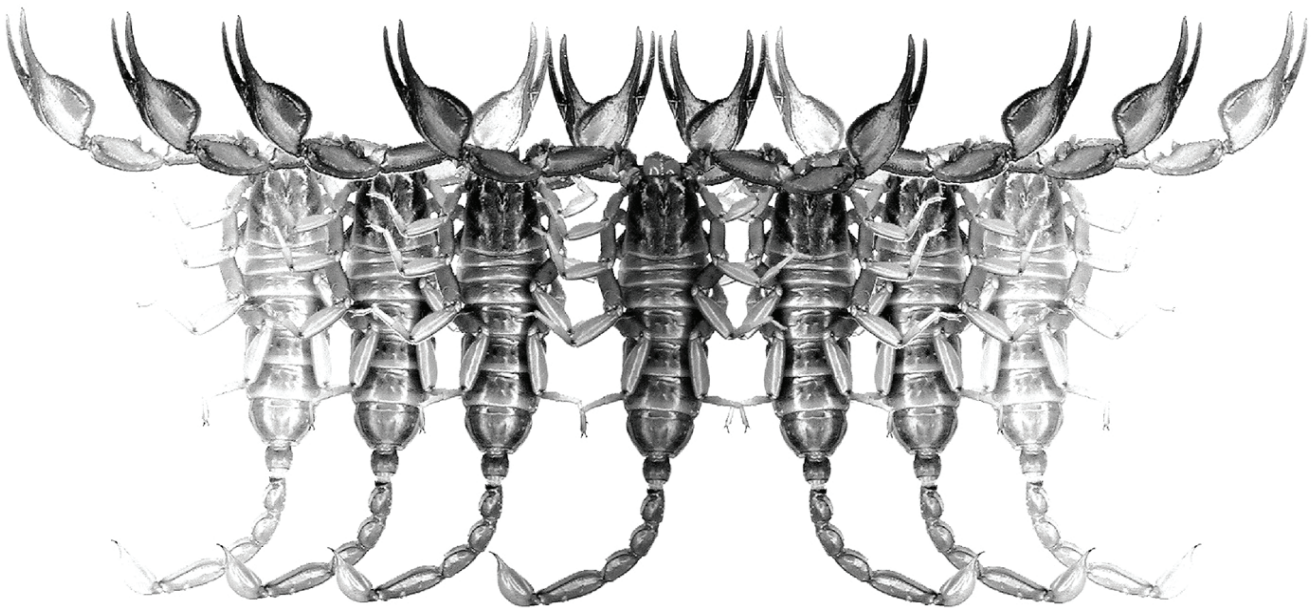


Euscorpius

Occasional Publications in Scorpiology



**Scorpions of Sri Lanka
(Arachnida: Scorpiones). Part III.
Heterometrus yaleensis sp. n. (Scorpionidae)**

František Kovařík, Kithsiri B. Ranawana, V. A. Sanjeewa Jayarathne,
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Scorpions of Sri Lanka (Arachnida: Scorpiones). Part III. *Heterometrus yaleensis* sp. n. (Scorpionidae)

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<http://zoobank.org/urn:lsid:zoobank.org:pub:7FD99C20-A9A1-4D96-990B-EA87D5899BAD>

Summary

Heterometrus yaleensis sp. n. from Sri Lanka, Southern Province, Yale National Park is described and compared with other species of the genus. The presence of a unique dorsointernal carina on the pedipalp chela distinguishes *H. yaleensis* sp. n. from all other *Heterometrus* species. Additional information is provided on the taxonomy and distribution of the genus *Heterometrus* in Sri Lanka, fully complemented with color photos of specimens of both sexes of the new species, as well as of their habitat. In addition to external morphology and hemispermatophore, we also describe the karyotype of *H. yaleensis* sp. n. (2n=99).

Introduction

Kovařík et al. (2016, 2018) summarized data about all 19 known scorpion species of Sri Lanka. These species are members of four families; Buthidae (13 species of genera *Buthoscorpio* Werner, 1936; *Charmus* Karsch, 1879; *Hottentotta* Birula, 1908; *Isometrus* Ehrenberg, 1828; *Lychas* C. L. Koch, 1845; and *Reddyanus* Vachon, 1972), Chaerilidae Pocock, 1893 (one species, *Chaerilus ceylonensis* Pocock, 1894), Hormuridae Laurie, 1896 (one species, *Liocheles australasiae* (Fabricius, 1775)), and Scorpionidae Latreille, 1802 (4 species of the genus *Heterometrus* Ehrenberg, 1828).

During a 2nd scorpological expedition in the period of 4 – 17 March 2018 to survey 17 carefully selected localities, we found several new localities for the genus *Heterometrus* (Fig. 53), and discovered in Yale National Park (Southern Province) a new species described here as *Heterometrus yaleensis* sp. n.

Methods & Material

Specimens collected during the scorpological expedition between 4 – 17 March 2018 are cited as „leg. Kovařík et al.“ These scorpions were collected by a research team consisting of the following members: František Kovařík, David Hoferek, František Štáhlavský, and Matyáš Hříman (Czech Republic); Kithsiri B. Ranawana, Sanjeewa Jayarathne, and Sanjaya Karunaratne (University of Peradeniya, Sri Lanka).

Specimens examined here were collected and exported legally, via permit R&E/RES/NFSRCM/2018-01 issued by the Forest Department, Sri Lanka. We only collected samples needed for taxonomic revisions of each species. For

conservation purposes, additional samples of species that were encountered at various sites were not taken, but were recorded photographically in the field.

Nomenclature and measurements herein follow Stahnke (1971), Kovařík (2009), and Kovařík & Ojanguren Affilastro (2013), except for trichobothriotaxy (Vachon, 1974), hemispermatophore (see legends of Figs. 40–45), and sternum (Soleglad & Fet, 2003).

Karyotype analyses were based on chromosome preparations prepared by the spreading technique which is frequently used in scorpions (e. g., Kovařík et al., 2009; Plíšková et al., 2016). The chromosomes were stained by 5% Giemsa solution in Sørensen phosphate buffer for 30 min. Five spermatocyte nuclei were measured using the software Image J 1.45r (<http://rsbweb.nih.gov/ij>) with the plugin Levan (Sakamoto & Zacaro, 2009).

Systematics

Family Scorpionidae Latreille, 1802

Heterometrus Ehrenberg, 1828 (Figs. 1–53, Table 1)

Buthus (*Heterometrus*) Ehrenberg in Hemprich & Ehrenberg, 1828: pl. 1, figs 1–2 (part, only fig. 2); Hemprich & Ehrenberg, 1829: 351.

Heterometrus: Kovařík, 2004: 1–59, figs. 1–32 (complete reference list until 2004); Kovařík, 2009: 34–49, 73–113, figs. 1–283; Kovařík et al., 2016: 96–113, figs. 15, 458–546, 571–574.

		<i>H. yaleensis</i> sp. n.	<i>H. yaleensis</i> sp. n.
Dimensions (MM)		♂ holotype	♀ paratype
Carapace	L / W	12.276 / 12.068	15.781 / 14.485
Mesosoma	L	18.374	39.947
Tergite VII	L / W	4.234 / 9.993	5.861 / 11.748
Metasoma + telson	L	44.657	47.072
Segment I	L / W / D	5.077 / 5.897 / 5.222	5.604 / 6.937 / 5.168
Segment II	L / W / D	5.948 / 5.449 / 4.875	6.130 / 6.119 / 5.067
Segment III	L / W / D	6.551 / 4.986 / 4.767	6.662 / 5.872 / 4.885
Segment IV	L / W / D	7.659 / 4.723 / 4.162	7.521 / 5.275 / 4.207
Segment V	L / W / D	9.924 / 4.282 / 4.083	10.637 / 4.392 / 4.172
Telson	L / W / D	9.498 / 4.103 / 3.181	10.518 / 3.583 / 3.072
Pedipalp	L	46.520	46.661
Femur	L / W	10.610 / 4.510	10.248 / 4.717
Patella	L / W	12.519 / 4.951	11.751 / 5.662
Chela	L	23.391	24.662
Manus	W / D	11.458 / 6.039	13.094 / 6.578
Movable finger	L	12.299	14.725
Total	L	75.307	102.80

Table 1. Comparative measurements of *Heterometrus yaleensis* sp. n. types. Abbreviations: length (L), width (W, in carapace it corresponds to posterior width), depth (D).

TYPE SPECIES. *Buthus (Heterometrus) spinifer* Ehrenberg, 1828, by subsequent designation (Karsch, 1879: 20).

ETYMOLOGY. Named after Yale National Park, which includes both localities of the new species.

DIAGNOSIS: Pedipalp femur with three trichobothria, only one of which is on the internal surface. Patella of pedipalp with 19–20 trichobothria, three on ventral surface, and 13 on external surface. Chela of pedipalp with 26 trichobothria. Retrolateral pedal spurs absent. Lateroapical margins of tarsi produced into rounded lobes. Metasomal segments I to IV with paired ventral submedian carinae. Stridulatory organ located on opposing surfaces of pedipalp coxa and first leg. Total length 60 to 180 mm.

***Heterometrus yaleensis* sp. n.**

(Figures 1–53, Table 1)

<http://zoobank.org/urn:lsid:zoobank.org:act:DC95D39E-5F59-4AE1-9387-562B5C4AF0EA>

TYPE LOCALITY AND TYPE REPOSITORY. **Sri Lanka**, Southern Province, Yale National Park, 06°13'48.1"N 81°20'27.7"E, 7 m. a.s.l. (Locality **18CE**), FKCP (the first author collection).

TYPE MATERIAL. Sri Lanka, Southern Province, Yale National Park, 06°13'48.1"N 81°20'27.7"E, 7 m. a. s. l. (Locality **18CE**), 8.-9.III.2018, 1♂ (holotype) 1♀ (paratype), leg. Kovařík et al.; 06°23'46.5"N 81°23'34.1"E, 40 m. a. s. l. (Locality **18CC**), 7.-8.III.2018, 1♀ (paratype), leg. Kovařík et al.

DIAGNOSIS. Total length of adults 75 (male) to 103 (female) mm. Base color uniformly reddish brown to black, telson yellow to reddish brown, legs yellow to reddish brown, lighter than body. Chelicerae yellow with dark reticulation, anterior manus and fingers reddish black. Pectines with 13–14 teeth in both sexes. Male pedipalp chela, femur and patella narrower and longer than female, ratio chela length/ manus width 2.04 in male, 1.88 in female. Chela lobiform in both sexes, strongly tuberculate with pronounced carination, including dorsointernal carina on chela in both sexes. Patella of pedipalp with several small internal tubercles. Carapace smooth, very sparsely granulated laterally. Metasomal segment I wider than long, length/ width ratio 0.80–0.86 in both sexes. Telson hirsute, elongate, ventrally sparsely granulate, vesicle approximately as long as aculeus.

Description. Total length male holotype 75.3 mm, female paratype 102.8 mm. Coloration (Figs. 1–4, 51–52): base color uniformly reddish brown to black; telson and sternopectinal area yellow to reddish brown; legs yellow to reddish brown, lighter than body. Measurements of the carapace, telson, segments of the metasoma and segments of the pedipalps are given in Table 1.

Chelicerae (Figs. 26–27). Chelicerae yellow strongly reticulate, anterior part reddish black. Fingers reddish brown



Figures 1–2: *Heterometrus yaleensis* sp. n., holotype male, dorsal (1) and ventral (2) views. Scale bar: 10 mm.

to black. Dentition typical for the genus, teeth sharp. Tegument basally smooth and glossy without granulation.

Pedipalps (Figs. 5–21). Orthobothriotaxic type C. Pedipalp femur with three trichobothria, only one of which lies on the internal surface. Patella of pedipalp with 19 trichobothria (Figs. 16–18), one internal, two dorsal, three ventral and 13 external. Chela of pedipalp with standard 26 trichobothria (Figs. 13–15). Male with fingers, chela, femur and patella of pedipalp narrower and longer than female, ratio of chela length/manus width 2.04 in male, 1.88 in female. Chela lobiform in male, strongly tuberculate with pronounced carination, including dorsointernal carina in both sexes. Patella smooth with seven obsolete carinae developed, with several small internal tubercles. Femur smooth, with four granulate carinae developed. Fingers extremely short, especially the fixed finger of the female (Fig. 21).

Carapace (Figs. 36 and 38). Slightly trapezoidal (narrower anteriorly) and slightly longer than wide; anterior margin

strongly concave medially. Tegument smooth very sparsely granulated laterally. Median and posteriolateral furrows wide and deep, others absent. Median eyes large and raised; three pairs of lateral eyes of the same size, aligned along each anterolateral corner.

Mesosoma (Figs. 1–4, 36–39). Tergites smooth, lacking carinae. Sternum standard for the genus: type 2 with six sides, with posterior emargination and convex lateral lobes, vertical compression absent, apex width slightly narrower than posterior width. Pectines of typical size for the genus, short, wide and setose. Pectinal tooth count 13–14 in both sexes. Pectines with 3 marginal lamellae, 4 middle lamellae. Sternites lack carinae, surfaces smooth and sparsely setose. Posterior margins of sternites IV–VI each with smooth median patch.

Legs (Figs. 22–25). Retrolateral pedal spurs absent. Lateroapical margins of tarsi produced into rounded lobes. Legs smooth, without carinae and granules, unevenly hirsute.



Figures 3–4: *Heterometrus yaleensis* sp. n., paratype female, dorsal (3) and ventral (4) views. Scale bar: 10 mm.

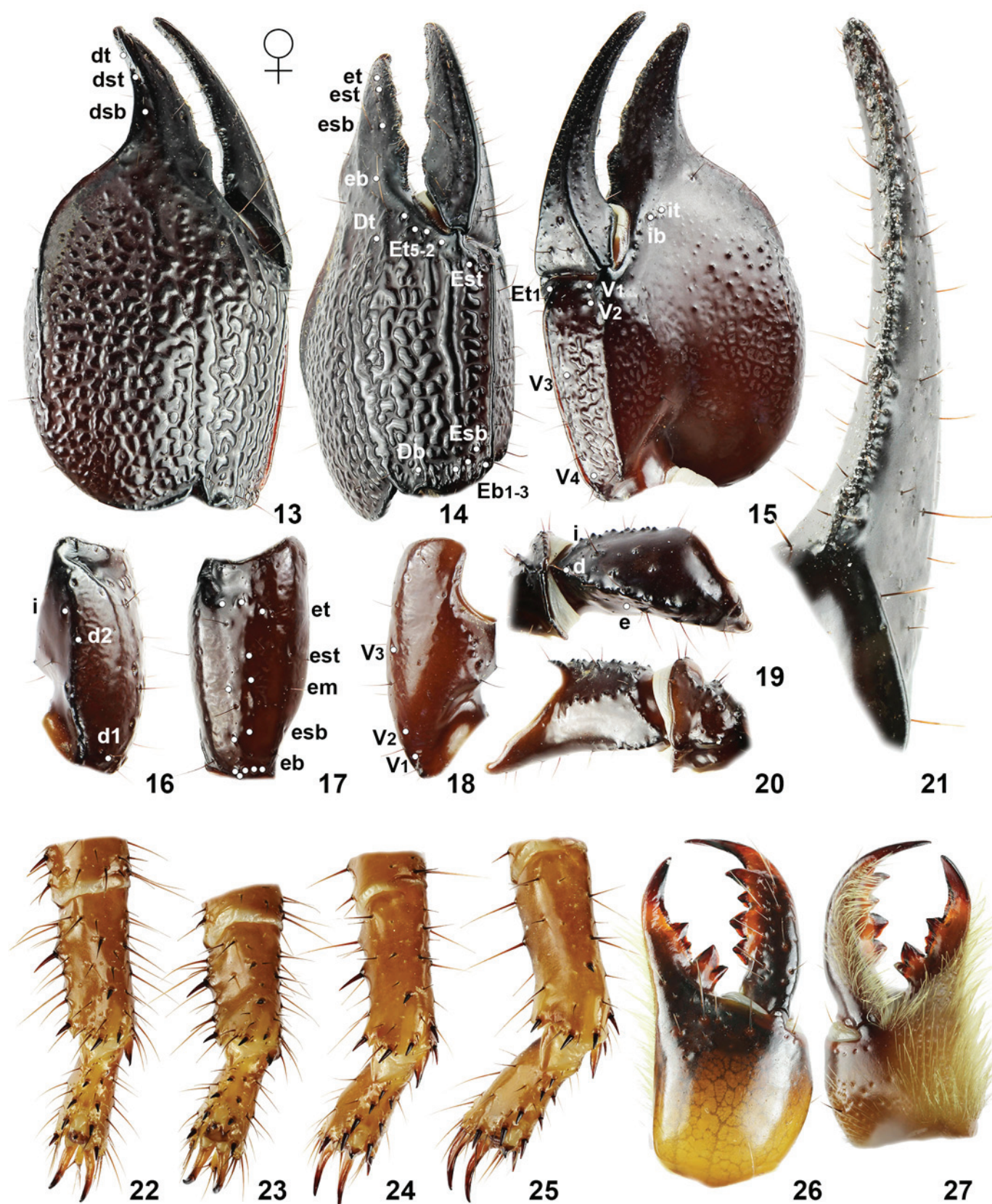
Tarsomere I hirsute. Tarsomere II with spiniform setae and several spines. Spiniform seta formula of tarsomere II is 4/4: 4/4: 5/4: 5/4.

Metasoma and telson (Figs. 28–35). All segments with carinae developed. All carinae on metasoma V and dorsal carinae on metasoma II–IV granulate, others smooth. Metasomal segment

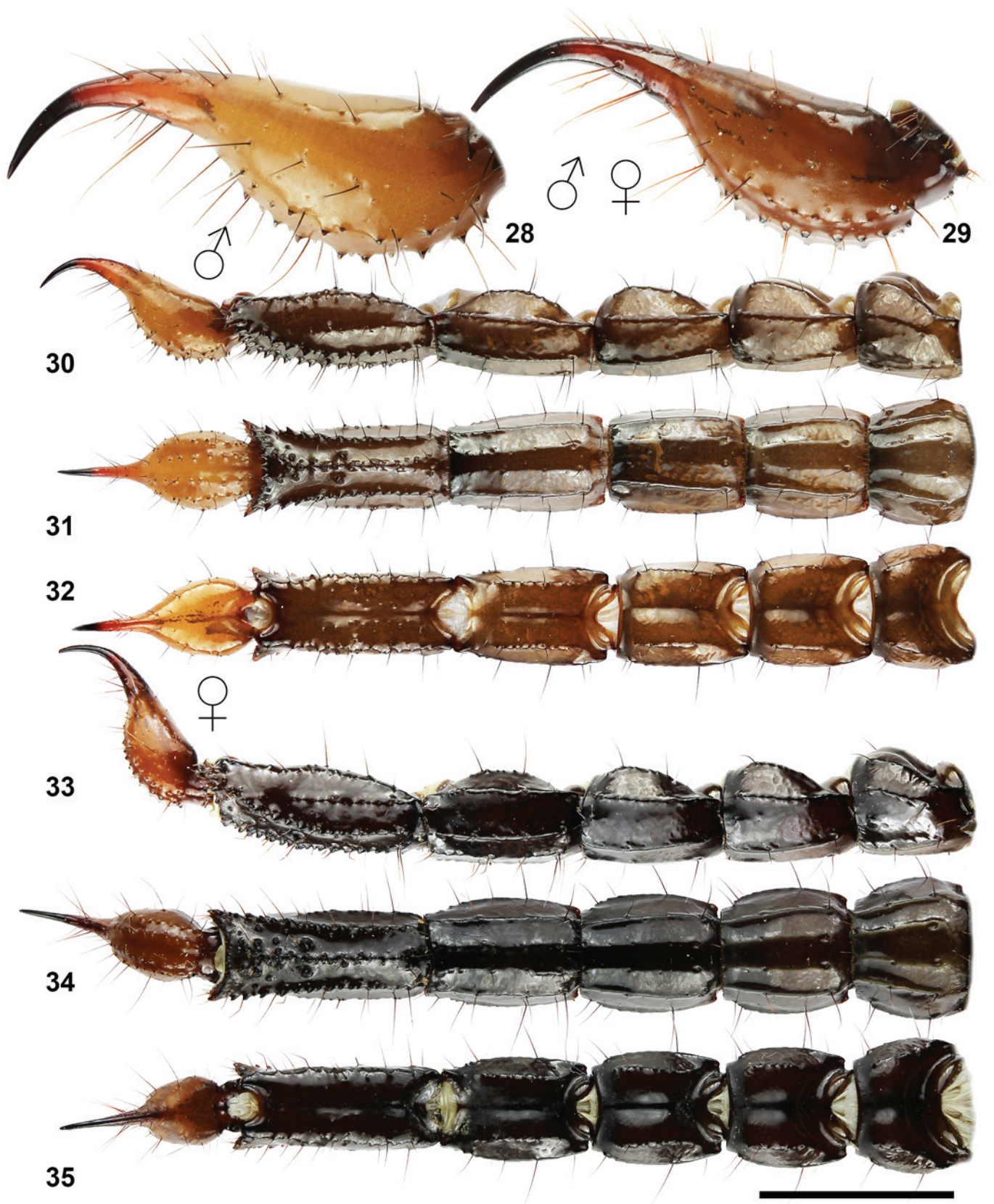
I wider than long, length/ width ratio 0.80–0.86 in both sexes. The metasoma I–IV with eight carinae, metasoma V with seven carinae. All metasomal segments completely smooth without granules. Several minute granules present only on dorsal aspect of metasoma V. Metasoma sparsely hirsute with long reddish macrosetae. Telson hirsute with long macrosetae,



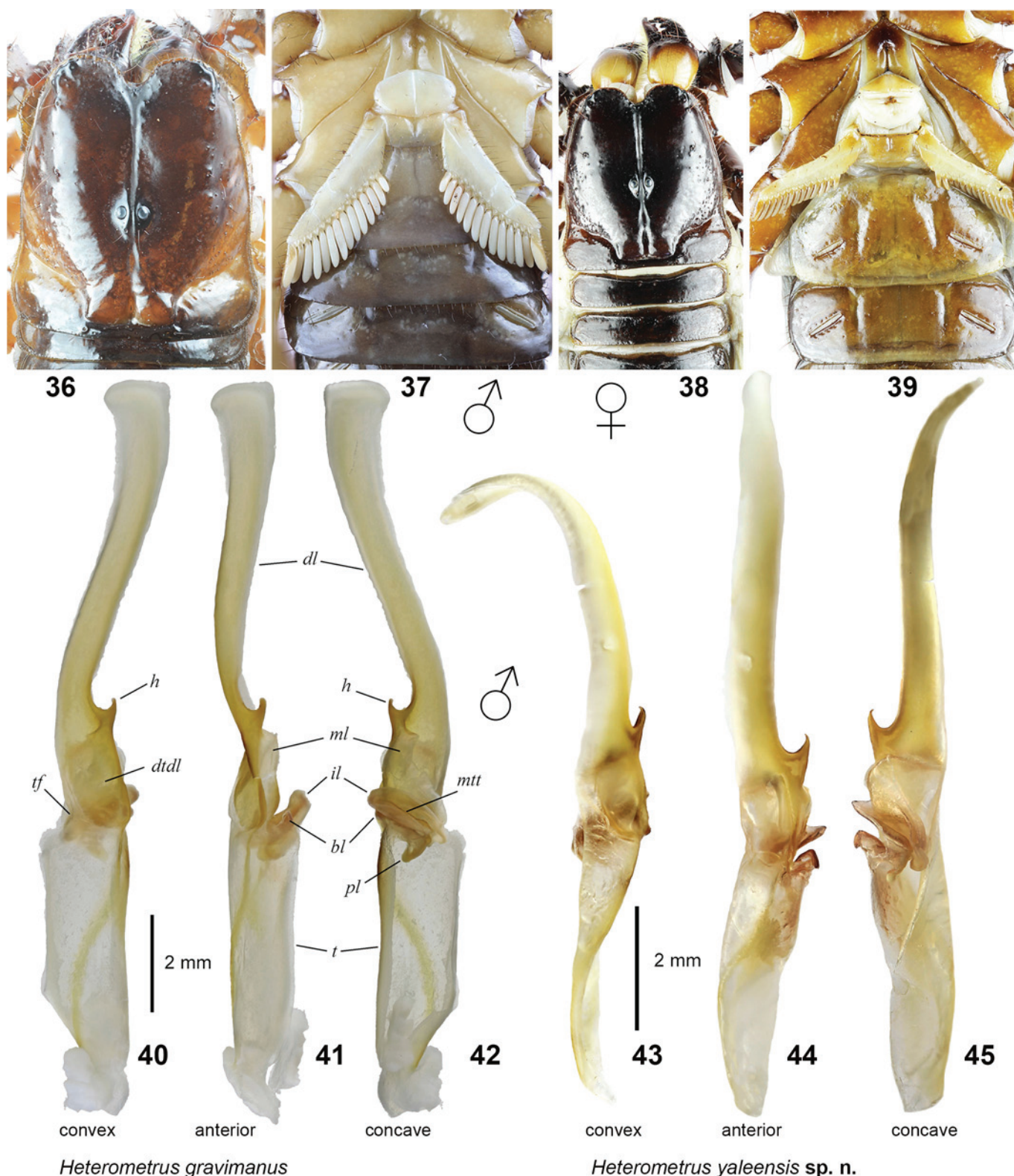
Figures 5–12: *Heterometrus yaleensis* sp. n., holotype male, pedipalp chela dorsal (5), external (6), and ventral (7) views, pedipalp patela dorsal (8), external (9), and ventral (10) views, pedipalp femur dorsal (11) and ventral (12) views.



Figures 13–27: *Heterometrus yaleensis* sp. n., paratype female. **Figures 13–21.** Pedipalp chela dorsal (13), external (14), and ventral (15) views, pedipalp patella dorsal (16), external (17), and ventral (18) views, pedipalp femur dorsal (19) and ventral (20) views, and pedipalp movable finger dorsal view (21). The trichobothrial pattern is indicated in Figures 13–19. **Figures 22–25.** Distal segments of legs I–IV, retrolateral views. **Figures 26–27.** Right chelicera dorsal (26) and ventral (27) views.



Figures 28–35: *Heterometrus yaleensis* sp. n., telson and metasoma. **Figures 28, 30–32.** Holotype male, telson lateral (28), metasoma and telson, lateral (30), ventral (31), and dorsal (32) views. **Figures 29, 33–35.** Polotype female, telson lateral (29), metasoma and telson, lateral (33), ventral (34), and dorsal (35) views. Scale bar: 10 mm (30–35).



Figures 36–45: Figures 36–39, 43–45: *Heterometrus yaleensis* sp. n. Figures 40–42: *H. gravimanus* (Pocock, 1894). Figures 36–37. Holotype male, carapace and tergite I (36), and sternopectinal region and sternites III–V (37). Figures 38–39. Paratype female, carapace and tergites I–II (38), and sternopectinal region and sternites III–IV (39). Figures 40–45. Comparison of right hemispermatophores of *H. gravimanus* from North Central Province, Anuradhapura District, Mihintale, 08°20'51.8"N 080°30'27.7"E, 156 m a.s.l. (40–42; reproduced from Kovařík et. al., 2016) and *H. yaleensis* sp. n., holotype male (43–45). Convex (40 and 43), anterior (41 and 44) and concave (42 and 45) aspects. Scale bars: 2 mm (40–42 and 43–45). Abbreviations: *bl*, basal lobe; *dl*, distal lamina; *dt dl*, dorsal trough of distal lamina; *h*, hook; *ml*, median lobe; *mtt*, median transverse trough; *pl*, proximal lobe; *t*, trunk; *tf*, truncal flexure.



Figures 46–48: Chromosomes of male holotype *Heterometrus yaleensis* sp. n. ($2n=99$). **Figure 46.** Mitotic metaphase. **Figure 47.** Pachytene. **Figure 48.** Metaphase I. Arrows indicate chromosomes of quadrivalent, arrowheads indicate chromosomes of tetravalent. Scale bar = 10 μ m.

smooth, sparsely granulated ventrally. Vesicle elongate, lateral profile elliptic or weakly pyriform. Aculeus curved with thick base, distally sharply bent, approximately as long as vesicle.

Hemispermaphore (Figs. 43–45). Lamelliform. Distal lamina long, slender, basal capsular portion short, ca. 10% of total lamina length, wider, dorsal trough nearly flat with slightly elevated transverse strip, bordered internally by strong carina; portion of lamina distal to hook uniform in width throughout most of its length; distal terminus of lamina rounded, slightly tapered, not dilated or expanded. Hook prominent, with curved, sharp tip and wide triangular base, lacking dorsal trough. Median lobe elongate, extending from base of hook to truncal flexure, with fine longitudinal carina and trough along internal side. Inner lobe and median transverse trough large, prominent. Basal and proximal lobes smaller but well developed, blunt, rounded. All lobes of capsule region smooth, without barbs or spicules. Trunk broader than both capsule and distal lamina, parallel-sided, with moderately sclerotized diagonal axial rib.

Karyotype (Figs. 46–48). We analyzed the male holotype. The diploid number of this species is 99 chromosomes (Fig. 46). During pachytene and metaphase I we identified also one quadrivalent and one trivalent in addition to 46 bivalents (Figs. 47, 48). The chromosomes that form multivalents have different lengths. The quadrivalents comprise the two longest chromosomes of the karyotype (1.86 % and 1.71 % of the diploid set) and two shorter chromosomes (1.07 % and 0.89 % of the diploid set). The tetravalent comprises one longer chromosome (1.38 % of the diploid set) and two very short chromosomes (0.71 % and 0.61% of the diploid set). Despite the different lengths, all chromosomes that form multivalents seem to be metacentric. Metacentric morphology of chromosomes predominate also in bivalents (34 pairs). We identified only seven pairs of submetacentric (pairs Nos. 9, 11, 18, 20, 29, 42, 43), three pairs of subtelocentric (pairs Nos. 35, 38, 41) and two pairs of telocentric chromosomes (pairs Nos. 45, 46).

AFFINITIES. The described features distinguish *H. yaleensis* sp. n. from all other species of the genus. *H. yaleensis* sp. n. is

reliably distinguished from all other *Heterometrus* species by the unique carination of the chela, with a strongly developed dorsointernal carina (Figs. 5 and 13 versus figs. 180–231 in Kovařík, 2009: 99–101). Other major taxonomically important characters are the shape and granulation of the pedipalp chela with extremely short fixed finger (Figs. 5 and 13) and the spiniform seta formula of tarsomere II 4/4: 4/4: 5/4: 5/4.

COMMENTS ON LOCALITIES AND LIFE STRATEGY. At the type locality (Locality No. **18CE**, Southern Province, Yale National Park, 06°13'48.1"N 81°20'27.7"E, 7 m. a.s.l.) and locality No. **18CC** (Southern Province, Yale National Park, 06°23'46.5"N 81°23'34.1"E, 40 m. a.s.l.) *H. yaleensis* sp. n. constructed oblique 30 to 50 cm long burrows once or twice curved, situated in open terrain (Figs. 49–50). On the ground among leaf litter we also recorded at both of these localities *Lychnis srilankensis* Lourenço, 1997 and at locality 18CC *Reddyanus basilicus* (Karsch, 1879).

At locality 18CC we recorded temperature varied from 31 °C (maximum temperature at day) to 24.7 °C (minimum temperature at night) and humidity varied between 48% and 78%. At the locality 18CE we recorded a minimum nighttime temperature of 24.3 °C (temperature) and nighttime humidity of 65%.

Acknowledgments

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Figures 49–50: *Heterometrus yaleensis* sp. n., locality 15CC (49) and type locality 15CE (50)



Figures 51–52: *Heterometrus yaleensis* sp. n., in vivo habitus. Male holotype (51) and female paratype (52).

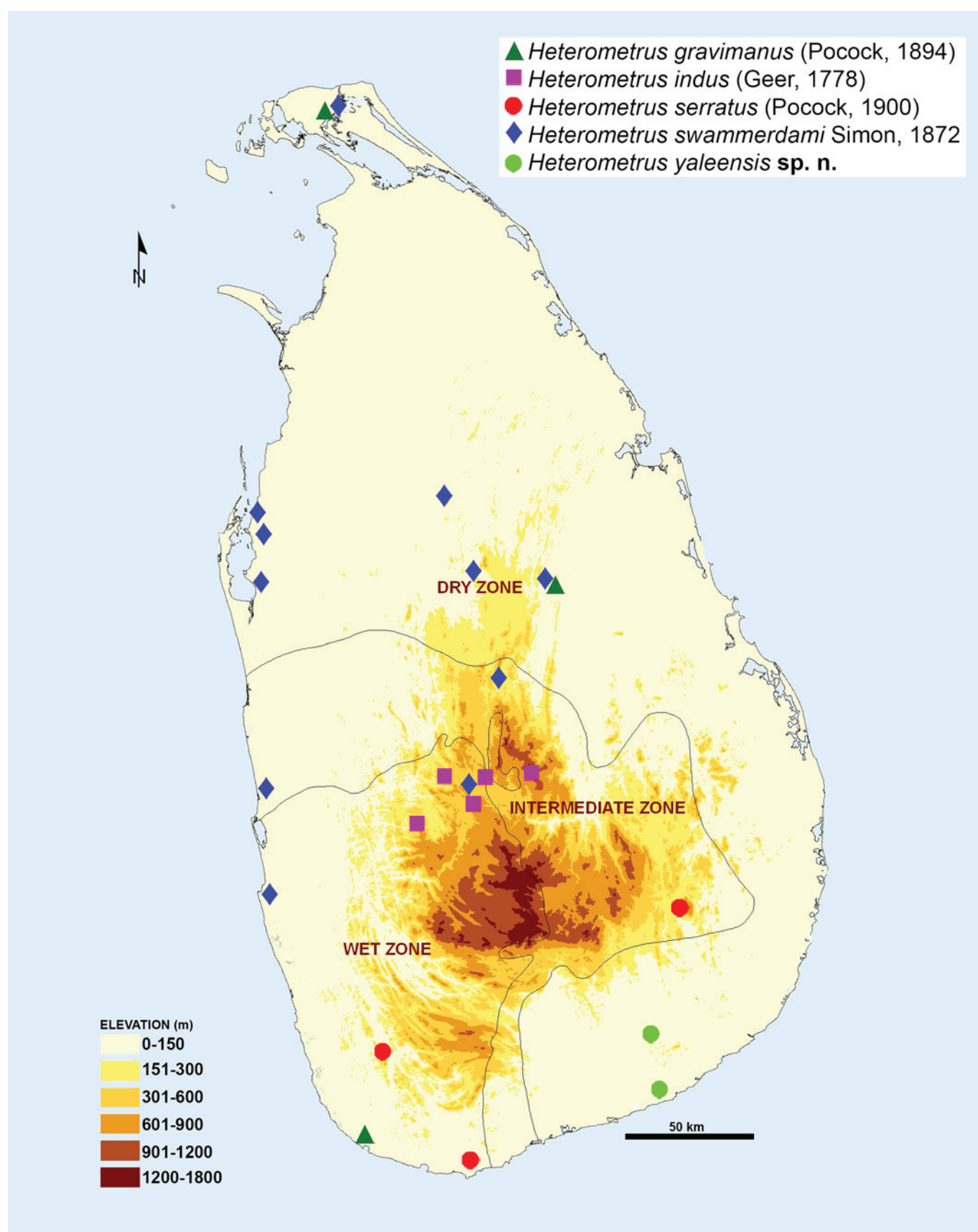


Figure 53: Map showing confirmed distribution of the Sri Lankan *Heterometrus* species.

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