tropea et al., 2012, *E. carpathicus* (Linnaeus, 1767), *E. ciliciensis* Birula, 1898, *E. drenskii* Tropea et al., 2015, *E. erymanthius* Tropea et al., 2013, *E. feti* Tropea, 2013, *E. giachinoi* Tropea & Fet, 2015, *E. sicanus* (C. L. Koch, 1837), *E. tergestinus* (C. L. Koch, 1837), *E. oglasae* Di Caporiacco, 1950, *E. vailatii* Tropea & Fet, 2015; or polydentate (10–15 tines), e.g. *Euscorpius birulai* Fet et al., 2014, *E. concinnus* (C. L. Koch, 1837), *E. italicus* (Herbst, 1800), *E. kritscheri* Fet et al., 2013, *E. mylonasi* Fet et al., 2014, *E. naupliensis* (C. L. Koch, 1837), *E. stahlavskyi* Tropea et al., 2014 (Vachon, 1948; Scherabon, 1987; Gantenbein & al. 2002; Jacob et al., 2004b; Vignoli et al., 2007; Fet et al., 2013, 2014; Tropea et al., 2013, 2014a, 2014b, 2015a, 2015b; Tropea & Fet, 2015; Tropea & Ozimec, 2019; our unpublished data). There is no simple dichotomy of low and high counts, as wider variation is observed in counts of *Alpiscorpius germanus* (C.L. Koch, 1837) (4–12) and *A. mingrelicus* (Kessler, 1874) (6–13) (Scherabon, 1987; Jacob et al., 2004b; Tropea et al., 2015b), and intermediate counts (8–13) in *Euscorpius gocmeni* Tropea et al., 2014, *E. lycius* Yağmur et al., 2013, and *Alpiscorpius phrygius* Bonacina, 1980 (Yağmur et al., 2013; Tropea et al., 2014a, 2015b).

The species *Tetratrichobothrius flavicaudis* (DeGeer, 1778) stands apart from the others in bearing only a single denticle on the *cls* (Vachon, 1948; Molteni et al., 1983; Scherabon, 1987; Jacob et al., 2004b). Fet & Soleglad (2002) inferred that this condition is derived, based on an outgroup comparison to *Megacormus* in which the *cls* has multiple tines. Indeed, the *cls* is oligodentate (5–8 tines) in *M. granosus* (Gervais, 1843), *M. grubbsi* Sissom, 1994, *M. segmentatus* Pocock, 1900, and polydentate (11–13 tines) in *M. franckei* Kovařík, 2020, and *M. gertschi* Díaz Nájera, 1966 (Francke, 1979; González-

Santillán & Padilla, 2015; our unpublished data). In *M. xichu* González-Santillán et al., 2017, the denticle count has greater latitude (6–13), similar to *A. germanus* (González-Santillán et al., 2017; our unpublished data). Jacob et al. (2004b) also expressed the opinion that the single denticle in *T. flavicaudis* was apomorphic and further noted a reduction in number of capsule lobes and a non-spiculate *tmsd* in this species. They suggested that this was concordant with the DNA phylogeny of Gantenbein et al. (1999). However, in that phylogeny, *T. flavicaudis* was a basal outgroup to *E. carpathicus*, *A. germanus* and *E. italicus* (see also, e.g.: Salomone et al., 2007; Fet et al., 2016), which predicts expression of plesiomorphic rather than apomorphic characters. At the same time, it is also possible that atrophy of capsule lobes and *cls* dentition is an autapomorphy for *T. flavicaudis*, a character reversal that does not reflect its phylogenetic position.

Both oligodentate and polydentate *cls* appear in disparate lineages of *Euscorpius* and *Alpiscorpius* (Fet et al., 2016), implying substantial homoplasy in this character. The phylogeny of *Megacormus* has not been elucidated, so it is unclear which character state is associated with more basal species. Uncertainty about the primitive state in euscorpiids, together with the basic structural difference between the *cls* of euscorpiids and scorpiopids, prevents us from polarizing *cls* denticle counts of scorpiopids by outgroup comparison to euscorpiids. On the contrary, recent phylogenomic analyses have placed either brothein chactids (*Brotheas*) (Sharma et al., 2018: 41, fig. 3) or scorpiopids (Santibáñez-López et al., 2019: 27, fig. 2) as immediate outgroups of euscorpiids (*Euscorpius* + *Megacormus*). Absence of the *cls* in *Brotheas* (Monod et al., 2017) argues for this being the primitive ancestral state for euscorpiids,

and for independent evolution of the different type of *cls* in scorpiopids. We considered the following possibilities for *cls* dentition as an ordered multistate character: (I) oligodente = 0, polydente = 1, rudimentary or absent = 2, with transformations 0→1, 0→2; (II) rudimentary or absent = 0, oligodente = 1, polydente = 2, with transformations 0→1, 0→2; and (III) rudimentary or absent = 0, oligodente = 1, polydente = 2, with transformations 0→1→2. For our DNA phylogeny, consistency indices were 0.50, 0.66 and 0.40 respectively, favoring model II. Thus, the most parsimonious hypothesis is to assume that the rudimentary or absent *cls* is the plesiomorphic state, and that the oligodente and polydente *cls* are independently derived features. Independent derivation of oligodente and polydente *cls* supports monophyly of Groups 1 and 4 (Fig. 186). We thus hypothesize that *Scorpiops leptochirus* possesses the most primitive capsule, one in which neither *cls* nor *dpl* is developed, the distal plate with basal crest are missing, and the *tmsd* has smaller spicules than in other species. Another unique feature of *S. leptochirus* was the broad connection of capsule distal carina with mid-axial rib (figs. 165, 175), contrasting with the narrow junction in the 15 other species examined. This simple capsule was not an abnormality in an isolated specimen, as we observed the same characters in both left and right capsules from two males of *S. leptochirus* (cf. Figs. 165, 168, 175).

Systematics

Family Scorpiopidae Kraepelin, 1905
(Figures 1–81, 90–815, Tables 1–9)

Scorpiopsinae Kraepelin, 1905: 341 (incorrect original spelling); Birula, 1917: 58; Werner, 1934: 282; Kästner, 1941: 237; Millot & Vachon, 1949: 428; Stahnke, 1974: 112, 116; Tikader & Bastawade, 1983: 380; Sissom, 1990: 114; Nenilin & Fet, 1992: 6.

Scorpiopsidae Stockwell, 1989; Stockwell, 1992: 411; Kovařík, 1998: 141; Lourenço, 1998: 245.

Scorpiopidae Fet, 2000: 487 (corrected spelling); Kovařík, 2000: 154; Prendini & Wheeler, 2005: 482, tab. 10; Kamenz & Prendini, 2008: 6, 10, 25, 44; Volschenk et al., 2008: 655, 665, 675, tab. 1–2; Prendini, 2011: 117; Loria & Prendini, 2014: 5, 20, 22, tab. 4, S1-10, S2-8; Beron, 2015: 11, 16; Lourenço, 2015: 9; Santibáñez-López et al., 2016: 2, tab. 1; Monod et al., 2017: 2–3, 10, 13, 15, 18, 38; Monod et. al., 2019: 110, 183.

Scorpiopini Soleglad & Sissom, 2001: 89, 93, 96; Soleglad & Fet, 2003b: 88, 106, 120, tab. 9; Fet & Soleglad, 2005: 12.

Scorpiopinae Soleglad & Fet, 2003a: 25 (in part); Coddington et al., 2004: 309 (in part).

Diagnosis. Total length 24–75 mm. Carapace anterior margin with deep median notch. Inner accessory denticles present on pedipalp chelal fingers. Median eyes and median ocular tubercle present. Lateral eyes with 2–3 larger ocelli, one small ocellus may also be present. Cheliceral movable finger with dorsal distal denticle slightly shorter than ventral distal denticle, dorsal margin with two large subdistal denticles, ventral margin with 4–7 smaller denticles or crenulations. Ventral aspect of cheliceral fixed finger smooth without denticles. Sternum pentagonal. Pectines short, with 4–14 teeth, fulcra present or absent. Hemispermatophore lamelliform, distal lamina long, slender, terminally curved and tapered, capsule conforming to 2-folds bauplan, truncal flexure absent, terminal membrane of sperm duct spiculate, trunk with mid-axial rib. Ovariuterus 6-celled, oocyte development apoikogenic. Pedipalp chela more or less compressed, flattened. Pedipalp fingers with median denticles aligned in linear row (or rows), outer denticles usually present and displaced externally, inner accessory denticles present. Trichobothrial pattern type C, with additive neobothriotaxy, trichobothrial counts: patella 16–75 external, 6–28 ventral, chela manus 4–16 ventral. External surface of chela with Eb_3 level with or distal to Db. Legs with two pedal spurs, tibial spurs absent. Tarsomere II with row of 3–11 stout spinules on ventral surface. Metasoma with paired ventrosubmedian carinae. Telson without subaculear tubercle, often with annular construction at base of aculeus.

Type genus. *Scorpiops* Peters, 1861.

Subordinate taxa. *Scorpiops* Peters, 1861 and *Parascorpiops* Banks, 1928. Validity of the monophyletic genus *Parascorpiops* was not tested, either here or in Šťáhlavský et al. (in press). Banks (1928) defined the genus *Parascorpiops* with type species *P. montanus*, by the possession of two pairs of lateral eyes (vs. three pairs in *Scorpiops*). Francke (1976) questioned whether lateral eye counts were a reliable generic character, and several species of the genus *Scorpiops* are now known to have a third pair of lateral eyes that are greatly reduced, giving the impression of only 2 pairs present. We found only one unique character for the genus *Parascorpiops*: dentition of the pedipalp movable finger composed of irregular denticles in three or four rows (Fig. 104). All species of *Scorpiops* have fingers with median denticles aligned in a regular linear row, or two rows (Figs. 105–121).

Remarks on karyotypes. The karyotypes have already been described in 19 scorpiopid species (Kovařík et al., 2013a, 2015a, 2015c; Šťáhlavský et al., in press). In our present study we supplemented previous information with the karyograms in 16 of them (Figs. 800–815). All chromosomes of scorpiopid species are monocentric, i. e. chromosomes have a defined centromere. This cytogenetic feature is typical for the whole parvorder Iurida (e.g. Shanahan, 1989; Schneider et al., 2009; Štundlová et al., 2019). Because all karyotyped scorpiopid species are now classified into the genus *Scorpiops*, the 2n of this genus ranges from 48 to 147 (Šťáhlavský et al., in press). Such a high variability of diploid numbers are known also in other genera from different families belonging to the Iurida such as *Hadogenes* (Hormuridae): 2n=48–174, *Urodacus* (Urodacidae): 2n=29–175, *Alpiscorpius* (Euscorpiidae): 2n=46–90, and *Heterometrus* (Scorpionidae): 2n=54–112

(see Schneider et al., 2020). High interspecific karyotype variability in these entire groups, including the genus *Scorpiops*, underscores the importance of cytogenetic markers as an important tool in species delimitation of scorpions with monocentric chromosomes (Plíšková et al., 2016). Despite the high differences of karyotypes among scorpiopid species, their karyotypes usually possess a predominance of one-armed (acrocentric) chromosomes (see Šťáhlavský et al., in press). The high number of bi-armed chromosomes (almost one third) has been documented only in the species *Scorpiops neradi* (2n=48) with the lowest known number of chromosomes within scorpiopid species. This high number of bi-armed chromosomes in this species and also the high incidence (in 75% of species) of one trivalent during meiosis I comprising one extra-large bi-armed chromosome and two shorter acrocentrics, indicates Robertsonian translocations in the karyotype evolution of this group. Moreover, a high variability of nucleolus organizer regions (NORs) location within scorpiopid species was documented. Despite their stable number (always one pair), the NORs changed position from terminal to pericentromeric location and were identified on chromosomes of different lengths among analyzed species (from the longest chromosomes in *Scorpiops citadelle* and *S. leptochirus* to almost the shortest chromosomes in *S. montanus*) (see Figs. 800–815). These differences in NOR locations and predominance of one-armed chromosomes also indicate an important role of inversions during the karyotype evolution. It is evident that the differentiation of karyotypes within scorpiopid scorpions is a dynamic process that includes complex chromosomal rearrangements that leads to the specific features of all recognized species. For this reason, we fully recommend implementing the characterization of karyotypes as one of the important characters in the description of new scorpiopid species in the future.

Genus *Scorpiops* Peters, 1861
(Figures 1–75, 77–81, 90–103, 105–127, 129–254, 257–815, Tables 1–9)
http://zoobank.org/urn:lsid:zoobank.org:act:45E3D60F-43C5-4655-9675-E8C72D771112

Scorpiops Peters, 1861: 510; Kraepelin, 1899: 179–182; Vachon, 1980: 143–159, figs. 1–40; Tikader & Bastawade, 1983: 403–452, figs. 1129–1246; Francke, 1985: 13 (in part); Sissom, 1990: 114; Kovařík, 1998: 142; Lourenço, 1998: 246; Fet, 2000: 491–495 (in part); Kovařík, 2000: 162–198, figs. 1–7, 14–22, 25, 28, 29, 31–72 (in part); Soleglad & Sissom, 2001: 93–97, figs. 3, 13–14, 86, 96, 101, 114, 147, 159, 183, 202, 220 (in part); Qi et al., 2005: 2–14, figs. 1–46; Dupré, 2007: 10 (in part); Kovařík, 2009: 27, 32; Kovařík & Ahmed, 2009: 1–10, figs. 1–26; Di et al., 2011a: 1–2 (in part); Francke, 2019: 15; Kovařík, 2020: 1–43, figs. 1–241, tables 1–3.

= *Dasyscorpiops* Vachon, 1974: 952–953, figs. 142, 147, 160–162 (type species *Dasyscorpiops grandjeani* Vachon,

1974); Francke, 1976: 82; Francke, 1985: 7; Kovařík, 1998: 141; Fet, 2000: 488; Kovařík, 2000: 156; Soleglad & Sissom, 2001: 93–97, figs. 5, 16, 95, 104; Dupré, 2007: 5; Kovařík, 2009: 32; Francke, 2019: 7. **Syn. n.** **http://zoobank.org/urn:lsid:zoobank.org:act:D7B64009-0663-4482-8A15-6C88213A30B2**

= *Scorpiops* (*Neoscorpiops*) Vachon, 1980: 150, 151, figs. 10–16 (type species *Scorpiops montanus satarensis* Pocock, 1900); Tikader & Bastawade, 1983: 382–483, figs. 1060–1128; Francke, 1985: 13. **Syn. n.** **http://zoobank.org/urn:lsid:zoobank.org:act:E04E0206-554E-47BC-9BCC-28D94DA02843**

= *Scorpiops* (*Alloscorpiops*) Vachon, 1980: 151, figs. 18–25 (type species *Scorpiops anthracinus* Simon, 1887); Francke, 1985: 13. **Syn. n.** **http://zoobank.org/urn:lsid:zoobank.org:act:7EDB9233-E168-4E52-AB25-4B5066112656**

= *Scorpiops* (*Euscorpiops*) Vachon, 1980: 155, figs. 26–32 (type species *Scorpiops asthenurus* Pocock, 1900); Tikader & Bastawade, 1983: 452–476, figs. 1247–1305; Francke, 1985: 13 (syn. by Kovařík, 2000: 164, restored to generic status by Soleglad & Sissom, 2001: 93, and synonymized here again). **http://zoobank.org/urn:lsid:zoobank.org:act:AE9E0E91-2234-424D-89FE-6716B2ACCF38**

Alloscorpiops: Stockwell, 1989: 120; Fet, 2000: 487–488; Kovařík, 2000: 155–156, figs. 8, 24, 26; Soleglad & Sissom, 2001: 49, 93, figs. 4, 61, 99, 103, 117, 136, 143, 177, 188–189, 201; Dupré, 2007: 2; Kovařík, 2009: 32; Kovařík, 2013: 1–11, figs. 1–24.

Euscorpiops: Stockwell, 1989: 120; Fet, 2000: 488–489; Soleglad & Sissom, 2001: 93–97, figs. 6, 15, 60, 65, 97, 115, 145, 178, 185–186, 190, 203, 222; Dupré, 2007: 5; Kovařík, 2009: 32; Di et al., 2010b: 50; 2011b: 5; Francke, 2019: 8.

Neoscorpiops: Stockwell, 1989: 120; Fet, 2000: 489–490; Kovařík, 2000: 158–162, figs. 9–12, 27, 30; Soleglad & Sissom, 2001: 93–97, figs. 61, 67, 98, 102, 113, 125, 131–132, 176, 184, 200, 221, 223; Dupré, 2007: 7; Kovařík, 2009: 32; Francke, 2019: 11.

= *Alloscorpiops* (*Laoscorpiops*) Lourenço, 2013a: 52–55, figs. 2–3 (type species *Alloscorpiops* (*Laoscorpiops*) *calmonti* Lourenço, 2013); Francke, 2019: 3 (syn. by Kovařík et al., 2013: 1). **http://zoobank.org/urn:lsid:zoobank.org:act:060BD6BA-61FF-45E9-A8B9-05F3DFBDBE9A**

= *Scorpiops* (*Vietscorpiops*) Lourenço & Pham, 2015a: 212–217, figs. 1–6 (type species *Scorpiops* (*Vietscorpiops*) *dentidactylus* Lourenço & Pham, 2015). **Syn. n.** **http://zoobank.org/urn:lsid:zoobank.org:act:91B89979-0C30-4BB0-A7AB-0B1FACF81886**

= *Plethoscorpiops* Lourenço, 2017: 352–357, figs. 6–10 (type species *Plethoscorpiops profusus* Lourenço, 2017); Francke, 2019: 14. **Syn. n.** **http://zoobank.org/urn:lsid:zoobank.org:act:A1E7D2EC-609B-44BE-8D65-95DEA842D37A**

Vietscorpiops: Pham et al., 2017: 136.

Alloscorpiops (*Alloscorpiops*): Francke, 2019: 3.

Type species. *Scorpio hardwickii* Gervais, 1843.

Diagnosis. See family diagnosis.

Subordinate taxa.
Scorpiops affinis Kraepelin, 1898
Scorpiops afghanus Lourenço & Qi, 2006
Scorpiops alexandreanneorum (Lourenço, 2013), **comb**. **n**.
Scorpiops anthracinus Simon, 1887, **comb**. **n**.
= *Scorpiops lindstroemii* Thorell, 1889
= *Scorpiops lugubris* Thorell, 1889
Scorpiops artemisae (Kovařík et al., 2015), **comb**. **n**.
Scorpiops asthenurus Pocock, 1900
Scorpiops bastawadei **sp**. **n**.
Scorpiops beccaloniae (Kovařík, 2005), **comb**. **n**.
Scorpiops bhutanensis Tikader & Bastawade, 1983
Scorpiops binghamii Pocock, 1893
Scorpiops birulai **sp**. **n**.
Scorpiops braunwalderi Kovařík, 2000
Scorpiops calmonti (Lourenço, 2013), **comb**. **n**.
Scorpiops cavernicola (Lourenço & Pham, 2013), **comb**. **n**.
Scorpiops ciki **sp**. **n**.
Scorpiops chiangmai (Lourenço, 2019), **comb**. **n**., **nomen dubium**
Scorpiops citadelle (Kovařík, 2013), **comb**. **n**.
Scorpiops dakrong (Lourenço & Pham, 2014)
Scorpiops dastychi Kovařík, 2000
Scorpiops deccanensis Tikader & Bastawade, 1977
Scorpiops demisi Kovařík, 2005
Scorpiops dii **sp**. **n**.
Scorpiops dunlopi **sp**. **n**.
Scorpiops farkaci Kovařík, 1993
= *Scorpiops* (*Vietscorpiops*) *dentidactylus* Lourenço & Pham, 2015, **syn**. **n**.
Scorpiops feti Kovařík, 2000
Scorpiops furai Kovařík, 2020
Scorpiops grandjeani (Vachon, 1974), **comb**. **n**.
Scorpiops grosseri Kovařík, 2020
Scorpiops hardwickii (Gervais, 1843)
= *Scorpiops crassimanus* Pocock, 1899
= ? *Scorpiops insculptus* Pocock, 1900
= ? *Chaerilus pirpanjalus* Mani, 1959
Scorpiops harmsi Kovařík, 2020
Scorpiops hofereki Kovařík, 2020
Scorpiops ingens Yin et al., 2015
Scorpiops irenae Kovařík, 1994
Scorpiops jendeki Kovařík, 1994
Scorpiops kaftani Kovařík, 1993
Scorpiops kamengensis (Bastawade, 2006), **comb**. **n**.
Scorpiops kautti **sp**. **n**.
Scorpiops kejvali Kovařík, 2020
Scorpiops krabiensis **sp**. **n**.
Scorpiops kubani (Kovařík, 2004), **comb**. **n**.
Scorpiops langxian Zhu, Qi & Lourenço, 2005
Scorpiops leptochirus Pocock, 1893
Scorpiops lii (Di & Qiao, 2020), **comb**. **n**.

Scorpiops lhasa Di & Zhu, 2009
Scorpiops lindbergi Vachon, 1980
= *Scorpiops kraepelini* Lourenço, 1998
Scorpiops longimanus Pocock, 1893
Scorpiops luridus Zhu, Lourenço & Qi, 2005
Scorpiops maharashtraensis (Mirza et al., 2013), **comb**. **n**.
Scorpiops margerisonae Kovařík, 2000
Scorpiops montanus Karsch, 1879
Scorpiops neradi (Kovařík et al., 2013), **comb**. **n**.
Scorpiops novaki (Kovařík, 2005), **comb**. **n**.
= *Euscorpiops karschi* Lourenço, Zhu & Qi, 2005, **syn**. **n**.
Scorpiops oligotrichus Fage, 1933
Scorpiops orioni (Kovařík et al., 2015), **comb**. **n**.
Scorpiops pachmarhicus Bastawade, 1992
Scorpiops pakistanus Kovařík & Ahmed, 2009
Scorpiops pakseensis **sp**. **n**.
Scorpiops petersii Pocock, 1893
Scorpiops phaltanensis (Sulakhe et al., 2020), **comb**. **n**.
Scorpiops phatoensis **sp**. **n**.
Scorpiops prasiti **sp**. **n**.
Scorpiops problematicus Kovařík, 2000
Scorpiops profusus (Lourenço, 2017), **comb**. **n**.
Scorpiops pseudomontanus Kovařík & Ahmed, 2009
Scorpiops puerensis (Di et al., 2010), **comb**. **n**.
Scorpiops rohtangensis Mani, 1959
Scorpiops satarensis Pocock, 1900
Scorpiops scheibeae **sp**. **n**.
Scorpiops schumacheri **sp**. **n**.
Scorpiops sejnai Kovařík, 2000
Scorpiops sherwoodae **sp**. **n**.
Scorpiops shidian (Zhu et al., 2005), **comb**. **n**.
Scorpiops solegladi **sp**. **n**.
Scorpiops solidus Karsch, 1879
Scorpiops songi Di & Qiao, 2020
Scorpiops spitiensis Zambre et al., 2014
Scorpiops taxkorgan Lourenço, 2018
Scorpiops tenuicauda Pocock, 1894
Scorpiops thailandus **sp**. **n**.
Scorpiops thaomischi (Kovařík, 2012), **comb**. **n**.
Scorpiops tibetanus Hirst, 1911
= *Scorpiops atomatus* Qi, Zhu & Lourenço, 2005, **syn**. **n**.
= *Scorpiops pococki* Zhu, Qi &Lourenço, 2005, **syn**. **n**.
Scorpiops troglodytes (Lourenço & Pham, 2015), **comb**. **n**.
Scorpiops tryznai Kovařík, 2020
Scorpiops vachoni (Zhu et al., 2005), **comb**. **n**.
= *Euscorpiops validus* Di et al., 2010, **syn**. **n**.
Scorpiops viktoriae (Lourenço & Košulič, 2018), **comb**. **n**.
Scorpiops vonwicki Birula, 1913
Scorpiops wongpromi (Kovařík et al., 2013), **comb**. **n**.
Scorpiops wrzecionkoi Kovařík, 2020
Scorpiops xui (Sun & Zhu, 2010), **comb**. **n**.
Scorpiops yagmuri Kovařík, 2020
Scorpiops yangi (Zhu et al., 2007), **comb**. **n**.
Scorpiops zhangshuyuani (Ythier, 2019), **comb**. **n**.
Scorpiops zubairahmedi Kovařík, 2009
Scorpiops zubairi Kovařík, 2020

Figures 187–226: *Scorpiops* spp., pedipalp chela dorsal and external views. **Figures 187–188**. *S. affinis*, male, lectotype. **Figures 189–190**. *S. afghanus*, female, holotype. **Figures 191–192**. *S. braunwalderi*, male, holotype. **Figures 193–194**. *S. dastychi*, male, paratype. **Figures 195–196**. *S. demisi*, female, holotype. **Figures 197–198**. *S. farkaci*, male, holotype. **Figures 199–200**. *S. feti*, male, paratype. **Figures 201–202**. *S. furai*, female, holotype. **Figures 203–204**. *S. grosseri*, female, holotype. **Figures 205–206**. *S. hardwickii*, female, India, Uttaranchal State, ca. 30 km N of Bageshwar, SE of Dhakuri vill., 2600-2800 m a. s. l., FKCP. **Figures 207–208**. *S. harmsi*, female, holotype. **Figures 209–210**. *S. hofereki*, female, holotype. **Figures 211–212**. *S. irenae*, female, holotype. **Figures 213–214**. *S. jendeki*, male, holotype. **Figures 215–216**. *S. kejvali*, male, holotype. **Figures 217–218**. *S. langxian*, male, China, Tibet, W. Kangtissu Shan Mts., Nakaeh Cushul, 4200 m a. s. l., FKCP. **Figures 219–220**. *S. leptochirus*, male (306), India, Meghalaya State, Nong Poh env., FKCP. **Figures 221–222**. *S. lhasa*, female, topotype, China, Tibet, Lhasa, 3700 m a. s. l., FKCP. **Figures 223–224**. *S. lindbergi*, male, holotype of *S. kraepelini*. **Figures 225–226**. *S. luridus*, female, topotype, China, Tibet, Lang district, FKCP.

Figures 227–268: Pedipalp chela dorsal and external views. **Figures 227–228**. *Scorpiops margerisonae*, male, holotype. **Figures 229–230**. *S. oligotrichus*, male, Laos, Tham Xang Caves, FKCP. **Figures 231–232**. *S. pakistanus*, male, holotype. **Figures 233–234**. *S. petersii*, male, India, Himachal Pradesh State, Molta, FKCP. **Figures 235–236**. *S. pseudomontanus*, male, holotype. **Figures 237–238**. *S. solidus*, male, holotype. **Figures 239–240**. *S. tibetanus*, male, topotype of *S. pococki*, FKCP. **Figures 241–242**. *S. tryznai*, female, holotype. **Figures 243–244**. *S. vonwicki*, female, holotype. **Figures 245–246**. *S. wrzecionkoi*, female, holotype. **Figures 247–248**. *S. yagmuri*, male, holotype. **Figures 249–250**. *S. zubairahmedi*, male, holotype. **Figures 251–252**. *S. zubairi*, male, holotype. **Figures 253–254**. *S. grandjeani*, female, Thailand, Kapang, FKCP. **Figures 255–256**. *Parascorpiops montanus*, female, Malaysia, Borneo, Sarawak, Matang, FKCP. **Figures 257–260**. *S. anthracinus*, male (257–258) and female (259–260), Thailand, Phetchaburi Province, Kaeng Krachan, FKCP. **Figures 261–264**. *S. citadelle*, male, topotype (261–262) and female, paratype (263–264). **Figures 265–268**. *S. wongpromi*, male, holotype (265–266) and female, paratype (267–268).

Figures 269–298: Pedipalp chela dorsal and external views. **Figures 269–296**. Species previously placed in genus *Euscorpiops*. **Figures 269–270**. *Scorpiops artemisae*, male, holotype. **Figures 271–272**. *S. asthenurus*, male, India, Meghalaya State, Nong Poh env., FKCP. **Figures 273–274**. *S. beccaloniae*, male, holotype. **Figures 275–276**. *S. kaftani*, female, holotype. **Figures 277–278**. *S. kamengensis*, male, India, Arunachal Pradesh State, Hunli vicinity, 28°19'32"N 95°57'31"E, FKCP. **Figures 279–280**. *S. kubani*, male, paratype. **Figures 281–282**. *S. longimanus*, male, India, Assam State, 50 km E of Tezpur, 1800 m a. s. l., FKCP. **Figures 283–284**. *S. montanus*, male, India, Uttarakhand State, Dhika forest, 29.65°N 78.94°E, FKCP. **Figures 285–286**. *S. novaki*, male, holotype. **Figures 287–288**. *S. orioni*, male, holotype. **Figures 289–290**. *S. problematicus*, male topotype, Thailand, Chiang Mai Province, Doi Poi mt., FKCP. **Figures 291–292**. *S. sejnai*, male, holotype. **Figures 293–294**. *S. shidian*, male, topotype, China, Yunnan Province, Shidian district, Jiucheng town, 24.43°N 99.09°E, FKCP. **Figures 295–296**. S. *thaomischi*, male, holotype. **Figures 297–298**. *S. tenuicauda* (previously placed in genus *Neoscorpiops*), male, lectotype.
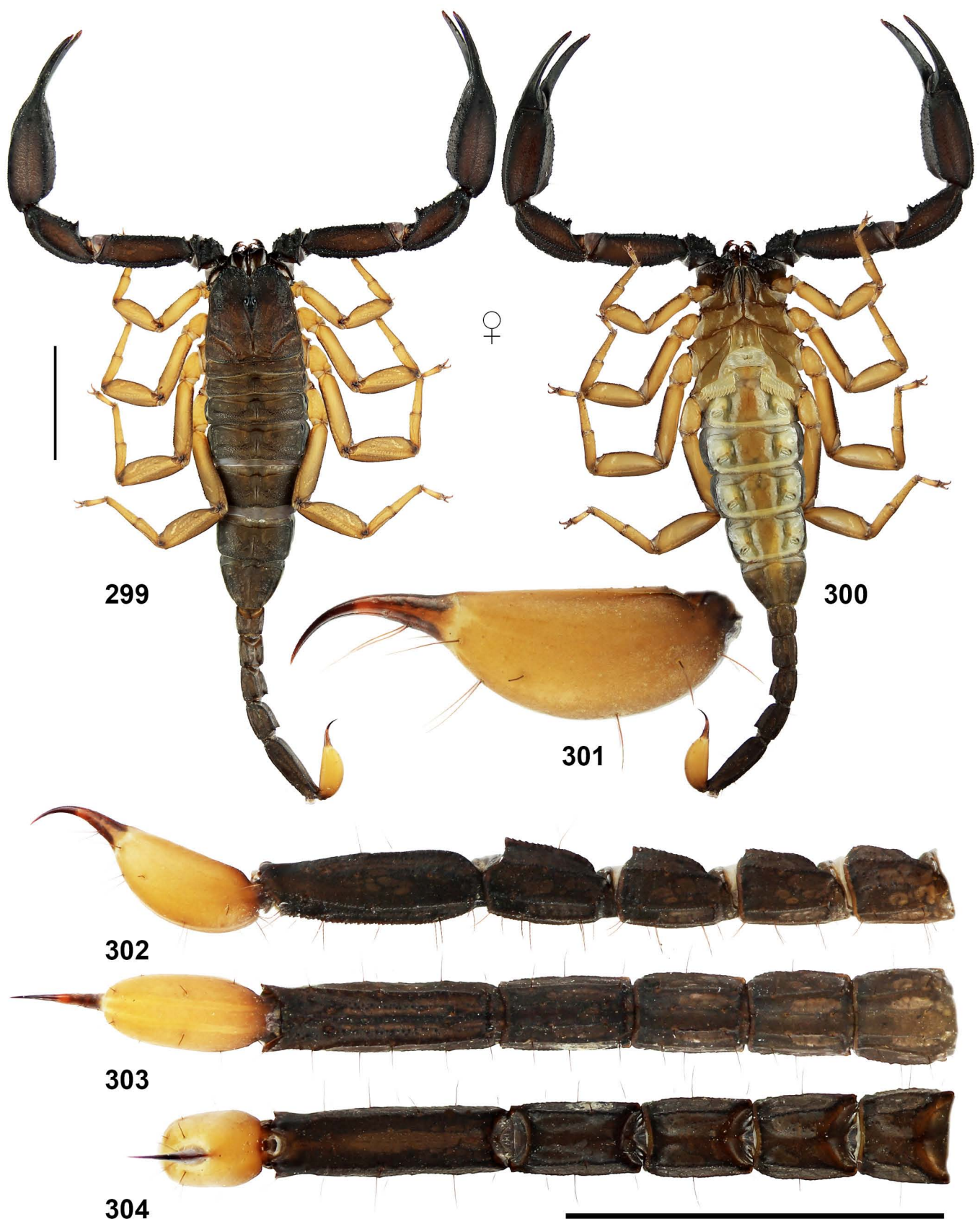
Figures 299–304: *Scorpiops bastawadei* **sp. n.**, female holotype. **Figures 299–300**. dorsal (299) and ventral (300) views. **Figures 301–304**. Telson lateral (301), and metasoma and telson lateral (302), ventral (303), and dorsal (304) views. Scale bars: 10 mm (299–300, 302–304).

Dimensions (mm)		*S. grandjeani* ♀	*S. bastawadei* sp. n. ♀ paratype	*S. bastawadei* sp. n. ♀ holotype
Carapace	L / W	9.32 / 9.20	8.70 / 7.91	8.59 / 8.65
Mesosoma	L	17.81	24.75	23.57
Tergite VII	L / W	4.27 / 6.03	4.53 / 5.53	4.55 / 5.68
Metasoma + telson	L	29.42	25.88	25.66
Segment I	L / W / D	3.00 / 2.86 / 2.41	2.79 / 2.59 / 2.18	2.80 / 2.54 / 2.15
Segment II	L / W / D	3.25 / 2.51 / 2.34	2.94 / 2.43 / 2.03	2.77 / 2.23 / 1.98
Segment III	L / W / D	3.48 / 2.28 / 2.24	3.14 / 2.28 / 2.21	2.97 / 2.05 / 2.16
Segment IV	L / W / D	4.09 / 2.19 / 2.19	3.55 / 2.15 / 2.13	3.59 / 1.86 / 2.11
Segment V	L / W / D	7.37 / 1.91 / 2.18	6.03 / 1.92 / 2.03	6.34 / 1.75 / 1.85
Telson	L / W / D	8.23 / 2.11 / 2.12	7.43 / 2.00 / 2.16	7.19 / 1.95 / 2.05
Pedipalp	L	39.86	34.41	33.32
Femur	L / W	11.05 / 3.00	9.49 / 2.79	9.00 / 2.87
Patella	L / W	8.97 / 3.12	7.56 / 2.87	7.66 / 3.16
Chela	L	19.84	17.36	16.66
Manus	W / D	3.86 / 3.30	3.97 / 2.99	4.33 / 3.11
Movable finger	L	9.93	8.68	8.33
Total	**L**	**56.55**	**59.33**	**57.82**

Table 2. Comparative measurements of adult females of *Scorpiops grandjeani* and *S. bastawadei* **sp. n**. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

Scorpiops bastawadei sp. n.
(Figures 229–304, 309–326, 328–330, 799, Tables 2, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:5B3DC6D7-3586-44EA-A593-59A29FA484EC

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Satun Province*, S of Wang Prachan, 6.725226°N 100.162902°E, 122 m a. s. l.; FKCP.

TYPE MATERIAL. (FKCP). **Thailand**, *Satun Province*, S of Wang Prachan, 6.725226°N 100.162902°E, 122 m a. s. l., UV detection, in rock crack at rockface, primary forest, XII. 2019, 1♀ (holotype, 1842, parturition 26.III.2020), 14 juveniles born 26.III.2020 (paratypes, still alive, 1ˢᵗ ecdysis 2.IV.2020, 2ⁿᵈ ecdysis VI.2020) 1♀ (paratype), leg. Martin Reinartz; near Phattalung (7.49°N 99.52°E), XI.2005, 1♀ (paratype), leg. V. Fura.

ETYMOLOGY. The specific epithet honors Deshabhushan Bastawade (India) for his friendship and contribution to understanding Indian scorpions.

DIAGNOSIS (♀). Total length 58 mm. Base color uniformly reddish black to black, telson and legs yellow. Pectine teeth 10–11 in female; fulcra absent; 3 marginal and 4–5 middle lamellae. Patella of pedipalp with 57–75 external and 22–26 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in female. Chela length to width ratio 3.8–4.4 in females. Pedipalp movable finger

with ca. 50 IAD, which have the same size as MD (ca. 85 in number) and create a second row; there are also 5 ID and 15 OD present. Tarsomere II of leg III with 4–6 stout median ventral spinules in a single row, and two pairs of flanking setae. Metasoma I with 10 carinae, metasoma II–IV with 8 carinae. Telson elongate and very finely granulate, length to depth ratio 3.7 in female; annular ring developed.

DESCRIPTION (♀). Total length 58–59 mm. Male unknown. Habitus as shown in Figs. 299–300. For position and distribution of trichobothria on pedipalps, see Figs. 309a–314a. Fingers of pedipalps undulate in female (Fig. 310).
Coloration (Figs. 299–300, 328). Base color uniformly reddish black. Telson, legs, and sternites are yellow. Chelicerae yellowish brown and reticulate, fingers black.
Carapace and mesosoma (Figs. 299–300, 318–321). Entire carapace covered with large granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth with two parallel furrows except sternite VII which has four granulate carinae. Pectine teeth number 10–11 in females. Pectines with 3 marginal and 4–5 middle lamellae; fulcra absent.
Metasoma and telson (Figs. 301–304). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carina of metasoma I incomplete, that of metasoma II represented by several posterior granules. Dorsolateral carinae of the second to fourth segments

Figures 305–317: **Figures 305–308**. *Scorpiops grandjeani*, female (1823), Thailand, Kapang, 8.004608°N 99.744415°E, FKCP, pedipalp patella dorsal (305), femur and trochanter dorsal (306), chela dorsal (307), and external (308) views. **Figures 309–317**. *Scorpiops bastawadei* **sp**. **n**., female holotype, pedipalp segments. Chela dorsal (309), external (310) and ventral (311) views. Patella dorsal (312), external (313) and ventral (314) views. Femur and trochanter dorsal (315), and ventral (316) views. Movable finger dentition under UV light (317). Trichobothrial pattern is indicated by white circles (309a–314a).
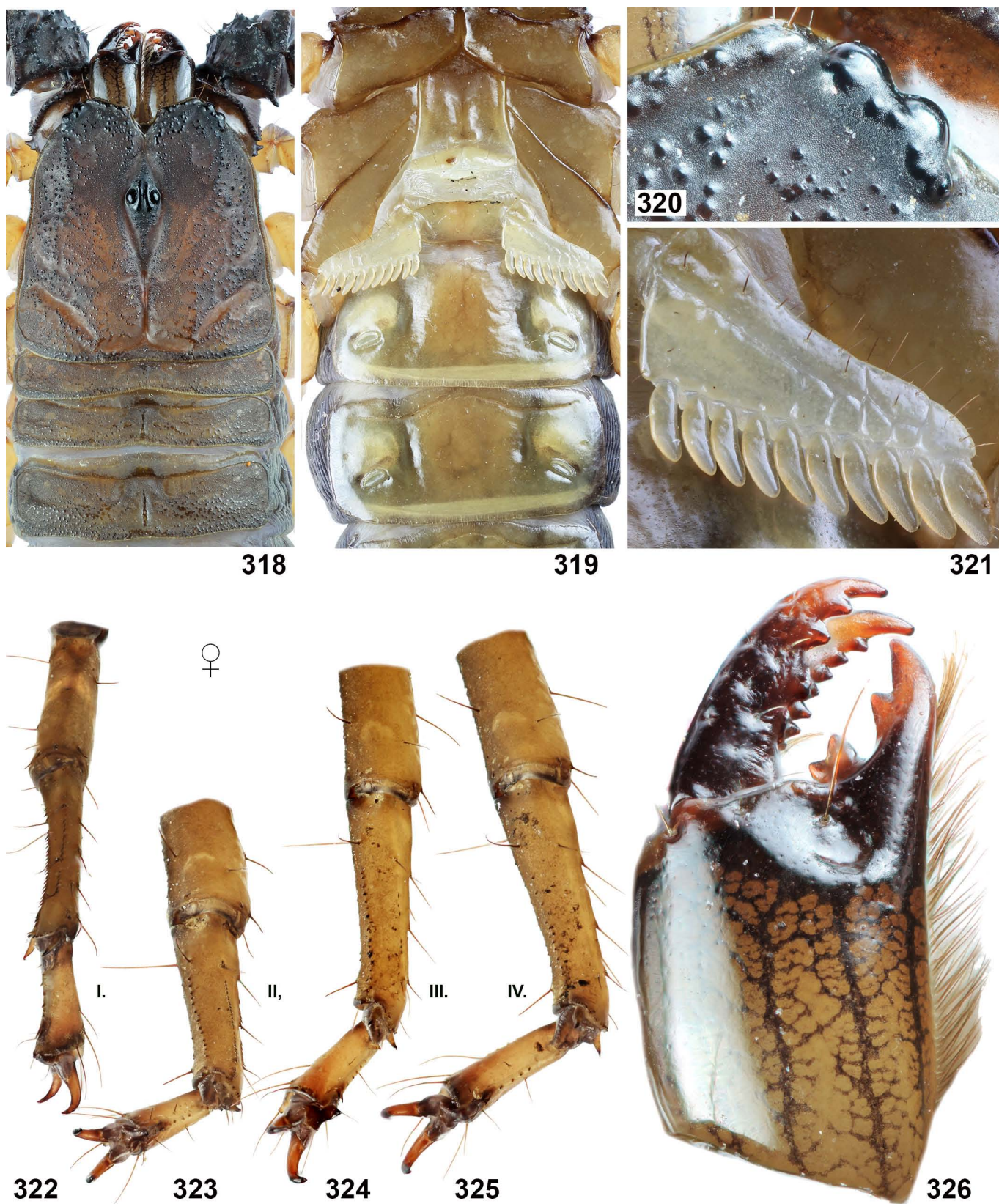
Figures 318–326: *Scorpiops bastawadei* **sp**. **n**., female holotype, carapace and tergites I–III (318), coxosternal area and sternites III–IV (319), lateral eyes (320), left pectine (321), left legs I–IV, prolateral aspect (322) and retrolateral aspect (323–325 respectively), and left chelicera dorsal view (326).

Figures 327–328: **Figure 327**. *Scorpiops grandjeani*, female (1823), Thailand, Kapang, 8.004608°N 99.744415°E, FKCP, in vivo habitus. **Figure 328**. *Scorpiops bastawadei* **sp**. **n**., female holotype, in vivo habitus.

Figures 329–330. *Scorpiops bastawadei* **sp. n**., female holotype, in vivo habitus with newborns (329), and with juveniles after first ecdysis (330).

Dimensions (mm)		*S. birulai* sp. n. ♂ holotype	*S. ciki* sp. n. ♂ holotype	*S. dii* sp. n. ♂ holotype	*S. dii* sp. n. ♀ paratype
Carapace	L / W	11.72 / 10.78	5.99 / 6.11	7.04 / 6.99	8.37 / 8.39
Mesosoma	L	14.79	9.45	8.22	23.27
Tergite VII	L / W	4.85 / 6.81	1.89 / 4.20	1.93 / 4.25	3.64 / 5.88
Metasoma + telson	L	38.67	18.41	22.77	26.08
Segment I	L / W / D	3.56 / 4.17 / 3.52	1.64 / 2.23 / 1.86	2.35 / 2.78 / 2.62	2.60 / 3.04 / 2.68
Segment II	L / W / D	4.13 / 3.70 / 3.35	1.98 / 1.87 / 1.79	2.42 / 2.44 / 2.12	2.86 / 2.74 / 2.33
Segment III	L / W / D	4.50 / 3.53 / 3.37	2.29 / 1.78 / 1.81	2.88 / 2.32 / 2.19	3.04 / 2.49 / 2.34
Segment IV	L / W / D	4.91 / 3.12 / 3.33	2.65 / 1.74 / 1.78	3.32 / 2.15 / 2.25	3.85 / 2.42 / 2.34
Segment V	L / W / D	9.80 / 3.21 / 3.40	4.60 / 1.72 / 1.63	5.67 / 2.04 / 1.94	6.38 / 2.39 / 2.25
Telson	L / W / D	11.77 / 3.42 / 3.10	5.25 / 1.96 / 1.80	6.13 / 2.14 / 1.89	7.35 / 2.16 / 2.07
Pedipalp	L	51.42	22.17	27.94	29.75
Femur	L / W	13.56 / 4.30	5.69 / 2.18	7.13 / 2.82	7.50 / 2.86
Patella	L / W	11.45 / 4.46	5.36 / 2.25	6.59 / 2.96	7.19 / 3.17
Chela	L	26.41	11.12	14.22	15.06
Manus	W / D	4.54 / 4.12	3.31 / 2.74	4.56 / 3.40	4.75 / 4.14
Movable finger	L	11.38	5.79	7.07	6.85
Total	**L**	**65.18**	**33.85**	**38.03**	**57.72**

Table 3. Comparative measurements of adults of *Scorpiops birulai* **sp**. **n**., *S. ciki* **sp**. **n**., and *S. dii* **sp**. **n**. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

terminate posteriorly in a pronounced tooth. Telson elongate and very finely granulate with annular ring developed.
Pedipalps (Figs. 309–317). Pedipalps very sparsely hirsute. Patella with 57–75 external and 22–26 ventral trichobothria. Chela with 4 *V* series trichobothria located on the ventral surface. Femur and patella granulated. Femur with 5–6 granulose carinae, and patella with 5 carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded reticulated granules, which in the central area form an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with an almost regular external secondary carina. Movable fingers with ca. 50 IAD, which have the same size as MD (ca. 85 in number) and create a second row; there are also 5 ID and 15 OD present.
Legs (Figs. 322–325). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces, but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs I–IV with row of 4–6 stout median ventral spinules, and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.
Measurements. See Table 2.

AFFINITIES. The most similar species is *S. grandjeani* in which the pedipalp chela has 4 *V* trichobothria located on the ventral surface, and the pedipalp patella has 54–59 external and 22–23 ventral trichobothria. This unique combination was the key character for the genus *Dasyscorpiops* which is herein synonymized with the genus *Scorpiops*. These two species could be easily differentiated by the shape of the

pedipalp segments which are in the female (male is unknown in both these species) more narrow in *S. grandjeani* than in *S. bastawadei* **sp**. **n**. (Figs. 327–328, Table 2, and fig. 12 in Lourenço, 1998: 251). In the females, pedipalp chela length to width ratio is 5.1–5.2 in *S. grandjeani*, vs. 3.8–4.4 in *S. bastawadei* **sp**. **n**.; pedipalp patella length to width ratio is 2.8–2.9 in *S. grandjeani*, vs. 2.4–2.6 in *S. bastawadei* **sp**. **n**.; and pedipalp femur length to width ratio is 3.6–3.7 in *S. grandjeani*, vs. 3.1–3.4 in *S. bastawadei* **sp**. **n**.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops birulai sp. n.
(Figures 159, 181, 186, 331–352, 359, 799, 801, Tables 3, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:FA2B49A2-6B88-4428-A1B0-DB6B75033D5B

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Chumphon Province*, Phato, 9.8292990°N 98.7731480°E; FKCP.

TYPE MATERIAL. **Thailand**, *Chumphon Province*, Phato, 9.8292990°N 98.7731480°E, 222 m a. s. l., 28.X.2019, 22:00 h, UV detection, scorpion walking around on tree, primary forest, new moon, 1♂ (holotype, 1800), leg. M. Stockmann, FKCP.

ETYMOLOGY. The specific epithet is a patronym honoring Alexei Andreevich Byalynitskii-Birulya (or A. A. Birula) (1864–1938), a renowned Russian zoologist and arachnologist who specialized in scorpions and solpugids.
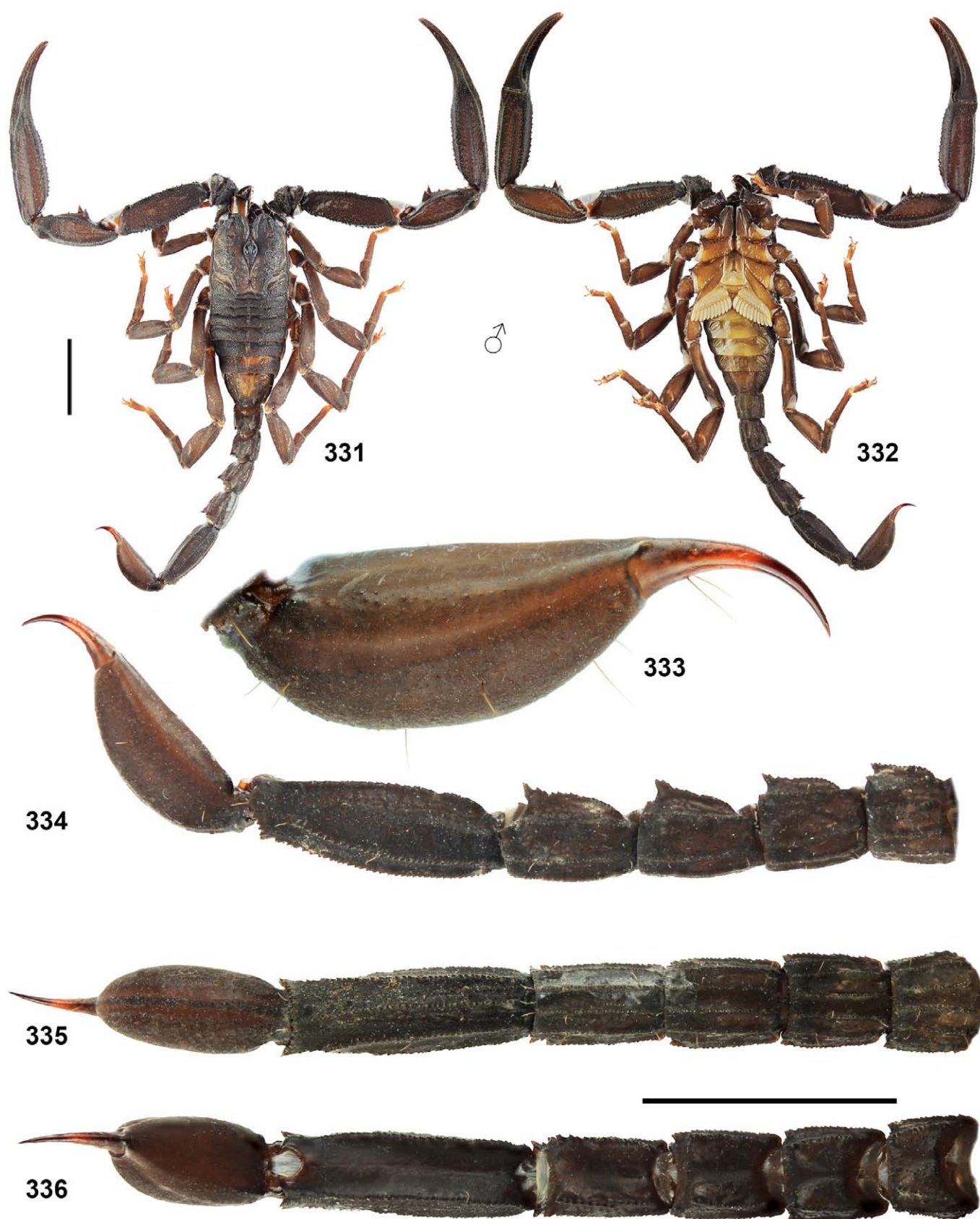
Figures 331–336: *Scorpiops birulai* **sp. n.**, male holotype. **Figures 331–332**. dorsal (331) and ventral (332) views. **Figures 333–336**. Telson lateral (333), and metasoma and telson lateral (334), ventral (335), and dorsal (336) views. Scale bars: 10 mm (331–332, 334–336).

Figures 337–346: *Scorpiops birulai* **sp. n.**, male holotype, pedipalp segments. Chela dorsal (337), external (338) and ventral (339) views. Patella dorsal (340), external (341) and ventral (342) views. Femur and trochanter dorsal (343), and ventral (344) views. Fixed (345) and movable (346) finger dentition. Trichobothrial pattern is indicated by white circles (337a–342a).

Scorpiops birulai **sp**. **n**. **347**

♂ **348**

I. **349**   II. **350**   III. **351**   IV. **352**

Scorpiops sherwoodae **sp**. **n**.

353

354

I. II. III. IV.

355 356 357 358
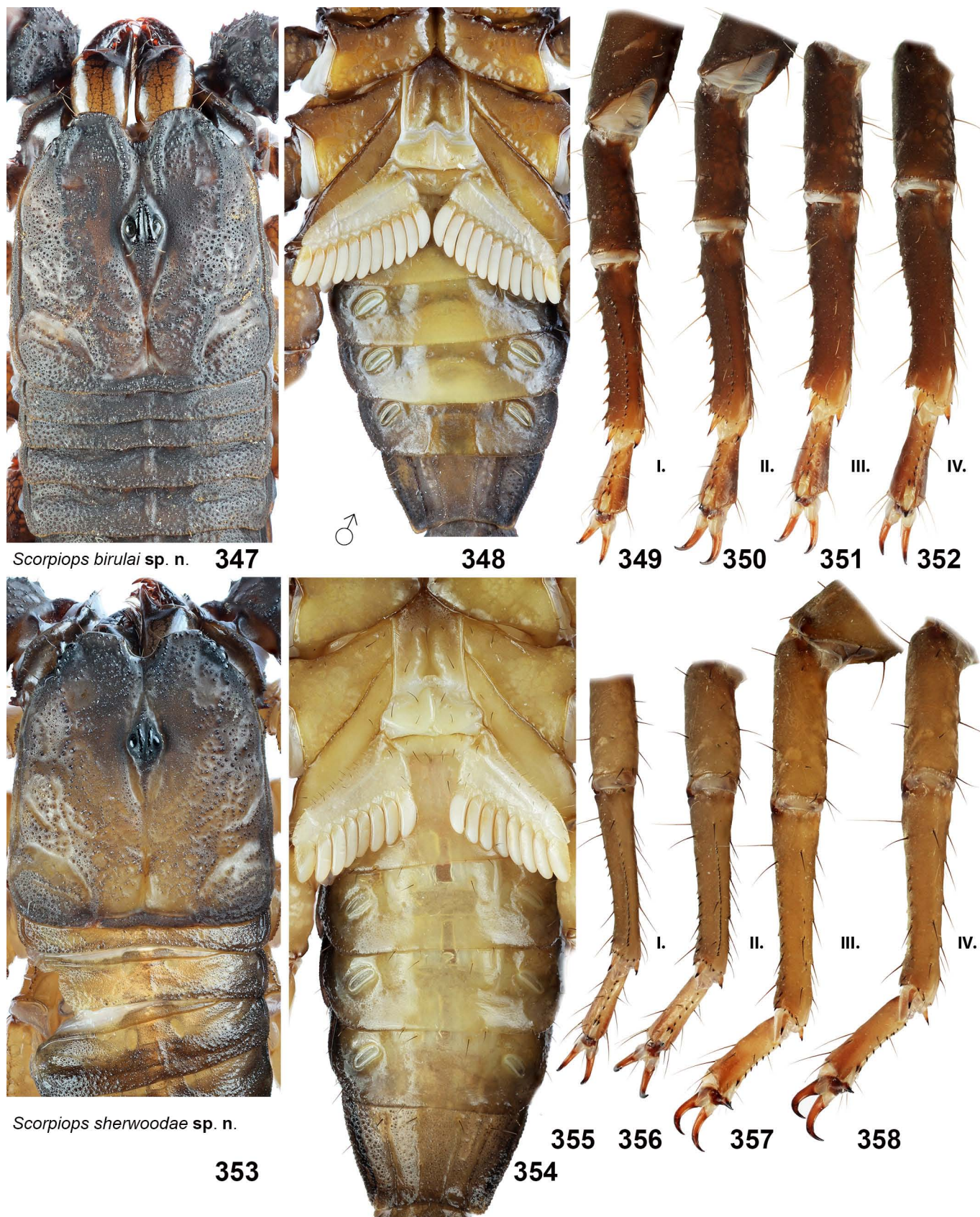
Figures 347–358: **Figures 347–352**. *Scorpiops birulai* **sp**. **n**., male holotype, carapace and tergites I–IV (347), coxosternal area and sternites (348), left legs I–IV, retrolateral aspect (349–352 respectively). **Figures 353–358**. *Scorpiops sherwoodae* **sp**. **n**., male holotype, carapace and tergites I–IV (353), coxosternal area and sternites (354), left legs I–IV, retrolateral aspect (355–358 respectively).
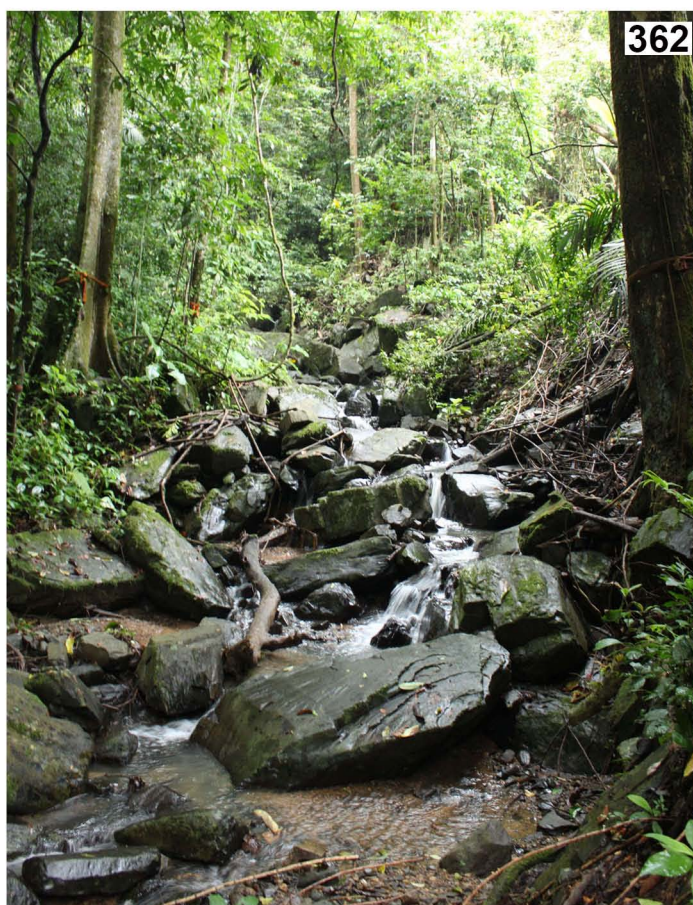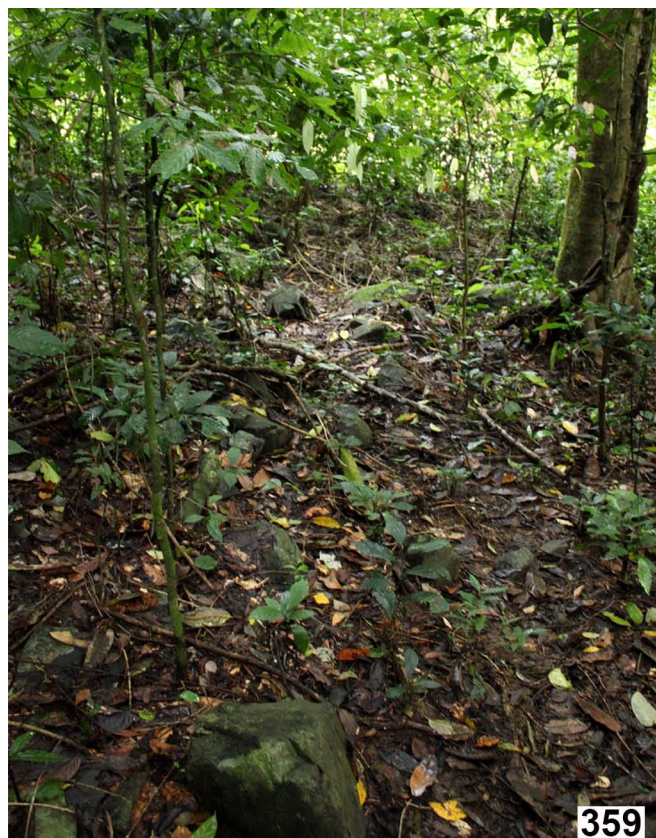
Figures 359–362. Thailand, type localities of *Scorpiops birulai* **šp. n**. (359), *S. kautti* **sp. n**. (360), *S. krabiensis* **sp. n**. (361), and *S. phatoensis* **sp**. **n**. (362).

DIAGNOSIS (♂). Total length 65 mm. Base color uniformly reddish black to black. Telson and tarsomere II of legs reddish brown. Pectine teeth number 11 in male; fulcra present; 3 marginal and 4 middle lamellae. Patella of pedipalp with 27 (5 *eb*, 7 *esb*, 2 *em*, 6 *est*, and 7 *et*) external and 18 ventral trichobothria. Chela of pedipalp with 12 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in male. Chela length to width ratio 5.8. Pedipalp movable finger with ca. 70 IAD, which have the same size as MD (more than 100 in number) and create a second row; there are also 7–8 ID and 18 OD present. Tarsomere II of leg III with row of six stout median ventral spinules, and two pairs of flanking setae. Metasoma I with 10 and metasoma II–IV with 8 carinae. Telson elongate and sparsely granulate, length to depth ratio 3.8 in male; annular ring developed.

DESCRIPTION (♂ holotype). Total length 65 mm. Female unknown. Habitus as shown in Figs. 331–332. For position and distribution of trichobothria on pedipalps, see Figs. 337a–342a. Fingers of pedipalps undulate in male (Fig. 338). **Coloration** (Figs. 331–332). Base color uniformly reddish black to black, telson, legs, and sternites are reddish brown. Chelicerae reddish brown and reticulate, fingers black. **Carapace and mesosoma** (Figs. 347–348). Entire carapace covered with large granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth to very finely granulated with two parallel furrows except sternite VII which has four granulate carinae. Pectine teeth number 11 in male holotype. Pectines with 3 marginal and 4 middle lamellae; fulcra present. **Metasoma and telson** (Figs. 333–336). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carina of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of the second to fourth segments terminate posteriorly in a pronounced tooth. Telson elongate and sparsely granulate with annular ring developed. **Pedipalps** (Figs. 337–346). Pedipalps very sparsely hirsute. Patella with 27 (5 *eb*, 7 *esb*, 2 *em*, 6 *est*, and 7 *et*) external and 18 ventral trichobothria. Chela with 12 ventral trichobothria located on the ventral surface. Femur and patella granulated. Femur with 5–6 granulose carinae, and patella with 5 carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with a regular external secondary carina. Movable fingers with ca. 70 IAD, which have the same size as MD (more than 100 in number) and create a second row; there are also 7–8 ID and 18 OD present.

Legs (Figs. 349–352). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs I–IV with 5–7 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.
Measurements. See Table 3.

AFFINITIES. Among species which have 11–14 ventral trichobothria on the chela manus, only four other species have 18 ventral trichobothria on the pedipalp patella. However, they differ as follows: *S. calmonti* (Lourenço, 2013) has one or two trichobothria of the ventral *V* series traversing the ventroexternal carina, and positioned on the external surface of the manus; males of *S. sherwoodae* **sp. n.** and *S. anthracinus* Simon, 1887 have fingers of pedipalps strongly undulate; and *S. citadelle* (Kovařík, 2013) has total length 37–53 mm, reduced fulcra, and almost straight pedipalp fingers in males. In contrast, *S. birulai* **sp. n.** has all *V* series trichobothria of the chela manus on the ventral surface, fingers of pedipalps undulate in male, total length 65 mm, and fulcra present.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops ciki sp. n.
(Figures 363–373, 799, Tables 3, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:C0797B5A-78A4-4A50-A93E-F2A5FA2BB71C

TYPE LOCALITY AND TYPE REPOSITORY. **Myanmar**, *Chin State*, Chin Hills, Myohaung (20.59°N 93.17°E); FKCP.

TYPE MATERIAL. **Myanmar**, *Chin State*, Chin Hills, Myohaung (20.59°N 93.17°E), IX.2001, 1♂ (holotype), leg. E. Čik, FKCP.

ETYMOLOGY. The species epithet is a patronym honoring Eduard Čik, the collector of holotype of the new species.

DIAGNOSIS (♂). Total length 34 mm. Base color reddish brown to black. Telson and legs yellow to yellowish brown. Pectine teeth number 6–7 in male, fulcra absent. Pectines with 2 marginal and 4 middle lamellae. Patella of pedipalp with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external and 8 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in female. Chela length to width ratio 3.6 in male. Pedipalp movable finger with ca. 45 IAD which create a second row, parallel with MD (ca. 65 in number). There are also 4 ID and 11 OD present. Tarsomere II of legs with row of 6–7 stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae and metasoma II–IV with 8 carinae. Telson elongate and smooth, length to depth ratio 2.9 in male; annular ring developed.
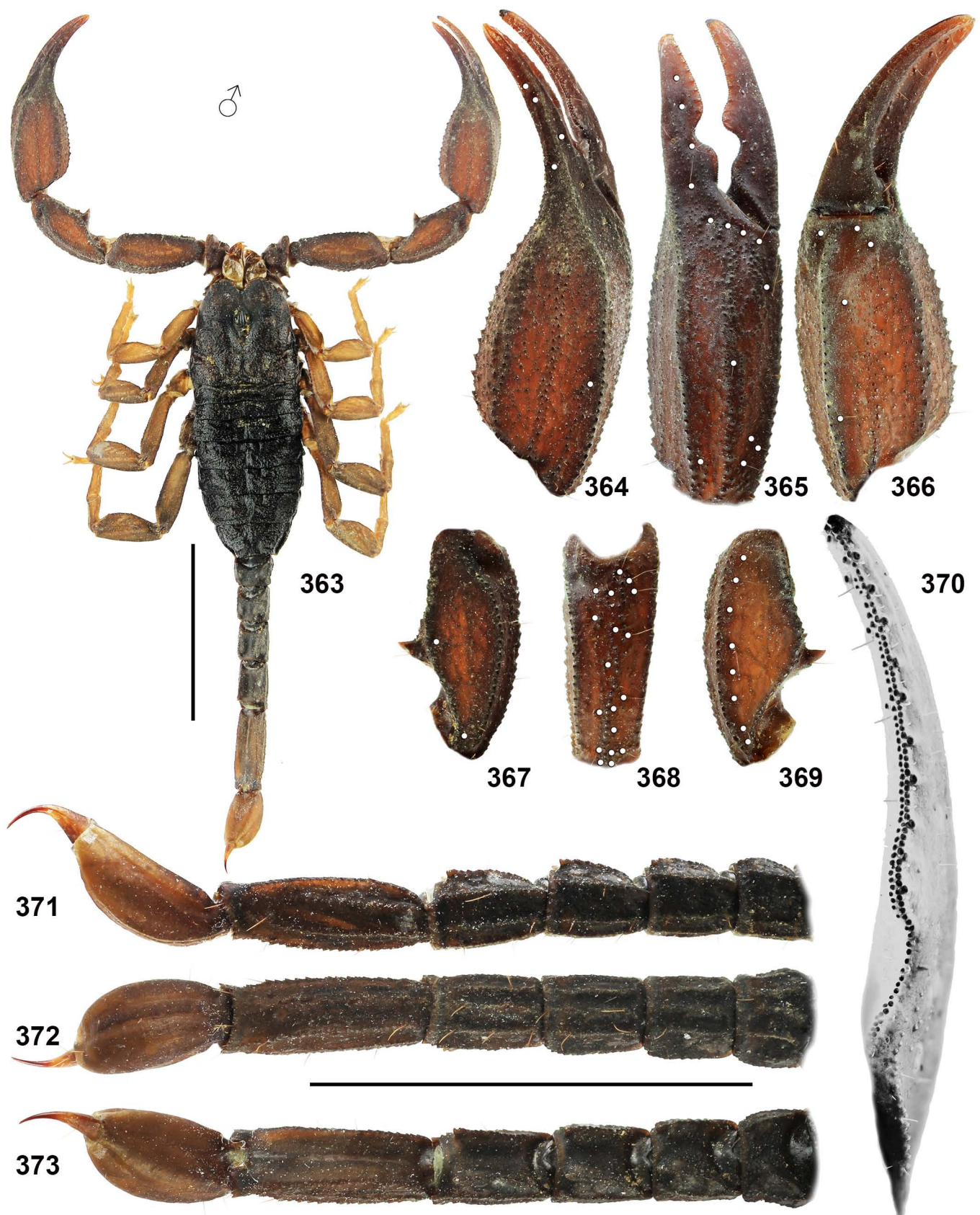
Figures 363–373: *Scorpiops ciki* **sp. n.**, male holotype. **Figure 363**. Dorsal view. **Figures 364–370**. Pedipalp segments. Chela dorsal (364), external (365) and ventral (366) views. Patella dorsal (367), external (368) and ventral (369) views. Movable finger (370) dentition under UV light. Trichobothrial pattern is indicated by white circles. **Figures 371–373**. Metasoma and telson lateral (371), ventral (372), and dorsal (373) views. Scale bars: 10 mm (363, 371–373).

DESCRIPTION (♂ holotype). Total length 34 mm. Female unknown. Habitus as shown in Fig. 363. For position and distribution of trichobothria on pedipalps, see Figs. 364–369. Fingers of pedipalps undulate in male (Fig. 365).

Coloration (Fig. 363). Base color uniformly reddish brown to black. Telson and legs yellow to yellowish brown. Chelicerae yellowish brown and reticulate.

Carapace and mesosoma (Fig. 363). Entire carapace covered with both large and minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites finely granulated with two parallel furrows except sternite VII, which has four sparsely granulate carinae. Pectine teeth number 6–7 in males, fulcra absent. Pectines with 2 marginal and 4 middle lamellae.

Metasoma and telson (Figs. 371–373). Metasoma very sparsely hirsute and granulated. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments III–IV granulate with sharp granules, which terminate posteriorly with a barely pronounced tooth. Telson elongate and smooth with annular ring developed.

Pedipalps (Figs. 364–370). Pedipalps very sparsely hirsute. Patella with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external trichobothria and 8 ventral trichobothria. Chela with 4 *V* series trichobothria which are located on the ventral surface. Femur and patella granulated. Femur with 5 granulose carinae and patella with 5 complete carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded granules, which are in the central area replaced by large granules forming a dorsal secondary carina. External surface of chela covered by minute and larger sparse granules which indicate a external secondary carina. Movable fingers with ca. 45 IAD, which form a second row, parallel to MD (ca. 65 in number) and there are also 4 ID and 11 OD present.

Legs. Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral and ventrolateral surfaces. Tarsomere II of legs I–IV with 6–7 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 incomplete carinae; both femur and patella are finely granulated.

Measurements. See Table 3.

AFFINITIES. The combination of five characters (chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*; patella of pedipalp with 8 ventral and 18 external trichobothria; fingers of pedipalps undulate in male; pedipalp movable finger with ca. 45 IAD; and chela length to width ratio 3.6 in male) is unique in the entire genus *Scorpiops*. The most similar species is *S. asthenurus* from India and Bhutan which differs by a larger number of IAD (ca. 60 versus ca. 45) and different shape of the chela which is narrower in *S. asthenurus* (see Figs. 271–272 versus 364–365 and Table 9).

DISTRIBUTION. Myanmar (Fig. 799).

Scorpiops dii sp. n.
(Figures 162, 184, 186, 374–413, 799, 803, Tables 3, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:8F00E611-0313-400A-9879-884A44D0B88E

Euscorpiops sp. 3: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Chang Mai Province*, Mae Kum Pong (18.862°N 99.35°E), 55 km N Chang Mai, 600-800 m a. s. l.; FKCP.

TYPE MATERIAL. **Thailand**, *Chang Mai Province*, Mae Kum Pong (18.862°N 99.35°E), 55 km N Chang Mai, 600-800 m a. s. l., X.2018, UV detection, 1♂ (holotype) 2♂2♀ (paratypes, 1568), local collector, FKCP.

ETYMOLOGY. The specific epithet honors Zjiyong Di (China) for his contribution to the knowledge of the scorpiopid fauna of China.

DIAGNOSIS (♂♀). Total length 38 mm (male) to 58 mm (female). Base color uniformly reddish black to black. Telson and tarsomere II of legs reddish brown. Pectine teeth number 7–8 in male, 7 in females; fulcra absent; marginal lamellae I (basal) and III present, marginal lamella II undefined, connected with middle lamella to form one compact unit. Patella of pedipalp with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external and 9–11 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in middle of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in both sexes. Chela length to width ratio 3.11 in male, 3.17 in female. Pedipalp movable finger with 50–56 IAD, which have the same size as MD (more than 90 in number) and create a second row; there are also 6 ID and 14 OD present. Tarsomere II of leg III with row of five stout median ventral spinules and two pairs of flanking setae. Metasoma I–II with 10 carinae and metasoma II–IV with 8 carinae. Telson elongate and granulate, length to depth ratio 3.26 in male and 3.55 in female; annular ring developed in both sexes.

DESCRIPTION (♂♀). Total length 38 mm (male) to 58 mm (female). Habitus as shown in Figs. 374–377. For position and distribution of trichobothria on pedipalps, see Figs. 386a–391a. Sexual dimorphism minor: adult males have larger pectines than adult females; fingers of pedipalps undulate in both sexes (Figs. 387 and 397).

Coloration (Fig. 413). Base color uniformly reddish black to black. Telson and tarsomere II of legs reddish brown, sternites lighter, yellowish to reddish brown. Chelicerae yellowish brown and reticulate, fingers black.

Carapace and mesosoma (Figs. 402–405). Entire carapace covered with both large and minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth to very

Figures 374–377: *Scorpiops dii* **sp. n. Figures 374–375**. Male holotype in dorsal (374) and ventral (375) views. **Figures 376–377**. Female paratype in dorsal (376) and ventral (377) views. Scale bar: 10 mm.
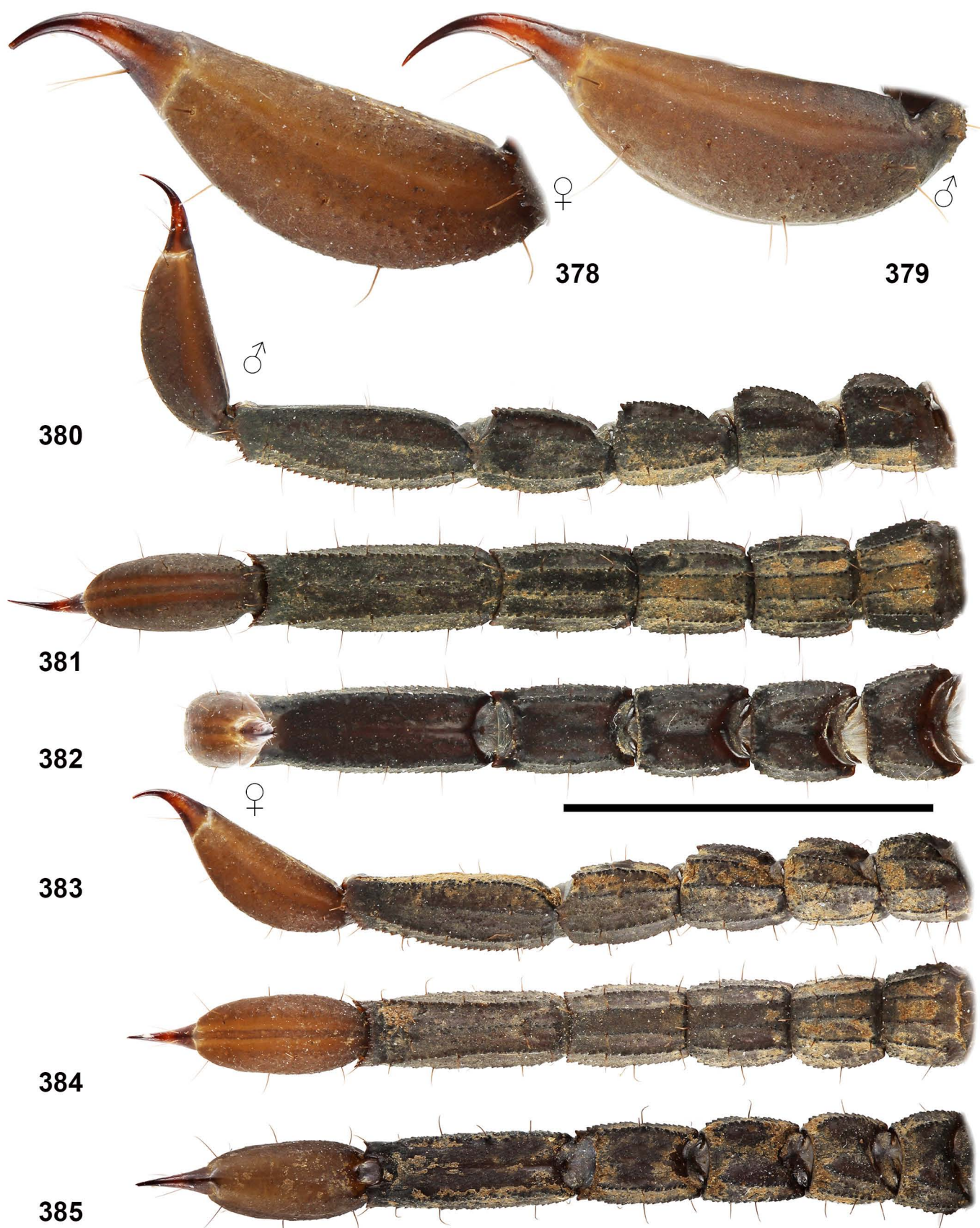
Figures 378–385: *Scorpiops dii* **sp. n**. **Figures 379–382**. Male holotype, telson lateral (379), and metasoma and telson lateral (380), ventral (381), and dorsal (382) views. **Figures 378, 383–385**. Female paratype, telson lateral (378), and metasoma and telson lateral (383), ventral (384), and dorsal (385) views. Scale bar: 10 mm (380–385).
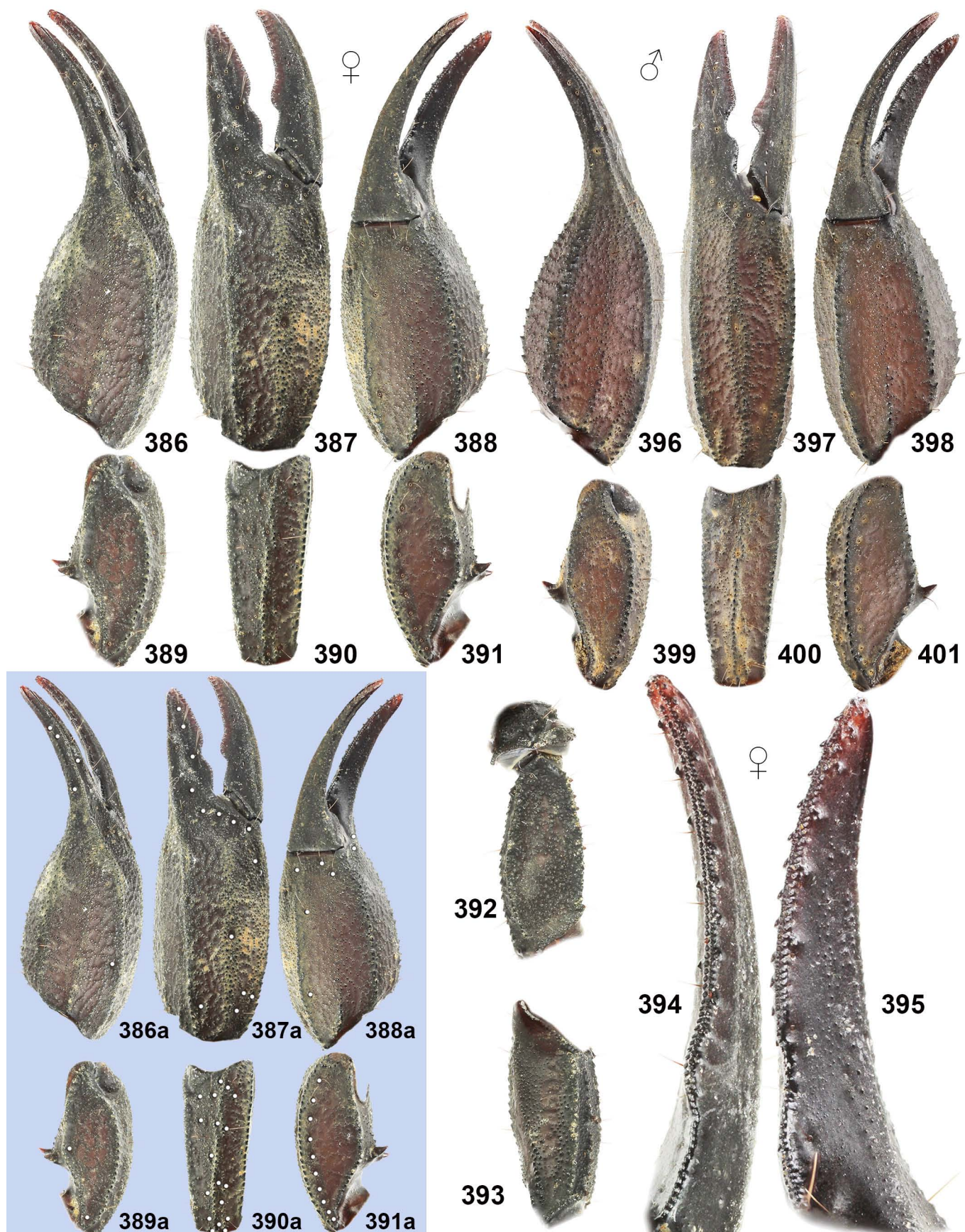
Figures 386–401: *Scorpiops dii* **sp. n.**, pedipalp segments. **Figures 386–395**. Female paratype, chela dorsal (386), external (387) and ventral (388) views. Patella dorsal (389), external (390) and ventral (391) views. Trochanter and femur dorsal (392) and femur ventral (393) views. Movable (394) and fixed (395) finger dentition. Trichobothrial pattern is indicated by white circles (386a–391a). **Figures 396–401**. Male holotype, chela dorsal (396), external (397) and ventral (398) views. Patella dorsal (399), external (400) and ventral (401) views.
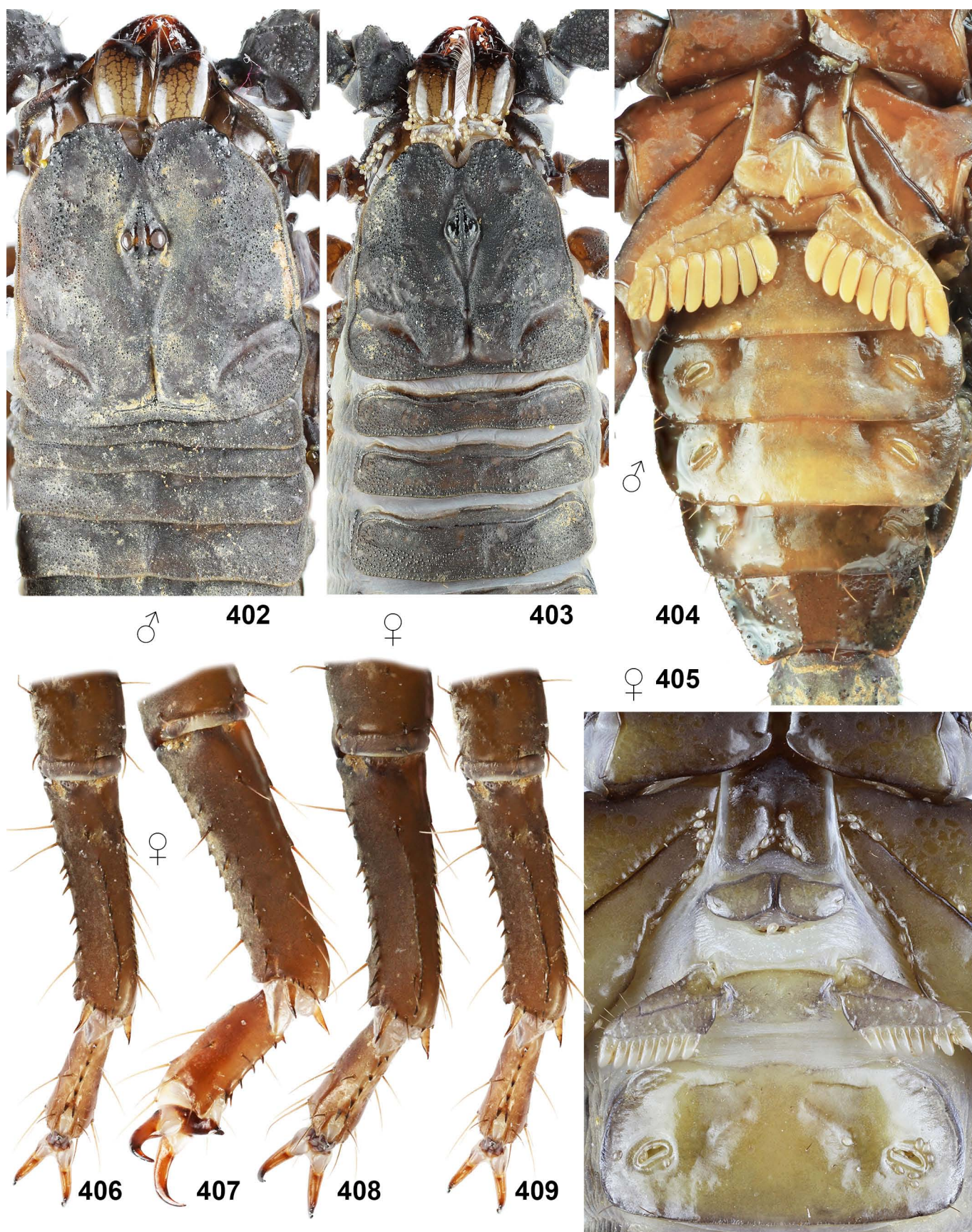
Figures 402–409: *Scorpiops dii* **sp**. **n**. **Figures 402**, **404**. Male holotype, carapace and tergites I–IIII (402), and coxosternal area and sternites (404). **Figures 403**, **405–409**. Female paratype, carapace and tergites I–III (403), coxosternal area and sternite III (405) (with parasitic mites), left legs I–IV, retrolateral aspect (406–409 respectively).

Figures 410–413: *Scorpiops dii* **sp. n.**, **Figures 410–412**. Female paratype, right chelicera in dorsal (410), ventral (411), and ventrointernal (412) views (parasitic mites attached at base of manus). **Figure 413**. Female paratype in vivo habitus.

Dimensions (mm)		*S. dunlopi* sp. n. ♀ holotype	*S. kautti* sp. n. ♂ holotype	*S. kautti* sp. n. ♀ paratype	*S. krabiensis* sp. n. ♂ holotype
Carapace	L / W	3.67 / 3.70	9.77 / 9.28	11.56 / 11.08	11.32 / 10.99
Mesosoma	L	8.84	13.09	29.96	16.02
Tergite VII	L / W	1.66 / 2.58	3.26 / 5.97	4.77 / 7.28	4.85 / 6.51
Metasoma + telson	L	11.50	30.55	33.03	37.66
Segment I	L / W / D	1.11 / 1.37 / 1.07	3.10 / 3.19 / 2.73	3.69 / 3.51 / 3.05	3.76 / 3.85 / 3.30
Segment II	L / W / D	1.34 / 1.16 / 1.03	3.31 / 2.92 / 2.74	3.43 / 3.19 / 2.93	3.99 / 3.22 / 2.82
Segment III	L / W / D	1.47 / 1.10 / 1.02	3.66 / 2.66 / 2.85	3.85 / 2.99 / 2.76	4.29 / 2.99 / 3.01
Segment IV	L / W / D	1.76 / 1.03 / 0.97	4.13 / 2.48 / 2.68	4.39 / 2.74 / 2.83	5.17 / 2.88 / 2.85
Segment V	L / W / D	2.78 / 1.09 / 0.99	7.69 / 2.47 / 2.47	8.22 / 2.66 / 2.79	9.35 / 2.74 / 2.73
Telson	L / W / D	3.04 / 1.15 / 0.98	8.66 / 2.79 / 2.73	9.45 / 2.70 / 2.69	11.1 / 2.99 / 3.26
Pedipalp	L	12.58	38.68	43.76	47.10
Femur	L / W	3.16 / 1.21	10.28 / 3.60	11.62 / 4.07	12.56 / 4.10
Patella	L / W	3.34 / 1.36	8.49 / 3.66	9.46 / 4.42	10.47 / 4.40
Chela	L	6.08	19.91	22.68	24.07
Manus	W / D	1.93 / 1.47	4.91 / 3.72	4.96 / 4.11	6.19 / 4.73
Movable finger	L	3.01	9.72	11.07	11.77
Total	**L**	**24.01**	**53.41**	**74.55**	**65.00**

Table 4. Comparative measurements of adults of *Scorpiops dunlopi* **sp**. **n**., *S. kautti* **sp**. **n**., and *S. krabiensis* **sp**. **n**. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

finely granulated with two parallel furrows except sternite VII, which has four sparsely granulate carinae. Pectine teeth number 7–8 in males and 7 in females. Pectines with marginal lamellae I (basal) and III present, marginal lamella II is not defined, but connected with middle lamella to form one compact unit.

Metasoma and telson (Figs. 378–385). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segments I–II with 10 carinae, III–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments III–IV terminate posteriorly in a slightly pronounced tooth. Telson elongate and granulate with annular ring developed in both sexes.

Pedipalps (Figs. 386–395). Pedipalps very sparsely hirsute. Patella with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external trichobothria and 9–11 ventral trichobothria. Chela with 4 *V* series trichobothria located on ventral surface. Femur and patella granulated. Femur with 5 granulose carinae, and patella with 5 carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with an almost complete external secondary carina. Movable fingers bear 50–56 IAD, which have the same size as MD (more than 90 in number) and create a second row; there are also 6 ID and 14 OD present.

Legs (Figs. 406–409). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral and ventrolateral surfaces. Tarsomere II of legs I–IV with row of 5 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated. **Measurements**. See Table 3.

AFFINITIES. The combination of five characters (chelal trichobothrium *Eb₃* located in distal half of manus between trichobothria *Dt* and *Est*; patella of pedipalp with 9–11 ventral and 18 external trichobothria; fingers of pedipalps undulate in both sexes; pedipalp movable finger with 50–56 IAD; and chela length to width ratio 3.1 in male) is unique in the entire genus *Scorpiops*.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops dunlopi sp. n.
(Figures 414–415, 420–442, 696, 701–702, 707, 799, Tables 4, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:B376006F-9E69-4100-9213-8E4D25AAB110

Euscorpiops sp. 1: Šťáhlavský et al., in press.
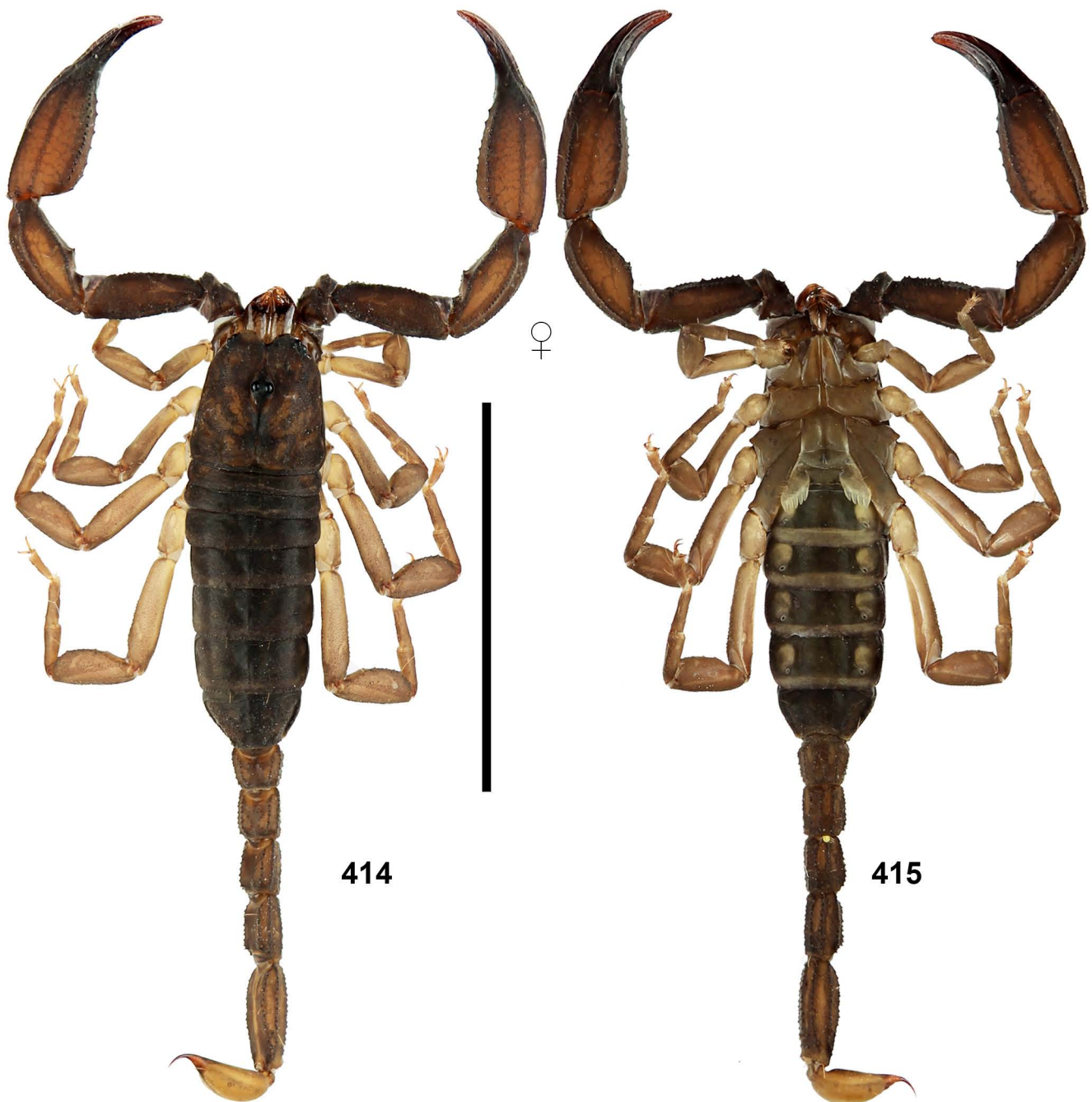
TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Phang Nga Province*, 2 km NE Phang Nga, Tham Pha Sua, 8.477309°N 98.539827°E, 40 m. a. s. l.; FKCP.

TYPE MATERIAL. **Thailand**, *Phang Nga Province*, 2 km NE Phang Nga, Tham Pha Sua, 8.477309°N 98.539827°E, 40 m a. s. l., 9.XI.2019, UV detection, under rock at rock face, primary forest, waxing moon, 1♀ (holotype, 1822), leg.

Figures 414–415: *Scorpiops dunlopi* **sp. n.**, female holotype, dorsal (414) and ventral (415) views. Scale bar: 10 mm.

Peter Kautt, FKCP; *Phang Nga Province*, 2 km NE Phang Nga, Tham Pha Sua, 8.475886°N 98.539477°E, 40 m. a. s. l., 14.I.2020, 19:00–22:00 h, UV detection, between rocks at rock face, primary forest, waning moon, 1♀ (paratype), leg. M. Stockmann, FKCP.

ETYMOLOGY. The species epithet is a patronym honoring Jason Dunlop (Museum für Naturkunde der Humboldt-Universität, Berlin, Germany), for his help with this paper.

DIAGNOSIS (♀). Total length 24 mm. Base color uniformly reddish brown to reddish black. Legs and telson yellow to orange. Pectine teeth number 4–5 in female, fulcra present but reduced. Pectines with 2 marginal and 2 middle lamellae. Patella of pedipalp with 16 (5 *eb*, 2 *esb*, 2 *em*, 3 *est*, 4 *et*) external and 6 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps straight in female. Chela length to width ratio 3.15 in female. Pedipalp movable finger with 12 IAD/ID, ca. 35 MD, and 7–8 OD; all these denticles create one irregular row. Tarsomere II of legs with row of 5–6 stout median ventral spinules. Metasoma I with 10 carinae, II–IV with 8 carinae, V with 7 carinae. Telson is sparsely granulate and elongate in female, length to depth ratio 3.1 in female; annular ring developed.
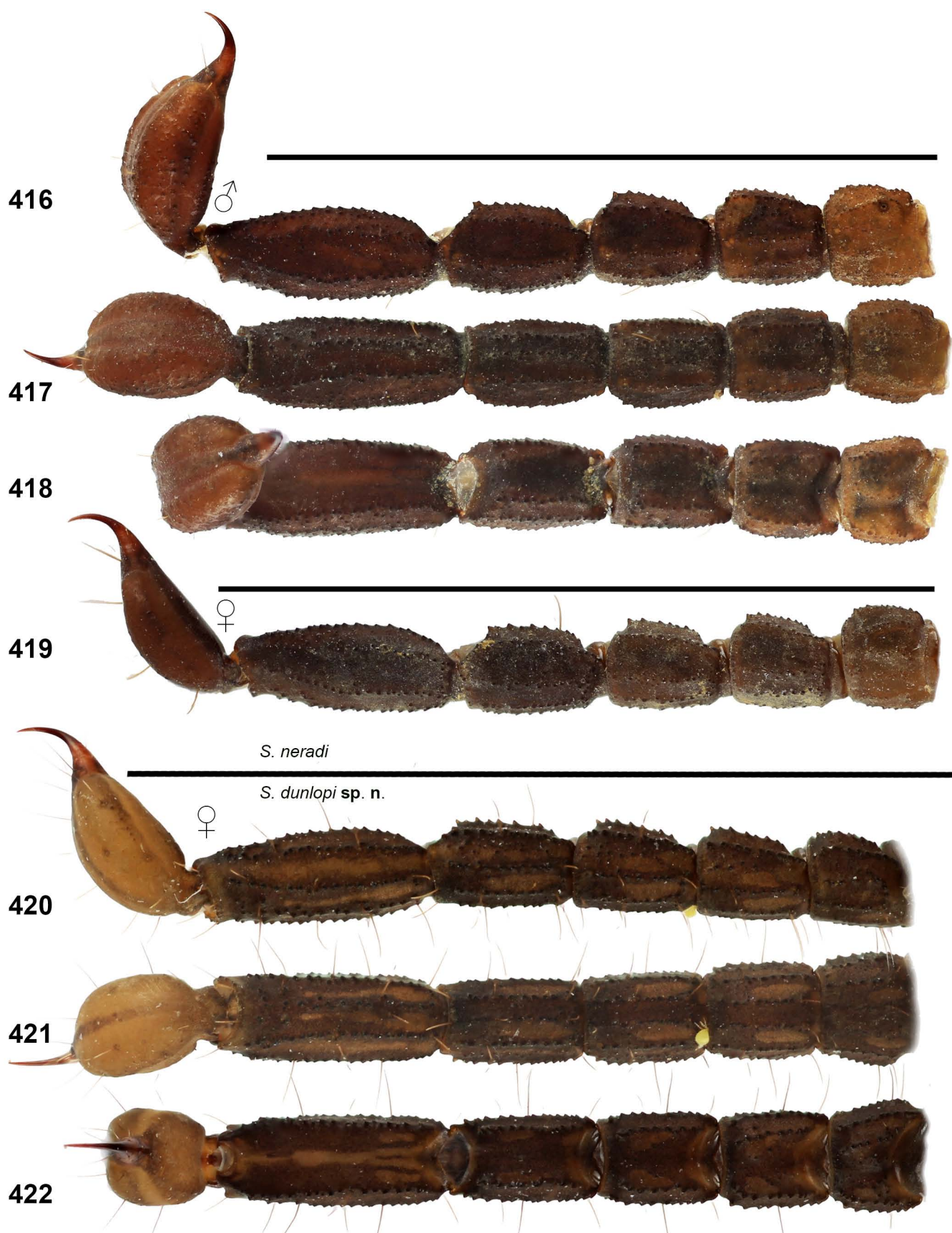
Figures 416–422: **Figures 416–418**. *Scorpiops neradi*, male holotype, metasoma and telson lateral (416), ventral (417), and dorsal (418) views. **Figure 419**. *S. neradi*, female paratype, metasoma and telson lateral view. **Figures 420–422**. *S. dunlopi* **sp. n.**, female holotype, metasoma and telson lateral (420), ventral (421), and dorsal (422) views. Scale bars: 10 mm (416–418, 419, 420–422).

Figures 423–432: *Scorpiops dunlopi* **sp. n.**, female holotype, pedipalp segments, chela dorsal (423), external (424) and ventral (425) views. Patella dorsal (426), external (427) and ventral (428) views. Trochanter and femur dorsal (429) and ventral (430) views. Movable (431) and fixed (432) finger dentition. Trichobothrial pattern is indicated by white circles.
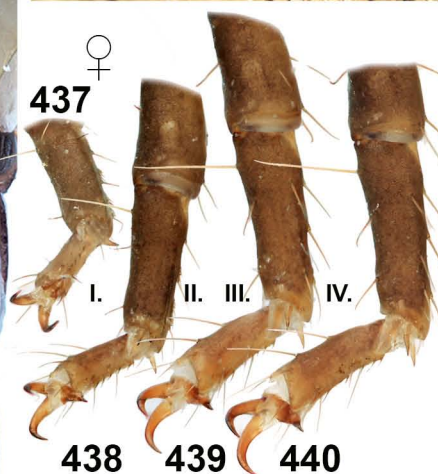
Figures 433–440: *Scorpiops dunlopi* **sp. n**. **Figures 433**. Female paratype with newborns. **Figures 434–440**. Female holotype in vivo habitus (434), carapace and tergites I–III (435), coxosternal area and sternites III–IV (436), left legs I–IV, retrolateral aspect (437–440 respectively).

Figures 441–442: *Scorpiops dunlopi* **sp. n**., female paratype with juveniles after first ecdysis.

DESCRIPTION (♀ holotype). Total length 24 mm. Male unknown. Habitus as shown in Figs. 414–415. For position and distribution of trichobothria on pedipalps, see Figs. 423–429. Fingers of pedipalps are straight in female (Fig. 424).

Coloration (Figs. 433–434). Base color uniformly reddish brown to reddish black. Telson and legs are yellow to orange. Chelicerae yellowish brown, dark in anterior part, and reticulate.

Carapace and mesosoma (Figs. 435–436). Entire carapace covered with both large and minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites finely granulated with two parallel furrows except sternite VII, which has four sparsely granulate carinae. Pectine teeth number 4–5 in female, fulcra reduced. Pectines with 2 marginal and 2 middle lamellae.

Metasoma and telson (Figs. 420–422). Metasoma sparsely hirsute and granulated. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with seven carinae. Median lateral carinae of metasoma V are developed. Dorsolateral carinae of segments III–IV granulate with sharp granules, which terminate posteriorly with a barely pronounced tooth. Telson elongate and smooth with annular ring developed.

Pedipalps (Figs. 423–432, 696). Pedipalps very sparsely hirsute. Patella with 16 (5 *eb*, 2 *esb*, 2 *em*, 3 *est*, 4 *et*) external and 6 ventral trichobothria. Chela with 4 ventral trichobothria located on ventral surface. Femur and patella are sparsely granulated. Femur with 5 granulose carinae and patella with 5 complete carinae with dorsal and ventral patellar spurs reduced. Manus dorsally with fine sparse, rounded granules, which are in the central area represented by large granules. External surface of chela is sparsely covered by minute granules. Movable fingers with 12 IAD+ID in a row, parallel with MD (ca. 35 in number) and there are also 7–8 OD present; all these denticles create one irregular row.

Legs (Figs. 437–440). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral and ventrolateral surfaces. Tarsomere II of legs I–IV with 5–6 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 incomplete carinae; both femur and patella are finely granulated.

Measurements. See Table 4.

AFFINITIES. The most similar species are *S. neradi*, *S. phatoensis* **sp. n.**, and *S. schumacheri* **sp. n.** These four species, with total length 23–30 mm, are the smallest members of the genus. Their pedipalp patella has 6–7 ventral and 16 external trichobothria (only 3 trichobothria in *est* series). Their pedipalp chela movable finger has ID and IAD in a row. In *S. dunlopi* **sp. n.** and *S. phatoensis* **sp. n.**, there are only 12–17 IAD/ID which do not create a parallel row with MD like in *S. neradi* and *S. schumacheri* **sp. n.**, which have 20–28 IAD/ID (Figs. 694–696). Both *S. dunlopi* **sp. n.** and *S. phatoensis* **sp. n.** are difficult to differentiate morphologically because the male of *S. dunlopi* **sp. n.** is unknown. However, *S. phatoensis* **sp. n.** has a slightly wider pedipalp chela in the female (chela length to width ratio 2.8 versus 3.15), and the validity of these two species was confirmed DNA analysis (Šťáhlavský et al., in press).

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops farkaci Kovařík, 1993
(Figs. 26, 197–198, 779, 788, 790, 799, Table 9)
http://zoobank.org/urn:lsid:zoobank.org:act:9984C122-2546-47CF-A7E0-C320018B4DD5

Scorpiops (*Scorpiops*) *farkaci* Kovařík, 1993: 109–111, figs. 1–6, 13–14; Kovařík, 1994: 65; Kovařík, 1995: 199.
Scorpiops farkaci: Kovařík, 1998: 142; Fet, 2000: 491–492; Kovařík, 2000: 172–174, figs. 1–6, 52, 53; Soleglad & Sissom, 2001: 93; Kovařík, 2009: 26, plate H, figs. 1–6.
=*Scorpiops* (*Vietscorpiops*) *dentidactylus* Lourenço & Pham, 2015a: 212–217, figs. 1–6 (Type locality and type repository: Vietnam, Dien Bien Province, Muong Nhe District, Nam Vi Commune, rainforest, limestone formation; MNHN). **Syn. n.**
http://zoobank.org/urn:lsid:zoobank.org:act:598E89A0-75A4-49B7-9EEB-40E429DBC28D
=*Vietscorpiops dentidactylus*: Pham et al., 2017: 136.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Mae Hong Son Province*, Ban Huai Po, 1600–1700 m a. s. l.; FKCP, NMPC.

TYPE MATERIAL EXAMINED (FKCP, NMPC). **Thailand**, *Mae Hong Son Province* (18.72°N 96.87°E), Ban Huai Po, 10.V.1991, leg. J. Farkač, 3♂ (holotype, paratypes Nos. 1–2), 4♀ (paratypes Nos. 5–8), 4♀juvs. (paratypes Nos. 9–12), 4juvs. before first ecdysis (paratypes Nos. 13–16), 2juvs. after first ecdysis (paratypes Nos. 17–18), 9juvs. after second ecdysis (paratypes Nos. 19–27), 2juvs. after third ecdysis (paratypes Nos. 28–29), rearing F. Kovařík.

OTHER MATERIAL EXAMINED (FKCP). **Thailand**, Thung Pong, near to Chiang Mai, X.2004, 1♀, leg. V. Fura,

DIAGNOSIS (♂♀). Total length 25–33 mm in males, 27–37 mm in females. Base color uniformly reddish black. Pectine teeth number 6–7 in males and 5–6 in females, fulcra absent. Pectines with 2 marginal and 1–3 middle lamellae. Patella of pedipalp with 17 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) external and 9 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in proximal half of manus between trichobothria *Dt* and *Db*. Fingers of pedipalps almost straight in both sexes; male has apophysis on movable finger developed. Chela length to width ratio 2.7–3.1 in male and 2.4–2.5 in female. Pedipalp movable finger with 25–30 IAD, ca. 55 MD which create 10 straight rows in a line and there are also 5 ID and 11–12 OD present. Metasoma I with 10 carinae and metasoma II–IV with 8 carinae. Telson bulbous, sparsely granulate, length to depth ratio 2.8 in both sexes; annular ring present.

COMMENTS. Lourenço & Pham (2015a) described *Scorpiops* (*Vietscorpiops*) *dentidactylus*, diagnosed by a unique character, an internal apophysis on the pedipalp movable finger (fig. 3a in Lourenço & Pham, 2015a). Because the holotype male was the only known specimen, the authors cited this character without knowing that it is present only in the male. Kovařík (1993) described *Scorpiops farkaci* according to 21 specimens which represented males, females and juveniles, and the apophysis on the pedipalp movable finger is presented only in males (Fig. 790). It is evident that this character represents an atypical sexual dimorphism. Lourenço & Pham (2015a) did not cite any characters that could decisively differentiate *S. dentidactylus* from *S. farkaci*. The only difference is that the types of *S. farkaci* have base color uniformly reddish black, while the male holotype of *V. dentidactylus* has base color uniformly reddish brown. A likely explanation for the color difference is fading of the latter after long storage in alcohol, since 1939 (cf. Lowe, 2018: 64–65). Otherwise, the published characters of *V. dentidactylus* and the holotype of *S. farkaci* match each other precisely. The inevitable conclusion is that *Scorpiops* (*Vietscorpiops*) *dentidactylus* Lourenço & Pham, 2015 is a junior synonym of *Scorpiops farkaci* Kovařík, 1993. In addition, below is described another related species *Scorpiops thailandus* **sp. n**. which has the same sexual dimorphism, but with smaller apophysis (Figs. 790 versus 791).

DISTRIBUTION. Thailand and Vietnam (Fig. 799).

Scorpiops kautti sp. n.
(Figures 96–97, 158, 179, 186, 360, 443–485, 799, 804, Tables 4, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:DC589A21-354C-47A3-9293-3C2E786918AC

Alloscorpiops/*Dasyscorpiops* sp. 1: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Nakhon Si Thammarat Province*, Nakhon Si Thammarat, Khao Wang Tong Cave, 9.204476°N 99.774275°E; FKCP.

TYPE MATERIAL (FKCP). **Thailand**, *Nakhon Si Thammarat Province*, Nakhon Si Thammarat, Khao Wang Tong Cave, 9.204476°N 99.774275°E, 40 m. a. s. l 03.XII.2017, UV detection, at rock face close to the cave, primary forest, full moon, 1♂ (holotype, 1631) 1♀ (paratype), leg. Peter Kautt; Nakhon Si Thammarat, Khao Wang Tong Cave, 9.204476°N 99.774275°E, 40 m. a. s. l., captive bred, 2♂ (paratypes, 1844), leg. M. Stockmann.

OTHER MATERIAL EXAMINED (FKCP). **Thailand**, *Nakhon Si Thammarat Province*, Nakhon Si Thammarat, Khao Wang Tong Cave, 9.204476°N 99.774275°E, 40 m. a. s. l., exuviae of 10 siblings captive by M. Stockmann.

ETYMOLOGY. The species epithet is a patronym honoring Peter Kautt, the collector of types of the new species.

DIAGNOSIS (♂♀). Adults from 53 mm (male) to 75 mm (female). Base color uniformly reddish black to black. Telson and tarsomere II of legs reddish brown. Pectine teeth number 13–14 in males, 11–12 in females; fulcra reduced to absent; 3 marginal and 3–5 middle lamellae. Patella of pedipalp with 46–58 external and 23–26 ventral trichobothria. Chela of pedipalp with 13–16 *V* series trichobothria of which the 2–3 most proximal are located on external surface near Eb_1. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in male and almost straight in female. Chela length to width ratio 4.05 in male, 4.57 in female. Pedipalp movable finger with 53–62 IAD, which have the same size as MD (> 100 in number) and create a second row; there are also 5 ID and 15 OD present. Tarsomere II of leg III with four stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae and metasoma II–IV with 8 carinae. Telson elongate and granulate, length to depth ratio 3.17 in male and 3.51 in female; annular ring developed in both sexes.

DESCRIPTION. Total length 53 mm (male) to 75 mm (female). Habitus as shown in Figs. 443–446. For position and distribution of trichobothria on pedipalps, see Figs. 457–463. Sexual dimorphism: adult males have larger pectines than females; fingers of pedipalps undulate in male and almost straight in female (Figs. 465 and 456).
Coloration (Figs. 482–483). Base color uniformly reddish black to black. Telson and tarsomere II of legs reddish brown, sternites lighter, yellowish to reddish brown. Chelicerae reddish brown and reticulate, fingers black.
Carapace and mesosoma (Figs. 443–446, 474–477). Entire carapace covered with large granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth to very finely granulated with two parallel furrows except sternite VII which has four granulate carinae. Pectine teeth number 13–14 in males and 11–12 in females. Pectines with 3 marginal and 3–5 middle lamellae; fulcra reduced to absent.
Metasoma and telson (Figs. 447–454). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly in a pronounced tooth. Telson elongate and granulate with annular ring developed in both sexes.
Pedipalps (Figs. 455–473). Pedipalps very sparsely hirsute. Patella with 46–58 external trichobothria (which cannot be assigned to standard *eb*, *esb*, *em*, *est*, and *et* territories) and 23–26 ventral trichobothria. Chela with 13–16 ventral trichobothria of which the 2–3 most proximal are located on external surface near Eb_1. Femur and patella granulated. Femur with 5 granulose carinae, and patella with 5 carinae and pronounced dorsal and ventral patellar spurs. Manus dorsally

Figures 443–446: *Scorpiops kautti* **sp. n**. **Figures 443–444**. Male holotype in dorsal (443) and ventral (444) views. **Figures 445–446**. Female paratype in dorsal (445) and ventral (446) views. Scale bar: 10 mm.
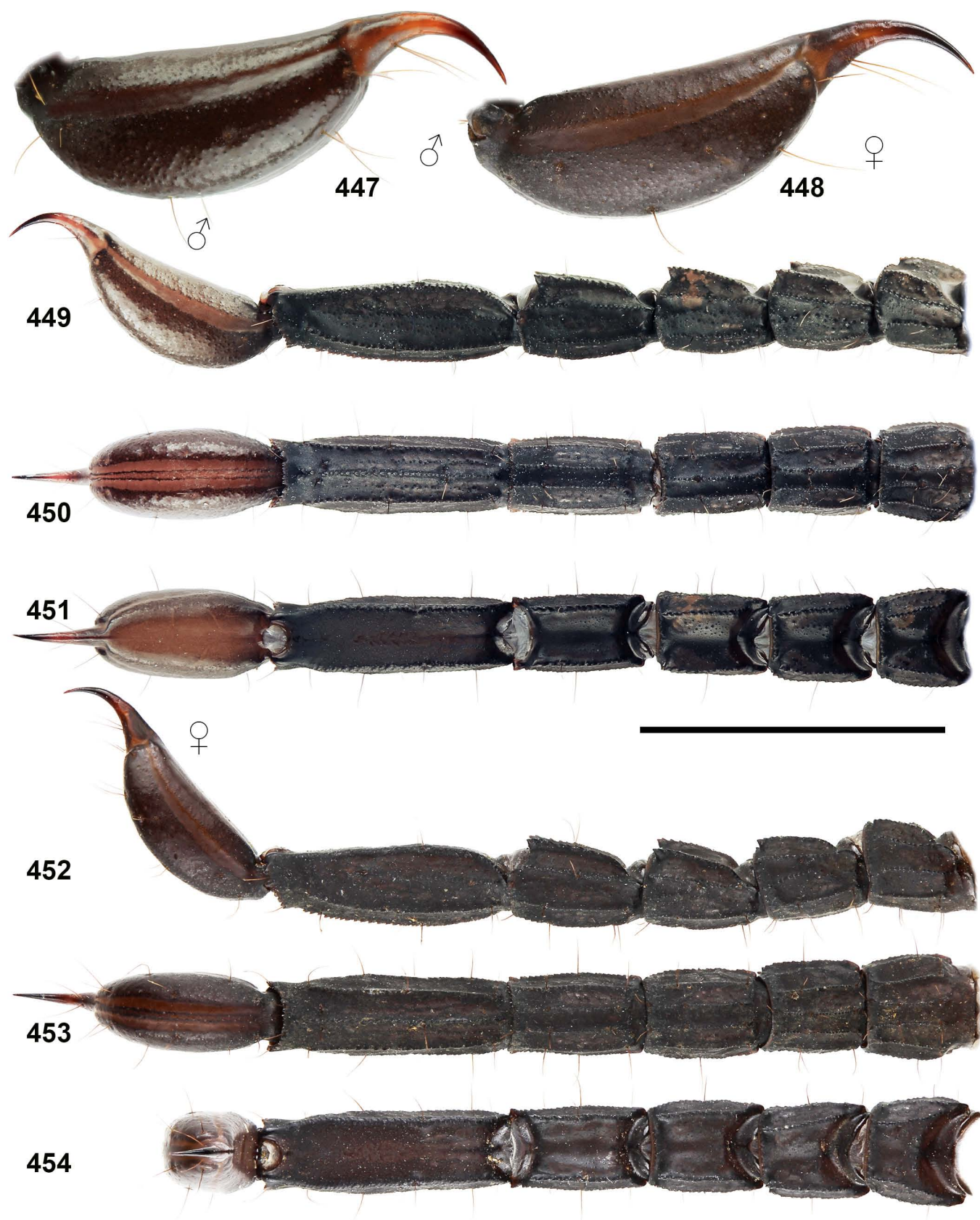
Figures 447–454: *Scorpiops kautti* **sp. n. Figures 447**, **449–451**. Male holotype, telson lateral (447), and metasoma and telson lateral (449), ventral (450), and dorsal (451) views. **Figures 448**, **452–454**. Female paratype, telson lateral (448), and metasoma and telson lateral (452), ventral (453), and dorsal (454) views. Scale bar: 10 mm (449–454).

Figures 455–473: *Scorpiops kautti* **sp. n.**, pedipalp segments. **Figures 455–463**. Female paratype, chela dorsal (455, 457), external (456, 458) and ventral (459) views. Patella dorsal (460), external (461) and ventral (462) views. Trochanter and femur dorsoexternal (463) view. Trichobothrial pattern is indicated by white circles (457–463). **Figures 464–473**. Male holotype, chela dorsal (464), external (465) and ventral (466) views. Patella dorsal (467), external (468) and ventral (469) views. Trochanter and femur dorsal (470) and ventral (471) views. Movable finger (472) dentition under white light (473) and UV light (473).
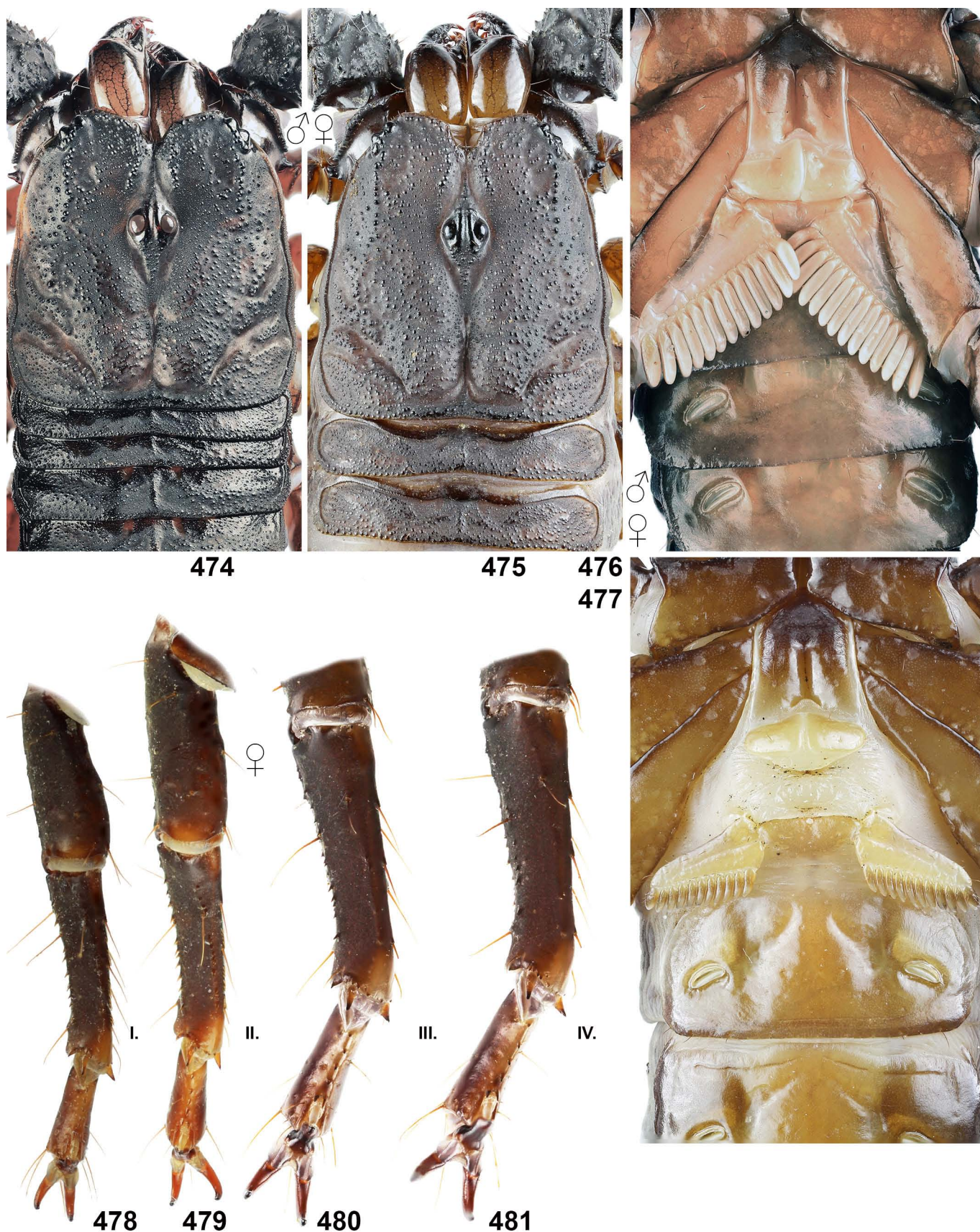
Figures 474–481: *Scorpiops kautti* **sp. n**. **Figures 474**, **476**. Male holotype, carapace and tergites I–III (474), coxosternal area and sternites III–V (476). **Figures 475**, **477–481**. Female paratype, carapace and tergites I–II (475), coxosternal area and sternite III (477), left legs I–IV, retrolateral aspect (478–481 respectively).

Figure 482. *Scorpiops kautti* **sp**. **n**., male paratype, in vivo habitus.

Figures 483–485: *Scorpiops kautti* **sp. n.**, female paratype, in vivo habitus (483), with newborns (484), and with juveniles after first ecdysis (485).

with fine, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with an almost complete external secondary carina. Movable fingers bear 53–62 IAD, which have the same size as MD (> 100 in number) and create a second row; there are also 5 ID and 15 OD present.
Legs (Figs. 478–481). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II, and also partly on ventrolateral surface of leg III. Tarsomere II of leg I with 5–6 stout median ventral spinules and two pairs of flanking setae, legs II–IV with 4 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.
Measurements. See Table 4.

AFFINITIES. Morphologically, the closest species are *S. krabiensis* **sp**. **n**. and *S. scheibeae* **sp**. **n**. Both *S. kautti* **sp**. **n**. and *S. krabiensis* **sp**. **n**. differ from *S. scheibeae* **sp**. **n**. in the shape and granulation of the metasomal segments, and in shape of the pronounced tooth at the posterior termination of dorsolateral carinae of metasoma IV (tooth is wide and divided into 3 peaks in *S. scheibeae* **sp**. **n**., but forms only one simple peak in *S. kautti* **sp**. **n**. and *S. krabiensis* **sp**. **n**.). The pedipalp chela is more narrow in *S. scheibeae* **sp**. **n**. than in *S. kautti* **sp**. **n**. and *S. krabiensis* **sp**. **n**. (pedipalp chela length to width ratio is 3.56 in *S. scheibeae* **sp**. **n**. vs. 3.17–3.4 in *S. kautti* **sp**. **n**. and *S. krabiensis* **sp**. **n**.). Also, *S. scheibeae* **sp**. **n**. has pedipalp movable finger with 68 IAD (Fig. 642) while *S. kautti* **sp**. **n**. and *S. krabiensis* **sp**. **n**. have 53–62 IAD (Figs. 473, 505). Both *S. kautti* **sp**. **n**. and *S. krabiensis* **sp**. **n**. are close and difficult to differentiate morphologically, but *S. krabiensis* **sp**. **n**. has 19 *V* series trichobothria on the chela manus, and *S. kautti* **sp**. **n**. has 13–16. Moreover, the validity of these two species was clearly confirmed by DNA analysis and different numbers of chromosomes (2n=87 in *S. kautti* **sp**. **n**. vs. 2n=81 in *S. krabiensis* **sp**. **n**., see Šťáhlavský et al., in press). All three of these species display a unique neobothriotaxic trichobothrial pattern. They have 13–19 *V* series trichobothria on the chela manus, the diagnostic character for the genus *Alloscorpiops* (herein synonymized), and they also have 46–61 patellar external trichobothria, the diagnostic character for the genus *Dasyscorpiops*. The high variability in numbers of patellar external trichobothria among siblings shows that the precise number of accessory trichobothria is not a reliable generic character, and for species level taxonomy can only be used in combination with other characters.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops krabiensis sp. n.
(Figures 180, 186, 361, 486–512, 799, 805, Tables 4, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:54F65562-5B86-4F3F-B08D-18D699AC22DB

Alloscorpiops/Dasyscorpiops sp. 2: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Krabi Province*, Krabi, 8.120417°N 98.916539°E; FKCP.

TYPE MATERIAL (FKCP). **Thailand**, *Krabi Province*, Krabi, Suan Phrueksa Sawan Viewpoint, 8.120417°N 98.916539°E, 240 m a. s. l, 22.I.2020, 22:00 - 01:00 h, UV detection, in rock crack, in ambush position, recently molted to adulthood, waning moon, 1♂ (holotype, 1829), leg. M. Stockmann; Krabi, Tiger Cave Temple, 8.1275000°N 98.9244440°E, 80 m a.s.l., 27.VIII.2019, UV detection, in rock crack at rock face, waning moon, 1♂juv. (paratype, 1771), leg. Peter Kautt.

ETYMOLOGY. Named after the locality of occurrence.

DIAGNOSIS (♂). Total length 65 mm. Base color uniformly reddish black to black. Telson and legs reddish brown. Pectine teeth number 12 in males; fulcra reduced to absent; 3 marginal and 4 middle lamellae. Patella of pedipalp with 60–61 external and 26–28 ventral trichobothria. Chela trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Chela of pedipalp with 19 *V* series trichobothria, of which the 2–3 most proximal are located on external surface of manus. Fingers of pedipalps undulate in male. Chela length to width ratio 3.89. Pedipalp movable finger with ca. 60 IAD, which have the same size as MD (ca. 95 in number) and create a second row; there are also 6 ID and 15 OD present. Tarsomere II of leg III with 4–5 stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae and metasoma II–IV with 8 carinae. Telson elongate and granulate, length to depth ratio 3.40 in male; annular ring present.

DESCRIPTION (♂). Total length 65 mm. Female unknown. Habitus as shown in Figs. 486–489. For position and distribution of trichobothria on pedipalps, see Figs. 497–500, 503 and 506. Fingers of pedipalps undulate in male (Fig. 498).
Coloration (Figs. 511–512). Base color uniformly reddish black to black. Telson, legs, and sternites are reddish brown. Chelicerae yellowish brown and reticulate, fingers black.
Carapace and mesosoma (Figs. 486–492). Entire carapace covered with large granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth with two parallel furrows except sternite VII which is granulate and has four granulate carinae. Pectine teeth number 12 in males. Pectines with 3 marginal and 4 middle lamellae; fulcra reduced to absent.
Metasoma and telson (Figs. 493–496). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II–III and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of second to fourth segments terminate posteriorly in a pronounced tooth. Telson elongate sparsely granulate with annular ring developed.

Figures 486–489: *Scorpiops krabiensis* **sp. n. Figures 486–487**. Male holotype in dorsal (486) and ventral (487) views. **Figures 488–489**. Male juvenile paratype in dorsal (488) and ventral (489) views. Scale bar: 10 mm.
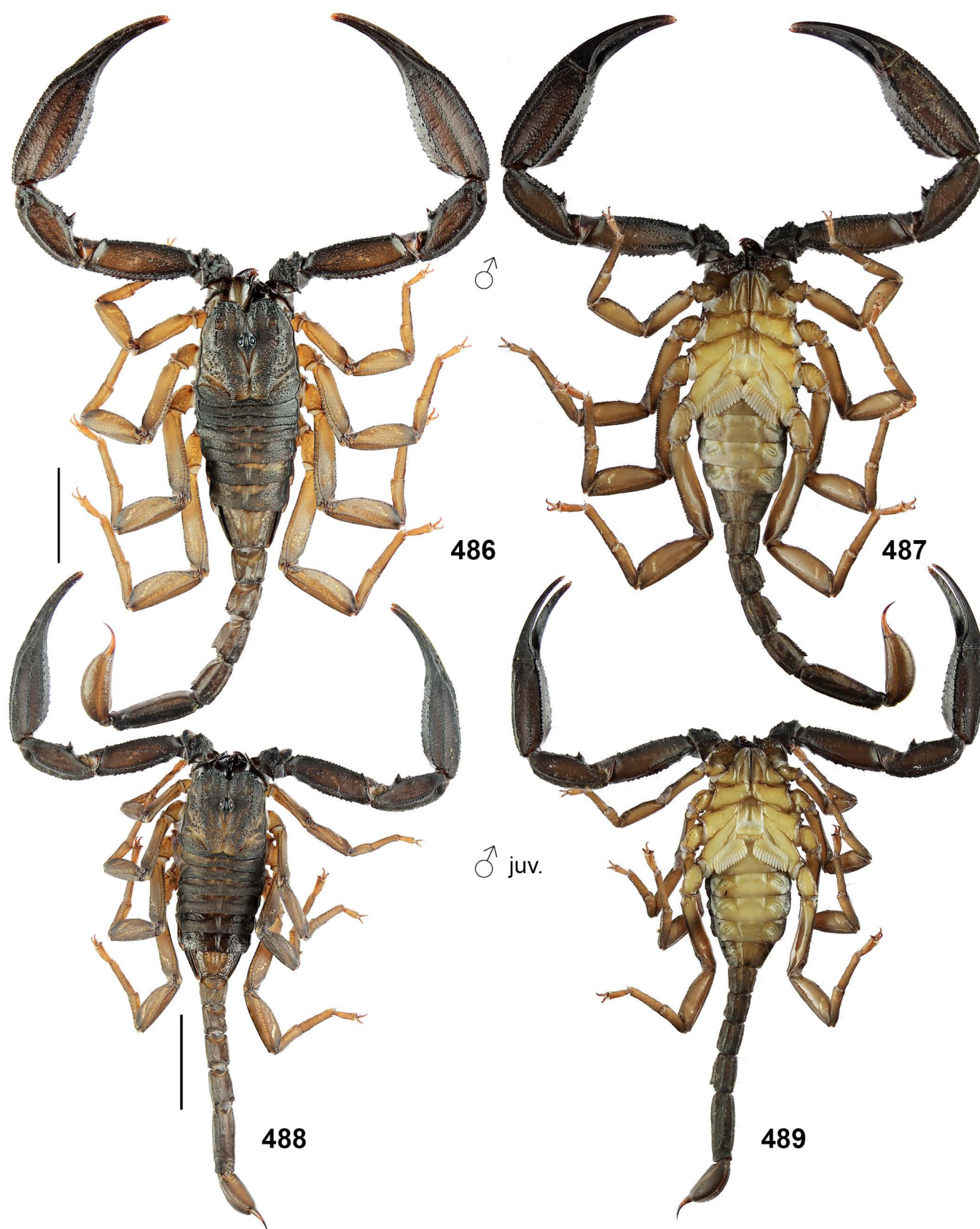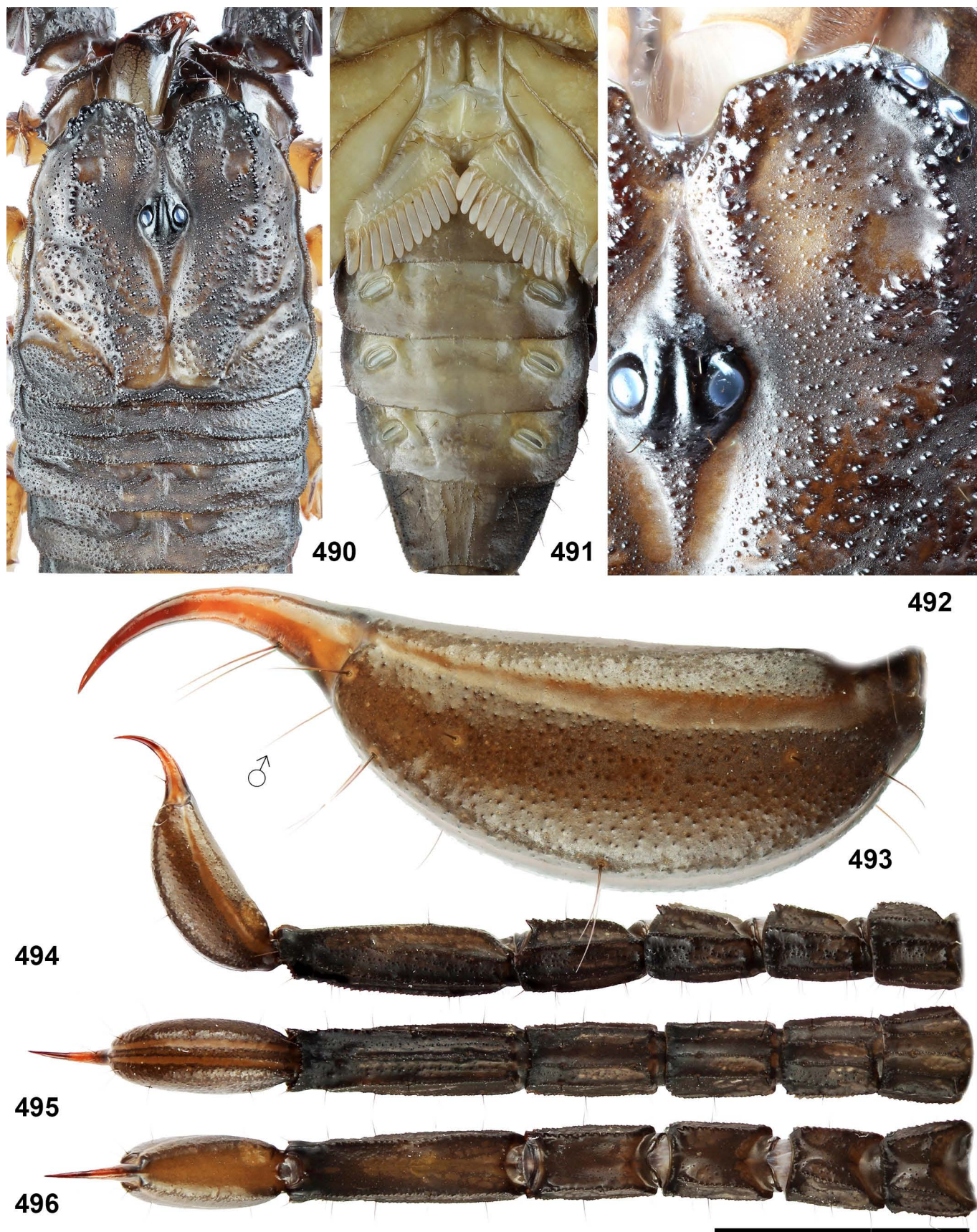
Figures 490–496: *Scorpiops krabiensis* **sp. n.**, male holotype. **Figures 490–492**. Carapace and tergites I–IV (490), coxosternal area and sternites (491), lateral and median eyes (492). **Figures 493–496**. Telson lateral (493), and metasoma and telson lateral (494), ventral (495), and dorsal (496) views. Scale bar: 10 mm (494–496).

Figures 497–506. *Scorpiops krabiensis* **sp. n.**, male holotype, pedipalp segments. Chela dorsal (497), external (498) and ventral (499) views. Patella dorsal (500), external (501 and 506) and ventral (502) views. Trochanter and femur dorsal (503) and ventral (504) views. Movable finger (505) dentition under UV light. Trichobothrial pattern is indicated by white circles (497–500, 503, 506).

Figures 507–510. *Scorpiops krabiensis* **sp. n.**, male holotype, left legs I–IV, retrolateral aspect.

Pedipalps (Figs. 497–505). Pedipalps very sparsely hirsute. Patella with 60–61 external and 26–28 ventral trichobothria. Chela with 19 ventral trichobothria from which 2–3 are located on external surface. Femur and patella granulated. Femur with 5–6 granulose carinae, and patella with 5 carinae, with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded reticulated granules, which in the central area form an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with a regular external secondary carina. Movable fingers bear ca. 60 IAD, which have the same size as MD (ca. 95 in number) and create a second row; there are also 6 ID and 15 OD present.

Legs (Figs. 507–510). Tibia and tarsomeres of legs with several setae not arranged into bristle combs but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs I–IV with 4–5 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.

Measurements. See Table 4.

AFFINITIES. See affinities under description of *S. kautti* **sp. n.**

DISTRIBUTION. Thailand (Fig. 799).

Figures 511–512. *Scorpiops krabiensis* **sp. n**., male holotype (511) and male juvenile paratype (512), in vivo habitus.

Dimensions (mm)		*S. pakseensis* **sp**. **n**. ♂ **holotype**	*S. pakseensis* **sp**. **n**. ♀ **paratype**	*S. phatoensis* **sp**. **n**. ♂ **holotype**	*S. phatoensis* **sp**. **n**. ♀ **paratype**
Carapace	L / W	5.86 / 5.85	6.27 / 6.37	4.03 / 4.07	4.02 / 4.31
Mesosoma	L	8.44	17.03	10.08	12.51
Tergite VII	L / W	1.89 / 3.95	3.15 / 4.88	2.00 / 3.21	1.59 / 3.73
Metasoma + telson	L	19.35	17.26	14.59	13.12
Segment I	L / W / D	1.80 / 2.22 / 1.87	1.65 / 2.17 / 1.66	1.57 / 1.75 / 1.60	1.25 / 1.84 / 1.55
Segment II	L / W / D	2.19 / 2.10 / 1.79	2.07 / 1.94 / 1.65	1.67 / 1.57 / 1.36	1.54 / 1.62 / 1.40
Segment III	L / W / D	2.40 / 1.90 / 1.74	2.25 / 1.79 / 1.57	1.84 / 1.52 / 1.43	1.68 / 1.52 / 1.36
Segment IV	L / W / D	3.03 / 1.86 / 1.89	2.64 / 1.73 / 1.57	2.19 / 1.45 / 1.38	2.00 / 1.50 / 1.30
Segment V	L / W / D	4.72 / 1.81 / 1.74	4.11 / 1.57 / 1.49	3.52 / 1.46 / 1.38	3.28 / 1.40 / 1.35
Telson	L / W / D	5.21 / 1.92 / 1.73	4.54 / 1.57 / 1.49	3.80 / 1.58 / 1.27	3.37 / 1.33 / 1.22
Pedipalp	L	24.62	22.11	16.91	13.85
Femur	L / W	6.47 / 2.41	5.48 / 2.26	4.55 / 1.75	3.46 / 1.45
Patella	L / W	6.47 / 2.52	5.63 / 2.51	4.60 / 1.76	3.71 / 1.71
Chela	L	11.68	11.00	7.76	6.68
Manus	W / D	3.63 / 3.06	3.77 / 3.40	2.07 / 1.94	2.41 / 2.23
Movable finger	L	5.38	5.74	3.28	3.01
Total	**L**	**33.65**	**40.56**	**28.70**	**29.65**

Table 5. Comparative measurements of adults of *Scorpiops pakseensis* **sp**. **n**. and *S. phatoensis* **sp**. **n**. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

Scorpiops novaki (Kovařík, 2005), **comb**. **n**.
(Figs. 63, 285–286, Table 9)
http://zoobank.org:act:63499543-BAB4-49BD-B58D-
5A969B73FAAE

Euscorpiops novaki Kovařík, 2005: 4–6, figs. 8, 11, 15–16; Qi et al., 2005: 15–18; Di et al., 2010b: 51.
= *Euscorpiops karschi* Lourenço et al. in Qi et al., 2005: 25, figs. 94–108; Di & Zhu, 2009a: 11–15, figs. 1–26; Di et al., 2010b: 51; Di et al., 2013: 58–59; Di et al., 2014: 10, 15; Fet & Kovařík, 2020: 4. **Syn**. **n**.
http://zoobank.org/urn:lsid:zoobank.org:act:
4A802177-1E05-4828-A4E4-E3E1C15B4C7

TYPE LOCALITY AND TYPE REPOSITORY. **China**, *Tibet* (*Xizang*), Bomi env., 29°52'N 95°45'E (29.87°N 95.75°E), ca. 3000 m a. s. l.; FKCP.

TYPE MATERIAL EXAMINED. **China**, *Tibet* (*Xizang*), Bomi env. 29°52'N 95°45'E (29.87°N 95.75°E), ca. 3000 m a. s. l., 1988, 1♂ (holotype), leg. P. Rojek, FKCP.

OTHER MATERIAL EXAMINED. **China**, *Tibet* (*Xizang*), Zayü District, Xia Zayü Town, 28°30'N 97°00'E (28.50°N 97.00°E), 2♀, topotypes of *Euscorpiops karschi* Lourenço, Zhu & Qi, 2005, 2008, donor Zhiyong Di, FKCP.

DIAGNOSIS (♂♀). Total length 44–49 mm. Base color uniformly reddish brown. Pectine teeth number 8–9 in males and 7–8 in females, fulcra reduced to absent. Pectens have three marginal and 3–5 middle lamellae present. Patella of pedipalp with 18–

19 (5 *eb*, 2 *esb*, 2 *em*, 4–5 *est*, 5 *et*) external and 8–9 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium *Eb₃* located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps flexed in both sexes. Chela length to width ratio 3.6 in male and 3.4–3.5 in females. Pedipalp movable finger with ca. 60 IAD, which form second row, parallel with MD (ca. 70 in number); there are also 4 ID and 11–13 OD present. Tarsomere II of legs with 5–7 stout median ventral spinules and two pairs of flanking setae. Telson elongate and sparsely granulate, length to depth ratio 3.3 in male and 3.18 in female; annular ring developed in both sexes.

COMMENTS. It is determined here that the holotype of *Euscorpiops novaki* and topotypes *Euscorpiops karschi* match each other precisely in the following key characters: trichobothrial pattern, pedipalp finger dentation, pectinal tooth count and lamellar structure, proportions, setation, carination and sculpture of pedipalps, carapace, tergites, sternites, and metasoma, shape of the telson, as well as armature of chelicerae and pedipalp fingers. In the original descriptions, Qi et al. (2005: 25 and 29) differentiated these two species from the same area of distribution according to one more pectine tooth and one more ventral trichobothrium on the patella pedipalp. Both differences lie within the scope of normal intraspecific variation (see Table 9). The undeniable conclusion is that *Euscorpiops karschi* Lourenço et al. in Qi et al., 2005: 25 is a junior synonym of *Euscorpiops novaki* Kovařík, 2005, **syn**. **n**.

DISTRIBUTION. China (Tibet) (Fig. 799).

Scorpiops pakseensis sp. n.
(Figures 153, 174, 186, 513–561, 799, 809, Tables 5, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:E1A4981C-9921-4A11-A21B-0152CB744028

Euscorpiops/Scorpiops sp. 1: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Laos**, 70km SSE of Pakse, Xe Pian (15.15°N 106.25°E); FKCP.

TYPE MATERIAL (FKCP). **Laos**, 70km SSE of Pakse, Xe Pian (15.15°N 106.25°E), mother XII.2018, leg. V. Fura, 1♀ (paratype, 1648) and 1♂ (holotype 1828), male from litter of paratype, born 5.IV.2019, 1st ecdysis 10.IV.2019, 2nd ecdysis 25.V.2019, 3rd ecdysis 15.X.2019, and 4th maturity ecdysis 6.I.2020, breeder F. Kovařík.

ETYMOLOGY. Named after the occurrence near Pakse city.

DIAGNOSIS (♂♀). Total length 34 mm (male) – 41 mm (female). Base color uniformly reddish brown to black. Legs and telson yellow to reddish brown. Pectine teeth number 6 in male and 4 in female, fulcra absent. Pectines with 2 marginal and 1–3 middle lamellae. Patella of pedipalp with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external and 9 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in middle of manus approximately at level as *Dt*. Fingers of pedipalps very slightly undulate in males, straight in female. Chela length to width ratio 3.2 in male, 2.9 in female. Pedipalp movable finger with ca. 25 IAD and ca. 50 MD which create two irregular parallel rows; there are also 2 basal ID and 11–12 OD present. Tarsomere II of legs with row of 5–9 stout median ventral spinules. Telson is sparsely granulate, more bulbous in male, length to depth ratio 2.7 in male and 2.9 in female; annular ring developed in both sexes, more in male.

DESCRIPTION (♂♀). Total length 34 (male) – 41 (female) mm. Habitus as shown in Figs. 513–516. For position and distribution of trichobothria on pedipalps, see Figs. 527–532. Sexual dimorphism: adult males have relatively larger pectines than females; pedipalp chela is more narrow in male; fingers of pedipalps are very slightly undulate in male and straight in female (Figs. 534 and 526).
Coloration (Figs. 513–516, 558–561). Base color uniformly reddish black to black. Legs and telson are yellow to reddish brown, sternites lighter, yellowish to reddish brown. Chelicerae yellowish brown and reticulate, fingers reddish brown.
Carapace and mesosoma (Figs. 513–516, 542–545). Entire carapace covered with minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma finely granulated, with one median carina developed. Tergite VII is pentacarinate. Sternites smooth with two parallel furrows except sternite VII which is finely granulated with two

or four granulate carinae indicated. Pectine teeth number 6 in male and 4 in female. Pectines with 2 marginal and 1–3 middle lamellae; fulcra absent.
Metasoma and telson (Figs. 517–524). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly in a pronounced tooth. Telson elongate and granulate with annular ring developed in male and indicated in female.
Pedipalps (Figs. 525–541). Pedipalps very sparsely hirsute. Patella with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external and 9 ventral trichobothria. Chela with 4 *V* series trichobothria located on ventral surface. Femur and patella are finely granulated. Femur with 3–4 granulose carinae, and patella with 5 carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine reticulated, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela covered by minute granules, with an almost complete external secondary carina with larger sparse granules. Movable fingers with 25 IAD of different sizes (both smaller and larger than MD) in a row, parallel with MD (ca. 50 in number) and there are also 2 basal ID and 11–12 OD present.
Legs (Figs. 546–549, 552–555). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs with row of 5–9 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.
Measurements. See Table 5.

AFFINITIES. The combination of four characters (chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*; patella of pedipalp with 9 ventral and 18 external trichobothria; fingers of pedipalps undulate in male; and pedipalp movable finger with ca. 25 IAD) is unique in the entire genus *Scorpiops*.

DISTRIBUTION. Laos (Fig. 799).

Scorpiops phatoensis sp. n.
(Figures 142, 155, 176, 186, 362, 562–600, 792, 799, 810, Tables 5, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:736EED55-9F20-4AB1-8D72-6099B4758705

Euscorpiops/Scorpiops sp. 3: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Chumphon Province*, Phato, 9.8292990°N 98.7731480°E; FKCP.

TYPE MATERIAL (FKCP). **Thailand**, *Chumphon Province*, Phato, 9.8292990°N 98.7731480°E, 222 m a. s. l. (Fig. 362),
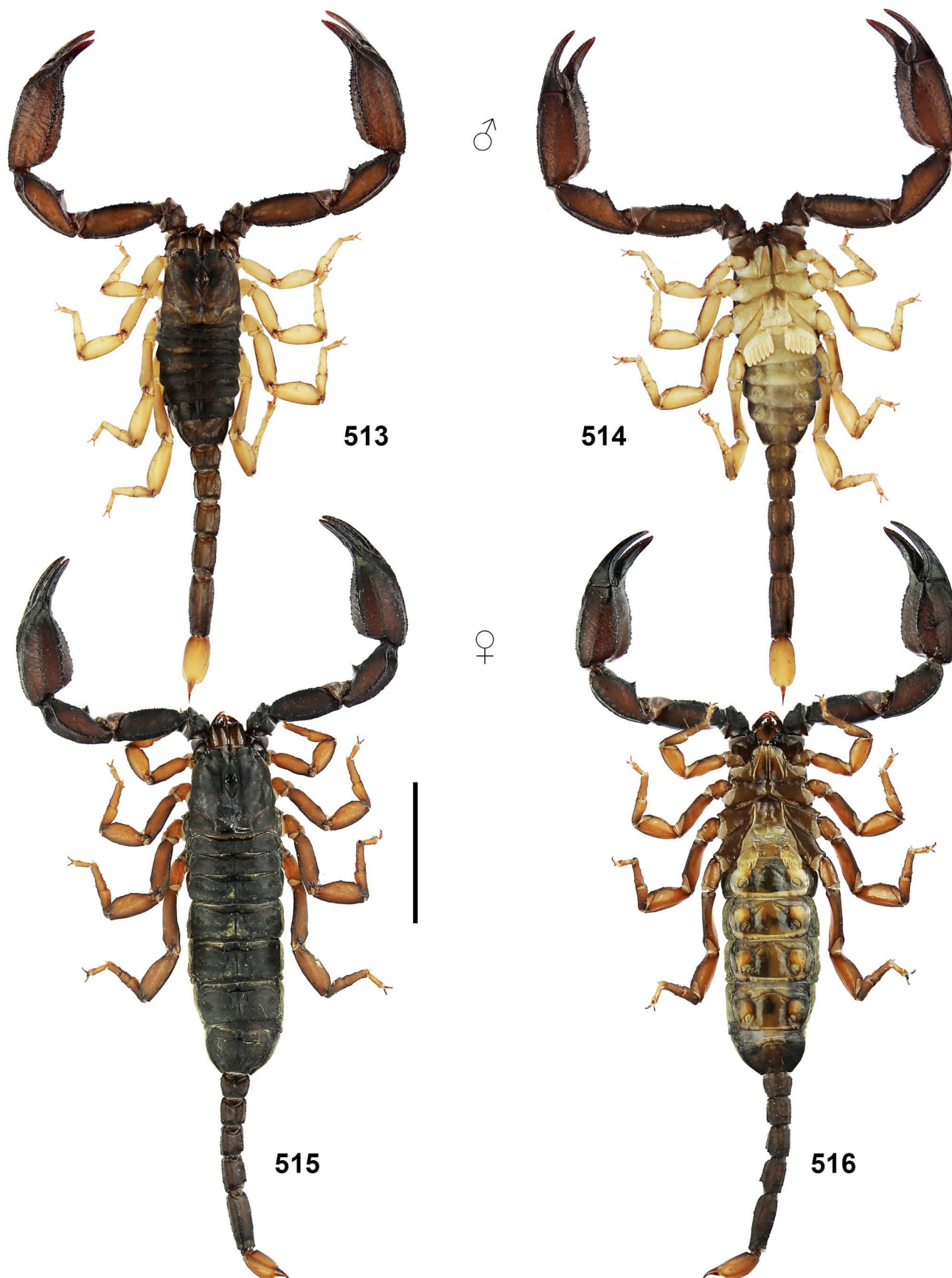
Figures 513–516: *Scorpiops pakseensis* **sp. n**. **Figures 513–514**. Male holotype in dorsal (513) and ventral (514) views. **Figures 515–516**. Female paratype in dorsal (515) and ventral (516) views. Scale bar: 10 mm.
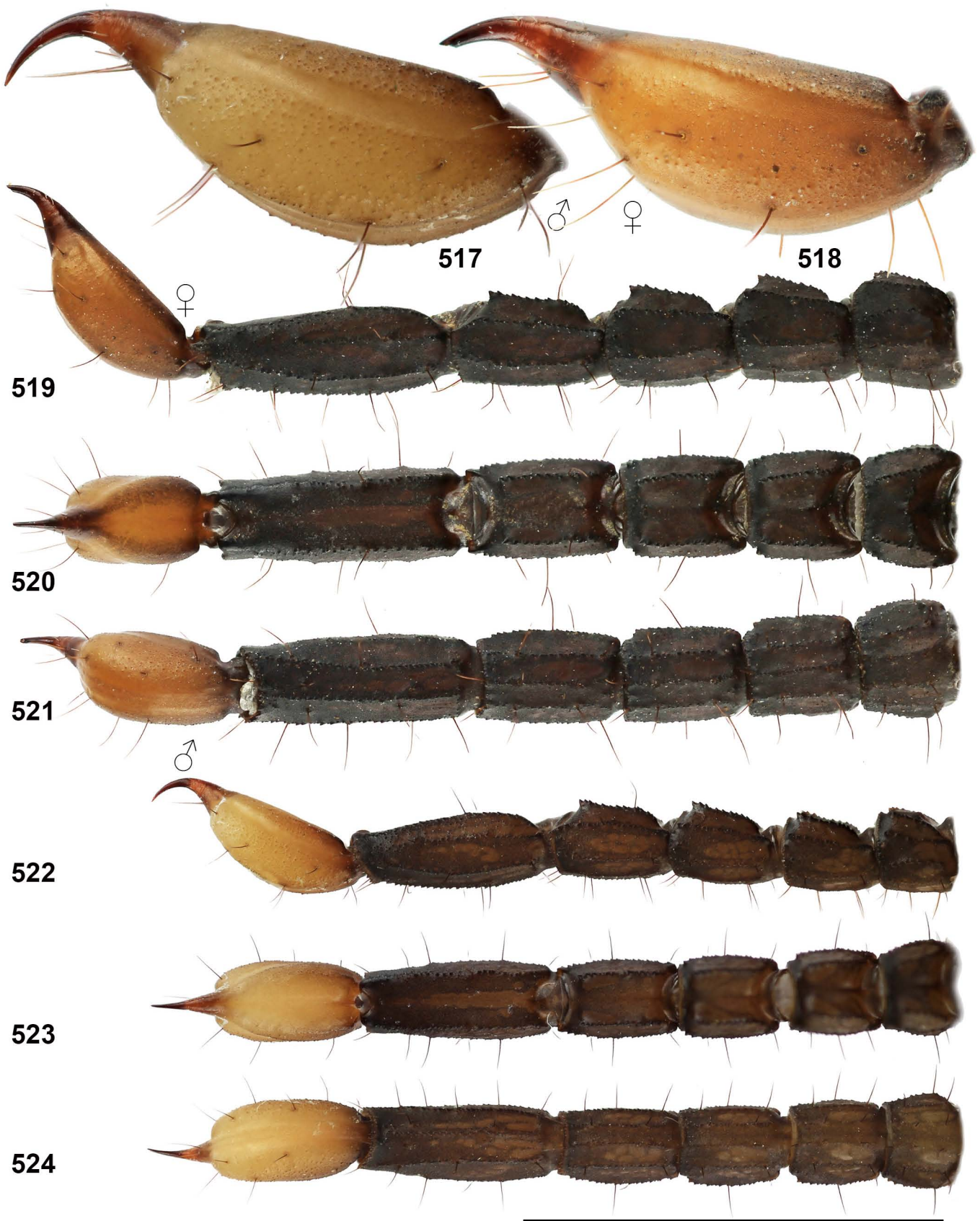
Figures 517–524: *Scorpiops pakseensis* **sp. n**. **Figures 517, 522–524**. Male holotype, telson lateral (517), and metasoma and telson lateral (522), dorsal (523), and ventral (524) views. **Figures 518–521**. Female paratype, telson lateral (518), and metasoma and telson lateral (519), dorsal (520), and ventral (521) views. Scale bar: 10 mm (519–524).

Figures 525–541: *Scorpiops pakseensis* **sp. n.**, pedipalp segments. **Figures 525–532**. Female paratype, chela dorsal (525, 527), external (526, 528) and ventral (529) views. Patella dorsal (530), external (531) and ventral (532) views. Trichobothrial pattern is indicated by white circles (527–532). **Figures 533–541**. Male holotype, chela dorsal (533), external (534) and ventral (535) views. Patella dorsal (536), external (537) and ventral (538) views. Trochanter and femur dorsal (539) and ventral (540) views. Movable finger (541) dentition under UV light.
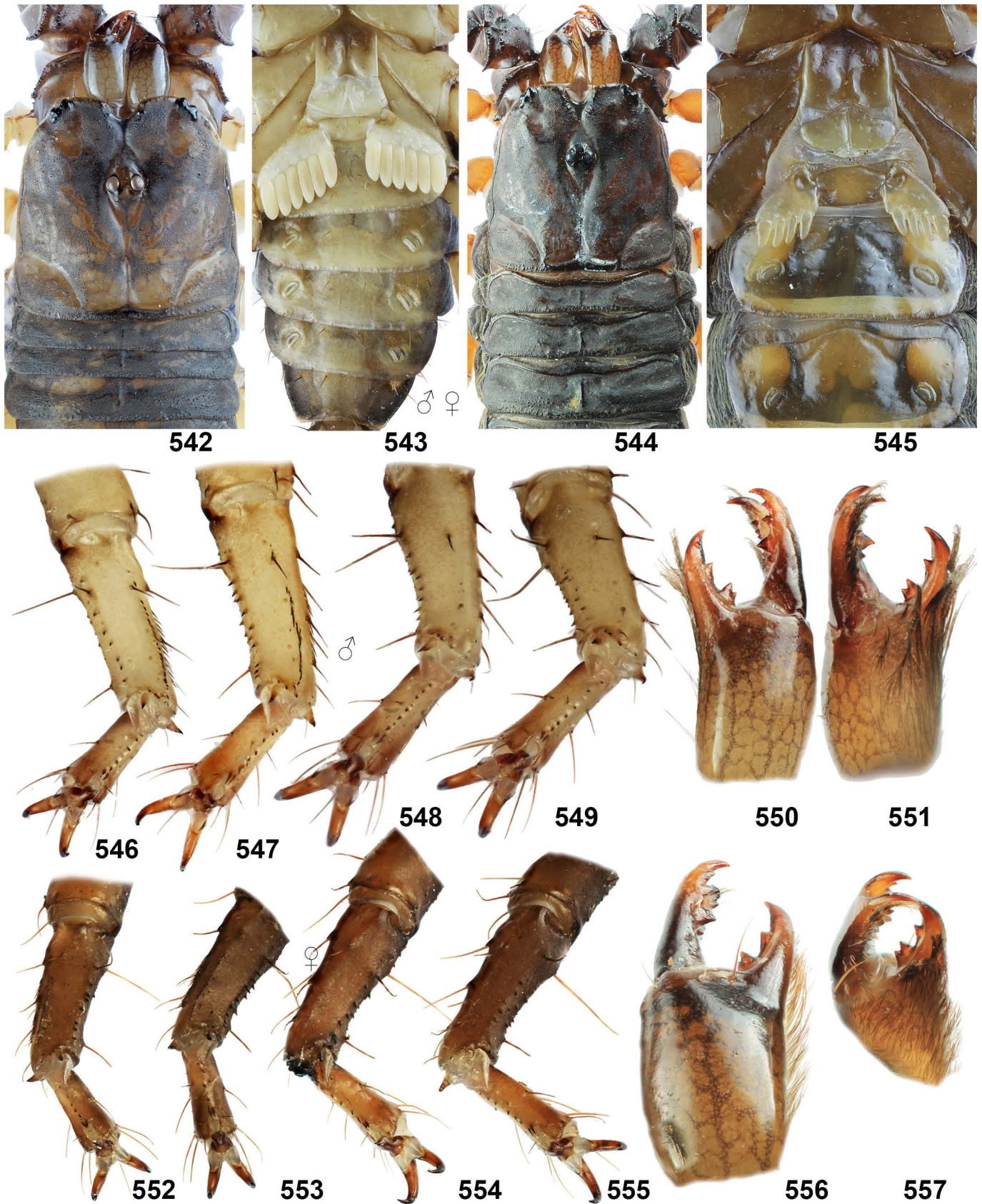
Figures 542–557: *Scorpiops pakseensis* **sp. n**. **Figures 542–543**, **546–551**. Male holotype, carapace and tergites I–III (542), coxosternal area and sternites (543), left legs I–IV, retrolateral aspect (546–549 respectively), and right chelicera in dorsal (550) and ventral (551) views. **Figures 544–545, 552–557**. Female paratype, carapace and tergites I–III (544); coxosternal area and sternites III–IV (545), right legs I–IV, retrolateral aspect (552–555 respectively), and left chelicera in dorsal (556) and ventral (557) views.

Figures 558–559. *Scorpiops pakseensis* **sp**. **n**., male holotype (558) and female paratype (559) in vivo habitus.

Figures 560–561. *Scorpiops pakseensis* **sp**. **n**., female paratype, with newborns (560) and juveniles after first ecdyis (561). One of these juveniles is male holotype.
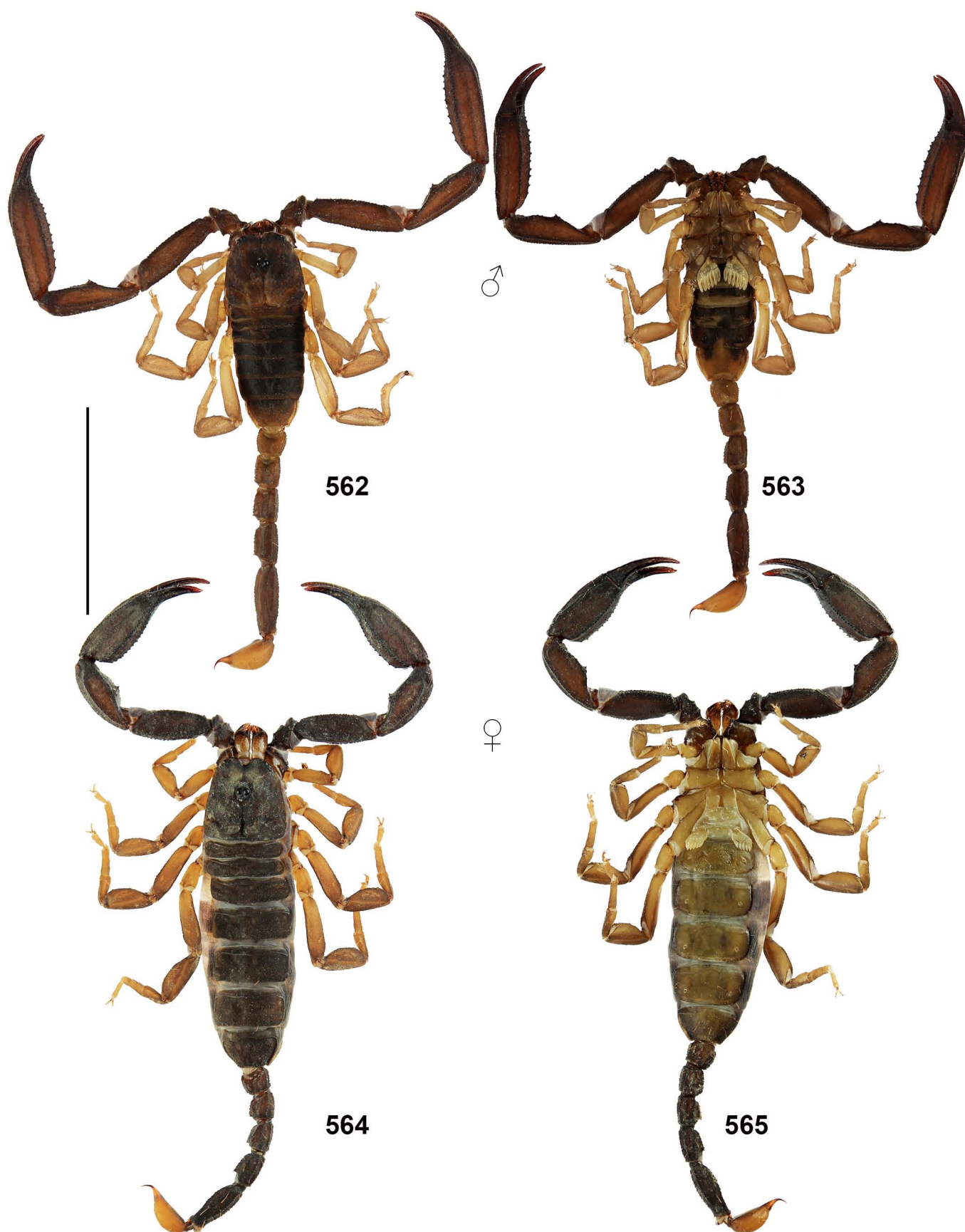
Figures 562–565: *Scorpiops phatoensis* **sp**. **n**. **Figures 562–563**. Male paratype in dorsal (562) and ventral (563) views. **Figures 564–565**. Female paratype in dorsal (564) and ventral (565) views. Scale bar: 10 mm.
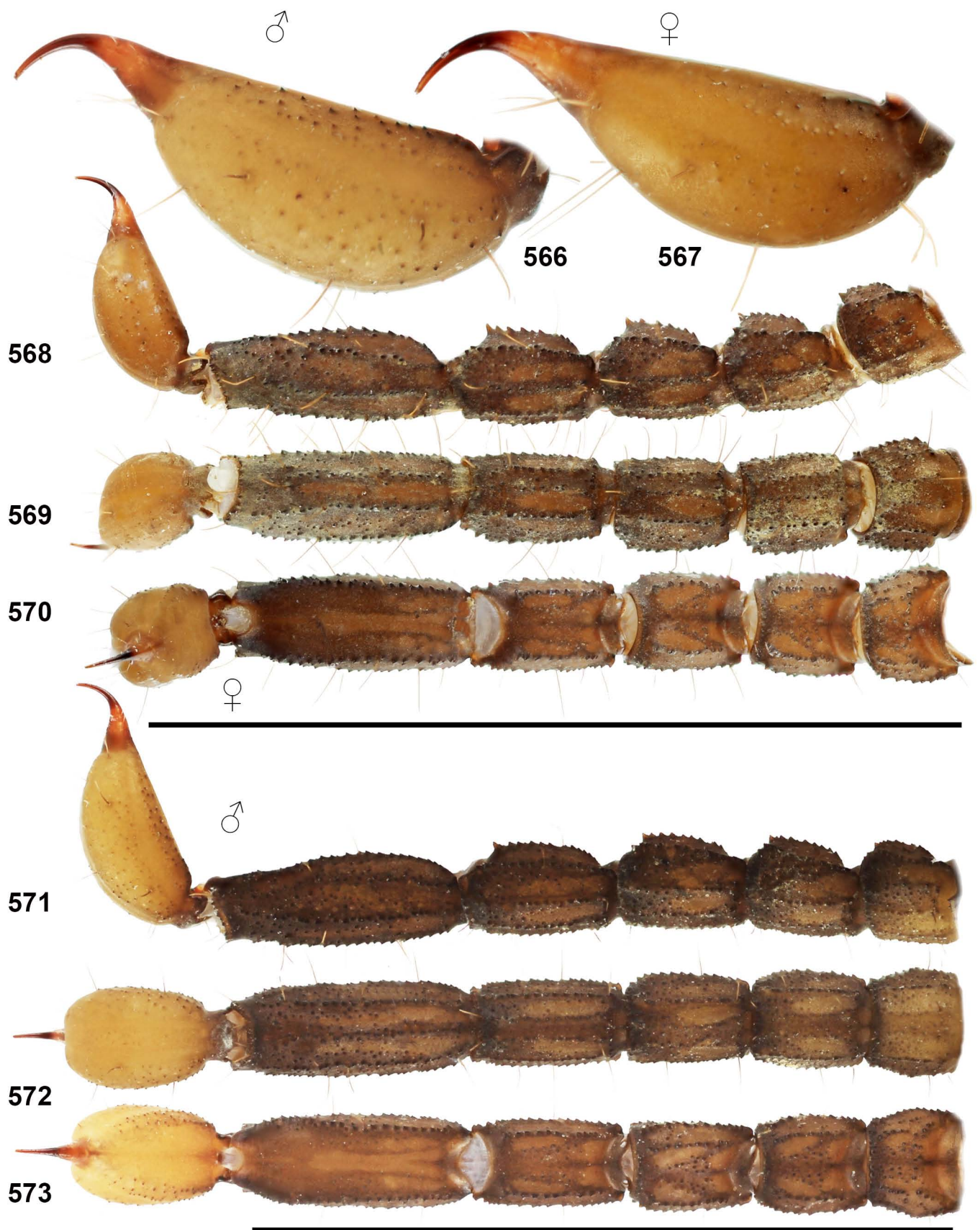
Figures 566–573: *Scorpiops phatoensis* **sp. n**. **Figures 566**, **571–573**. Male holotype, telson lateral (566), and metasoma and telson lateral (571), ventral (572), and dorsal (573) views. **Figures 567**, **568–570**. Female paratype, telson lateral (567), and metasoma and telson lateral (571), ventral (572), and dorsal (573) views. Scale bars: 10 mm (568–570, 571–573).

Figures 574–589: *Scorpiops phatoensis* **sp**. **n**., pedipalp segments. **Figures 574–581**. Female paratype, chela dorsal (574), external (575) and ventral (576) views. Patella dorsal (577), external (578) and ventral (579) views. Movable (580) and fixed (581) finger dentition. Trichobothrial pattern is indicated by white circles (574a–579a). **Figures 582–589**. Male holotype, chela dorsal (582), external (583) and ventral (584) views. Patella dorsal (585), external (586) and ventral (587) views. Trochanter and femur dorsal (588) and ventral (589) views.
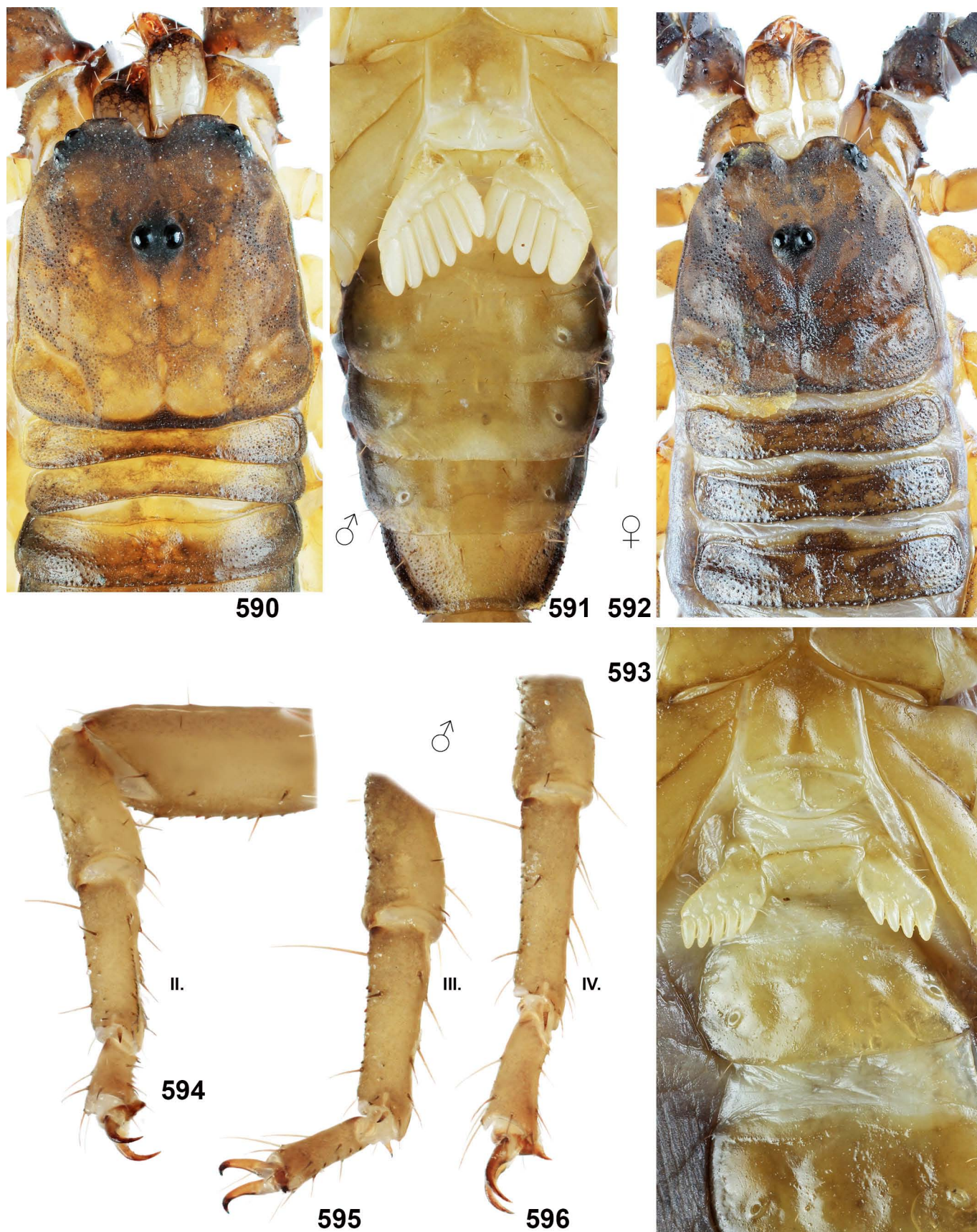
Figures 590–596: *Scorpiops phatoensis* **sp. n. Figures 590–591**, **594–596**. Male holotype, carapace and tergites I–III (590), coxosternal area and sternites (591), left legs II–IV, retrolateral aspect (594–596 respectively). **Figures 592–593**. Female paratype, carapace and tergites I–III (592), coxosternal area and sternites III–IV (593).

Figures 597–598. *Scorpiops phatoensis* **sp**. **n**., male holotype (597) and female paratype (598) in vivo habitus.

Figures 599–600. *Scorpiops phatoensis* **sp. n**., female paratype with newborns (599) and with juveniles after first ecdysis (600) in vivo habitus.

14.VII.2019, under rocks, primary forest, waxing moon, 1♂ (holotype, 1729) 1♀ (paratype), leg. Martin and Petra Reinartz; Phato, 9.8292990°N 98.7731480°E, 222 m a. s. l., 27.X.2019, 19:00-22:00, UV detection, under rocks and in rock cracks, primary forest, new moon, 1♂5♀ (paratypes, 1819), leg. M. Stockmann.

ETYMOLOGY. Named after the locality of occurrence near Phato city.

DIAGNOSIS (♂♀). Total length 28–30 mm. Base color uniformly reddish black. Pectine teeth number 5–6 in males and 4–5 in females, fulcra absent. Pectines with 2 marginal and 1–2 middle lamellae. Patella of pedipalp with 16 (5 *eb*, 2 *esb*, 2 *em*, 3 *est*, 4 *et*) external trichobothria and 6 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium *Eb₃* located in middle of manus at same level or distal as *Dt*. Fingers of pedipalps slightly straight in both sexes. Chela length to width ratio 3.7 in male and 2.8 in female. Pedipalp movable finger with ca. 17 IAD and ID, ca. 40 MD which create 8 straight rows in a line, and there are also 8 OD present. Tarsomere II of legs with row of 4–6 stout median ventral spinules and two pairs of flanking setae. Metasoma I with 8 or 10, and metasoma II–IV with 8 carinae. Telson rather elongate, sparsely granulate, more so in male, length to depth ratio 2.8–3 in both sexes; annular ring present.

DESCRIPTION (♂♀). Total length 28–30 mm. Habitus as shown in Figs. 562–565. For position and distribution of trichobothria on pedipalps, see Figs. 574a–579a. Sexual dimorphism: adult males have larger pectines than females; pedipalp chela and patella are more narrow in male; fingers of pedipalps are straight in both sexes (Figs. 575 and 583).
Coloration (Figs. 562–565, 597–600). Base color uniformly reddish black to black. Legs and telson are yellow to reddish brown, sternites lighter, yellowish to reddish brown. Chelicerae yellowish brown and reticulate, fingers reddish brown.
Carapace and mesosoma (Figs. 562–565, 590–593). Entire carapace covered with minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with two, or two normal and one reduced pairs of lateral eyes. Mesosoma granulated, with one median carina developed. Tergite VII is pentacarinate. Sternites smooth or finely granulated with two parallel furrows except sternite VII which is strongly granulated without carinae. Pectine teeth number 5–6 in males and 4–5 in female. Pectines with 2 marginal and 1–3 middle lamellae; fulcra absent.
Metasoma and telson (Figs. 566–573). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 or 8 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly in a pronounced tooth. Telson elongate and granulate with annular ring developed in both sexes.

Pedipalps (Figs. 574–589). Pedipalps very sparsely hirsute. Patella with 16 (5 *eb*, 2 *esb*, 2 *em*, 3 *est*, 4 *et*) external and 6 ventral trichobothria. Chela with 4 *V* series trichobothria located on ventral surface. Femur and patella are finely granulated. Femur with 3–4 granulose carinae, and patella with 5 carinae, with dorsal patellar spurs reduced and ventral patellar spurs pronounced. Manus dorsally with fine rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela covered by minute granules, with an almost complete external secondary carina with larger sparse granules. Movable fingers with ca. 17 IAD and ID in a row, parallel with MD (ca. 40 in number) which create 8 straight rows in a line, and there are also 8 OD present.
Legs (Figs. 594–596). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs with row of 4–6 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.
Measurements. See Table 5.

AFFINITIES. See affinities under description of *S. dunlopi* **sp. n**.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops prasiti sp. n.
(Figures 601–633, 799, Tables 6, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:4401E957-2A7E-4E1F-A68D-775D3CF8349C

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Mae Hong Son Province*, Pang Mapha District, Limestone sinkhole env., 19°31'45.95"N 98° 9'41.20"E (19.52°N 98.15°E); FKCP.

TYPE MATERIAL. **Thailand**, *Mae Hong Son Province*, Pang Mapha District, Limestone sinkhole env., 19°31'45.95"N 98° 9'41.20"E (19.52°N 98.15°E), 7.XII.2014, 2♂1♀ (holotype and paratypes), leg. Prasit Wongprom and Chaowalit Songsangchote; FKCP.

ETYMOLOGY. The specific epithet is a patronym honoring Prasit Wongprom, one of the collectors of the new species.

DIAGNOSIS (♂♀). Total length 48–53 mm. Base color uniformly reddish black. Telson and legs reddish brown. Pectine teeth number 8 in males, 6–7 in female, fulcra absent. Pectines with 3 marginal and one middle lamellae. Patella of pedipalp with 20–22 (5 *eb*, 2 *esb*, 2 *em*, 6 *est*, 5–7 *et*) external and 14–15 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium *Eb₃* located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in both sexes. Chela length to width ratio 5.52 in male, 3.73 in female. Pedipalp movable finger with ca. 70 IAD which create a second row, parallel with MD (ca. 95 in number). There are also 7 ID and 14–15 OD present. Tarsomere

Dimensions (mm)		*S. prasiti* sp. n. ♂ holotype	*S. prasiti* sp. n. ♀ paratype	*S. schumacheri* sp. n. ♂ holotype	*S. schumacheri* sp. n. ♀ paratype
Carapace	L / W	7.48 / 6.96	7.69 / 7.71	3.58 / 4.16	4.05 / 4.08
Mesosoma	L	21.01	22.81	6.12	8.73
Tergite VII	L / W	3.18 / 4.92	3.49 / 5.37	1.40 / 2.59	1.48 / 2.97
Metasoma + telson	L	23.43	22.22	13.73	12.37
Segment I	L / W / D	2.22 / 2.35 / 2.01	2.27 / 2.54 / 2.25	1.26 / 1.58 / 1.37	1.36 / 1.50 / 1.28
Segment II	L / W / D	2.67 / 2.18 / 1.86	2.45 / 2.27 / 2.06	1.59 / 1.45 / 1.26	1.46 / 1.35 / 1.17
Segment III	L / W / D	2.94 / 2.09 / 1.84	2.66 / 2.04 / 1.87	1.82 / 1.35 / 1.29	1.65 / 1.31 / 1.10
Segment IV	L / W / D	3.34 / 1.92 / 1.87	3.31 / 1.93 / 1.85	2.13 / 1.29 / 1.27	1.84 / 1.23 / 1.13
Segment V	L / W / D	5.70 / 1.89 / 1.93	5.48 / 1.81 / 1.84	3.26 / 1.34 / 1.27	2.90 / 1.20 / 1.12
Telson	L / W / D	6.56 / 1.93 / 1.89	6.05 / 1.80 / 1.76	3.67 / 1.59 / 1.35	3.16 / 1.13 / 1.00
Pedipalp	L	38.27	31.94	12.65	13.66
Femur	L / W	11.04 / 2.94	8.67 / 2.82	3.54 / 1.33	3.58 / 1.34
Patella	L / W	8.92 / 2.95	7.41 / 3.17	3.60 / 1.53	3.68 / 1.60
Chela	L	18.31	15.86	5.51	6.40
Manus	W / D	3.32 / 2.73	4.25 / 3.14	2.14 / 1.58	2.03 / 1.50
Movable finger	L	7.93	7.84	3.39	3.43
Total	**L**	**51.92**	**52.72**	**23.43**	**25.15**

Table 6. Comparative measurements of adults of *Scorpiops prasiti* **sp. n.** and *S. schumacheri* **sp. n.** Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

II of legs with row of 4–6 stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae and metasoma II–IV with 8 carinae. Telson elongate and finely granulated granulate, length to depth ratio 3.4 in male and 3.36 in female; annular ring developed in both sexes.

Description (♂♀). Total length 48–53 mm. Habitus as shown in Figs. 601–604. For position and distribution of trichobothria on pedipalps, see Figs. 613–618. Sexual dimorphism: adult males have larger pectines than females; pedipalp chela is more narrow in male; fingers of pedipalps undulate in both sexes (Figs. 614 and 621).

Coloration (Figs. 601–604). Base color uniformly reddish black to black. Legs and telson are reddish brown, sternites lighter, yellowish to reddish brown. Chelicerae yellowish brown and reticulate, fingers reddish brown.

Carapace and mesosoma (Figs. 601–604, 627–630). Entire carapace covered with minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma finely granulated, with one median carina developed. Tergite VII is pentacarinate. Sternites smooth with two parallel furrows except sternite VII which is finely granulated with two or four granulate carinae indicated. Pectine teeth number 8 in male and 6–7 in female. Pectines with 3 marginal and 1 middle lamellae; fulcra absent.

Metasoma and telson (Figs. 605–612). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae,

and V with 5 carinae. Median lateral carinae of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly in a pronounced tooth. Telson elongate and granulate with annular ring developed in both sexes.

Pedipalps (Figs. 613–626). Pedipalps very sparsely hirsute. Patella with 20–22 (5 *eb*, 2 *esb*, 2 *em*, 6 *est*, 5–7 *et*) external and 14–15 ventral trichobothria. Chela with 4 *V* series trichobothria located on ventral surface. Femur and patella are finely granulated. Femur with 3–4 granulose carinae, and patella with 5 carinae, with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine reticulated, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela covered by minute granules, with an almost complete external secondary carina with larger sparse granules. Movable fingers with ca. 70 IAD which create a second row, parallel with MD (ca. 95 in number) and there are also 7 ID and 14–15 OD present.

Legs (Figs. 631–633). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs with row of 4–6 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.

Measurements. See Table 6.

Affinities. The combination of five characters (chelal trichobothrium *Eb*₃ located in distal half of manus between

Figures 601–604: *Scorpiops prasiti* **sp**. **n**. **Figures 601–602**. Male holotype in dorsal (601) and ventral (602) views. **Figures 603–604**. Female paratype in dorsal (603) and ventral (604) views. Scale bar: 10 mm.

Figures 605–612: *Scorpiops prasiti* **sp**. **n**. **Figures 605–608**. Female paratype, telson lateral (605), and metasoma and telson lateral (606), ventral (607), and dorsal (608) views. **Figures 609–612**. Male holotype, telson lateral (609), and metasoma and telson lateral (610), ventral (611), and dorsal (612) views. Scale bars: 10 mm (606–608, 610–612).

Figures 613–626: *Scorpiops prasiti* **sp. n.**, pedipalp segments. **Figures 613–619**. Male holotype, chela dorsal (613), external (614) and ventral (615) views. Patella dorsal (616), external (617) and ventral (618) views. Movable finger (619) dentition. Trichobothrial pattern is indicated by white circles (613–618). **Figures 620–625**. Female paratype, chela dorsal (620), external (621) and ventral (622) views. Patella dorsal (623), external (624) and ventral (625) views. Movable finger (626) dentition under UV light.
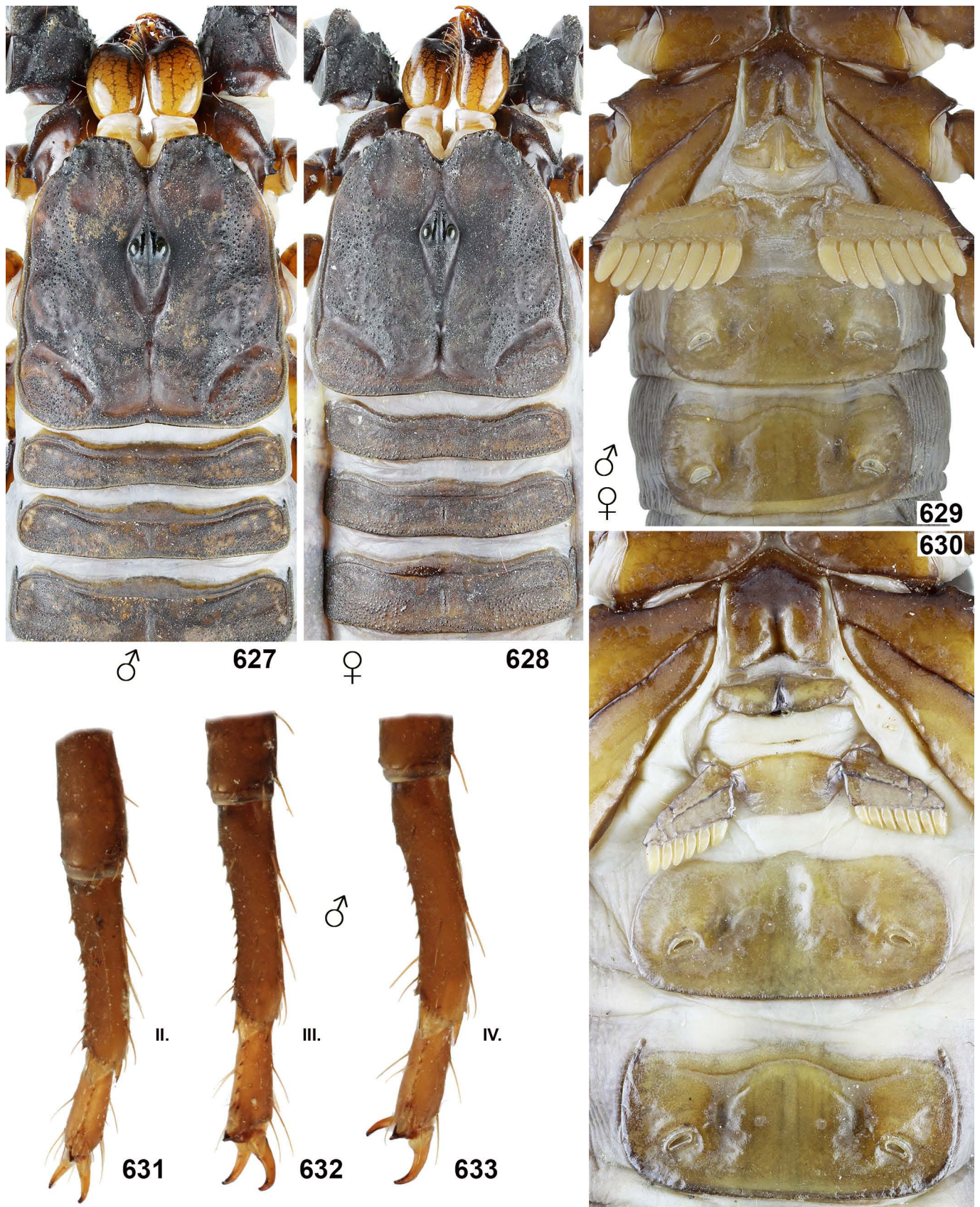
Figures 627–633: *Scorpiops prasiti* **sp. n. Figures 627**, **629**, **631–633**. Male holotype, carapace and tergites I–III (627), coxosternal area and sternites III–IV (629), and left legs II–IV, retrolateral aspect (631–633 respectively). **Figures 628**, **630**. Female paratype, carapace and tergites I–III (628), coxosternal area and sternites III–IV (630).

trichobothria *Dt* and *Est*; patella of pedipalp with 14–15 ventral and 20–22 external trichobothria; fingers of pedipalps undulate in both sexes; pedipalp movable finger with ca. 70 IAD; and chela length to width ratio 5.5 in male) is unique in the entire genus *Scorpiops*. The most similar species is *S. alexandreanneorum* from Laos which differs in having fingers of pedipalps straight in the male (vs. undulate in *S. prasiti* **sp. n.**), different shape of pedipalp chela which is narrower in *S. alexandreanneorum* (see Table 9) and total length (38 mm in *S. alexandreanneorum* vs. 48–53 mm in *S. prasiti* **sp. n.**). The combination of 13–18 patellar ventral and 22–27 patellar external trichobothria was also a diagnostic character for the genus *Neoscorpiops* from India, which is here synonymized with *Scorpiops*. *S. prasiti* **sp. n.** differs from all species previously placed in *Neoscorpiops* by the shape of the chela which is narrower in *S. prasiti* **sp. n.** (chela length to width ratio 5.5 in *S. prasiti* **sp. n.** vs. 2.8–5.1 in species previously placed in genus *Neoscorpiops*). Additionally, all species previously placed in the genus *Neoscorpiops* have pedipalp fingers undulate in males.

Distribution. Thailand (Fig. 799).

Scorpiops scheibeae sp. n.
(Figures 634–652, 799, Tables 7, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:11191FD9-ADA9-4FF9-94D5-86127C76D660

Type locality and type repository. **Thailand**, *Nakhon Si Thammarat Province*, Khanom District, Khao Krot Cave, 9.239995°N 99.801509°E; FKCP.

Type material. **Thailand**, *Nakhon Si Thammarat Province*, Khanom District, Khao Krot Cave, 9.239995°N 99.801509°E, 36 m a. s. l., 24.I.2019, UV detection, in rock cracks close to the cave, primary forest, decrescent moon, 1♂ (holotype), leg. M. Stockmann, FKCP.

Etymology. The species epithet is a patronym honoring Renate Scheibe from University Osnadrück who assisted one of authors (MS) with a venom extraction project.

Diagnosis (♂). Total length 70 mm. Base color uniformly reddish black to black. Telson and tarsomere II of legs reddish brown. Pectine teeth number 12 in male; fulcra reduced to absent; 3 marginal and 5 middle lamellae. Patella of pedipalp with 58 external and 24 ventral trichobothria. Chela of pedipalp with 14 *V* series trichobothria, of which the 3 most proximal are located on external surface near *Eb₁*. Chelal trichobothrium *Eb₃* located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in male. Chela length to width ratio 4. Pedipalp movable finger with 68 IAD, which have the same size as MD (> 100 in number) and create a second row; there are also 5 ID and 15 OD present. Tarsomere II of leg III with four stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae and metasoma II–IV

with 8 carinae. Telson elongate and granulate, length to depth ratio 3.56 in male; annular ring developed.

Description (♂ holotype). Total length 70 mm. Female unknown. Habitus as shown in Figs. 634–635. For position and distribution of trichobothria on pedipalps, see Figs. 639–641. Fingers of pedipalps undulate in male (Fig. 640).
Coloration (Figs. 634–635, 652). Base color uniformly reddish black to black. Telson, legs, and sternites are reddish brown. Chelicerae reddish brown and reticulate, fingers black.
Carapace and mesosoma (Figs. 634–635, 647–648). Entire carapace covered with large granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth to very finely granulated with two parallel furrows except sternite VII which has four granulate carinae. Pectine teeth number 12 in male holotype. Pectines with 3 marginal and 4 middle lamellae, fulcra reduced or absent.
Metasoma and telson (Figs. 636–638, 651). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly in a pronounced tooth which is on metasoma IV wide with three peaks. Telson elongate and granulate with annular ring developed.
Pedipalps (Figs. 639–642). Pedipalps very sparsely hirsute. Patella with 58 external trichobothria (which cannot be assigned to standard *eb*, *esb*, *em*, *est*, and *et* territories) and 24 ventral trichobothria. Chela with 14 *V* series trichobothria, of which the 3 most proximal are located on external surface near *Eb₁*. Femur and patella granulated. Femur with 5 granulose carinae, and patella with 5 carinae, with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with an irregular external secondary carina. Movable fingers bear 68 IAD, which have the same size as MD (more than 100 in number) and create a second row; there are also 5 ID and 15 OD present.
Legs (Figs. 643–646). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs I–II, IV with 5 stout median ventral spinules and two pairs of flanking setae, leg III with 4 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.
Measurements. See Table 7.

Affinities. See affinities under description of *S. kautti* **sp. n.**

Distribution. Thailand (Fig. 799).

♂
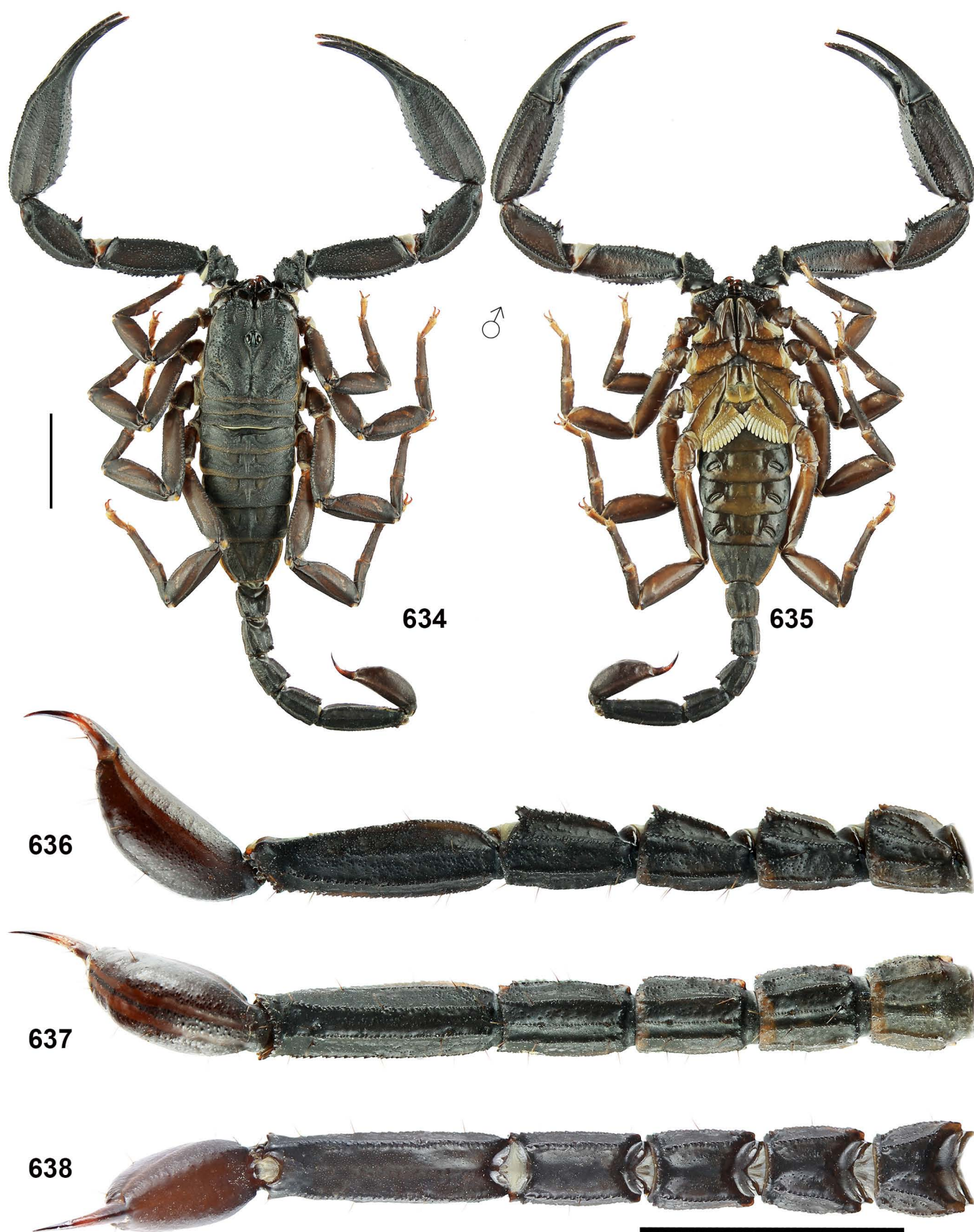
Figures 634–638: *Scorpiops scheibeae* **sp. n.**, male holotype. **Figures 634–635**. Dorsal (634) and ventral (635) views. **Figures 636–638**. Metasoma and telson lateral (636), ventral (637), and dorsal (638) views. Scale bars: 10 mm (634–635, 636–638).

Figures 639–642: *Scorpiops scheibeae* **sp. n.**, male holotype, pedipalp segments. Chela and patell dorsal (639), external (640) and ventral (641) views. Movable finger dentition (642). Trichobothrial pattern is indicated by white circles (639–641).

Figures 643–646. *Scorpiops scheibeae* **sp. n**., male holotype, left legs I–IV, prolateral/ ventral aspect.
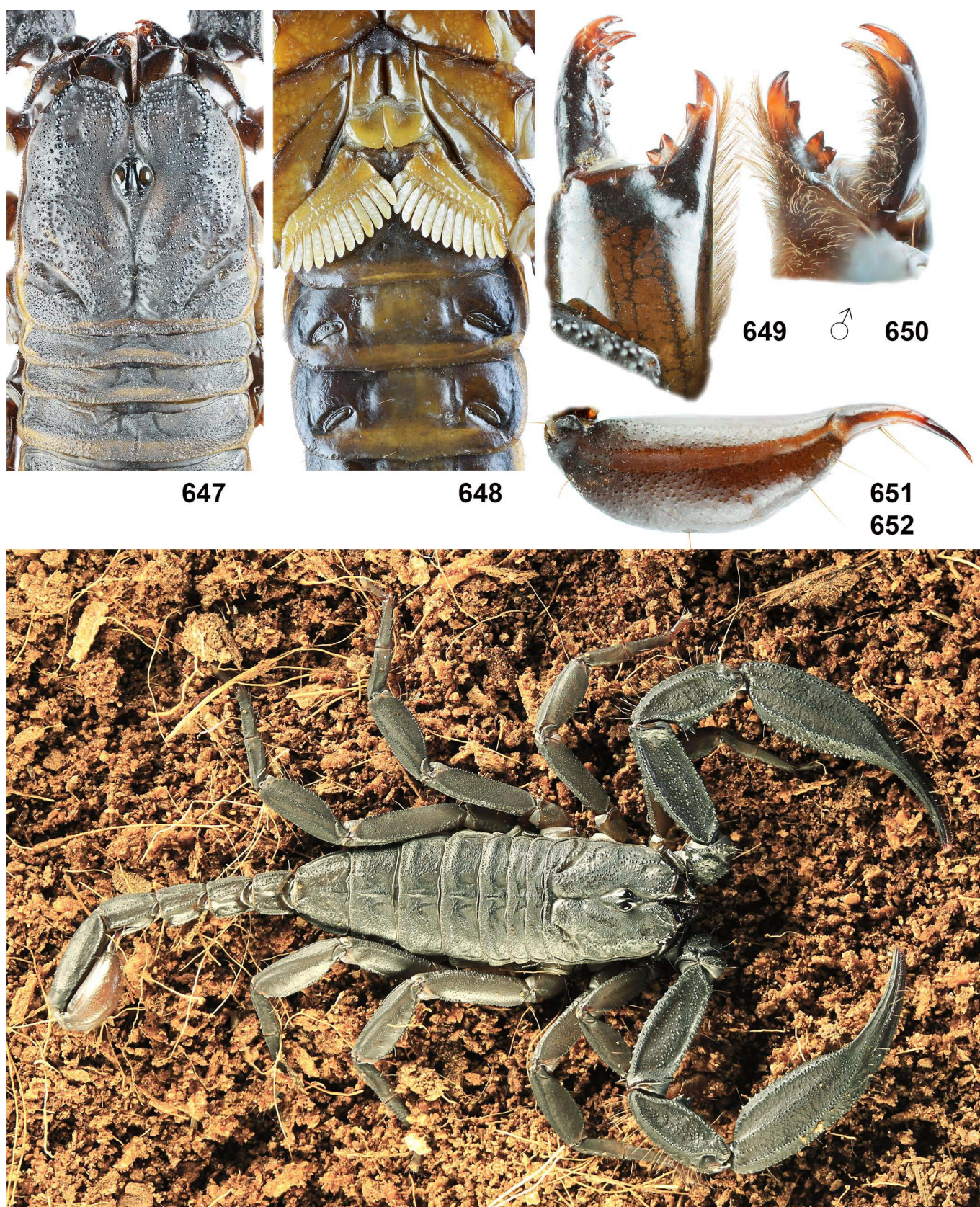
Figures 647–652: *Scorpiops scheibeae* **sp. n.**, male holotype. **Figures 647–648**. Carapace and tergites I–III (647), coxosternal area and sternites III–IV (648), left chelicera in dorsal (649) and ventral (650) views. **Figure 651**. Telson lateral view. **Figure 652**. Male holotype in vivo habitus.

Dimensions (mm)		*S. scheibeae* **sp. n.** ♂ holotype	*S. sherwoodae* **sp. n.** ♂ holotype	*S. solegladi* **sp. n.** ♀ holotype
Carapace	L / W	11.40 / 10.49	9.90 / 9.00	5.20 / 5.90
Mesosoma	L	21.43	14.70	10.56
Tergite VII	L / W	5.48 / 7.02	3.37 / 5.53	1.27 / 3.82
Metasoma + telson	L	36.51	32.68	16.26
Segment I	L / W / D	3.62 / 3.62 / 3.10	3.28 / 3.17 / 2.85	1.75 / 1.62 / 1.69
Segment II	L / W / D	3.86 / 3.14 / 2.92	3.75 / 2.62 / 2.70	1.79 / 1.69 / 1.52
Segment III	L / W / D	4.04 / 2.97 / 2.96	4.08 / 2.54 / 2.58	1.99 / 1.58 / 1.49
Segment IV	L / W / D	4.93 / 2.73 / 3.08	4.72 / 2.44 / 2.48	2.26 / 1.58 / 1.48
Segment V	L / W / D	9.21 / 2.53 / 2.91	7.95 / 2.42 / 2.41	3.84 / 1.50 / 1.35
Telson	L / W / D	10.85 / 3.19 / 3.05	8.90 / 2.84 / 2.80	4.63 / 1.54 / 1.28
Pedipalp	L	45.96	41.94	20.23
Femur	L / W	12.29 / 4.05	11.53 / 3.49	4.97 / 2.00
Patella	L / W	10.23 / 4.55	9.68 / 3.42	4.77 / 2.02
Chela	L	23.44	20.73	10.49
Manus	W / D	5.86 / 4.78	4.50 / 4.32	2.56 / 2.49
Movable finger	L	11.59	10.68	5.31
Total	**L**	**69.34**	**57.28**	**32.02**

Table 7. Comparative measurements of adults of *Scorpiops scheibeae* **sp. n.**, *S. sherwoodae* **sp. n.**, and *S. solegladi* **sp. n.** Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

Scorpiops schumacheri **sp. n.**
(Figures 156, 177, 186, 653–689, 692–693, 695, 699–700, 704, 705, 799, 813, Tables 6, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:7974FB0F-ECBC-43E1-B115-DD8E41F2D614

Euscorpiops sp. 2: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Trang Province*, Trang, 7.565100°N 99.623855°E; FKCP.

TYPE MATERIAL (FKCP). **Thailand**, *Trang Province*, Trang, 7.565100°N 99.623855°E, captive bred, 1♂ (holotype, 1821), leg M. Stockmann; Trang, 7.565100°N 99.623855°E, X.2018, UV detection, 5♀ (paratypes, 1562, 1639, 1733), local collector.

ETYMOLOGY. It is a pleasure to name this species after Patrick Schumacher (Germany) who collected some scorpions together with Mark Stockmann.

DIAGNOSIS (♂♀). Total length 23–26 mm. Base color uniformly yellowish brown to reddish black. Legs and telson yellow to orange. Pectine teeth number 6 in male and 4–5 in females, fulcra reduced. Marginal lamella III present, other surfaces of pectines form one compact unit with an incomplete furrow between areas where marginal and middle lamellae are usually delimited. Patella of pedipalp with 16 (5 *eb*, 2 *esb*, 2 *em*, 3 *est*, 4 *et*) external trichobothria and 7 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in middle of manus usually between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in male and straight in females. Chela length to width ratio 2.57 in male, 3.15–3.17 in females. Pedipalp movable finger with 25–28 IAD and 42–48 MD which create two irregular parallel rows; ID and OD absent, or incorporated into these two rows. Tarsomere II of legs with row of 5–8 stout median ventral spinules. Telson is sparsely granulate, bulbous in males and elongate in females, length to depth ratio 2.72 in male and 3.16 in females; annular ring developed in both sexes.

DESCRIPTION (♂♀). Total length 23–26 mm. Habitus as shown in Figs. 653–656. For position and distribution of trichobothria on pedipalps, see Figs. 669–675. Sexual dimorphism: adult males have larger pectines than females; pedipalp chela is more narrow in female; fingers of pedipalps undulate in male and straight in females (Figs. 670 and 680).
Coloration (Figs. 653–656, 686–689). Base color uniformly yellowish brown to reddish black. Legs and telson yellow to orange, sternites lighter. Chelicerae yellowish brown and reticulate, fingers reddish brown.
Carapace and mesosoma (Figs. 653–656, 657–658). Entire carapace sparsely covered with minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma finely granulated, with one median carina developed. Tergite VII is pentacarinate. Sternites smooth to finely granulated with two parallel furrows, sternite VII is finely granulated
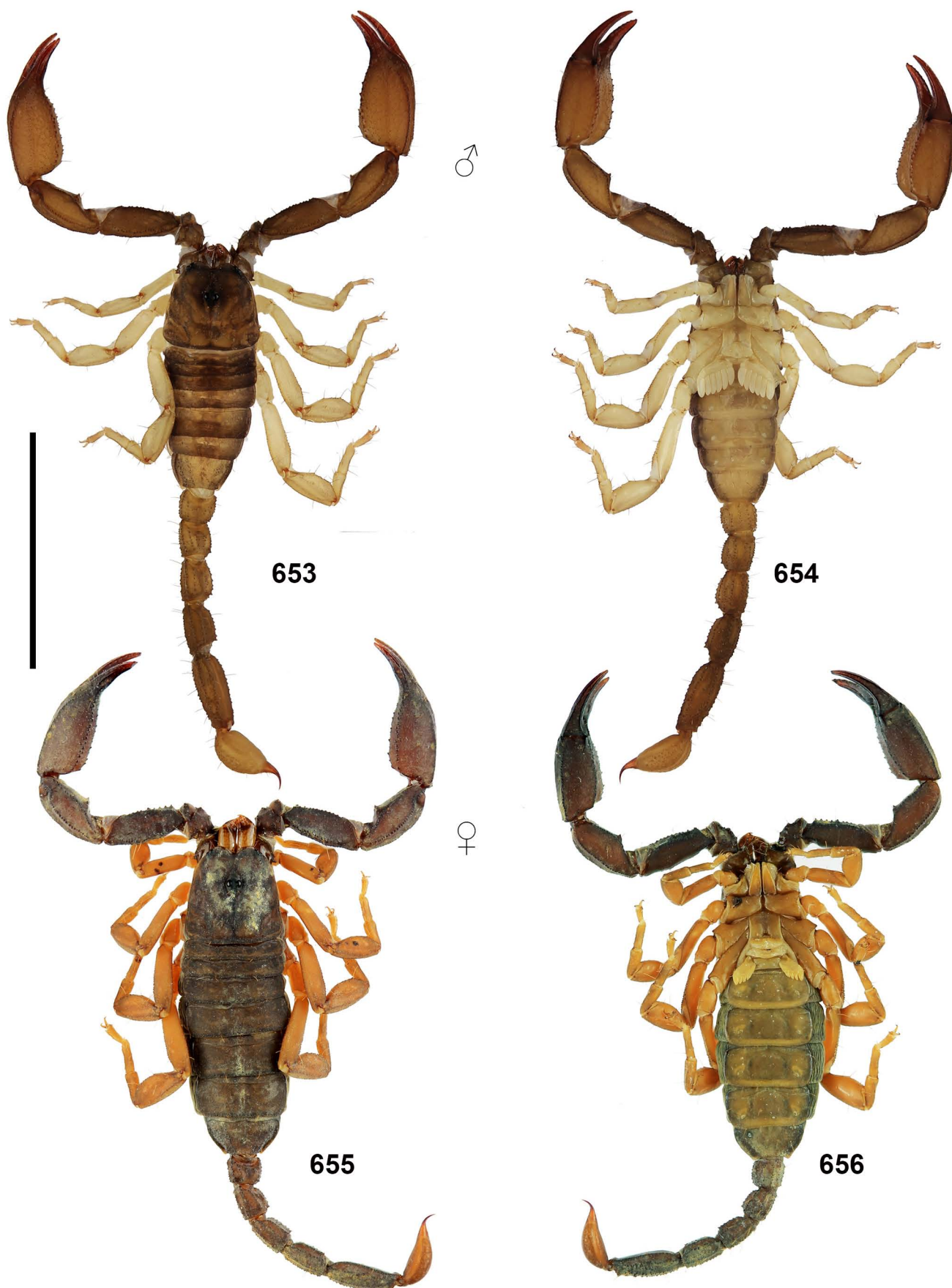
Figures 653–656: *Scorpiops schumacheri* **sp. n**. **Figures 653–654**. Male holotype in dorsal (653) and ventral (654) views. **Figures 655–656**. Female paratype in dorsal (655) and ventral (656) views. Scale bar: 10 mm.
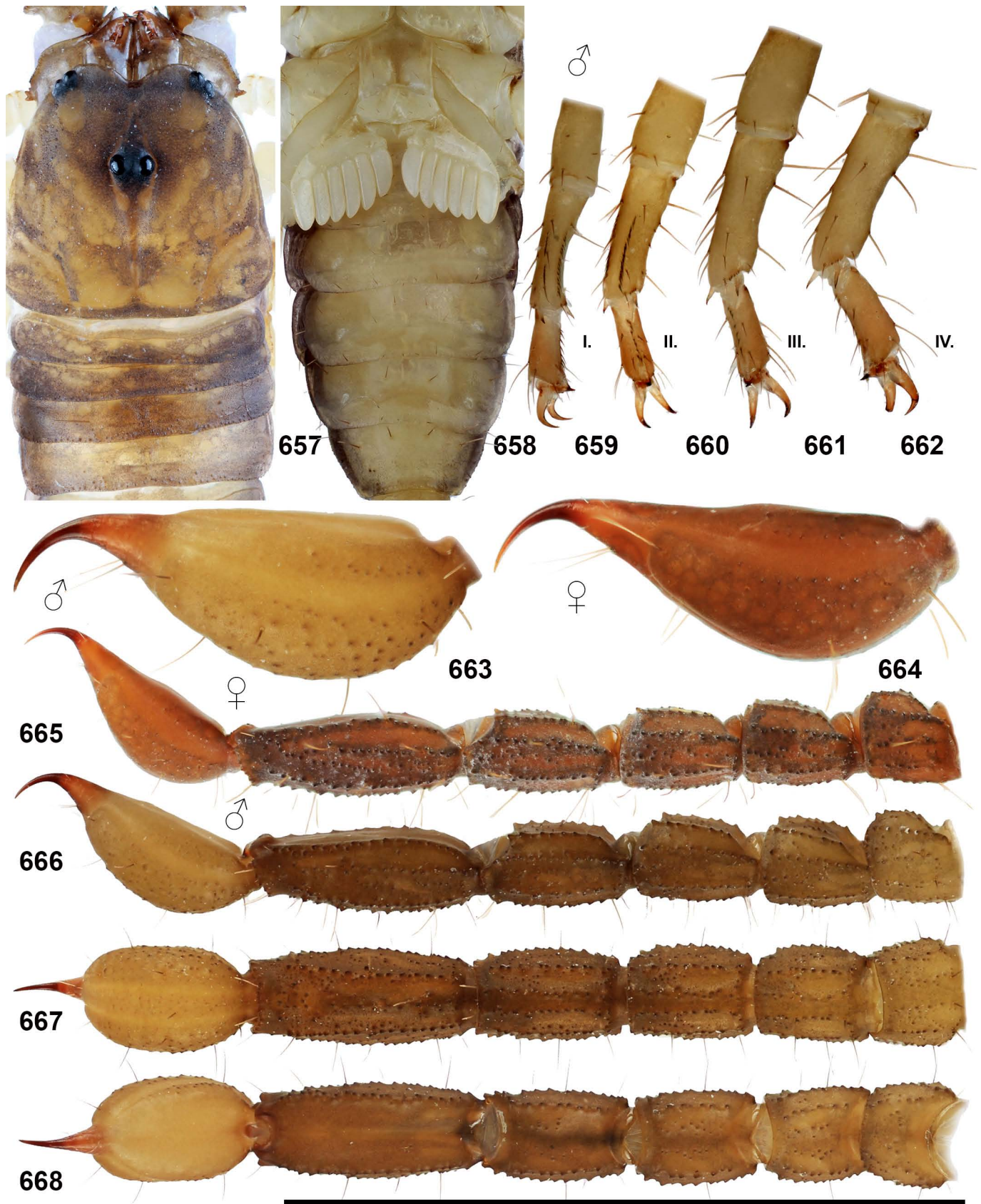
Figures 657–668: *Scorpiops schumacheri* **sp. n**. **Figures 657–663**, **666–668**. Male holotype, carapace and tergites I–IV (657), coxosternal area and sternites (658), right legs I–IV, retrolateral aspect (659–662 respectively), telson lateral (663), and metasoma and telson lateral (666), ventral (667), and dorsal (668) views. **Figures 664–665**. Female paratype, telson lateral (664), and metasoma and telson lateral (665). Scale bar: 10 mm (665–668).

Figures 669–678. *Scorpiops schumacheri* **sp**. **n**., male holotype, pedipalp segments. Chela dorsal (669), external (670) and ventral (671) views. Patella dorsal (672), external (673) and ventral (674) views. Trochanter and femur dorsal (675) and ventral (676y) views. Movable (677) and fixed (678) finger dentition. Trichobothrial pattern is indicated by white circles (669–675).
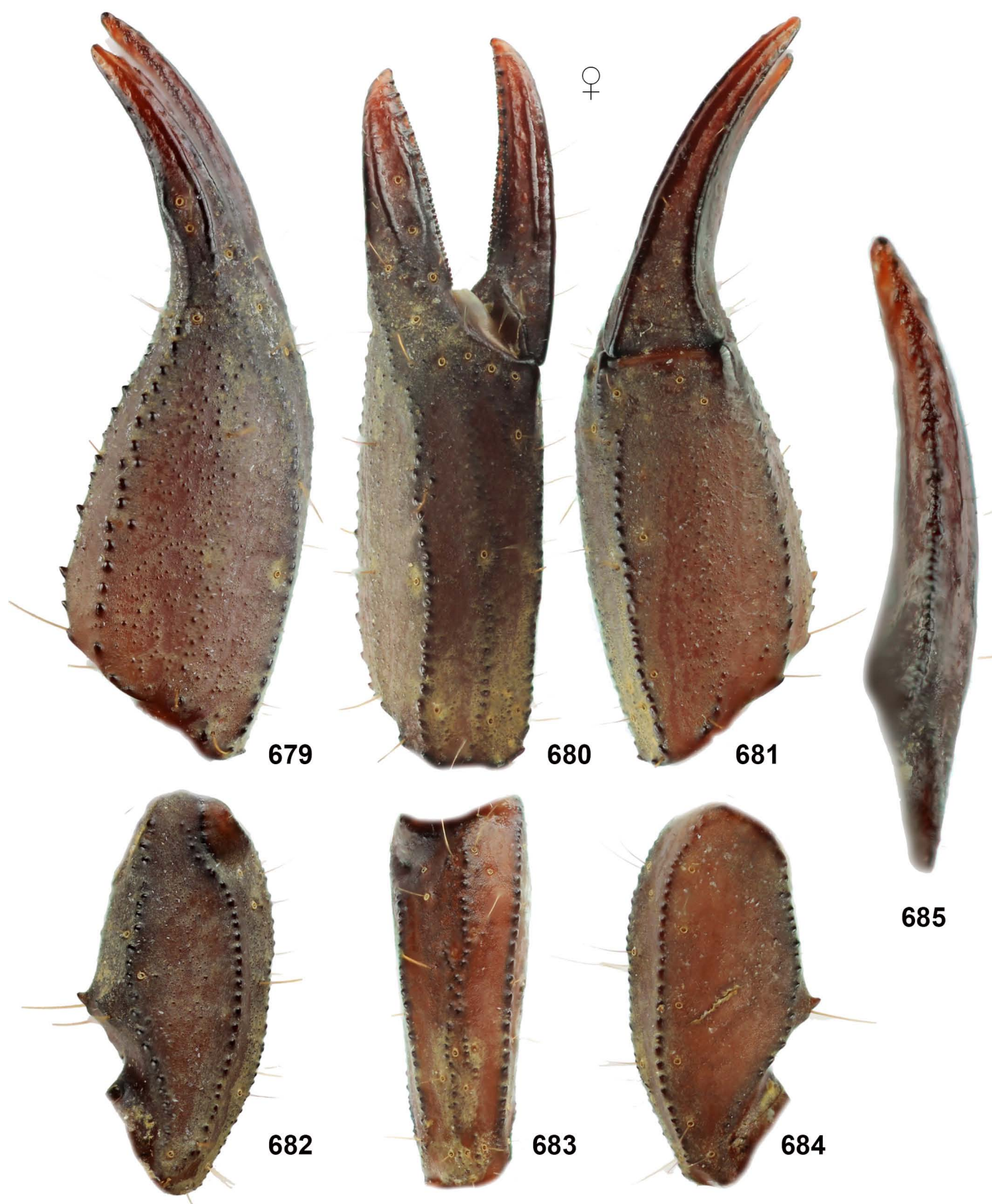
Figures 679–685. *Scorpiops schumacheri* **sp. n.**, female paratype, pedipalp segments. Chela dorsal (679), external (680) and ventral (681) views. Patella dorsal (682), external (683) and ventral (684) views. Movable finger dentition (685).

Figures 686–687. *Scorpiops schumacheri* **sp. n**., male holotype (686) and female paratype (687) in vivo habitus.

Figures 688–689. *Scorpiops schumacheri* **sp. n.**, female paratype with newborns (688) and with juveniles after first ecdysis (689).
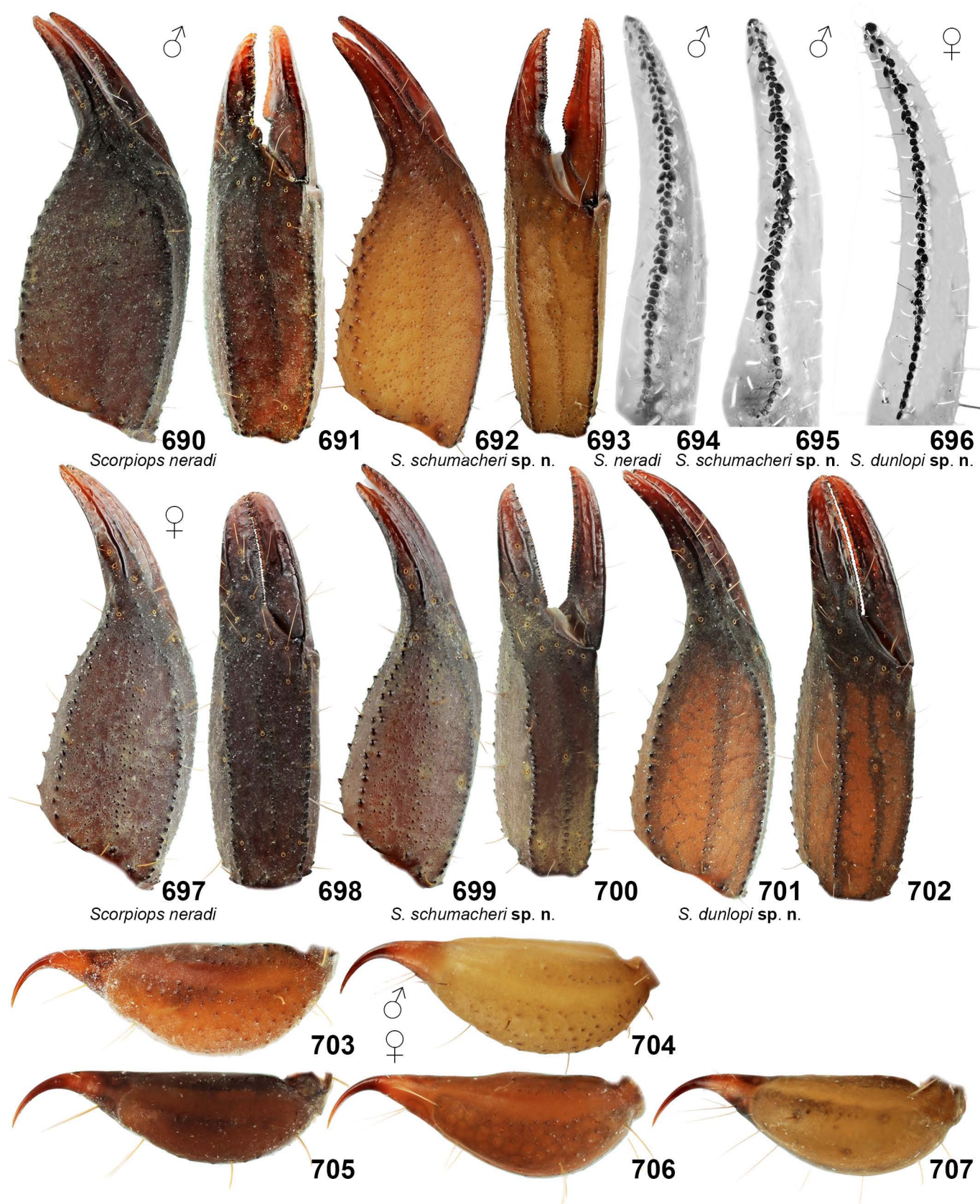
Figures 690–707: Comparison of three similar species *Scorpiops neradi* (690–691, 693, 697–698, 703, 705), *S. schumacheri* **sp. n.** (692–693, 695, 699–700, 704, 705), and *S. dunlopi* **sp. n.** (696, 701–702, 707). **Figures 690–693**, **697–702**. Pedipalp chela dorsal and external views of males (690–693) and females (697–702). **Figures 694–696**. Movable finger dentition under UV light. **Figures 703–707**. Telson lateral views of males (703–704) and females (705–707).

without carinae. Pectine teeth number 6 in male and 4–5 in females. Pectinal marginal lamella III present, other surfaces of pectines create one compact unit with unfinished furrow between locations of marginal and middle lamellae. Fulcra absent.

Metasoma and telson (Figs. 663–668). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma I–V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV do not terminate posteriorly in a pronounced tooth. Telson elongate and sparsely granulate with annular ring present in both sexes.

Pedipalps (Figs. 669–685). Pedipalps very sparsely hirsute. Patella with 16 (5 *eb*, 2 *esb*, 2 *em*, 3 *est*, 4 *et*) external and 7 ventral trichobothria. Chela with 4 *V* series trichobothria located on ventral surface. Femur and patella are finely granulated. Femur with 3–4 granulose carinae, and patella with 5 carinae, and dorsal and ventral patellar spurs. Manus dorsally with fine rounded granules. External surface of chela covered by minute granules, with an almost complete external secondary carina with larger sparse granules. Movable fingers with 25–28 IAD and 42–48 MD which create two irregular parallel rows; ID and OD absent or incorporated into these two rows.

Legs (Figs. 659–662). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs with row of 5–8 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.

Measurements. See Table 6.

AFFINITIES. The most similar species are *S. neradi*, *S. phatoensis* **sp. n.**, and *S. schumacheri* **sp. n.** (see affinities under description of *S. dunlopi* **sp. n.** where *S. schumacheri* **sp. n.** is differentiated from *S. dunlopi* **sp. n.** and *S. phatoensis* **sp. n.**). Fingers of pedipalps are more strongly and differently undulate in male *S. neradi* compared to male *S. schumacheri* **sp. n.** (see Fig. 691 versus 693), and the pedipalp patella of *S. neradi* has 6 ventral trichobothria while that of *S. schumacheri* **sp. n.** has 7.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops sherwoodae **sp. n.**
(Figures 133, 138, 151, 172, 186, 353–358, 708–728, 799, 812, Tables 7, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:925C5620-41F3-4DB6-ACE6-51FF485E7E0C

Euscorpiops/Scorpiops sp. 2: Šťáhlavský et al., in press.

TYPE LOCALITY AND TYPE REPOSITORY. **Thailand**, *Phang Nga Province*, 2 km NE Phang Nga, Tham Pha Sua, 8.477309°N 98.539827°E, 40 m a. s. l.; FKCP.

TYPE MATERIAL (FKCP). **Thailand**, *Phang Nga Province*, 2 km NE Phang Nga, Tham Pha Sua, 8.477309°N 98.539827°E, 40 m a. s. l., 9.XI.2019, UV detection, in rock crack at rock face, primary forest, waxing moon, 1♂ (holotype, 1820), leg. Peter Kautt; *Phang Nga Province*, 2 km NE Phang Nga, Tham Pha Sua, 8.475886°N 98.539477°E, 40 m a. s. l., 14.I.2020, 19:00 - 22:00 h, UV detection, in rock cracks at rock face, primary forest, waning moon, 1♂ (paratype, 1830), leg. M. Stockmann.

ETYMOLOGY. The specific epithet is a patronym honoring Danniella Sherwood, who located the holotype of *Scorpiops hardwickii* in the BMNH collections and provided important detailed photographs of the holotype (e. g. Fig. 30).

DIAGNOSIS (♂). Total length 57 mm. Base color uniformly reddish black to black. Telson white to yellow, and legs yellowish brown. Pectine teeth number 8–9 in males; fulcra present; 2 marginal and 2 middle lamellae. Patella of pedipalp with 18 (5 *eb*, 2 *esb*, 3 *em*, 4 *est*, 4 *et*) external and 19 ventral trichobothria. Chelal trichobothrium Eb_3 located in middle of manus at level as *Dt*. Chela of pedipalp with 4 *V* series trichobothria, located on the ventral surface of manus. Fingers of pedipalps undulate in male. Chela length to width ratio 4.6. Pedipalp movable finger with ca. 75 IAD, which have the same size as MD (ca. 110 in number) and create a second row; there are also 5 ID and 14–15 OD present. Tarsomere II of leg III with 7 stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae and metasoma II–IV with 8 carinae. Telson elongate and sparsely granulate, length to depth ratio 3.18 in males; annular ring present.

DESCRIPTION (♂ holotype). Total length 57 mm. Female unknown. Habitus as shown in Figs. 708–709. For position and distribution of trichobothria on pedipalps, see Figs. 714a–719a. Fingers of pedipalps undulate in male (Fig. 715).
Coloration (Figs. 708–709, 725–727). Base color uniformly reddish black to black. Telson white to yellow, legs, and sternites are yellowish brown. Chelicerae reddish brown and reticulate, fingers black.
Carapace and mesosoma (Figs. 708–709, 353–354). Entire carapace covered with large granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth to very finely granulated with two parallel furrows except sternite VII which has four granulate carinae. Pectine teeth number 8 in male holotype. Pectines with 2 marginal and 2 middle lamellae.
Metasoma and telson (Figs. 710–713). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II, and median lateral and ventral carinae of metasoma V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly
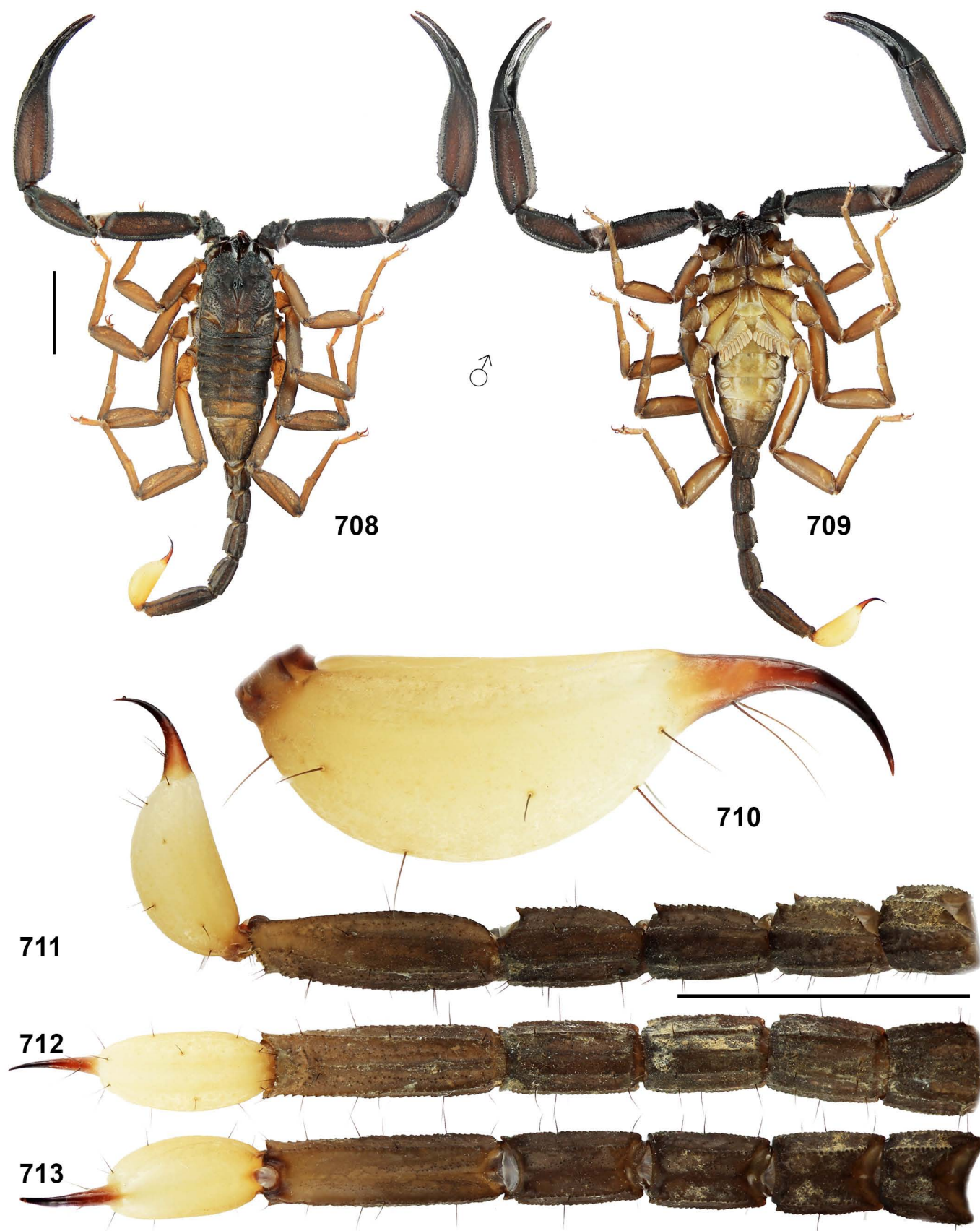
Figures 708–713: *Scorpiops sherwoodae* **sp. n**. **Figures 708–709**. Male paratype in dorsal (708) and ventral (709) views. **Figures 710–713**. Male holotype, telson lateral (710), and metasoma and telson lateral (711), ventral (712), and dorsal (713) views. Scale bars: 10 mm (708–709, 711–713).

Figures 714–724: *Scorpiops sherwoodae* **sp. n**. **Figures 714–723**. Male holotype, pedipalp segments. Chela dorsal (714), external (715) and ventral (716) views. Patella dorsal (717), external (718) and ventral (719) views. Trochanter and femur dorsal (720) and ventral (721) views. Movable finger dentition (723). Trichobothrial pattern is indicated by white circles (714a–719f). **Figure 724**. Male paratype, movable finger dentition under UV light.

Figures 725. *Scorpiops sherwoodae* **sp**. **n**., male holotype in vivo habitus.
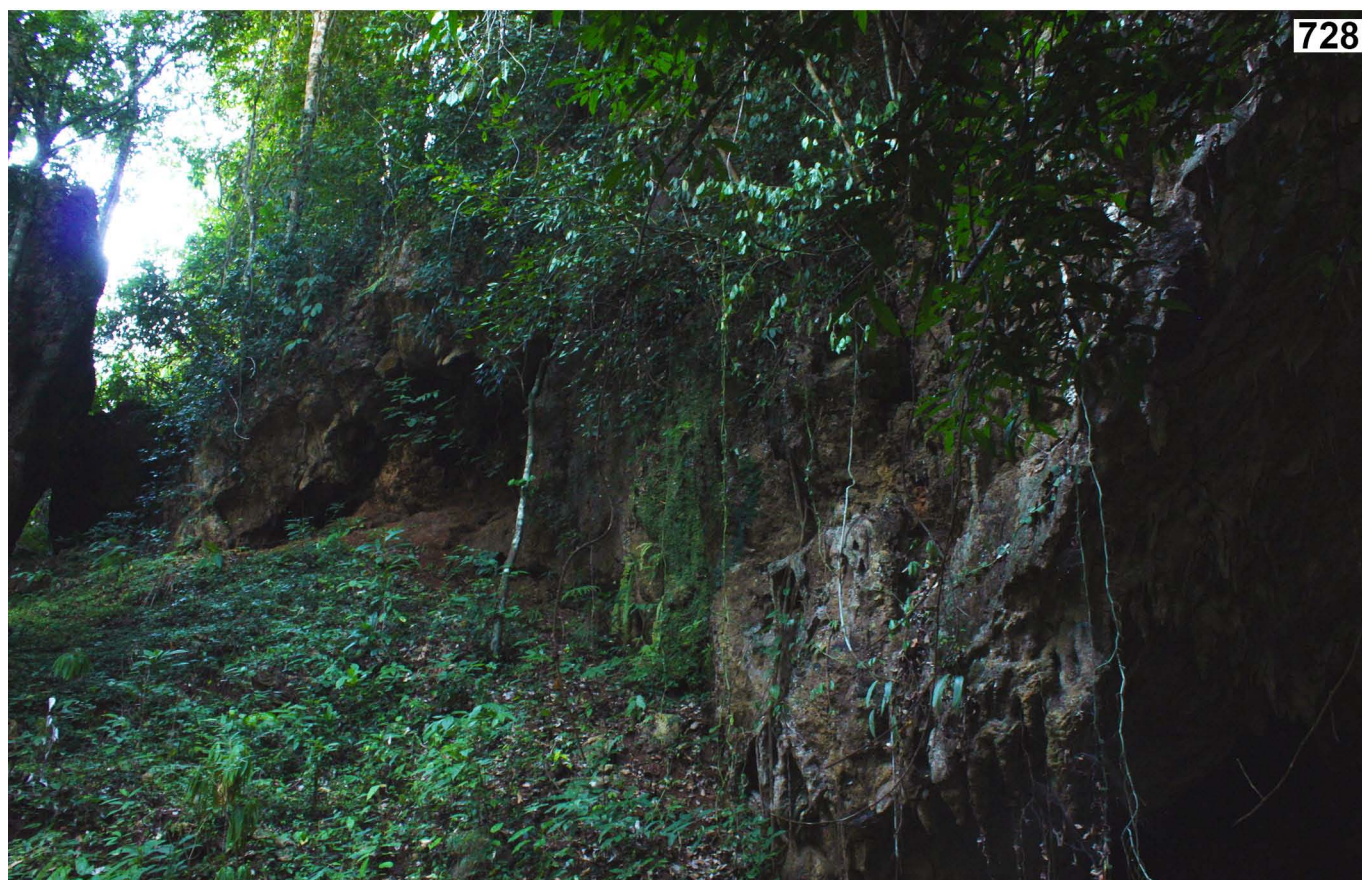
Figures 726–728. *Scorpiops sherwoodae* **sp. n.**, male holotype in vivo habitus at type locality (726), Female juvenile (non type) in vivo habitus (727), and type locality (728, also type locality for *S. dunlopi* **sp. n.**).

in a pronounced tooth. Telson elongate and sparsely granulate with annular ring.

Pedipalps (Figs. 714–724). Pedipalps very sparsely hirsute. Patella with 18 (5 *eb*, 2 *esb*, 3 *em*, 4 *est*, 4 *et*) and 19 ventral trichobothria. Chela with 4 *V* series trichobothria located on the ventral surface. Femur and patella are sparsely granulated. Femur with 4–5 granulose carinae, and patella with 5 carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded granules, which are in the central area replaced by large granules forming an irregular dorsal secondary carina. External surface of chela densely covered by minute granules, with a regular external secondary carina. Movable fingers bear ca. 70 IAD, which have the same size as MD (more than 100 in number) and create a second row; here are also 5 ID and 14–5 OD present.

Legs (Figs. 355–358). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces but with sparse rows of spinules on dorsolateral surfaces and on legs I–II also with dense rows on ventrolateral surface. Tarsomere II of leg I with 6, II with 5, III–IV with 7 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.

Measurements. See Table 7.

AFFINITIES. The combination of pedipalp chela with 4 ventral trichobothria and patella with 19 ventral and 18 external trichobothria is unique in the entire genus *Scorpiops*.

DISTRIBUTION. Thailand (Fig. 799).

Scorpiops solegladi sp. n.
(Figures 129, 729–753, 799, Tables 7, 9)
http://zoobank.org/urn:lsid:zoobank.org:act:1272AAE1-35F4-4BAE-96F8-DD47ECB61D9B

TYPE LOCALITY AND TYPE REPOSITORY. **Vietnam**, *Lào Cai Province*, ca. 15 km from Sa Pa (22.01°N 102.81°E), 600 m a. s. l.; FKCP.

TYPE MATERIAL (FKCP). **Vietnam**, *Lào Cai Province*, ca. 15 km from Sa Pa (22.01°N 102.81°E), 600 m a. s. l. III.2010, 1♀(holotype), leg. Z. Bříza; *Lai Châu Province*, Than Uyen (21.97°N 103.86°E), III.2010, 1♀ (paratype), leg. V. Fura.

ETYMOLOGY. The specific epithet honors Michael E. Soleglad (USA) for his friendship, contribution to understanding Scorpiopidae, and lifelong dedication to scorpions.

DIAGNOSIS (♀). Total length 32–35 mm. Base color reddish brown to black with yellow spots. Pectine teeth number 4–6 in females, fulcra absent; pectines from one compact unit with an incomplete furrow between areas where marginal and middle lamellae are usually delimited. Patella of pedipalp with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external and 10–11 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria

located on ventral surface. Chelal trichobothrium Eb_3 located in middle of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps straight in females. Chela length to width ratio 4.1 in female. Pedipalp movable finger with 50–60 IAD which create a second row, parallel with MD (67–70 in number) and there are also 4 ID and 12–13 OD present. Tarsomere II of legs with row of 5–7 stout median ventral spinules and two pairs of flanking setae. Telson elongate and very finely granulate, length to depth ratio 3.62 in female; annular ring present.

DESCRIPTION (♀). Total length 32–35 mm. Male unknown. Habitus as shown in Figs. 729–730. For position and distribution of trichobothria on pedipalps, see Figs. 735–741. Fingers of pedipalps are straight in females (Fig. 736).

Coloration (Figs. 729–730). Base color uniformly reddish black to black with yellow spots. Chelicerae reddish brown and reticulate, anterior part and fingers are black.

Carapace and mesosoma (Figs. 729–730, 751–753). Entire carapace covered with both large and minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with 3 pairs of lateral eyes of which two are normal and one is reduced. Mesosoma granulated, with one median carina. Tergite VII is pentacarinate. Sternites smooth with two parallel furrows except sternite VII which is finely granulated without carina developed. Pectine teeth number 4–6 in females, fulcra absent. Pectines create one compact unit with an incomplete furrow between areas of marginal and middle lamellae, or with two marginal lamellae indicated.

Metasoma and telson (Figs. 731–734). Metasoma sparsely hirsute and granulated, with sparse, minute granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of the segment IV terminate posteriorly in a pronounced tooth. Telson elongate and very finely granulate with annular ring developed.

Pedipalps (Figs. 735–750). Pedipalps very sparsely hirsute. Patella with 18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 5 *et*) external and 10–11 ventral trichobothria. Chela with 4 *V* series trichobothria located on the ventral surface. Femur and patella are finely granulated. Femur with 5 granulose carinae, and patella with 5 carinae with dorsal and ventral patellar spurs pronounced. Manus dorsally with fine, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela covered by minute granules which indicate an external secondary carina. Movable fingers bear 50–60 IAD which have the same size as MD (67–70 in number) and create a second parallel row. There are also 4 ID and 12–13 OD present.

Legs. Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces, but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs I–IV with 5–7 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.

Measurements. See Table 7.

♀
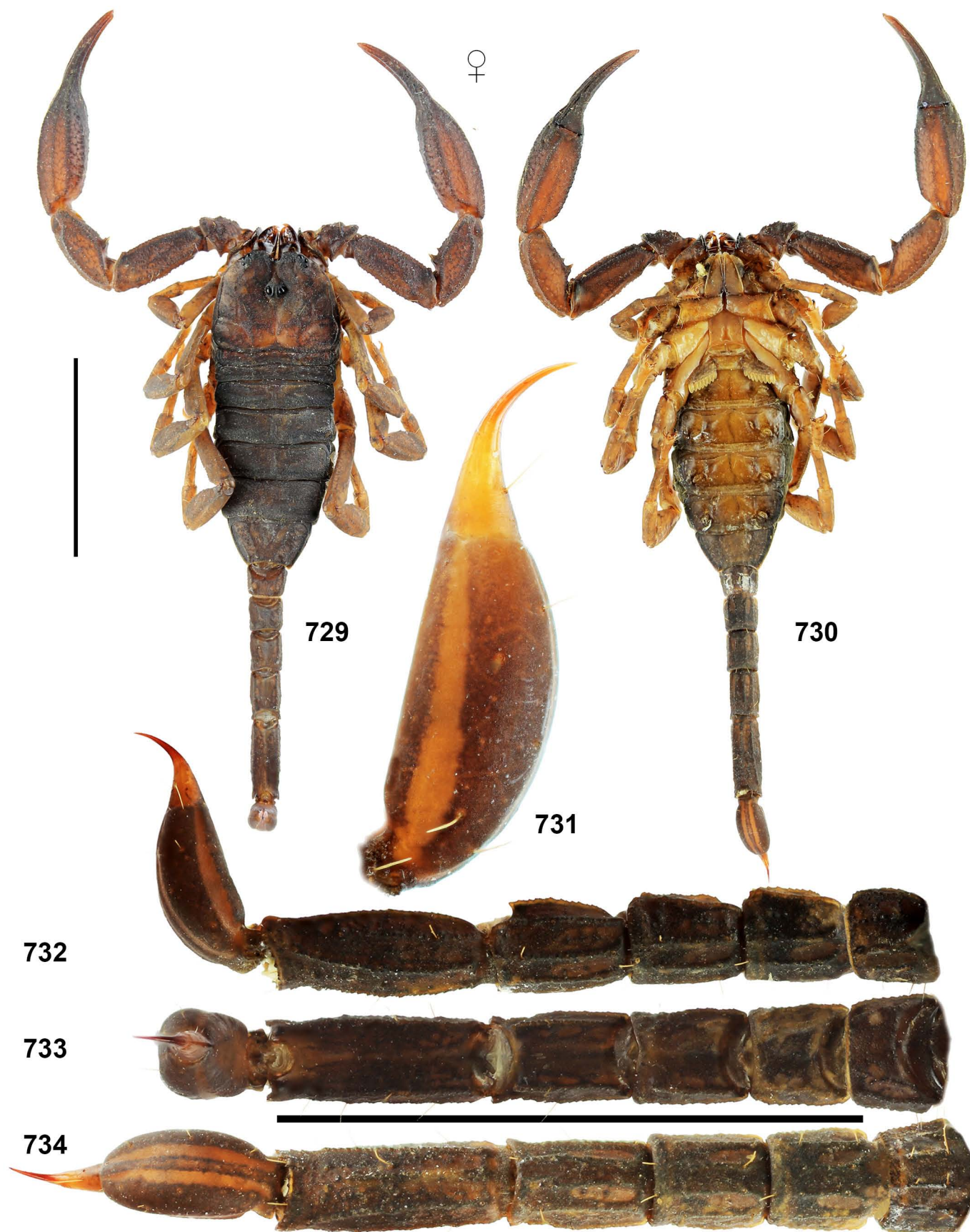
Figures 729–734: *Scorpiops solegladi* **sp. n. Figures 729–730**, **732–734**. Female holotype, dorsal (729) and ventral (730) views. Metasoma and telson lateral (732), ventral (733), and dorsal (734) views. **Figure 731**. Female paratype, telson lateral. Scale bars: 10 mm (729–730, 732–734).
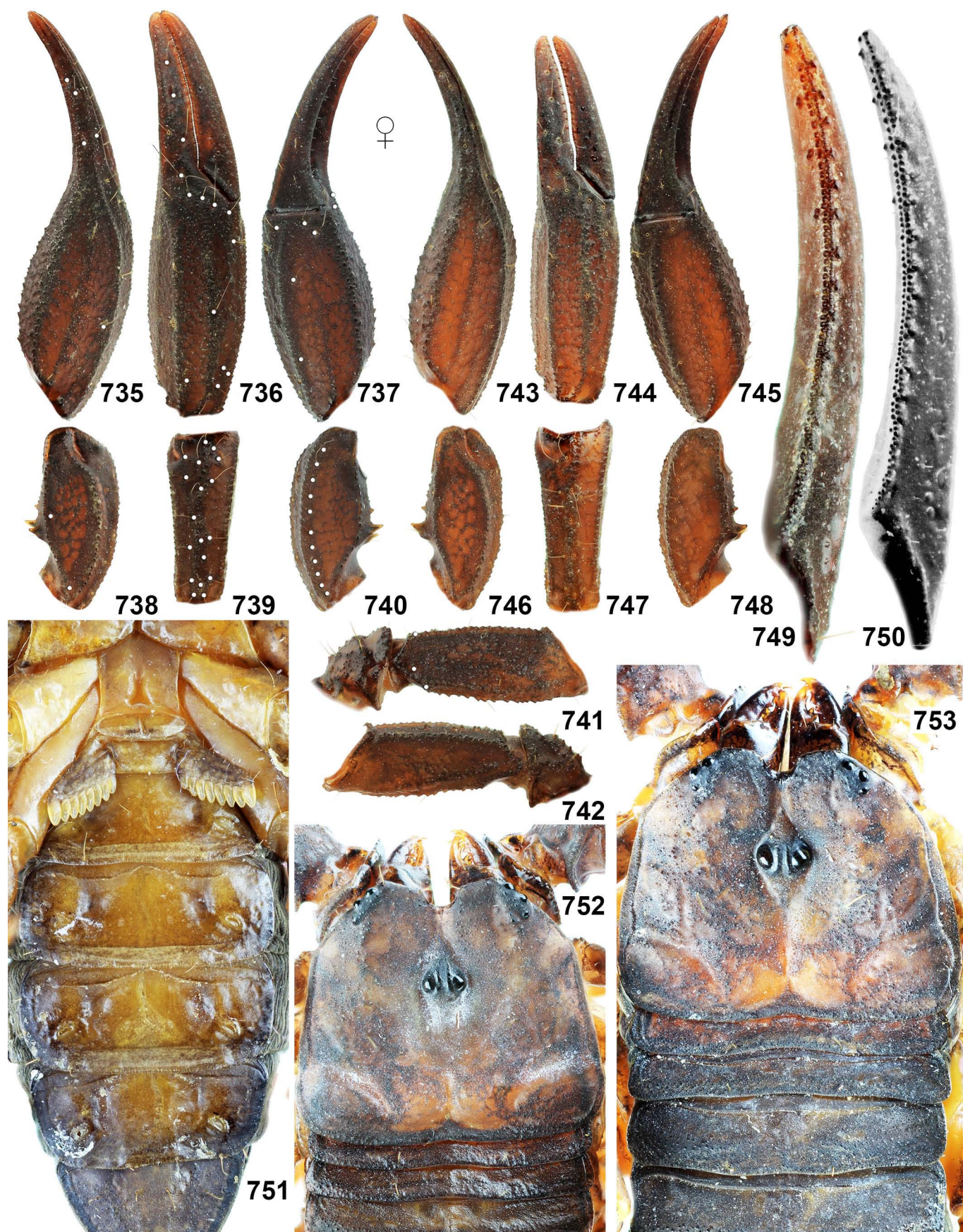
Figures 735–753: *Scorpiops solegladi* **sp. n.**, female paratype (735–742, 749–752), and female holotype (743–748, 753). **Figures 735–750**. Pedipalp segments. Chela dorsal (735, 743), external (736, 744) and ventral (737, 745) views. Patella dorsal (738, 746), external (739, 747) and ventral (740, 748) views. Femur and trochanter dorsal (741), and ventral (742) views. Movable finger dentition under white (749) and UV light (750). Trichobothrial pattern is indicated by white circles (735–741). **Figure 751**. Coxosternal area and sternites. **Figures 752–753**. Carapace and tergites I–III (IV).

Dimensions (mm)		*S. thailandus* sp. n. ♂ holotype	*S. thailandus* sp. n. ♀ paratype	*S. affinis* ♂ LT, ZMUH	*S. anthracinus* ♂ FKCP
Carapace	L / W	4.03 / 3.93	3.90 / 3.92	4.66 / 4.73	13.10 / 13.16
Mesosoma	L	5.90	12.28	9.89	33.38
Tergite VII	L / W	1.24 / 2.52	1.92 / 2.90	1.56 / 3.87	6.64 / 9.07
Metasoma + telson	L	13.40	11.52	18.05	44.24
Segment I	L / W / D	1.39 / 1.54 / 1.26	1.11 / 1.42 / 1.27	1.92 / 2.37 / 2.01	4.03 / 4.99 / 4.03
Segment II	L / W / D	1.51 / 1.40 / 1.27	1.31 / 1.24 / 1.17	2.22 / 2.17 / 1.85	4.71 / 4.45 / 4.12
Segment III	L / W / D	1.78 / 1.28 / 1.25	1.47 / 1.15 / 1.17	2.49 / 2.05 / 1.72	5.07 / 4.22 / 4.01
Segment IV	L / W / D	2.11 / 1.21 / 1.16	1.81 / 1.05 / 1.14	2.77 / 1.86 / 1.67	6.08 / 3.81 / 3.96
Segment V	L / W / D	3.28 / 1.32 / 1.09	2.92 / 1.11 / 1.10	4.18 / 1.65 / 1.55	11.58 / 3.73 / 3.80
Telson	L / W / D	3.33 / 1.41 / 1.19	2.90 / 1.13 / 0.97	4.47 / 1.84 / 1.61	12.77 / 3.80 / 3.59
Pedipalp	L	18.22	14.33	16.91	46.97
Femur	L / W	5.07 / 1.51	3.81 / 1.37	4.13 / 1.85	11.25 / 4.58
Patella	L / W	5.16 / 1.53	3.90 / 1.51	4.44 / 1.80	10.69 / 4.61
Chela	L	7.99	6.62	8.34	25.03
Manus	W / D	2.18 / 1.66	2.06 / 1.58	3.21 / 2.92	8.12 / 6.55
Movable finger	L	3.28	2.93	4.28	13.44
Total	**L**	**23.33**	**27.70**	**32.6**	**90.72**

Table 8. Comparative measurements of adults of *Scorpiops thailandus* **sp. n.**, *S. affinis* Kraepelin, 1898, and *S. anthracinus* Simon, 1887. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D), lectotype (LT).

Affinities. The combination of six characters (chela trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*; patella of pedipalp with 7 ventral and 18 external trichobothria; fingers of pedipalps straight in females; pedipalp movable finger with 50–60 IAD; and total length 32–35 mm) is unique in the entire genus *Scorpiops*.

Distribution. Vietnam (Fig. 799).

Scorpiops thailandus sp. n.
(Figures 754–778, 780–787, 789, 791, 793–799, 814, Tables 8–9)
http://zoobank.org/urn:lsid:zoobank.org:act:2B2A8926-46D3-45F8-987F-0164EDADE5EA

Vietscorpiops sp.: Šťáhlavský et al., in press.

Type locality and type repository. **Thailand**, *Nakhon Nayok Province*, Khao Yai (14.51°N 101.39°E); FKCP.

Type material (FKCP). **Thailand**, *Nakhon Nayok Province*, Khao Yai (14.51°N 101.39°E), 2013, 1♀(paratype), leg. M. Černička, 4♂5♀ (holotype and paratypes, 513, 525), breed F. Kovařík 2013-2015; *Nakhon Ratchasima Province*, Pak Chong (14.73°N 101.42°E), ca. 60 km of Saraburi, X.2004, 2♀(paratypes), leg. V. Fura; *Phetchabun Province*, Nam Nao (Fig. 798, 16.86°N 101.31°E), ca. 130 km E of Phitsanulok, X.2004, 1♂ (paratype), leg. V. Fura.

Etymology. Named after the locality of occurrence.

Diagnosis (♂♀). Total length 23–28 mm. Base color uniformly reddish black. Pectine teeth number 6–7 in males and 5–6 in females, fulcra absent. Pectines with 2 marginal and 1–3 middle lamellae. Patella of pedipalp with 17 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) external trichobothria and 8–9 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in middle of manus at same level as *Dt*. Fingers of pedipalps slightly straight in both sexes; male has small internal apophysis on movable finger. Chela length to width ratio 3.6–3.7 in male and 3.2 in female. Pedipalp movable finger with 25–30 IAD, ca. 55 MD which create 10 straight rows in a line and there are also 4–5 ID and 11 OD present. Tarsomere II of legs with row of 6–7 stout median ventral spinules and two pairs of flanking setae. Metasoma I–II with 10 carinae, and metasoma III–IV with 8 carinae. Telson rather elongate, sparsely granulate, more so in male, length to depth ratio 2.8 in male and 3 in female; annular ring present.

Description (♂♀). Total length 23–28 mm. Habitus as shown in Figs. 754–757. For position and distribution of trichobothria on pedipalps, see Figs. 766a–771a. Sexual dimorphism: adult males have larger pectines than females; pedipalp chela and patella are more narrow in male; fingers of pedipalps are straight in both sexes (Figs. 767 and 774); male has the small apophysis on the internal surface of the movable finger reduced in size (Fig. 791).
Coloration (Figs. 754–757, 793–797). Base color uniformly reddish black to black. Legs and telson are yellow to reddish brown, sternites lighter, yellowish to reddish brown. Chelicerae yellowish brown and reticulate, fingers reddish brown.
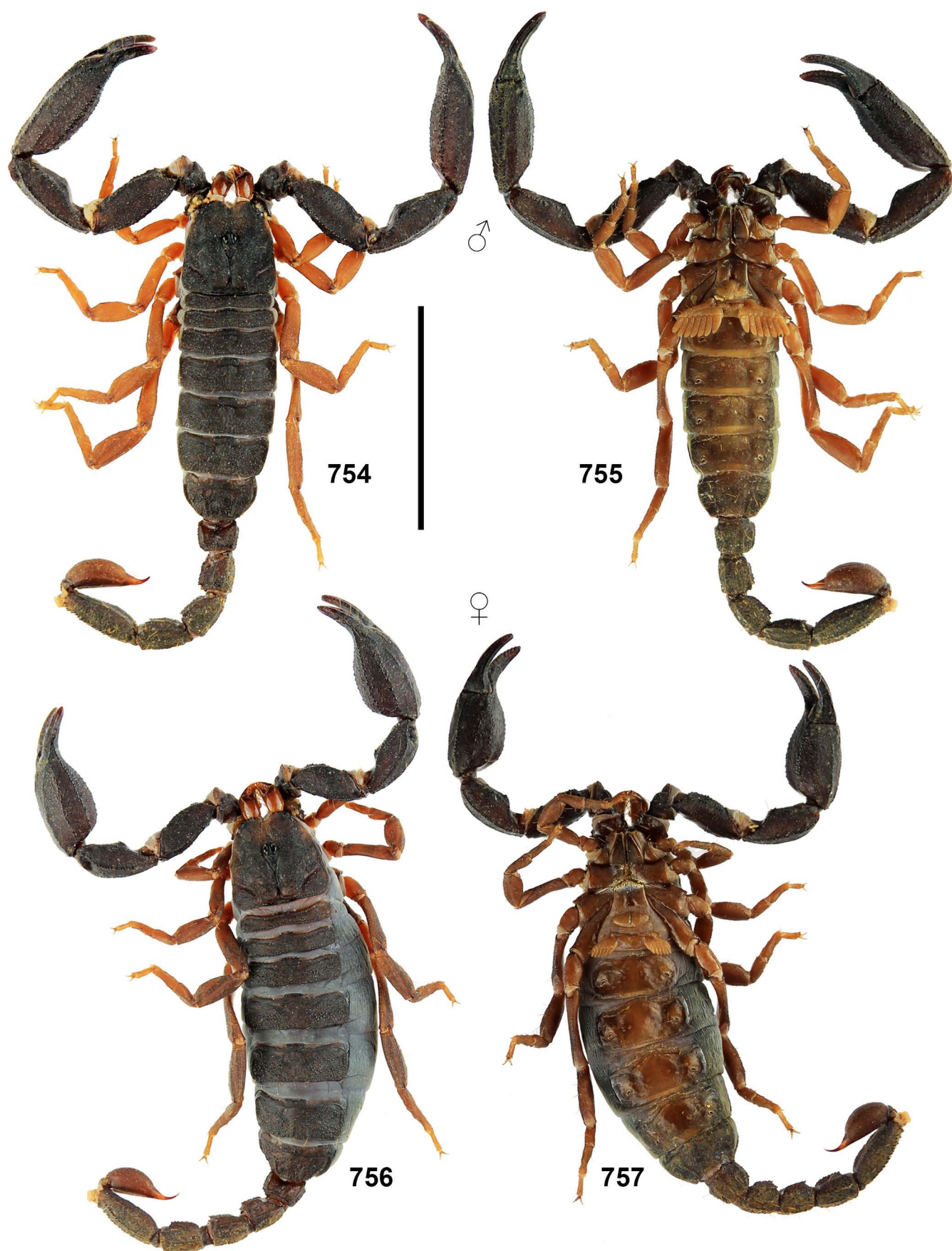
Figures 754–757: *Scorpiops thailandus* **sp**. **n**. **Figures 754–755**. Male holotype in dorsal (754) and ventral (755) views. **Figures 756–757**. Female paratype in dorsal (756) and ventral (757) views. Scale bar: 10 mm.
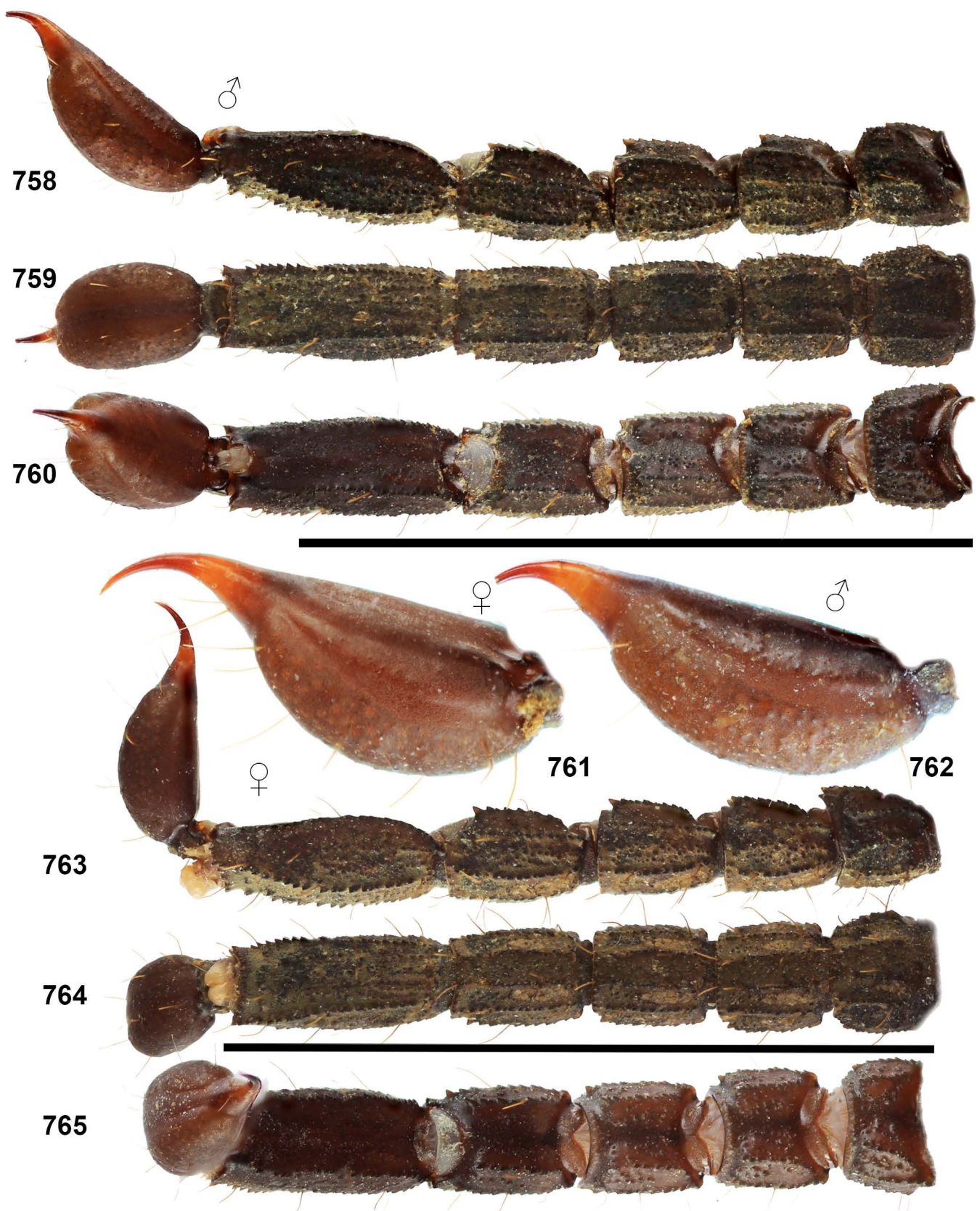
Figures 758–765: *Scorpiops thailandus* **sp. n. Figures 758–760**, **762**. Male holotype, metasoma and telson lateral (758), ventral (759), and dorsal (760) views, and telson lateral (762). **Figures 761**, **763–765**. Female paratype, telson lateral (761), and metasoma and telson lateral (763), ventral (764), and dorsal (765) views. Scale bars: 10 mm (758–760, 763–765).
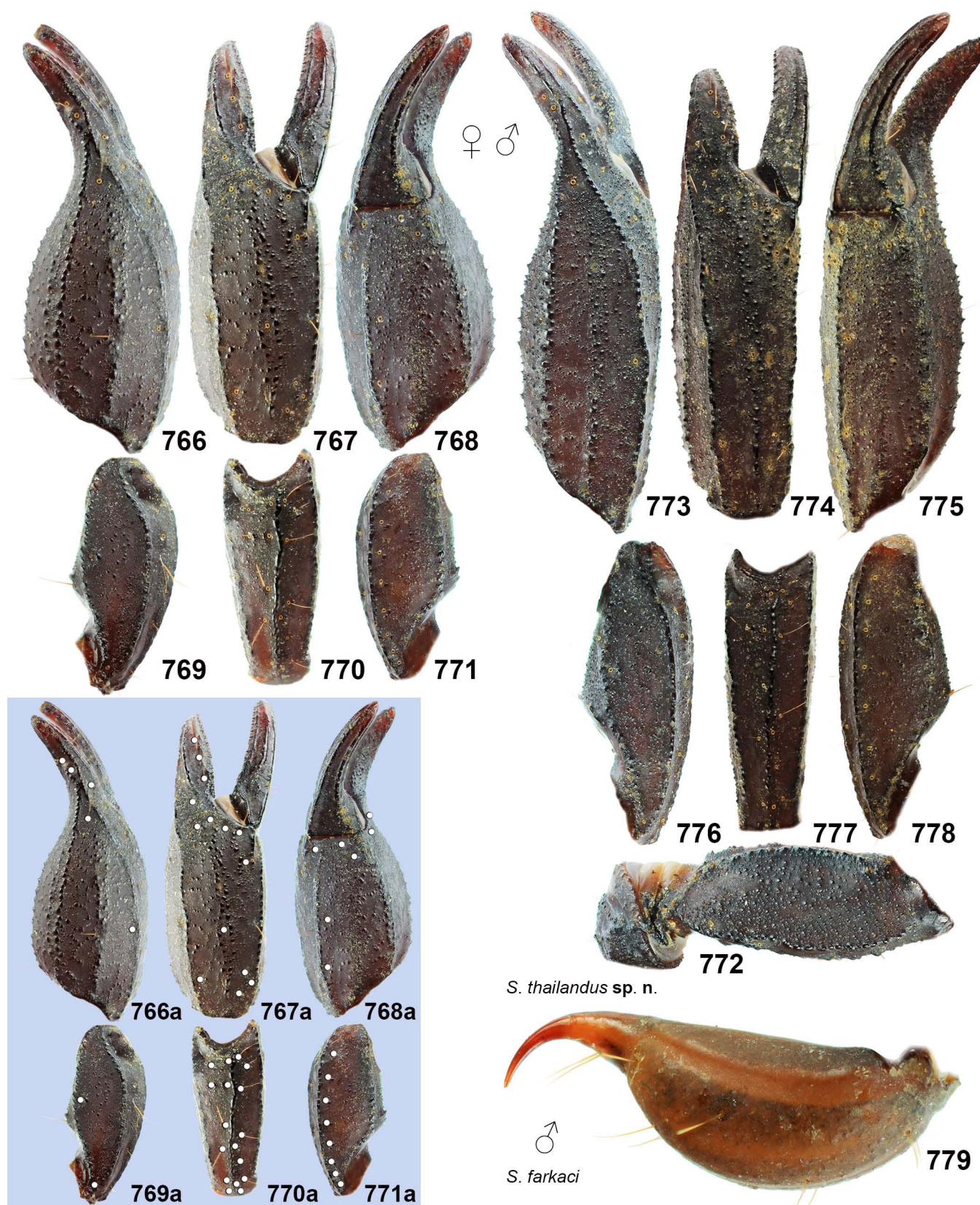
Figures 766–779: **Figures 766–778**: *Scorpiops thailandus* **sp. n**., pedipalp segments. **Figures 766–772**. Female paratype, chela dorsal (766), external (767) and ventral (768) views. Patella dorsal (769), external (770) and ventral (771) views. Trochanter and femur in dorsal (772) view. Trichobothrial pattern is indicated by white circles (766a–771a). **Figures 773–778**. Male holotype, chela dorsal (773), external (774) and ventral (775) views. Patella dorsal (776), external (777) and ventral (778) views. **Figure 779**. *Scorpiops farkaci*, male paratype, telson lateral.
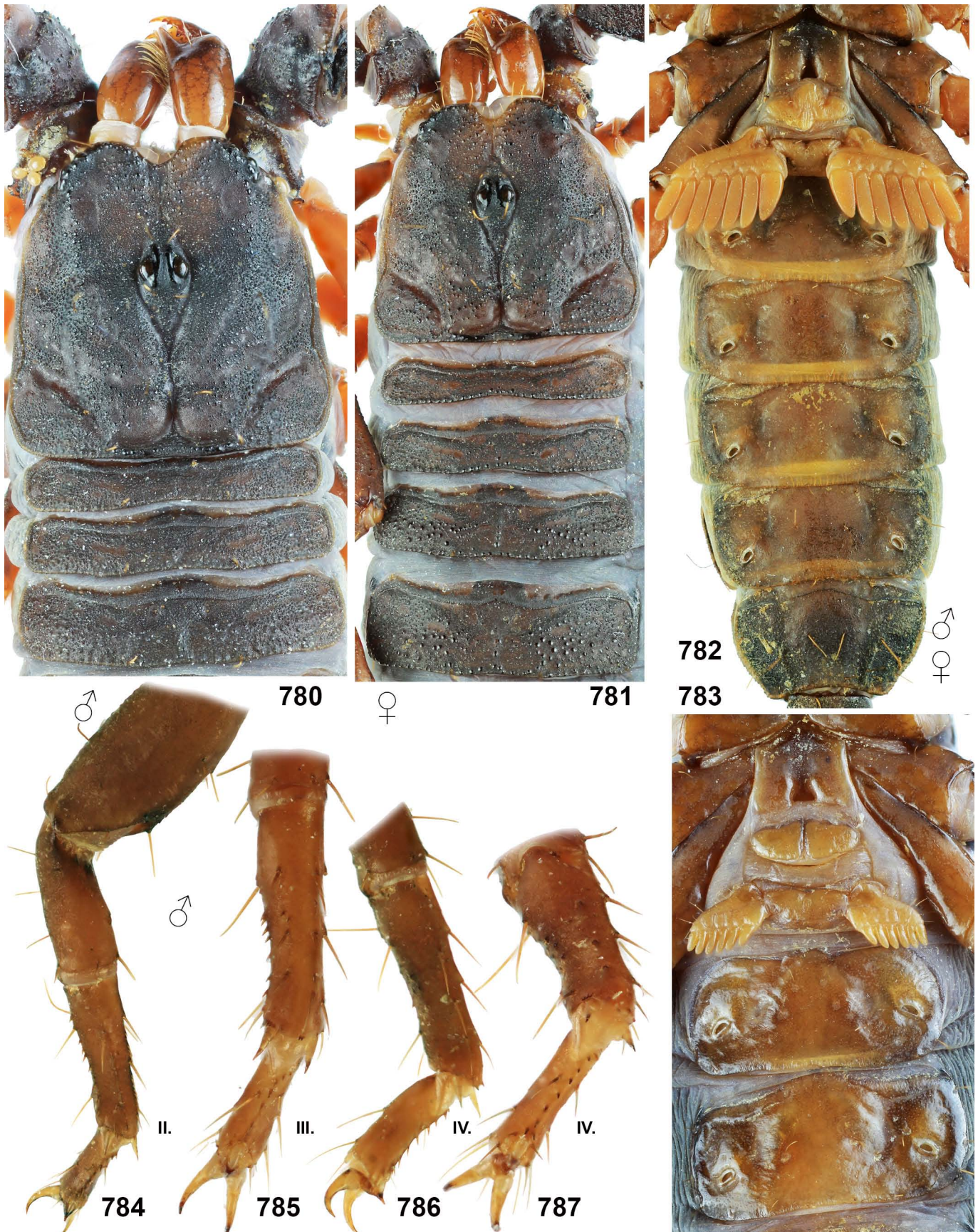
Figures 780–787: *Scorpiops thailandus* **sp. n. Figures 780**, **782**, **784–787**. Male holotype, carapace and tergites I–III (780), coxosternal area and sternites (782), left legs I–IV, retrolateral aspect (784–787 respectively). **Figures 781**, **783**. Female paratype, carapace and tergites I–IV (781), and coxosternal area and sternites III–IV (783).
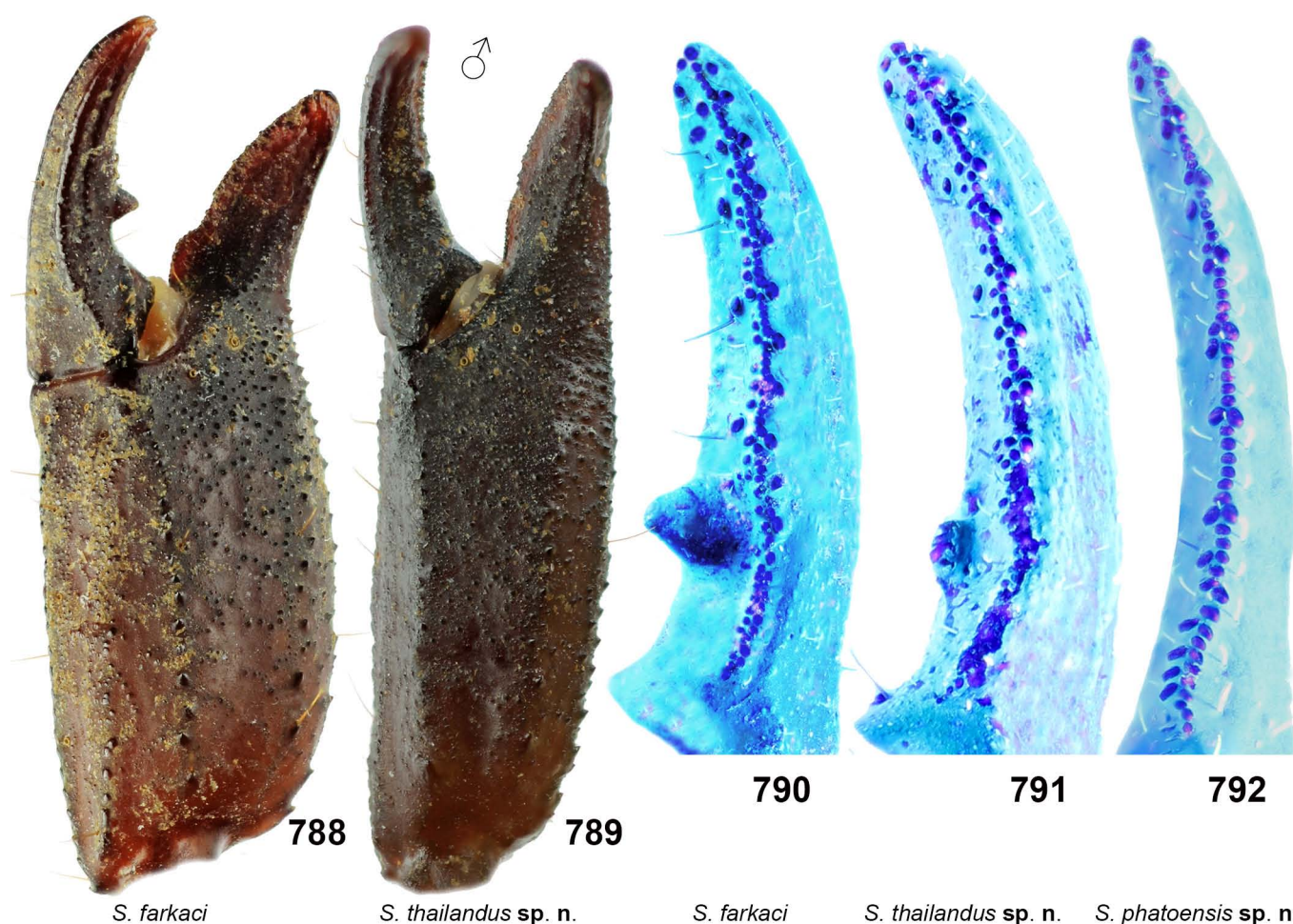
Figures 788–792: Comparison males of three similar species *Scorpiops farkaci* (788, 790), *S. thailandus* **sp**. **n**. (789, 791), and *S. phatoensis* **sp**. **n**. (792). **Figures 788–789**. Pedipalp chela internal views. **Figures 790–792**. Movable finger dentition under UV light.

Carapace and mesosoma (Figs. 754–757, 780–783). Entire carapace covered with minute granules; carinae absent. Anterior margin of carapace with a deep median notch. Carapace with two, or two normal and one reduced pairs of lateral eyes. Mesosoma granulated, with one median carina developed. Tergite VII is pentacarinate. Sternites smooth or finely granulated with two parallel furrows except sternite VII which is strongly granulated with two carinae incomplete. Pectine teeth number 6–7 in males and 5–6 in females. Pectines with 2 marginal and 1–3 middle lamellae; fulcra absent.

Metasoma and telson (Figs. 758–765). Metasoma sparsely hirsute and granulated, with sparse, relatively large granules. Metasomal segment I with 10 carinae, II–IV with 8 carinae, and V with 5 carinae. Median lateral carinae of metasoma II and V indicated by isolated granules that may coalesce into carinae. Dorsolateral carinae of segments II–IV terminate posteriorly in a pronounced tooth. Telson elongate and granulate, more so in males, with annular ring developed in both sexes.

Pedipalps (Figs. 766–778). Pedipalps very sparsely hirsute. Patella with 17 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) external and 8–9 ventral trichobothria. Chela with 4 *V* series trichobothria located on the ventral surface. Femur and patella are finely granulated. Femur with 3–4 granulose carinae, and patella with 5 carinae, with dorsal patellar spurs reduced and ventral patellar spurs pronounced. Manus dorsally with fine reticulated, rounded granules, which in the central area form an irregular dorsal secondary carina. External surface of chela covered by minute granules, with an almost complete external secondary carina with larger sparse granules. Movable fingers with ca. 25–30 IAD, ca. 55 MD which create 10 straight rows in a line and there are also 4–5 ID and 8 OD present.

Legs (Figs. 784–787). Tibia and tarsomeres of legs with several setae not arranged into bristle combs on dorsal surfaces, but with rows of spinules on dorsolateral surfaces and on legs I–II also on ventrolateral surface. Tarsomere II of legs with row of 6–7 stout median ventral spinules and two pairs of flanking setae. Femur with 3–4 and patella 4–5 carinae; both femur and patella granulated.

Measurements. See Table 8.

AFFINITIES. See comments under diagnosis of *S. farkaci*.

DISTRIBUTION. Thailand (Fig. 799).

Figures 793–794: *Scorpiops thailandus* **sp. n.**, female (793) and male (794) paratypes in vivo habitus.

Figures 795–796: *Scorpiops thailandus* **sp. n.**, female paratype with newborns (795) and with juveniles after first ecdysis (796).

Figures 797–798: *Scorpiops thailandus* **sp. n.**, male paratype shortly after adulthood (fifth) ecdysis (797) and locality Thailand, Nam Nao (798).

Scorpiops tibetanus Hirst, 1911
(Figs. 46, 143, 239–240, 799, Table 9)
http://zoobank.org/urn:lsid:zoobank.org:act:2D39F679-D308-4C69-86FC-ACA385D68C84

Scorpiops tibetanus Hirst, 1911: 472–473; Vachon, 1980: 151; Fet, 2000: 494; Kovařík, 2000: 196, figs. 47, 68–69; Soleglad & Sissom, 2001: 93; Kovařík, 2002: 19; Kovařík & Whitman, 2005: 117; Qi, Zhu & Lourenço, 2005: 29; Di et al., 2013: 75–85, figs. 102–118.
 = *Scorpiops atomatus* Qi, Zhu & Lourenço, 2005: 6–10, figs. 16–31 (type locality and type repository: China, Tibet, Lang District, 29°02'N 93°08'E (29.03°N 93.13°E); MHBU); Kovařík & Ahmed, 2009: 10; Di et al., 2013: 59–61, figs. 1–21; Di et al., 2014: 11, 16; Fet & Kovařík, 2020: 4. **Syn. n.** http://zoobank.org/urn:lsid:zoobank.org:act:8631287F-BF7A-4ADF-A7F8-0DF8F6D1AD24
= *Scorpiops pococki* Zhu et al. in Qi et al., 2005: 14–18, figs. 47–61 (type locality and type repository: China, Tibet, Gyaca District, 29°08'N 92°43'E; MHBU); Di et al., 2013: 72–75, figs. 64–84; Di et al., 2014: 12, 16. **Syn. n.** http://zoobank.org/urn:lsid:zoobank.org:act:4D806174-9C42-4137-84D1-F577422567D0

TYPE LOCALITY AND TYPE REPOSITORY. **China**: *Tibet* (*Xizang*), Tsangpo Valley, Chaksam Ferry; BMNH.

TYPE MATERIAL EXAMINED. **China**, *Tibet* (*Xizang*), Tsangpo Valley, Chaksam Ferry, 1♂ (holotype), BMNH.

OTHER MATERIAL EXAMINED. **China**, *Tibet* (*Xizang*), Lhasa (29.65°N 91.00°E), 3700 m a. s. l., 2♂1♀, 18.VI.1995, leg. A. Wrzecionko, FKCP; central Tibet, Shigatse (Xigaze) (29.27°N 88.88°E), 4000 m a. s. l., 8.VI.1996, 2♂4♀4juvs., leg. Paulus, FKCP; Gyaca District, 29°08'N 92°43'E (29.13°N 92.72°E), 1♂1♀, topotypes of *Scorpiops pococki* Zhu, Qi & Lourenço, 2008, donated by Zhiyong Di, FKCP.

DIAGNOSIS (♂♀). Total length 40–65 mm. Base color uniformly reddish brown. Pectine teeth number 7–11 in males and 6–9 in females, fulcra absent. Pectines with 2 marginal and 1 middle lamellae. Patella of pedipalp with 17 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4 *et*) external and 7–10 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in proximal half of manus between trichobothria *Dt* and *Db*. Fingers of pedipalps undulate in both sexes, usually more strongly in male. Chela length to width ratio 2–2.2 in male and 2.4 in female. Pedipalp movable finger with ca. 15–20 IAD, parallel with MD (ca. 50 in number); there are also 3–4 ID and 10–13 OD present. Tarsomere II of legs with 7–9 stout median ventral spinules and two pairs of flanking setae. Metasoma I with 10 carinae, and metasoma II–IV with 8 carinae. Telson bulbous and granulate, length to depth ratio 2.5–2.7 in male and 2.7 in female; annular ring present.

COMMENTS. Zhu, Qi & Lourenço (2005) used invalid characters. For *S. atomatus*, they cited chela length 6.38 mm and width 4.08

mm for the holotype (see further comments under *S. vachoni* below). They did not compare *S. atomatus* and *S. pococki* with *S. tibetanus*, which occurs in the same area. We had the opportunity to directly examine the holotype of *S. tibetanus*, topotypes of *S. pococki*, and other specimens from the region. We determined that the studied specimens and published descriptions match each other precisely in the following key characters: trichobothrial pattern, pedipalp finger dentition, pectinal tooth count and lamellar structure, proportions, setation, carination and sculpture of pedipalps, carapace, tergites, sternites, and metasoma, shape of the telson, as well as armature of chelicerae and pedipalp fingers. In the original descriptions, Qi et al. (2005: 29) differentiated these species from the same area of distribution according to "smooth oval region found behind lateral ocular tubercles" which can be present or absent. We found strong variation in this character, especially noticeable under UV light, and we did not find any other character valid for species level differentiation. The undeniable conclusion is that *Scorpiops atomatus* Qi, Zhu & Lourenço, 2005 and *Scorpiops pococki* Zhu, Qi &Lourenço, 2005 are junior synonyms of *Scorpiops tibetanus* Hirst, 1911 **syn. n.**

DISTRIBUTION. China (Tibet) (Fig. 799).

Scorpiops vachoni (Zhu et al., 2005), **comb. n.**
(Fig. 799, Table 9)
http://zoobank.org/urn:lsid:zoobank.org:act:7AF0BD0F-0DCA-455C-B799-9A5B9E394E11

Euscorpiops vachoni (in part) Zhu et al. in Qi et al., 2005: 18, figs. 62–77; Di et al., 2010b: 52; Di et al., 2011b: 19–21, 69–72; Fet & Kovařík, 2020: 4.
= *Euscorpiops validus* Di et al., 2010a: 14–21, figs. 1–32 (Type locality: China, Yunnan Province, Honghe Prefecture (23.37°N 103.12°E)); Di et al., 2010b: 52; Di et al., 2011b: 21, figs. 73–91; Di et al., 2014: 10; 15. **Syn. n.** http://zoobank.org/urn:lsid:zoobank.org:act:D753D9B8-4857-494D-A177-D197D07CD21D

TYPE LOCALITY AND TYPE REPOSITORY. **China**: *Yunnan Province*, Mengla District, 21°29'N 101°33'E (21.48°N 101.55°E); MHBU.

DIAGNOSIS (♂♀). Total length 42–60 mm. Base color uniformly reddish brown. Pectine teeth number 6–8 in both sexes, fulcra absent. Pectines with three marginal and one middle lamellae. Patella of pedipalp with 17–18 (5 *eb*, 2 *esb*, 2 *em*, 4 *est*, 4–5 *et*) external and 8–11 ventral trichobothria. Chela of pedipalp with 4 *V* series trichobothria located on ventral surface. Chelal trichobothrium Eb_3 located in distal half of manus between trichobothria *Dt* and *Est*. Fingers of pedipalps undulate in both sexes. Chela length to width ratio probably 2.8–3.2 in both sexes. Pedipalp movable finger with IAD, which form second row, parallel with MD and there are also 6 ID and 11–13 OD present. Tarsomere II of legs with stout median ventral spinules and two pairs of flanking setae. Metasoma I–II with 10 carinae, and metasoma III–IV with 8 carinae. Telson elongate, and sparsely granulate; annular ring present.
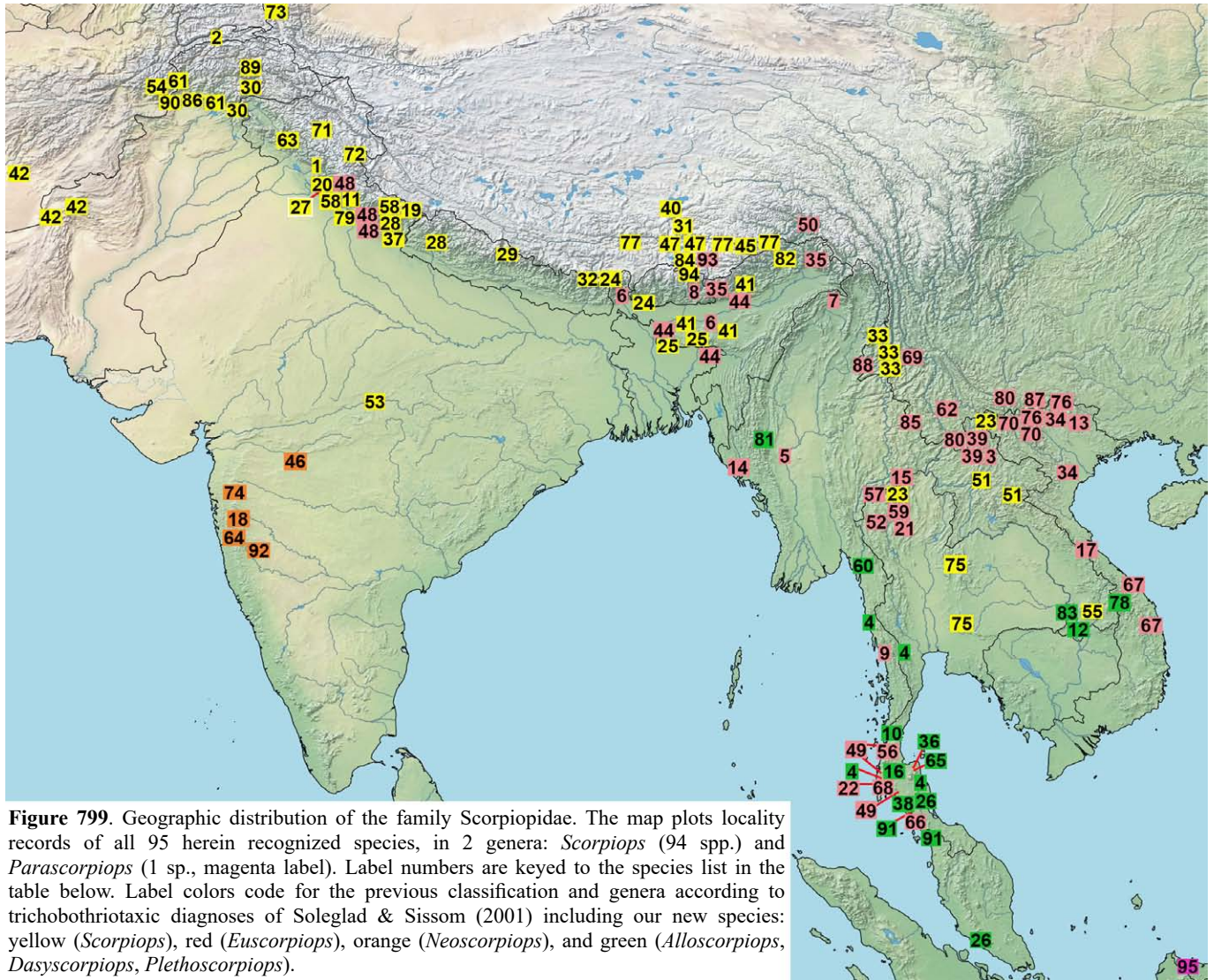
Figure 799. Geographic distribution of the family Scorpiopidae. The map plots locality records of all 95 herein recognized species, in 2 genera: *Scorpiops* (94 spp.) and *Parascorpiops* (1 sp., magenta label). Label numbers are keyed to the species list in the table below. Label colors code for the previous classification and genera according to trichobothriotaxic diagnoses of Soleglad & Sissom (2001) including our new species: yellow (*Scorpiops*), red (*Euscorpiops*), orange (*Neoscorpiops*), and green (*Alloscorpiops*, *Dasyscorpiops*, *Plethoscorpiops*).

1 *S. affinis* Kraepelin, 1898 (India, Nepal)	32 *S. irenae* Kovařík, 1994 (Nepal)	65 *S. scheibeae* **sp**. **n**. (Thailand)
2 *S. afghanus* Lourenço & Qi, 2006 (Afghanistan)	33 *S. jendeki* Kovařík, 1994 (China)	66 *S. schumacheri* **sp**. **n**. (Thailand)
3 *S. alexandreanneorum* (Lourenço, 2013) (Laos)	34 *S. kaftani* Kovařík, 1993 (Vietnam)	67 *S. sejnai* Kovařík, 2000 (Vietnam)
4 *S. anthracinus* Simon, 1887 (Myanmar, Thailand)	35 *S. kamengensis* (Bastawade, 2006) (India)	68 *S. sherwoodae* **sp**. **n**. (Thailand)
5 *S. artemisae* (Kovařík et al., 2015) (Myanmar)	36 *S. kautti* **sp**. **n**. (Thailand)	69 *S. shidian* (Zhu et al., 2005) (China)
6 *S. asthenurus* Pocock, 1900 (Bhutan, India)	37 *S. kejvali* Kovařík, 2020 (India)	70 *S. solegladi* **sp**. **n**. (Vietnam)
7 *S. beccaloniae* (Kovařík, 2005) (Myanmar)	38 *S. krabiensis* **sp**. **n**. (Thailand)	71 *S. solidus* Karsch, 1879 (India)
8 *S. bhutanensis* Tikader & Bastawade 1983 (Bhutan)	39 *S. kubani* (Kovařík, 2004) (China, Laos)	72 *S. spitiensis* Zambre et al., 2014 (India)
9 *S. binghamii* Pocock, 1893 (Myanmar)	40 *S. langxian* Zhu et al., 2005 (China, also 45)	73 *S. taxkorgan* Lourenço, 2018 (China)
10 *S. birulai* **sp**. **n**. (Thailand)	41 *S. leptochirus* Pocock, 1893 (Bangladesh, India)	74 *S. tenuicauda* Pocock, 1894 (India, also 64)
11 *S. braunwalderi* Kovařík, 2000 (India)	42 *S. lindbergi* Vachon, 1980 (Afghanistan, Pakistan)	75 *S. thailandus* **sp**. **n**. (Thailand)
12 *S. calmonti* (Lourenço, 2013) (Laos)	44 *S. longimanus* Pocock, 1893 (Bangladesh, India)	76 *S. thaomischi* (Kovařík, 2012) (Vietnam)
13 *S. cavernicola* (Lourenço & Pham, 2013) (Vietnam)	45 *S. luridus* Zhu et al., 2005 (China)	77 *S. tibetanus* Hirst, 1911 (China, also 31)
14 *S. ciki* **sp**. **n**. (Myanmar)	46 *S. maharashtraensis* (Mirza et al., 2013) (India)	78 *S. troglodytes* (Lourenço & Pham, 2015) (Vietnam)
15 *S. chiangmai* (Lourenço, 2019) (Thailand)	47 *S. margerisonae* Kovařík, 2000 (China)	79 *S. tryznai* Kovařík, 2020 (India),
16 *S. citadelle* (Kovařík, 2013) (Thailand)	48 *S. montanus* Karsch, 1879 (India)	80 *S. vachoni* (Zhu et al., 2005) (China)
17 *S. dakrong* (Lourenço & Pham, 2014) (Vietnam)	49 *S. neradi* (Kovařík et al., 2013) (Thailand)	81 *S. viktoriae* (Lourenço & Košulič, 2018) (Myanmar)
18 *S. deccanensis* Tikader & Bastawade, 1977 (India)	50 *S. novaki* (Kovařík, 2005) (China)	82 *S. vonwicki* Birula, 1913 (India)
19 *S. dastychi* Kovařík, 2000 (India)	51 *S. oligotrichus* Fage, 1933 (Laos)	83 *S. wongpromi* (Kovařík et al., 2013) (Laos, Thailand)
20 *S. demisi* Kovařík, 2005 (India)	52 *S. orioni* (Kovařík et al., 2015) (Thailand)	84 *S. wrzecionkoi* Kovařík, 2020 (China)
21 *S. dii* **sp**. **n**. (Thailand)	53 *S. pachmarhicus* Bastawade, 1992 (India)	85 *S. xui* (Sun & Zhu, 2010) (China)
22 *S. dunlopi* **sp**. **n**. (Thailand)	54 *S. pakistanus* Kovařík & Ahmed, 2009 (Pakistan)	86 *S. yagmuri* Kovařík, 2020 (Pakistan)
23 *S. farkaci* Kovařík, 1993 (Thailand, Vietnam)	55 *S. pakseensis* **sp**. **n**. (Laos)	87 *S. yangi* (Zhu et al., 2007) (China)
24 *S. feti* Kovařík, 2000 (India)	56 *S. phatoensis* **sp**. **n**. (Thailand)	88 *S. zhangshuyuani* (Ythier, 2019) (China)
25 *S. furai* Kovařík, 2020 (India)	57 *S. prasiti* **sp**. **n**. (Thailand)	89 *S. zubairahmedi* Kovařík, 2009 (Pakistan)
26 *S. grandjeani* (Vachon, 1974) (Malaysia, Thailand)	58 *S. petersii* Pocock, 1893 (India)	90 *S. zubairi* Kovařík, 2020 (Pakistan, also 86)
27 *S. grosseri* Kovařík, 2020 (India)	59 *S. problematicus* Kovařík, 2000 (Thailand)	91 *S. bastawadei* **sp**. **n**. (Thailand)
28 *S. hardwickii* (Gervais, 1843) (India, Nepal)	60 *S. profusus* (Lourenço, 2017) (Myanmar)	92 *S. phaltanensis* (Sulakhe et al., 2020) (India)
29 *S. harmsi* Kovařík, 2020 (Nepal)	61 *S. pseudomontanus* Kovařík & Ahmed, 2009 (Pakistan)	93 *S. lii* (Di & Qiao, 2020) (China)
30 *S. hofereki* Kovařík, 2020 (Pakistan)	62 *S. puerensis* (Di et al., 2010) (China)	94 *S. songi* Di & Qiao, 2020 (China)
31 *S. ingens* Yin et al., 2015 (China)	63 *S. rohtangensis* Mani, 1959 (India)	
31 *S. lhasa* Di & Zhu, 2009 (China)	64 *S. satarensis* Pocock, 1900 (India)	95 *Parascorpiops montanus* Banks, 1928 (Malaysia)

	Type locality	*Eb₃* pos.	chela ven.	pat. ven.	pat. ext.	IAD	MD	ID/OD	fingers ♂	fingers ♀	PTC ♂	PTC ♀	pectine	fulcra	chela L/W ♂	chela L/W ♀	telson L/D ♂	telson L/D ♀	TL
new. spp.																			
S. bastawadei **sp. n.**	Thailand	A	4	22–26	57–75	ca. 50	ca. 85	5/15	-	marg. u.	-	10–11	P4	absent	-	3.8–4.4	-	3.7	58
S. birulai **sp. n.**	Thailand	A	12	18	27	ca. 70	> 100	7–8/18	marg. u.	-	11	-	P4	present	5.8	-	3.8	-	65
S. ciki **sp. n.**	Myanmar	A	4	8	18	ca. 45	ca. 65	4/11	strong u.	-	6–7	-	P3	absent	3.6	-	2.9	-	34
S. dii **sp. n.**	Thailand	C	4	9–11	18	50–56	> 90	6/14	strong u.	strong u.	7–8	7	P2	absent	3.1	3.17	3.26	3.55	38–58
S. dunlopi **sp. n**.	Thailand	A	4	6	16	10–12	ca. 35	absent	-	straight	-	4–5	P3	reduced	-	3.15	-	3.1	24
S. kautti **sp. n.**	Thailand	A	13–16	23–26	46–58	53–62	> 100	5/15	strong u.	straight	13–14	11–12	P4	reduced	4.1	4.57	3.17	3.51	53–75
S. krabiensis **sp. n.**	Thailand	A	19	26–28	60–61	ca. 60	ca. 95	6/15	strong u.	-	12	-	P4	reduced	3.9	-	3.4	-	65
*S. pakseensi*s **sp. n.**	Laos	B	4	9	18	ca. 25	52	2/11–12	marg. u.	straight	6	4	P3	absent	3.2	2.9	2.7	2.9	34–41
S. phatoensis **sp. n.**	Thailand	B/C		6	16	ca. 10	ca. 40	5–7/8	straight	straight	5–6	4–5	P3	absent	3.7	2.8	2.8–3	2.8–3	28–30
S. prasiti **sp. n.**	Thailand	A	4	14–15	20–22	ca. 70	ca. 95	7/14–15	marg. u.	marg. u.	8	6–7	P4	absent	5.5	3.7	3.4	3.36	48–53
S. scheibeae **sp. n.**	Thailand	A	14	24	58	68	> 100	5/15	strong u.	-	12	-	P4	reduced	4	-	3.56	-	70
S. schumacheri **sp. n**.	Thailand	C	4	7	16	25–28	42–48	absent	marg. u.	straight	6	4–5	P2	reduced	2.6	3.1–3.2	2.72	3.16	23–26
S. sherwoodae **sp. n.**	Thailand	B	4	19	18	ca. 75	ca. 110	5/14–15	strong u.	-	8–9	-	P3	present	4.6	-	3.18	-	57
S. solegladi **sp. n.**	Vietnam	C	4	10–11	18	50–60	67–70	4/12–13	-	straight	-	4–6	P1	absent	-	4.1	-	3.62	32–35
S. thailandus **sp. n.**	Thailand	B	4	8–9	17	25–30	ca. 55	4–5/11	straight	straight	6–7	5–6	P3	absent	3.6–3.7	3.2	2.8	3	23–28
previously in *Alloscorpiops*																			
S. anthracinus Simon, 1887	Myanmar	A	10–12	15–21	23–29	70–75	ca. 90	7/15	strong u.	marg. u.	10–11	8–10	P4	reduced	3.1	3.4–3.5	3.5–3.7	3.4–3.5	69–94
S. calmonti (Lourenço, 2013)	Laos	A	13–14	18	30	ca. 75	ca. 90	4/14	-	straight	-	10	P4	absent	-	3.7	-	3.5	72
S. citadelle (Kovařík, 2013)	Thailand	A	9–13	19–21	29–34	70–75	90–100	5/15–16	straight	straight	10–11	8–9	P3	reduced	4.7–5.5	4.4–4.5	3.6–3.7	4.1–4.3	37–53
S. troglodytes (Lourenço & Pham, 2015)	Vietnam	A	9	14	21	-	-	-	-	-	9	-	-	absent	-	-	-	-	juv.
S. viktoriae (Lourenço & Košulič, 2018)	Myanmar	A	8–9	15–17	22	-	-	-	-	marg. u.	8	8–9	P4	reduced	-	3.6	-	3.4	51
S. wongpromi (Kovařík et al., 2013)	Thailand	A	11–12	21–22	33–41	60–70	ca. 90	5–6/13–14	strong u.	straight	10–12	9–11	P4	reduced	2.9–3	32–3.4	2.6–2.8	3	60–66
previously in *Euscorpiops*																			
S. alexandreanneorum (Lourenço, 2013)	Laos	C	4	14	21	ca. 60	ca. 70	4–5/8>	straight	-	7	-	P4	absent	6.8	-	3.9	-	38
S. artemisae (Kovařík et al., 2015)	Myanmar	A	4	14–15	20	ca. 60	ca. 70	4/12–13	marg. u.	straight	8	7–8	P2	absent	4.1	-	3.5	-	44
S. asthenurus Pocock, 1900	Bhutan	A	4	8–9	18	60	75	4–5/10–12	strong u.	marg. u.	8–9	7–8	P2	present	3.2–3.7	3.2–3.5	3.2	3.5	35–45
S. beccaloniae (Kovařík, 2005)	Myanmar	A	4	12	18	ca. 50	ca. 65	4/12–13	strong u.	-	8–9	-	P4	reduced	3.3	-	3.4	-	58
S. bhutanensis Tikader & Bastawade, 1983	Bhutan	A	4	7–8	17	-	-	-	-	marg. u.	7	-	P3	present	6.5	-	-	-	50
S. binghamii Pocock, 1893	Myanmar	A	4	12–13	20–21	-	-	-	strong u.	-	8–9	-	P4	present	3.6	-	3.1	-	50–60
S. cavernicola (Lourenco & Pham, 2013)	Vietnam	A	4	11	15–17	-	-	ca. 4/8	marg. u.	-	7	7	P4	reduced	4.2	4.2	3.6	3.9	42–43
S. chiangmai (Lourenço, 2019)	Thailand	A	4	17	16	-	-	-	-	-	-	7	-	absent	-	-	-	-	juv.
S. dakrong (Lourenço & Pham, 2014)	Vietnam	E	4	9	17	-	-	-	straight	straight	7	5–6	P3	absent	4	2.7	2.9	2.7	25–27
S. kaftani Kovařík, 1993	Vietnam	A	4	12–13	19	ca. 70	80–90	6/13–15	-	marg. u.	-	6–7	P4	absent	-	4.4	-	3.4	31–52
S. kamengensis (Bastawade, 2006)	India - AP	A	4	7–8	18–19	ca. 60	ca. 80	5/12–14	straight	straight	9	4–7	P3	absent	4	-	3.7	-	42–46
S. kubani (Kovařík, 2004)	Laos	C	4	9–10	18–19	ca. 50	ca70	4–5/11–13	strong u.	marg. u.	7–8	6–8	P2	absent	3.1–3.2	3.1–3.2	3.5	3.8	39–50
S. lii (Di & Qiao, 2020)	Ch - Tibet	A	4	6–7	17	-	-	-	strong u.	strong u.	4–6	4–6	-	reduced	3.6	3.3–3.4	2.85	3.4–3.5	37–39
S. longimanus Pocock, 1893	Bangladesh	A	4	9–11	18	50–60	ca. 80	5–6/13–14	marg. u.	straight	8–10	7–8	P2	present	3.6–4.2	3.2–3.5	4.2	3.5	45–72
S. montanus Karsch, 1879	India - UP	B/C/D	4	14–16	17	30–38	ca. 50	4–5/10–11	strong u.	strong u.	7–9	6–7	P4	absent	3.1–3.4	3.1–3.4	3.2	3	50–60
S. neradi (Kovařík et al., 2013)	Thailand	A	4	6	16	20–25	44–50	absent	strong u.	straight	6	4–5	P2	reduced	2.5	2.8	2.74	3.39	24–28
S. novaki (Kovařík, 2005)	Ch - Tibet	A	4	8–9	18–19	ca. 60	ca. 70	4/11–13	strong u.	strong u.	7–8	8–9	P4	absent	3.6	3.4–3.5	3.3	3.2	44–49
S. orioni (Kovařík et al., 2015)	Thailand	A	4	11–13	19	60–70	ca. 90	6/13	marg. u.	marg. u.	8–9	7–8	P4	absent	4.6	3–3.4	3.4	4	48–66
S. problematicus Kovařík, 2000	Thailand	A/C	4	11–12	19	50–60	ca. 75	5–6/13–14	marg. u.	marg. u.	7–8	6–7	P4	absent	3–3.3	3–3.3	3.3	3.5	45–49
S. puerensis (Di et al., 2010)	Ch-Yunnan	A	4	10–11	18	-	-	5–6/12–13	strong u.	strong u.	7–8	7–8	-	absent	2.6–2.8	2.6–2.8	3.7	3.0	50–60
S. sejnai Kovařík, 2000	Vietnam	B	4	9	18	ca. 35	ca. 65	4–5/13	marg. u.	marg. u.	6–7	4–5	P1	absent	2.75–3	-	3.4	2.9	32–43
S. shidian (Zhu et al., 2005)	Ch - Yunnan	A	4	10–12	17	ca. 60	ca. 80	6/13–15	marg. u.	marg. u.	7–8	6–7	P4	reduced	3.3–3.7	3.3–3.7	3.4–3.5	2.8–2.9	47–60
S. thaomischi (Kovařík, 2012)	Vietnam	A	4	10–12	18	ca. 55	ca. 90	6/12–13	strong u.	strong u.	7–9	6–8	P4	absent	3.3–3.5	3.3–3.5	3.2–3.3	3.2–3.3	42–62
S. vachoni (Zhu et al., 2005)	Ch - Yunnan	A	4	8–11	17–18	-	-	6/11–13	strong u.	strong u.	6–8	6–8	P4	absent	2.8–3.2	2.8–3.2	3.1	-	42–60
S. xui (Sun & Zhu, 2010)	Ch - Yunnan	A	4	10	18–19	-	-	6/13	marg. u.	marg. u.	8	7	-	absent	4–4.1	3.5–3.6	3.3	3.6	54–65
S. yangi (Zhu et al., 2007)	Ch - Yunnan	A	4	9–10	18	-	-	-	marg. u.	marg. u.	6–7	5–6	-	absent	3.4	3.3	3	3.4	46–52
S. zhangshuyuani (Ythier, 2019)	Ch - Yunnan	A/C	4	11	18	-	-	-	-	-	-	7–8	-	present	-	4.2–4.3	-	3.5	49–53

	Type locality	Eb_3 pos.	chela ven.	pat. ven.	pat. ext.	IAD	MD	ID/OD	fingers ♂	fingers ♀	PTC ♂	PTC ♀	pectine	fulcra	chela L/W ♂	chela L/W ♀	telson L/D ♂	telson L/D ♀	TL
previously in *Dasyscorpiops*																			
S. grandjeani (Vachon, 1974)	Malaysia	A	4	22–23	54–59	ca. 55	ca. 85	5/15	-	marg. u.	-	8–10	P4	absent	-	5.1–5.2	-	3.7	38–58
previously in *Neoscorpiops*																			
S. deccanensis Tikader & Bastawade, 1977	India - M	D	4	15–18	25–27	55–60	ca. 80	4–5/10–11	strong u.	marg. u.	6–7	6–7	P4	absent	2.8–3.1	2.8–3.1	3.2–3.3	3.2–3.3	38–56
S. maharashtraensis (Mirza et al., 2013)	India - M	D	4	13–17	24–26	-	-	-	strong u.	marg. u.	6–8	6–8	-	-	4.8–5.1	3.3–3.6	2.8–3.5	2.8–3.5	36–45
S. phaltanensis (Sulakhe et al., 2020)	India - M	D	4	17–19	27–29	-	-	-	strong u.	marg. u.	7–8	5–7	P4	absent	3.1	3.6	2.9–3.4	3.4–4.1	45–52
S. satarensis Pocock, 1900	India - M	D	4	12–14	22–24	55–60	ca. 80	4–5/10–11	strong u.	marg. u.	6–8	6–7	P4	absent	2.8–3.1	2.8–3.1	3.2–3.3	3.2–3.3	36–60
S. tenuicauda Pocock, 1894	India - M	D	4	14–16	24–27	55–60	ca. 80	4–5/11	strong u.	marg. u.	5–7	5–7	P3	absent	3.2–3.4	3.2–3.4	3.2–3.3	3.2–3.3	35–50
previously in *Plethoscorpiops*																			
S. profusus (Lourenço, 2017)	Myanmar	-	25	23	41–43	ca. 70	90–100	5/8	-	marg. u.	12–13	9	P4	present	-	4.9	-	3.6	62
previously in *Scorpiops*																			
S. affinis Kraepelin, 1898	India	D	4	7	17	8	ca. 60	4–5/10	strong u.	-	6	-	P3	reduced	2.22	-	2.78	-	33
S. afghanus Lourenço & Qi, 2006	Afghanistan	D	4	6	17	28–30	ca. 48	3/7	-	strong u.	-	5–6	P1	absent	-	2.22	-	2.78	42
S. braunwalderi Kovařík, 2000	India - UP	D	4	7	17	10	40	4/9	-	strong u.	-	6	P3	absent	-	2.4	-	2,7	40.5
S. dastychi Kovařík, 2000	India - UP	D	4	8	17	10	ca. 50	5/9	marg. u.	straight	6–7	4–5	P3	absent	3–3.2	2.4	3.1–3.3	2.7	35–41
S. demisi Kovařík, 2005	India - HP	D	4	14–15	18	ca. 40	ca. 75	4/9–10	-	marg. u.	-	7	P4	absent	-	3.6	-	3.6	41
S. farkaci Kovařík, 1993	Thailand	D	4	9	17	25–30	ca. 55	5/11–12	straight	straight	6–7	5–6	P3	absent	2.7–3.1	2.4–2.5	2.8	2.8	25–33
S. feti Kovařík, 2000	India - S	D	4	6–8	17	50–55	ca. 75	5/12	straight	straight	7–9	6–7	P1	absent	2.9–3.1	2.9–3.1	2.6	2.7	45–55
S. furai Kovařík, 2020	India - M	D	4	7	17	51–58	ca. 60	4/12–13	-	straight	8	7–8	P2	absent	-	2.83	-	3.07	45–52
S. grosseri Kovařík, 2020	India - HP	D	4	7	17	34–36	60–65	4/8	-	strong u.	-	4–5	P1	absent	-	2.66	-	2.65	59
S. hardwickii (Gervais, 1843)	Nepal	D	4	6–7	17	28–35	ca. 55	4–5/7–9	marg. u.	marg. u.	5–7	4–5	P1	absent	2.5	2.4	2.4	2.4–2.5	36–50
S. harmsi Kovařík, 2020	Nepal	D	4	7	17	40–42	70–73	4/7–8	-	marg. u.	-	5–6	P1	absent	-	2.8	-	3.31	55
S. hofereki Kovařík, 2020	Pakistan	D	4	7	17	38	62–68	5/9–10	-	marg. u.	-	4–6	P1	absent	-	2.9–3.1	-	2.6–3	48–60
S. ingens Yin et al., 2015	Ch - Tibet	D	4	6–8	17	-	-	-	strong u.	marg. u.	7–8	6–7	P3	absent	ca. 2.3	ca. 2.5	2.6–2.7	2.6–2.7	70–76
S. irenae Kovařík, 1994	Nepal	D	3	6	17	ca. 60	ca. 75	5/10	-	straight	-	5–6	P1	absent	-	3.1	-	3	51
S. jendeki Kovařík, 1994	Ch - Yunnan	D	4	6–7	17	ca. 10	ca. 50	5/9	straight	straight	4–5	4–5	P3	absent	2.1–2.3	2.1–2.3	2.7	2.9	25–42
S. kejvali Kovařík, 2020	India - U	D	4	7	17	32–35	66–68	4/8–10	marg. u.	marg. u.	7	5–6	P1	absent	3.2	2.64	3.16	3.05	37–52
S. langxian Zhu et al., 2005	Ch - Tibet	D	4	6–7	17	ca. 25	ca. 55	4/8	strong u.	strong u.	7–8	6	P3	absent	1.9–2.2	1.9–2.2	2.6	2.7	52–60
S. leptochirus Pocock, 1893	Bangladesh	D	4	6–8	17	ca. 40	ca. 65	4–5/14–15	straight	straight	7–9	6–8	P1	absent	3.8–4.1	3–3.3	2.7–2.9	2.7–2.9	40–58
S. lhasa Di & Zhu, 2009	Ch - Tibet	E	4	10–11	17	ca. 10	ca. 55	4–5/8–9	strong u.	strong u.	9–11	9–11	P4	present	3.1	2.9	2.8	3	35–40
S. lindbergi Vachon, 1980	Afghanistan	D	4	10–13	17–19	30–38	ca. 60	3–4/9	strong u.	straight	8–9	6–8	P4	present	2.6–2.9	2.6–2.9	2.7–3.0	2.7–3.0	33–55
S. luridus Zhu et al., 2005	Ch - Tibet	D	4	9	17	ca. 60	ca. 75	4/12	strong u.	marg. u.	10	8	P3	absent	-	2.7	-	-	70–87
S. margerisonae Kovařík, 2000	Ch - Tibet	D	4	8–10	17	ca. 30	ca. 40	4/8	strong u.	strong u.	9–13	8–10	P4	reduced	2.2–2.3	2.2	2.5	-	45–51
S. oligotrichus Fage, 1933	Laos	D	4	9	17	ca. 40	ca. 55	4/9	marg. u.	straight	7–9	6–7	P1	absent	3.2	3.9	3.3–3.5	3.3–3.5	32–50
S. pachmarhicus Bastawade, 1992	India - MH	D	4	10	17	-	-	-	-	straight	7	6	-	-	-	-	-	-	34–35
S. pakistanus Kovařík & Ahmed, 2009	Pakistan	D	4	9–10	17	ca. 40	ca. 60	4/10–11	strong u.	marg. u.	7–8	6–7	P4	reduced	2.4–2.5	2.7	3.2	3.4	55–72
S. petersii Pocock, 1893	India - HP	D	4	6–7	17	13–25	ca. 65	4–5/10–11	strong u.	strong u.	5–8	4–6	P1	absent	2.6	2.5	2.5–2.6	2.6	50–72
S. pseudomontanus Kovařík & Ahmed, 2009	Pakistan	D	4	14–18	17	ca. 45	ca. 70	4/13	strong u.	marg. u.	7–9	6–7	P4	absent	3.1–3.2	2.9	3.1	3.4	50–60
S. rohtangensis Mani, 1959	India - P	D	4	7	17	-	-	-	-	-	-	6	P1	absent	2.95	-	-	-	50
S. solidus Karsch, 1879	India - HP	D	4	6	17	12–18	40–50	4–5/8–10	marg. u.	marg. u.	5	5	P1	absent	2.2	2.2	2.4	2.6	32–40
S. songi Di & Qiao, 2020	Ch - Tibet	D	4	7–8	17	-	-	-	-	strong u.	7	6	P1	reduced	2.3–2.4	-	3.0–3.1	-	72
S. spitiensis Zambre et al., 2014	India - HP	D	4	7	16	-	-	-	strong u.	straight	5–6	5–6	-	present	2.5–2.9	2.9	2.7	-	27–40
S. taxkorgan Lourenço, 2018	Ch - Tibet	D	4	7	17	-	-	-	-	straight	7–8	6	-	reduced	3.2	-	3	-	35
S. tibetanus Hirst, 1911	Ch - Tibet	D	4	7–10	17	15–20	ca. 50	3–4/10–13	strong u.	strong u.	7–11	6–9	P3	absent	2–2.2	2.4	2.5–2.7	2.7	40–65
S. tryznai Kovařík, 2020	India - U	E	4	7	17	9	ca. 74	4/11–13	-	strong u.	-	6	P1	absent	-	3.13	-	2.85	61
S. vonwicki Birula, 1913	India - AP	E	4	7	17	ca. 10	ca. 65	4/11–13	-	strong u.	-	5–6	P2	present	-	2.92	-	3	52
S. wrzecionkoi Kovařík, 2020	Ch - Tibet	D	4	9–11	18–20	ca. 30	ca. 60	4/8	-	strong u.	-	8–9	P4	present	-	2.7	-	2.6	45–50
S. yagmuri Kovařík, 2020	Pakistan	D	4	18	17	ca. 70	> 100	5/13–15	strong u.	strong u.	8–9	7–8	P4	absent	3.6	3.4	3.43	3	43–47
S. zubairahmedi Kovařík, 2009	Pakistan	D	4	7	17	ca. 40	ca. 75	4/8	strong u.	-	6	-	P1	absent	3.38	-	2.5	-	60
S. zubairi Kovařík, 2020	Pakistan	D	4	6–7	17	22–26	ca. 45	4/8–9	strong u.	marg. u.	6–7	5	P1	absent	2.1-2.2	2.1-2.2	2.12	2.26	37–40

**Table 9**. Comparison of main morphological characters of *Scorpiops* spp.

Explanatory notes. Type locality (country or country and province/ state of type locality), Eb_3 pos. (five empirical combinations of Eb_3 vs. *Dt* position explained in §1. Placement of trichobothrium Eb_3 with respect to *Db* and *Dt* on pedipalp chela manus), chela ven. (number of trichobothria on ventral surface of pedipalp chela), pat. ven. (number of trichobothria on ventral surface of pedipalp patella), pat. ext. (number of trichobothria on external surface of pedipalp patella), IAD, MD, ID/OD (numbers of denticles in these series), fingers (shape of fingers , strong u. – strongly undulate, marg. u. – margins undulate, see §9. Sexual dimorphism), PTC (pectinal teeth counts), pectine (types explained in §12. Pectine morphology), chela L/W (chela length/width ratio), telson L/D (telson length/depth ratio), TL (total length in millimeters), India – AP (Arunachal Pradesh State), India – UP (Uttar Pradesh State), Ch (China), India – M (Maharashtra State), India – HP (Himachal Pradesh State), India – S (Sikkim State), India – U (Uttarakhand State), India – P (Punjab State).
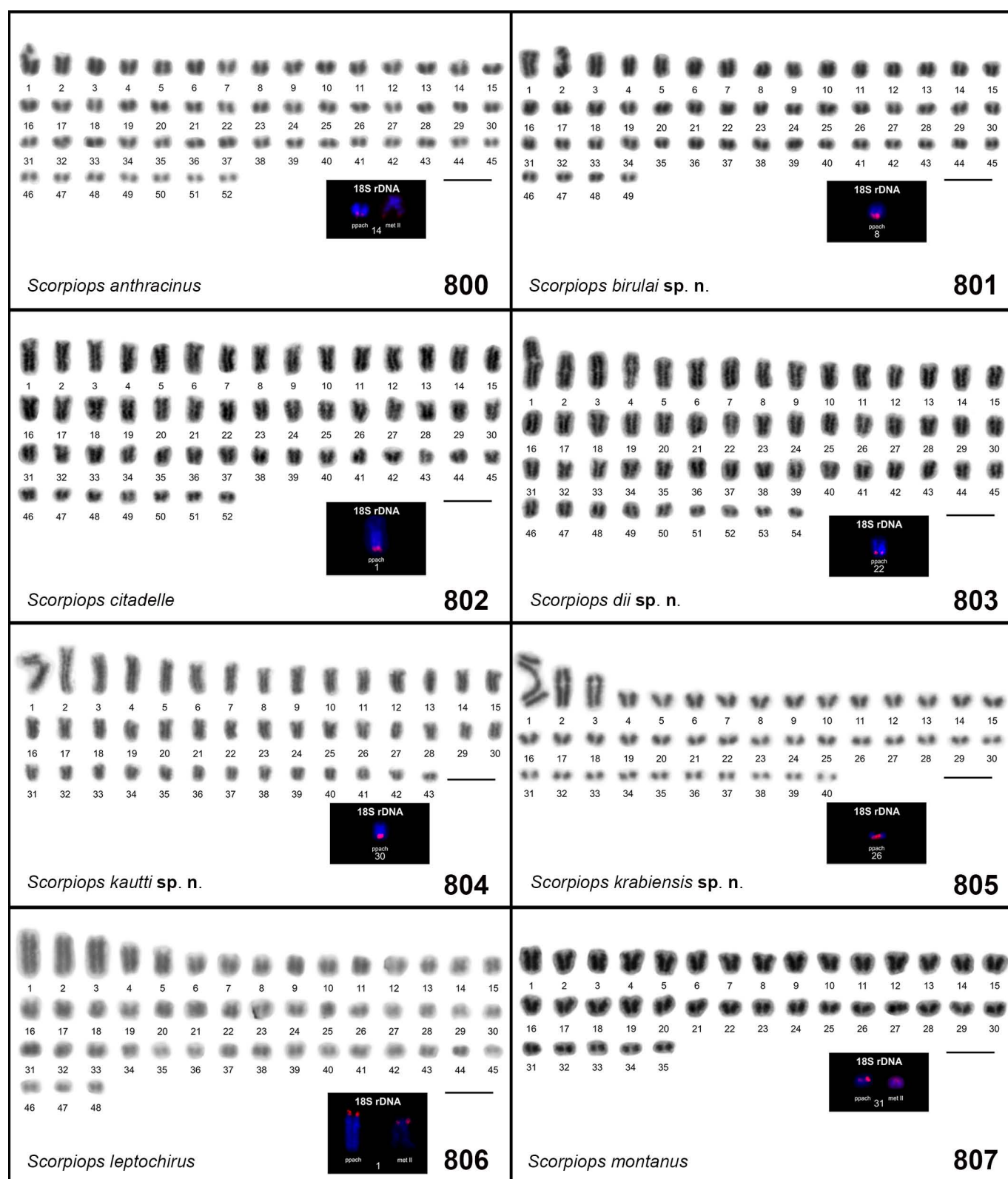
Figures 800–807: Male karyotypes of scorpiopid species based on postpachytene. **Figure 800**. *Scorpiops anthracinus* (2n=105, 51II+III). **Figure 801**. *Scorpiops birulai* **sp. n.** (2n=99, 96II+III). **Figure 802**. *Scorpiops citadelle* (2n=104, 52II). **Figure 803**. *Scorpiops dii* **sp. n.** (2n=109, 53II+III). **Figure 804**. *Scorpiops kautti* **sp. n.** (2n=87, 42II+III). **Figure 805**. *Scorpiops krabiensis* **sp. n.** (2n=81, 39II+III). **Figure 806**. *Scorpiops leptochirus* (2n=96, 48II). **Figure 807**. *Scorpiops montanus* (2n=70, 35II). Insets show the location of 18S rDNA (red signal) on the same chromosome as in the karyogram (ppach) and additionally on chromosomes during pachytene (pach) or metaphase II (met II). Abbreviation of postpachytene configuration: II – bivalent, III – trivalent. Scale bar: 10 μm.
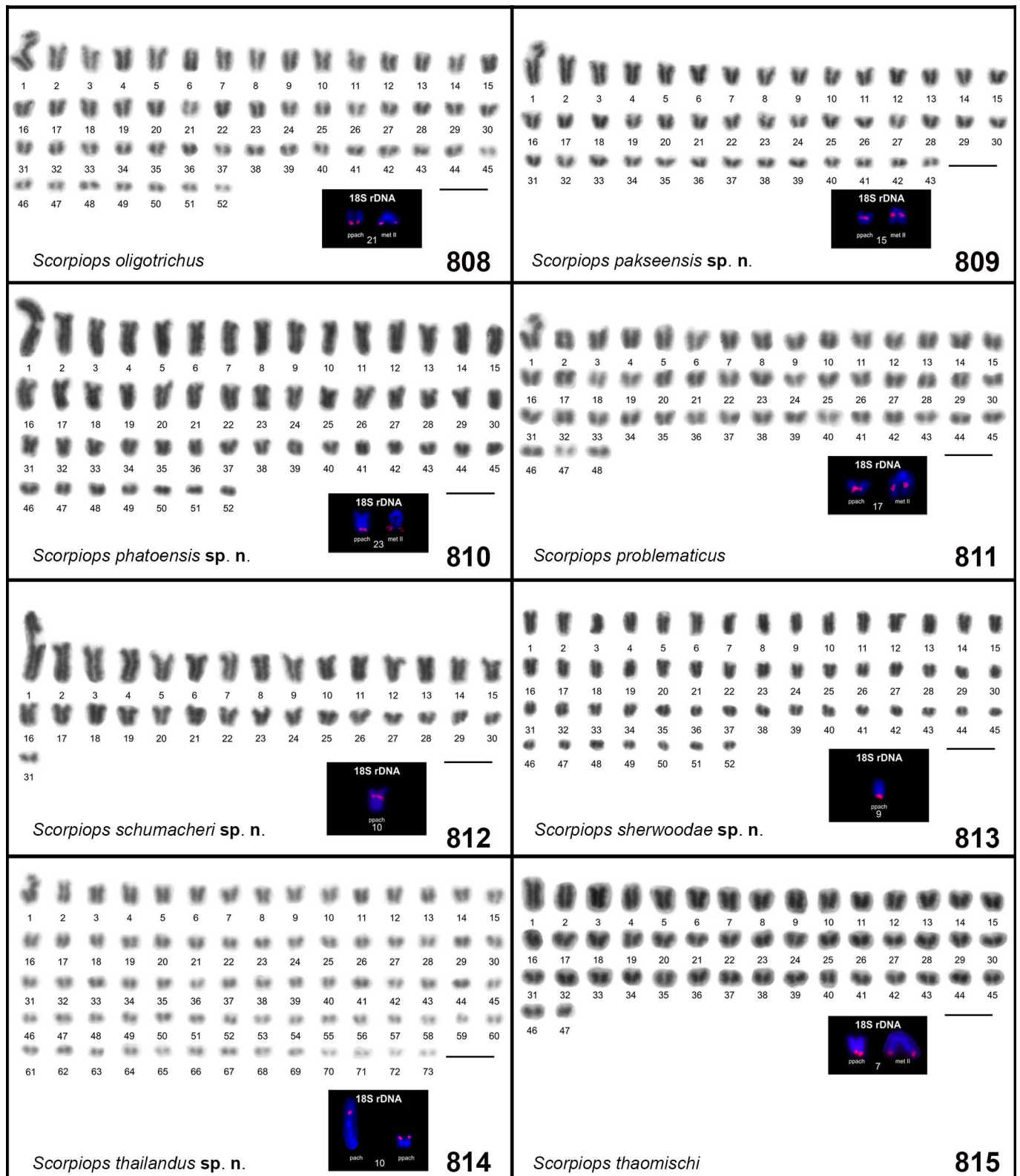
Figures 808–815: Male karyotypes of scorpiopid species based on postpachytene. **Figure 808**. *Scorpiops oligotrichus* (2n=105, 51II+III). **Figure 809**. *Scorpiops pakseensis* **sp. n.** (2n=87, 42II+III). **Figure 810**. *Scorpiops phatoensis* **sp. n.** (2n=105, 51II+III). **Figure 811**. *Scorpiops problematicus* (2n=97, 47II+III). **Figure 812**. *Scorpiops schumacheri* **sp. n.** (2n=63, 60II+III). **Figure 813**. *Scorpiops sherwoodae* **sp. n.** (2n=104, 52II). **Figure 814**. *Scorpiops thailandus* **sp. n.** (2n=147, 72II+III). **Figure 815**. *Scorpiops thaomischi* (2n=94, 47II). Insets show the location of 18S rDNA (red signal) on the same chromosome as in the karyogram (ppach) and additionally on chromosomes during pachytene (pach) or metaphase II (met II). Abbreviation of postpachytene configuration: II – bivalent, III – trivalent. Scale bar: 10 µm.

COMMENTS. In the descriptions of *E. vachoni*, *E. shidian*, *S. atomatus* and other species in Qi, Zhu & Lourenço (2005), incorrect measurements are listed. For example, the chela length to width ratio is incorrectly fixed as 1.47 (chela length 8.23, width 5.61 according to Qi, Zhu & Lourenço, 2005: 18) in the male holotype of *E. vachoni* and this is used as the main character for differentiation between *E. vachoni* with the erroneous ratio "1.5–1.9", and *E. validus* with the correct ratio 2.9–3.2. The authors commented that *E. validus* has "chela strong" (see Di et al., 2010a: 14) but in fact the higher value of the ratio indicates a narrower chela. We suspect that Qi, Zhu et Lourenço (2005) confounded "chela" with "manus" in their descriptions of *E. vachoni* and *E. shidian*, and that this error propagated in other papers (see also Zhu, Zhang & Lourenço, 2007: 20 and the keys in Di et al., 2010b: 50–51, and Di et al., 2014: 15). It is evident that *E. vachoni* and *E. validus* match each other precisely in all key characters if we ignore these published errors. The undeniable conclusion is that *Euscorpiops validus* Di et al., 2010 is a junior synonym of *Euscorpiops vachoni* Zhu et al., 2005, **syn. n**.

The type locality of *Euscorpiops vachoni* is China, Yunnan Province, 21°29'N 101°33'E but descriptions cited one male paratype from China, Tibet, Nyingchi District, Bayizhen Town, 29°41'N 94°21'E (Qi et al., 2005: 18). According to the distribution of Scorpiopidae (Fig. 799) it is very likely that the paratype from Tibet is actually a different species, most probably *S. novaki*.

DISTRIBUTION. China (Yunnan), see comments and Fig. 799.

Acknowledgements

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