

Revision of East Asian whip scorpions (Arachnida Uropygi Thelyphonida). II. Thailand and adjacent areas

Ревизия жгутоногих пауков Восточной Азии (Arachnida Uropygi Thelyphonida). II. Таиланд и соседние области

Joachim Haupt
Й. Хаупт

University of the Ryukyus, Tropical Biosphere Research Center (Iriomote Station), 870 Uehara, Taketomi-cho 907-15, Japan and Institut für Biologie, Technische Universität Berlin, FR 1-1, Franklinstraße 28/29, D-10587 Berlin, Germany
Университет островов Рюкю (Япония) и Институт биологии, Технический университет Берлина (ФРГ).

KEY WORDS: Arachnida, Uropygi, taxonomy, *Typopeltis*, *Ginosigma*, *Hypoctonus*, *Thelyphonus*, Thailand, revision.

КЛЮЧЕВЫЕ СЛОВА: Arachnida, Uropygi, таксономия, *Typopeltis*, *Ginosigma*, *Hypoctonus*, *Thelyphonus*, Таиланд, ревизия.

ABSTRACT. A revision of whip scorpions from Thailand and adjacent areas has led to the description of two new species, *Hypoctonus siamensis* sp.n. and *Typopeltis soidaoensis* sp.n. The females of *Typopeltis kasnakowi* Tarnani, 1900, and *T. tarnanii* Pocock, 1902, are described for the first time, and the diagnosis of the genus *Ginosigma* Speijer, 1936 is completed.

РЕЗЮМЕ: В результате ревизии жгутоногих пауков Таиланда и соседних областей даны описания *Hypoctonus siamensis* и *Typopeltis soidaoensis* spp.n. Впервые описаны самки *Typopeltis kasnakowi* Tarnani, 1900, и *T. tarnanii* Pocock, 1902; дан дополненный диагноз рода *Ginosigma* Speijer, 1936.

Introduction

The present study is inclined to complete a revision of *Typopeltis* species, and round up data on whip scorpions from Thailand in order to facilitate a survey on this group of Arachnids in continental East Asia. For practical reasons and in cause of the few records available, some species reported from areas adjacent to Thailand have also been included in this study.

Abbreviations see in Part I.

Taxonomic part

Whip scorpion species from Thailand and adjacent areas

Family Thelyphonidae Lucas, 1835

Subfamily Hypoctoninae Pocock, 1899 (pro Hypoctini Pocock, 1899)

Genus *Hypoctonus* Thorell, 1889

Hypoctonus siamensis sp.n.

Figs 1a, 2a, 3a, 4a.

Holotype. NHMW: ♂. Type locality. Khao Chong, 150 m alt., Thailand, P. Schwendinger leg., 1986-8-17. Paratype. NHMW (♀) from Doi Suthep, 1180 m alt., Thailand, P. Schwendinger leg., 1987-8-29/10-2. Other material examined: NHMW 1 ♀ (damaged), 3 nymphs from Doi Suthep, P. Schwendinger leg., 1987-9-30/7-3, 1985-12-2, 1986-1-1. NHMW 1 nymph from Khao Chong, Trang Province, Thailand, P. Schwendinger leg., 1986-8-17, NHMW 1 nymph from Sai Yok, 100 m alt., Kanchanaburi Province, West Thailand, P. Schwendinger leg. 1987-7-21, CAS 1 ♂ from Doi Suthep, 260 m alt., E.S. Ross & D.Q. Cavagnaro leg. 1962-7-15.

Diagnosis: Small, slender species, three opisthosomal tergites divided, median side of patella with a conspicuous triangular tooth. Male (Figs 1a, 2a) with a broad and flat patellar apophysis, genital plate with a posteromedian projection. Female (Figs 3a, 4a) with a proximal and two subapical teeth on median side of patellar apophysis, hind margin of genital plate regularly curved, ventral surface with slight median and posterolateral depressions.

Description: Keel lacking, ridge between anterior eyes reaching almost to front edge of carapace, where it is broader than between eyes. Front line of carapace even, indistinctly dentate, triangular projection from below rim. Transverse wrinkles in median part behind anterior eyes, carapace otherwise with coarse granules, except in areas around and behind anterior eyes (Fig. 1a). First three opisthosomal tergites with a median division.

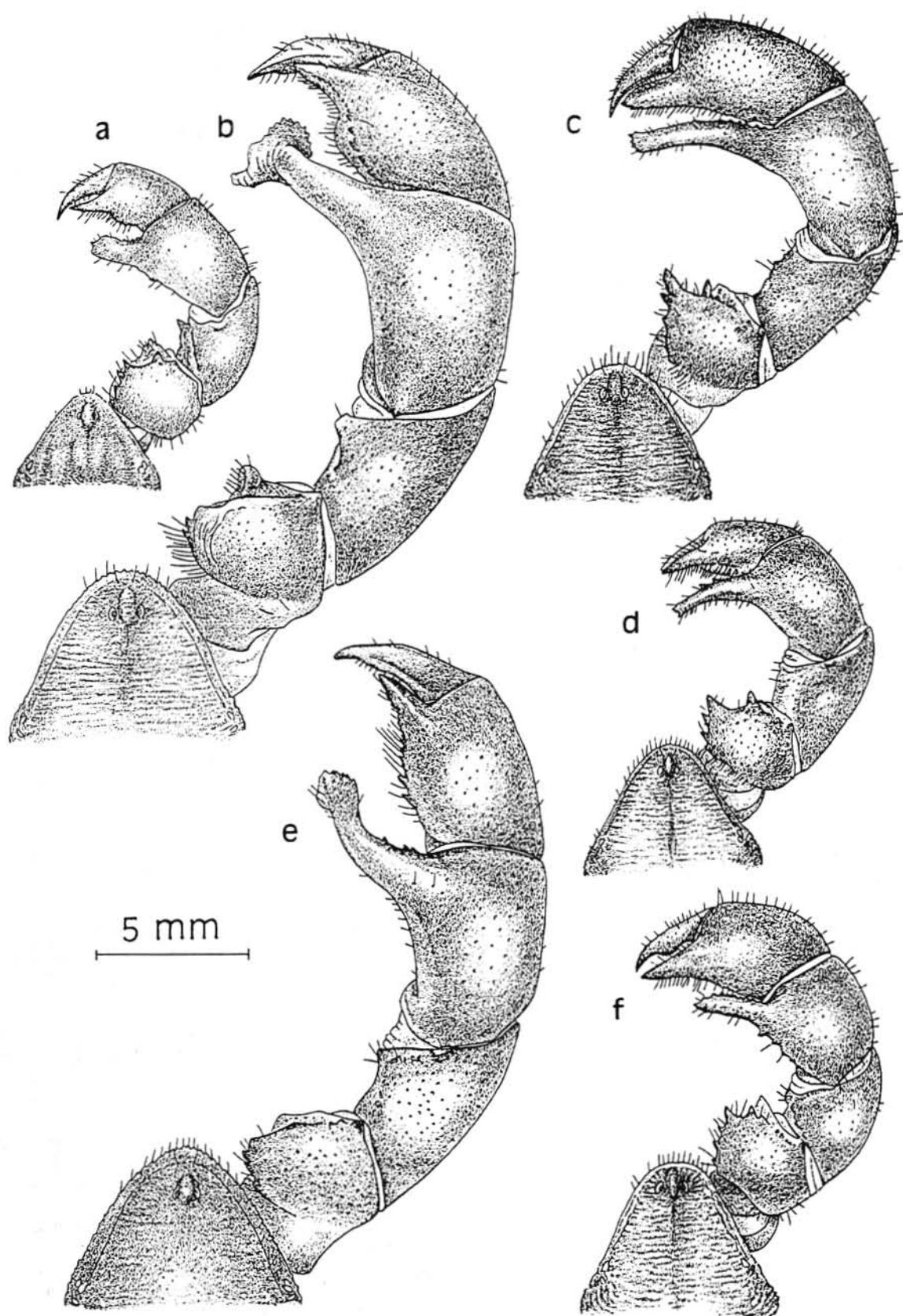


Fig. 1. Anterior part of prosoma and pedipalp of ♂ whip scorpions: a — *Hypoctonus siamensis* sp.n., b — *Tyropeltis dalyi*, c — *Tyropeltis kasnakowi*, d — *Tyropeltis soidaoensis* sp.n., e — *Tyropeltis tarnanii*, f — *Ginosigma schinkewitschi*.

Рис. 1. Передняя часть просомы и педипальпа ♂ жгутоногих пауков: а — *Hypoctonus siamensis* sp.n., б — *Tyropeltis dalyi*, в — *Tyropeltis kasnakowi*, д — *Tyropeltis soidaoensis* sp.n., е — *Tyropeltis tarnanii*, ф — *Ginosigma schinkewitschi*.

Male: Dorsal side of trochanter almost hexagonal, median side with four teeth, 4th stout, without acute tip, 5th also stout, situated at some distance from 4th and close to distal margin of trochanter (Fig. 1a). One large and one smaller tooth on ventral side of trochanter. Femur with a medioventral ridge leading to a large tooth. Patella with a stout triangular tooth on median side; apophysis broad and flat, terminating in two medial teeth and a round projection; a pronounced keel on ventral side and two short, slender teeth on ventrolateral side, parallel to keel. (In *Hypoctonus andersoni* Oates, 1889, a species which may be considered similar, the patellar apophysis is perfectly cylindrical for two-thirds of its length, then widening and terminating in a single, recurved spine). Genital plate (Fig. 2a) at a pronounced posterior margin with a clear-cut median part, ventral surface of median part even, paramedian convex parts with very delicate transverse wrinkles. Anterior and lateral parts of genital plate slightly punctate. 3rd sternite with a small median tooth at hind margin, weakly sclerotized sensillar field with numerous hair sensilla anterior to tooth. Body length: 23 mm, carapace 8 mm.

Female: No modifications on articles of tactile leg (paratype specimen with tarsal articles of left tactile leg shorter, apparently due to regeneration after injury at an earlier instar). Pedipalps (Fig. 3a): Dorsal side of trochanter broader than in male, tooth 5 closer to tooth 4 (paratype specimen with malformation on left side: additional teeth on ventral side of 4th tooth). Median patellar tooth acute, one proximal and two farther distal teeth on median side of patellar apophysis, a row of seven teeth on lateral side facing a serrated ridge of tibia. Genital plate (Fig. 4a) regularly curved at hind margin, but median clear-cut part narrower than in male, with a slight median and a slight posterolateral depression on ventral surface, a few transverse wrinkles in anteromedian area, punctation almost lacking, but upright hair sensilla present in anterior and lateral areas. 3rd sternite with a triangular, less heavily sclerotized area in anterior part, hind margin almost clear-cut in median part. Body length: 31 mm.

Subfamily Typopeltinae Rowland & Cooke, 1973

Genus *Typopeltis* Pocock, 1894

Typopeltis dalyi Pocock, 1900
Figs 1b, 2b.

Typopeltis dalyi Pocock, 1900: (♂): 297-298, figs 1, 1a-c

Typopeltis dalyi — Tarnani, 1901: 214.

Typopeltis dalyi — Gravely, 1916: 70.

Typopeltis dalyi — Rowland & Cooke, 1973: 69.

Material examined: Type. The original type material consisting of 2 ♂♂, 2 ♀♀, 1 ♂, is kept in BMNH. Locus typicus: Lacan, via Raheng (Tak, Tak Province), Thailand, coll. Mahon Daly, 1899-8-18.

Diagnosis: Large black species with coarse, irregular punctation on pedipalps. Male with a long patellar apophysis projecting ventromedially, 9-10 terminal teeth and a broad ventral keel in terminal section. Female genital plate emarginate at hind margin, surface with a pair of posteriorly converging depressions and a pair of anterolateral depressions.

Redescription: Male (Figs 1b, 2b): Prosomal cuticle wrinkled in anterior half. Keel prominent, flattened in

front of eye tubercle. Margin of carapace denticulate on anterior side, further backward with smooth, irregular teeth above 1st pair of legs, followed by fine teeth. Surface of pedipalps with coarse and irregular punctation (generally hair sensilla), cuticle delicately punctate in between. Trochanter of pedipalps anterior to median ridge with patch of wrinkles, two median teeth plus a stout anterior tooth. Femur with one acute ventromedian tooth. Patellar apophysis weakly denticulate on inner side, projecting far medioventrad, terminal part broadened, acute in posterior part, rounded and denticulate (9-10 teeth) in anterior part, with a broad, flat, longitudinal keel on ventral side. Tibia denticulate on medial side, tibial finger with smaller separate teeth in posterior part, anterior ridge with a regular row of stout teeth, similar to that on medial side of movable finger. Ventral surface of genital plate smooth, with hair sensilla especially numerous in lateral and anterior parts; slight median depression present. Hind margin with a delicate median margin of hairs and a flat posteromedian excavation. 3rd sternite with a triangular, weakly sclerotized field of bristles. Hind margin with a flat triangular process. Body length: 48 mm.

Female genital plate as described and illustrated by Pocock [1900: fig. 1c]: Hind margin emarginate in its middle third. Surface with a pair of depressions converging posteriorly, and an anterior, slightly depressed portion on each side, which emphasizes a low tuberculiform eminence.

Typopeltis harmandi Kraepelin, 1901
Figs 3b, 4b.

Typopeltis harmandi Kraepelin, 1901: 8, fig. 3.

Typopeltis harmandi — Gravely, 1916: 71.

Typopeltis harmandi — Speijer, 1936: 252.

Typopeltis harmandi — Rowland & Cooke, 1973: 69.

Material examined: Types. Two ♂♂ (one adult, the other juvenile) from Cochinchina (South Vietnam). ZMH: juvenile ♂ (Paratype), MNHN: ♂ juvenile ex typis, III, 1900, Cochinchina.

Note: Kraepelin characterized this species by two oval impressions close to the anterior margin of the genital plate (lacking in juvenile specimens), hind margin of genital plate concave, posterior surface with a shallow, almost circular impression, and lateral S-shaped furrows. Lateral surface of genital plate with coarse punctation.

No new material of this species could be obtained.

Speijer [1934] intended to create a new genus (*Gipopeltis* nom. nud.) for this species but, having failed to give its diagnosis, he left this name invalid.

Typopeltis kasnakowi Tarnani, 1900
Figs 1c, 2c, 3c, 4c, 5a.

Typopeltis kasnakowi Tarnani, 1900: 481-482.

Typopeltis kasnakowi — Tarnani, 1901: 207, pl. IX, figs 1-3.

Typopeltis kasnakowi — Gravely, 1916: 70.

Typopeltis kamahouii — Rowland & Cooke, 1973: 69 (lapsus for *kasnakowi*; erroneously mentioned for Siberia).

Material examined: Types. ZISP: 3 ♂♂, apparently missing. Type-locality. Aran-kull, Ta-ta-khaw and Watanaa, in the delta area of Menam River. ZMB 30673: ♂ from Phu Pha Nam Tip, Nong Pok District, Roi Et Province, NE Thailand (Lat. 16.22°N -104.18°E, J. Nabhitabhata leg. 1991-5-28/29. Other material: ZMB 30674: 2 ♂♂, 4 ♀♀, 12 nymphs: all material from Phu Pha Nam Tip non-hunting area, 330 m alt., Nong Pok District, Roi Et Province, North East Thailand (lat. 16.22°N — long. 104.18°E),

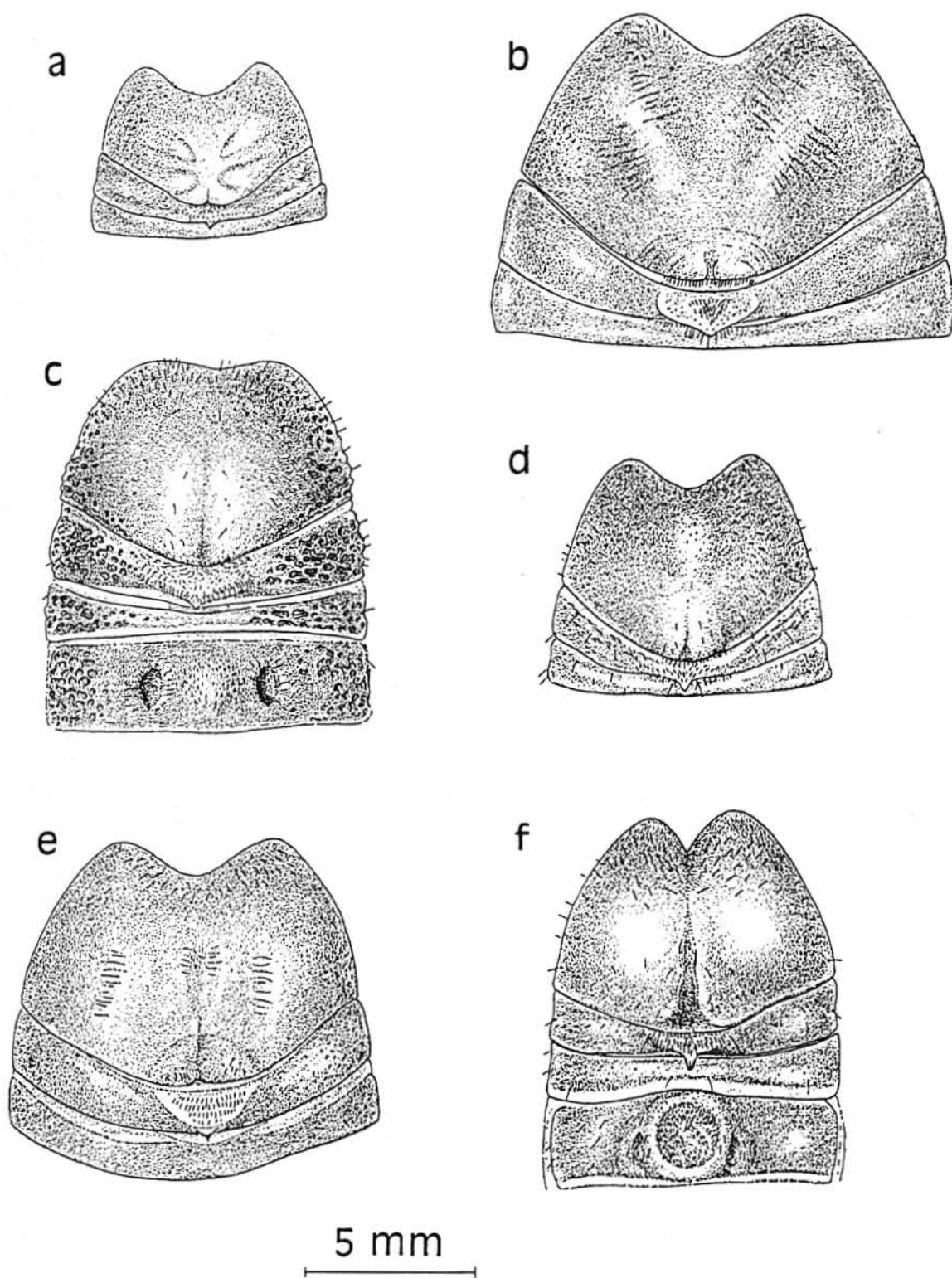


Fig. 2. Genital plate and subsequent opisthosomal sternites of ♂: a — *Hypoconus siamensis* sp.n., b — *Typopeltis dalyi*, c — *Typopeltis kasnakowi*, d — *Typopeltis soidaoensis* sp.n., e — *Typopeltis tarnanii*, f — *Ginosigma schinkewitschi*.

Рис. 2. Генитальная пластинка и последующие сегменты опистосомы ♂: а — *Hypoconus siamensis* sp.n., б — *Typopeltis dalyi*, в — *Typopeltis kasnakowi*, г — *Typopeltis soidaoensis* sp.n., д — *Typopeltis tarnanii*, е — *Ginosigma schinkewitschi*.

leg. J. Nabhitabhata 1991-5-28/29, TNC: 1 ♂, 1 ♀, 3 nymphs from Phu Pha Nam Tip, Nong Pok District, Roi Et Prov., leg. J. Nabhitabhata 1991-5-28/29.

Diagnosis: Reddish-brown, slender species. Male with a long, slender patellar apophysis carrying six teeth in laterobasal part and terminating in three teeth. Genital plate strongly convex, 5th sternite with a median oval field of long hair sensilla. Female with a small terminal tooth on ventral side of articles 6-8 of tactile leg. Genital plate with a W-shaped hind margin, a pair of large oval lateral depressions.

Redescription: Anterior part of prosoma flattened, a large lateral depression behind lateral eyes. Keel almost reaching the front of eye tubercle. Anterior rim of carapace denticulate. Opisthosomal tergites not divided. Ommatoids almost round. Flagellar organs on basal article about 3-4 times longer than wide, distal ones in basal area of corresponding article, generally oval or almost round, hardly twice as long as wide.

Male: Pedipalp (Fig. 1c) with smooth cuticle, covered with a few hair sensilla. Trochanter on upper surface almost triangular in median part, with a large acute tooth at tip (No. 4), 1st tooth almost reduced, 2nd small, 3rd at mediad base of 4th tooth, 5th slender and acute, at some distance from 4th. Two very small teeth at ventral edge. Femur without median tooth, only one very small tooth at ventromedian edge. Patella with a long, slender apophysis running parallel to tibia, and almost reaching its tip. Upper side rounded, but ventromedian edge forming a right angle. Inner ridge of patellar apophysis smooth, outer ridge with six teeth in basal half, distal half smooth; terminal part slightly bent ventrad, terminating in three teeth, middle one surmounted by two smaller ones on dorsal side. Tibia with a row of about 18 small teeth on median side, opposing the patellar apophysis. Tibial finger stout, with an acute tip. Genital plate (Fig. 2c) evenly rounded at hind margin, surface strongly convex, with a steep slope on lateral side and a median depression anterior to hind margin. Lateral part of plate and subsequent sternites with coarse lateral pits. 3rd sternite with a short terminal projection at hind margin, crescent-shaped central part elevated, less heavily sclerotized and densely covered with hair sensilla. 4th sternite short, median part less heavily sclerotized, 5th sternite with an oval median sensillar field surrounded by slightly wrinkled cuticle. Body length: 34 mm, carapace 12 mm.

Female: Articles 6-8 of tactile leg with a small terminal tooth: in 6th article on medial side, in 7th and 8th articles on lateral side (Fig. 5a), otherwise unmodified. Pedipalps (Fig. 3c): Trochanter much broader on upper side than in male, 1st tooth small but distinct, size of teeth increasing toward 4th, 5th tooth slightly smaller, placed on anterior side. Two acute teeth on ventral side. Femur with two small acute teeth at median edge, ventral side with a large acute tooth. Patella with three small teeth at median edge, apophysis with a subapical tooth on median side, a regular row of six teeth facing a denticulate part of tibial finger. Ventral side of patella with a small acute tooth close to distal rim. Ventromedian side of tibia with a large terminal tooth. Genital plate (Fig. 4c) with a W-shaped hind margin, ventral surface with a large, oval, lateral depression and a median depression anterior to hind margin. Cuticle inside depressions slightly wrinkled. 3rd sternite with a narrow, U-shaped impression extending laterally to projection of genital plate, anterior part of sternite less heavily sclerotized except for a narrow

median interruption. Lateral cuticle wrinkled. Body length: 39 mm.

Note: In general appearance, *T. kasnakowi* is very similar to *Thelyphonus wayi* Pocock, 1900, but the articles of the female tactile legs are unmodified, as far as blackened areas are concerned. The patellar apophysis is similar to that of *Typopeltis cantonensis*, but males of *T. cantonensis* lack the oval sensillar field on the 5th opisthosomal sternite.

Typopeltis soidaoensis sp.n.

Figs 1d, 2d, 3d, 4d.

Material examined: Holotype: NHMW: ♂ from Khao Soi Dao, 300 m alt., Chanthaburi Province, SE Thailand, P. Schwendinger leg. 1987-5-9. Paratype: NHMW: ♀ from the same locality.

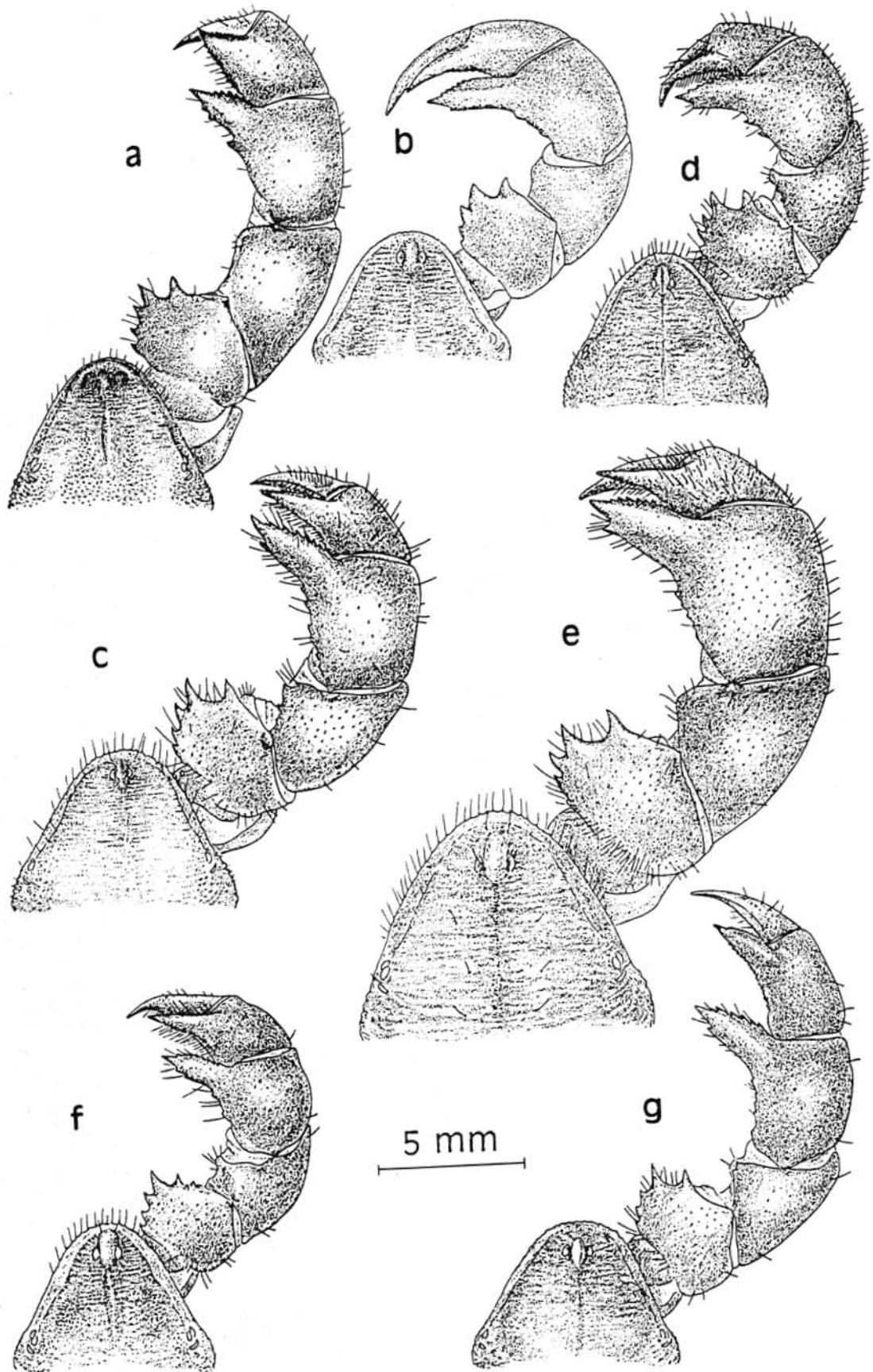
Other material: ZMB 30675: No. 2 ♀♀ from Thailand, purchased in Berlin, used for analysis of secretion products [Haupt et al., 1994]. MNHN: 1 ♀ from Tonkin, Jean Lavoisier leg. CAS: 1 ♀, 20 miles SE of Chanthaburi (= Chanthaburi), 75 m alt., coll. E.S. Ross & D.Q. Cavagnaro 1967-8-1. NHMG: 1 ♀ from Khao Yai National Park, Nakhon Ratchasima Province, Thailand, P. Schwendinger leg. 1987-5-5.

Diagnosis: Dark brown species, carapace with small regular granules. Keel petering beyond region of anterior eyes. Male patellar apophysis even on median side, five teeth of increasing size proximally on anterior side, surface of an evenly rounded genital plate convex with a small longitudinal depression at hind margin. Female patellar apophysis with a large subapical tooth and six teeth on anterior side, hind margin of genital plate cut straight in median part, 3rd sternite cut straight at hind margin.

Description: Keel reaching the region of anterior eyes, then less distinct and indicated by a row of separate small granules, pedipalps densely punctate, eye tubercle pronounced, anterior part broader. Anterior ridge of carapace with pronounced denticulation, which is lacking above pedipalps but continues above tactile leg. Opisthosomal tergites 2 and 3 with indistinct division. Whip organs: Basal one about thrice as long as wide, others oval, situated at proximal margin of articles.

Male: Pedipalp (Fig. 1d): Dorsal side of trochanter trapeziform, with four acute teeth of increasing size at median margin, 5th one slender, less acute, at distance on anterior side. Two strong ventral teeth. Femur only with a ventromedial acute tooth. Patellar apophysis slightly decreasing in width, gently bowing ventrad. Median side even, anterior (lateral) side in proximal part with five teeth of increasing size, bowing in distal direction. Distal part of apophysis with a subapical tooth on anterior side and with five short terminal fingers (two smaller ones in median position between lateral ones, one stout projection on ventral side). Tibia at distal margin with a strong medioventral tooth. Genital plate (Fig. 2d) evenly rounded at hind margin. Surface convex with a small longitudinal impression anterior to hind margin. Close to margin, a dense row of hair sensilla. 3rd sternite with a transverse, rhombic, less heavily sclerotized area of hair sensilla. Hind margin with a median dental projection. 4th sternite very short. Body length: 29 mm.

Female: Pedipalp (Fig. 3d): Trochanter similar to that of male, but 4th and 5th teeth more acute. Femur and patella at dorsomedian margin with two small teeth. Patellar apophysis smooth on posterior side, but with a big subapical tooth, six teeth of increasing size on anterior



side. Tarsal articles of tactile leg unmodified on surface, but with black glandular areas on ventral side of articles 6-9. Genital plate (Fig. 4d) rounded at posterior margin, but median part cut almost straight. Surface convex with three longitudinal slight depressions (median and slightly oblique lateral). 3rd sternite with hind margin cut straight and an unsclerotized anterior part (except for a thin median bar), following the shape of genital plate hind margin. Body length: 29-31 mm.

Typopeltis tarnanii Pocock, 1902

Figs 1e, 2e, 3e, 4e.

Typopeltis tarnanii Pocock, 1902: 164-165.

Typopeltis tarnani — Gravelly, 1916: 70.

Typopeltis tarnanii — Rowland & Cooke, 1973: 69.

Material examined: Holotype. BMNH (♂). Type locality. Lampun (= Lamphun), North Thailand, coll. Mahon Daly, 1901-1-3. Other material: NHMW: ♀ from Doi Saket, P. Schwendinger leg., 1986-5-17. MCZ: 1 ♂ from Doi Chiang Dao, leg. Harvard Asiatic Primate Expedition, April. CAS: 1 ♀ from East slope of Doi Suthep, 260 m alt., coll. E.S. Ross & D.Q. Cavagnano, 1962-7-15.

Diagnosis: Large blackish species with coarse cuticle on carapace. Male patellar apophysis bent anteroventrally, terminating in a denticulated rhombus (five teeth) with a broad rounded keel on ventral side. Female genital plate at hind margin slightly W-shaped, ventral surface with a quadrangular median plate, lateral depressions slightly converging toward hind margin.

Redescription: Carapace (Fig. 1e) with coarse cuticle (usually bases of hair sensilla) and transverse wrinkles, anterior margin of carapace denticulated, keel in the area of eye tubercle dissolving into small separate teeth.

Male: Pedipalp (left one lacking, therefore mirror-image of the right one for a better comparison, Fig. 1e): Trochanter on dorsomedian side with two acute teeth preceded by a hump, a further hump at anterior margin. Patellar apophysis bent in anteroventral direction, terminating in a rhombus with five teeth, ventral side of rhombus with a broad rounded keel. Basal trunk of apophysis with 2+1 teeth on anterior side. Tibia on median side with acute cones (two big cones in proximal position, one smaller, one big and 9 smaller successive tips). Tarsus flat on dorsal side, with a slightly depressed area with hair sensilla. One-fourth of tarsus occupied by a homogeneous, solid tip, median part of inner edge denticulated, opposing tibia. Genital plate (Fig. 2e) strongly convex, hair sensilla especially at margin, surface of posterior one-third depressed, hind margin with numerous fine bristles. 3rd sternite weakly sclerotized in median part, transverse area of hair sensilla, hind margin with a sharp median tooth.

Female: Keel (Fig. 3e) pronounced on more than half of the distance from lateral eyes to front of eye tubercle, but then only marked by a row of hair sensilla. Anterior part of carapace between eye tubercle and anterior rim slightly decreasing, indistinctly dentated at margin. Eye tubercle broad and smooth, flanked by lateral depressions. Pedipalp: Trochanter on upper side with 1st tooth almost lacking, only marked by base of hair sensillum. 2nd to 4th teeth of increasing length, 4th tooth marking

the anteromedian edge of trochanter, 5th tooth of about same size as 4th, set at distance. Patella at inner margin with a small tooth. Patellar apophysis broad, with a stout subapical tooth on median side, regular dentation on lateral side opposing a similar dentation at inner margin of tibia. Genital plate (Fig. 4e) at hind margin with a lateral curved projection, median part only slightly curved, thus slightly W-shaped, with hair sensilla at hind margin. Plate surface with a quadrangular median plate, bordered by a pair of lateral, slightly oblique, longitudinal depressions, slightly converging toward hind margin (sometimes with a shallow, posteromedian depression and a wrinkled cuticle at anterior margin). 3rd sternite with a crescent-shaped, less strongly sclerotized, median area; 5th to 6th sternites with a median group of hair sensilla directed posteriad, almost parallel to cuticular surface. Whip organs of characteristic, narrow, lengthy shape. Body length: 45 mm, carapace 16 mm.

Subfamily Thelyphoninae Lucas, 1835 (nom. corr. Rowland & Cooke, 1973)

Genus *Ginosigma* Speijer, 1936

New diagnosis: Prosomal keel incomplete, at least opisthosomal tergites 2-3 divided, females' two terminal tarsomeres of tactile leg modified: ultimate article lengthy, with a prominent keel. Male patellar apophysis unmodified, opisthosomal sternites 2, 3 and 5 modified.

Type-species: *Ginosigma schimkewitschi* (Tarnani, 1894)

Ginosigma schimkewitschi (Tarnani, 1894)

Figs 1f, 2f, 3f, 4f, 5b.

Thelyphonus schimkewitschi Tarnani, 1894: 31.

Thelyphonus schimkewitschi — Tarnani, 1894/95: 116-120, figs 7, 8, 10, 13, 14.

Thelyphonus schimkewitschi — Kraepelin, 1897: 29-30, pl. II, fig. 30.

Thelyphonus schimkewitschi — Kraepelin, 1899: 215, 219, 220, fig. 76.

Thelyphonus schimkewitschi — Pocock, 1900: 298.

Thelyphonus schimkewitschi — Gravelly, 1916: 77, figs 33, 43.

Ginosigma schimkewitschi — Speijer, 1936: 256.

Ginosigma schimkewitschi — Rowland & Cooke, 1973: 67.

Type locality: Bangkok. Material examined: CAS: 1 ♂, 1 ♀, 3 nymphs from Doi Suthep, 260 m alt., 1962-7-15. 1 ♀ with praenymphs from Yan Hee Dam, 250 m alt., coll. E.S. Ross & D.Q. Cavagnano, 1962-7-13. MNHN: B 141, 1 ♂ from Luang-Prabang, Laos, coll. Counillon, 1896-9-16. 1 ♀ from Cochinchina. 1 ♀ from Singapore. SMF: (RII/7649), 1 ♀ from Siam (ex coll. Roewer Lfd. Nr. 7649. ZMB: 15797 subadult ♂, Siam, Budenbender leg., 7018. 1 ♂, 1 ♀, Siam, Becker leg. NHMW: 1 Ser., Bangkok, Donau-Expedition, Rausonnet leg. 1868/69.

Diagnosis: A distinguished keel running forward from lateral eyes but petering already behind the region of a pronounced eye tubercle, cuticle in anterior part of carapace with transverse wrinkles. 5th sternite with a median, depressed, circular sensillar field, much larger in male. Female with a crown-shaped modification of last but one tarsal article of tactile leg, ultimate article much

Fig. 3. Anterior part of prosoma and pedipalpus of ♀ whip scorpions: a — *Hypoctonus siamensis* sp.n., b — *Typopeltis barmandi*, c — *Typopeltis kasnakowi*, d — *Typopeltis soidaoensis* sp.n., e — *Typopeltis tarnanii*, f — *Ginosigma schimkewitschi*, g — *Thelyphonus wayi*.

Рис. 3. Передняя часть просомы и педипальпы ♀ жгутоногих пауков: а — *Hypoctonus siamensis* sp.n., б — *Typopeltis barmandi*, в — *Typopeltis kasnakowi*, д — *Typopeltis soidaoensis* sp.n., е — *Typopeltis tarnanii*, ф — *Ginosigma schimkewitschi*, г — *Thelyphonus wayi*.

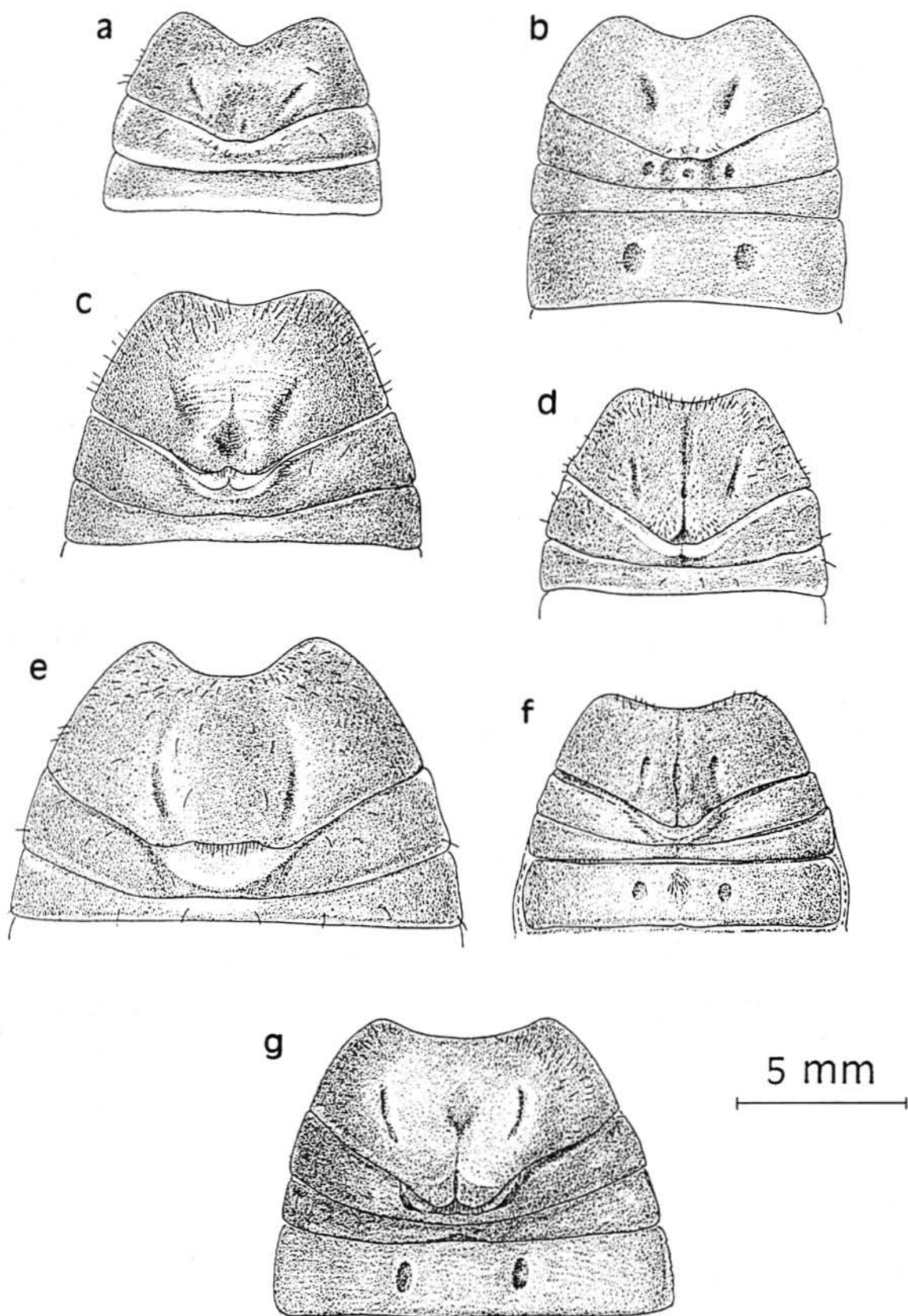


Fig. 4. Genital plate and subsequent opisthosomal sternites of ♀: a — *Hypoctonus siamensis* sp.n., b — *Typopeltis harmandi*, c — *Typopeltis kasnakowi*, d — *Typopeltis soidaoensis* sp.n., e — *Typopeltis tarnanii*, f — *Ginosigna schinkewitschi*, g *Thelyphonus wayi*.

Рис. 4. Генитальная пластинка и последующие сегменты опистосомы ♀: а — *Hypoctonus siamensis* sp.n., б — *Typopeltis harmandi*, в — *Typopeltis kasnakowi*, д — *Typopeltis soidaoensis* sp.n., е — *Typopeltis tarnanii*, ф — *Ginosigna schinkewitschi*, г *Thelyphonus wayi*.

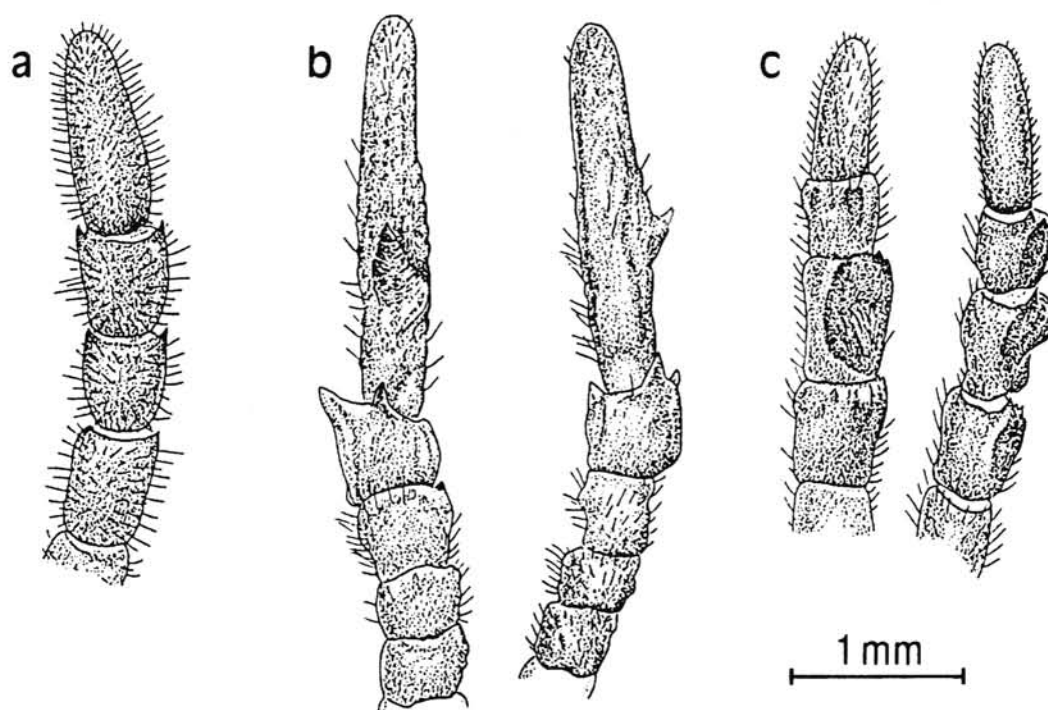


Fig. 5. Modifications of tarsal articles in the $\varnothing$ tactile leg: a — *Typopeltis kasnakowi*, b — *Ginosigma schimkewitschi*, c — *Thelyphonus wayi* (left side dorsal view and right side ventral view).

Рис. 5. Модификации члеников лапок на чувствительных лапах $\varnothing$: а — *Typopeltis kasnakowi*, б — *Ginosigma schimkewitschi*, в — *Thelyphonus wayi* (левая сторона дорсально и правая сторона вентрально).

longer, with a prominent keel and a protruding blunt tooth on it. Tarnani [1894/95] mentions formic acid as secretion product.

Redescription: Male: An almost rectangular upper surface of pedipalp trochanter, four teeth on median side, two teeth and a series of five small teeth on anterior side. Femur with a small cuticular stump on dorsomedian side, patella with a row of 2-5 teeth, patellar apophysis dentated on anterior (lateral) side, with a subterminal tooth on median side. Genital plate strongly convex, with a longitudinal median depression widening at posterior margin. 3rd sternite with a pronounced crescent-shaped sensillar field terminating at hind margin in a strong median tooth. 4th sternite unmodified, 5th with a round, crater-like sensillar field. Body length: ca. 27 mm.

Female with six teeth on upper surface of pedipalp trochanter. A characteristic crown-shaped structure with three prominent projections on last but one tarsal article of tactile leg. Terminal article elongated, with a prominent keel terminating in a blunt tooth. Genital plate at hind margin evenly rounded in middle part, surface with a median longitudinal depression, accompanied by a paired, shorter, oblique, lateral depression. Body length: 27-29 mm. Carapace 11 mm.

Note: Rowland & Cooke [1973] already pointed out that the genus *Ginosigma* [Speijer, 1936] is poorly diagnosed, and discussed the formal problems concerning the availability of this generic name. With a more intensive study of Indonesian Uropygi, *G.ombokensis* Speijer, 1936, from the island of Lombok, may well turn out to be an island population of *G. schimkewitschi*, and the genus *Ginosigma* synonymous with *Thelyphonus*.

Concerning the genus *Thelyphonus*, Speijer refers to modifications on articles 5-8 of the tactile leg of the adult female, which are 'gerimpeld en zwart gekleurd', i.e. notched and stained black. Pocock [1894] already questioned the importance of these morphological modifications in the distal articles of the female tactile leg. Similar black modifications appear also in other genera, and at least in females of the genus *Typopeltis* their occurrence is irregular [Haupt, 1996]. Therefore the genus *Thelyphonus* Latreille, 1802, is left over as ill-defined. At present, *Thelyphonus* is considered as the least specialized genus in Asia [Weygoldt, 1978] as regards the morphology and mating behaviour [Klingel, 1963].

Doubtful species

Genus *Thelyphonus* Latreille, 1802

Thelyphonus wayi Pocock, 1900

Figs 3g, 4g, 5c.

Thelyphonus wayi Pocock, 1900: 295-296, figs 3, 3a-3b.

Thelyphonus wayi — Gravely, 1916: 75.

Thelyphonus wayi — Rowland & Cooke, 1973: 66.

Material examined: Holotype. BMNH ($\varnothing$). Type locality. Battambang (= Batdambang, Kampuchea), coll. H.W.L. Way 1898-6-28.

Diagnosis: Almost black, with reddish-brown legs. In the adult female, 3rd article of tactile leg twice as long as wide and subequal to 2nd (articles 6-8 modified with black cuticular parts), tibial spurs present in 2nd to 4th legs, female genital plate angularly emarginate in the middle of its posterior border.

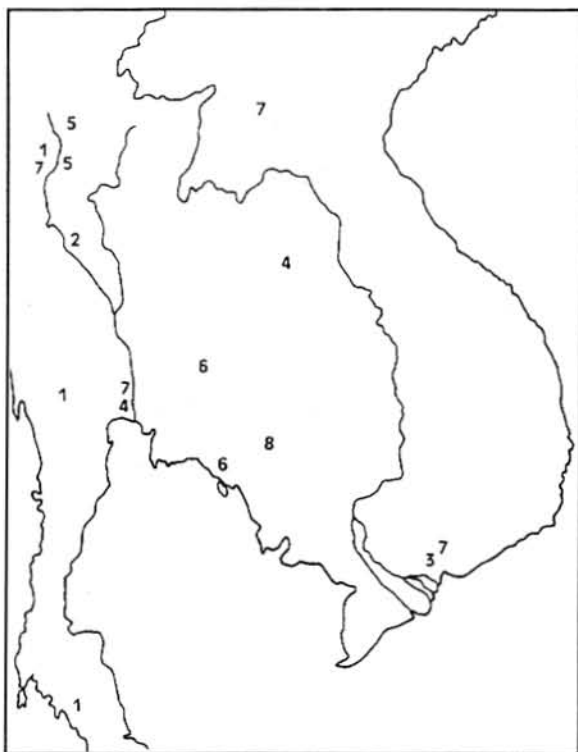


Fig. 6. Geographic records of whip scorpions in Thailand and adjacent areas: 1 — *Hypoctonus siamensis*, 2 — *Typopeltis dalyi*, 3 — *Typopeltis barmandi*, 4 — *Typopeltis kasnakowi*, 5 — *Typopeltis tamaritii*, 6 — *Typopeltis soidaoensis*, 7 — *Ginosigma schinkewitschi*, 8 — *Thelyphonus wayi*.

Рис. 6. География находок жгутоногих пауков в Таиланде и соседних областях: 1 — *Hypoctonus siamensis*, 2 — *Typopeltis dalyi*, 3 — *Typopeltis barmandi*, 4 — *Typopeltis kasnakowi*, 5 — *Typopeltis tamaritii*, 6 — *Typopeltis soidaoensis*, 7 — *Ginosigma schinkewitschi*, 8 — *Thelyphonus wayi*.

Prosoma with a short and broad eye tubercle. Cuticle of carapace with slight transverse wrinkles, finely and densely punctate. Anterior half of keel turning toward lateral side and petting. Margin of carapace on front side with irregular denticulation, in the region of 1st pair of legs more strongly and more regularly denticulated. Pedipalp trochanter on dorsal side with five acute teeth on median side. Patellar apophysis distally with coarse denticulation, tibial apophysis with regular denticulation on both sides, surface almost even, with a few hair sensilla. Distal article of tactile leg unmodified, but articles 6-8 with small terminal teeth on medial side, 6th article even with three such projections, additional blackish coloration and modified sculpturing on medial side of articles 6-8 (Fig. 5c). Hind margin of genital plate with a W-shaped posteromedian projection, median part with a regular row of hair sensilla. 3rd sternite with a median, less heavily sclerotized impression of crescent shape, surrounded on posterior side by a stronger cuticular portion. Body length: 37 mm.

Note: Male unknown. Female known only from the holotype. Because of the tarsal modifications, Pocock placed this species into the genus *Thelyphonus*. Nevertheless, the habitus is that of a *Typopeltis*, and the close resemblance with the female of *Typopeltis kasnakowi* casts some doubt about the relations to this species.

Moreover, the black modifications are not symmetrical (Fig. 5c). Without knowledge of the male, and possibly the mating behaviour, which could explain the importance of modifications in articles of the tactile leg, no further conclusions can be drawn.

Key to the genera of continental Asian whip scorpions (including Japan, Taiwan and Hainan).

1. Coxa of pedipalp with a distinct accessory tooth at inner margin 2
- Coxa of pedipalp without distinct accessory tooth at inner margin 3
2. Prosoma without keel between lateral and median eyes, ♂ pedipalp rather long *Labochirus*
- Prosoma with a keel between lateral and median eyes *Uroproctus*
3. ♂ patellar apophysis modified, posterior opisthosomal tergites without suture 4
- ♂ patellar apophysis unmodified, posterior opisthosomal tergites with a suture 5
4. Prosoma with a partial or entire keel between median and anterior eyes *Typopeltis*
- Prosoma without keel between median and anterior eyes *Hypoctonus*
5. ♀ terminal tarsomere keel- or bayonet-shaped *Ginosigma*
- Tarsal articles of ♀ tactile leg with other differentiations *Thelyphonus*

Key to species of *Typopeltis*

1. Patellar apophysis modified ♂♂ 2
- Patellar apophysis unmodified ♀♀ 10
2. Patellar apophysis very slender, more or less straight, anterior and posterior sides almost parallel 3
- Patellar apophysis more or less strongly curved ventrally, terminal part paw-shaped 6
3. Dorsal view of pedipalp trochanter more or less triangular, with four big anteromedian teeth, 5th (anterior) tooth with a broad base *cantonensis*
- Pedipalp trochanter different 4
4. Patellar apophysis with anterior and posterior sides distinctly converging *soidaoensis*
- Patellar apophysis with anterior and posterior sides more or less parallel 5
5. 4th opisthosomal sternite with a circular sensillar pit, lateral parts of sternites coarsely punctate *kasnakowi*
- 4th opisthosomal sternite without circular sensillar pit, body length less than 29 mm, anterior tooth on dorsal side of trochanter acute, slightly bent laterally *vanoorti*
6. Anterior tooth on dorsal side of trochanter stout, thumb-like *crucifer*
- Anterior tooth on dorsal side of trochanter different 7
7. Dorsal view of pedipalp trochanter appearing smooth, rounded, whereas anterior tooth on dorsal side reduced 8
- Dorsal side of pedipalp trochanter with a small but distinct anterior tooth, large anteromedian teeth, in dorsal view therefore with an acute anteromedian tip 9
8. Terminal part of patellar apophysis extensively broadened, with a distinct ventral keel *dalyi*

- Terminal part of patellar apophysis hardly broadened *tarnanii*
- 9. Terminal part of patellar apophysis largely broadened, terminal teeth stout, trochanter forming a large, triangular, anteromedian projection *stimpsonii*
- Terminal part of patellar apophysis hardly broadened, terminal teeth acute, dorsal view of trochanter more compact *niger*
- 10. Genital plate with a sinusoid hind margin 11
- Genital plate with or without simple median excavation at hind margin 14
- 11. Ventral surface of genital plate with central pit surrounded by a cuticular wall 12
- Ventral surface of genital plate different 13
- 12. Cuticular wall on ventral surface of genital plate almost quadrangular *niger*
- Cuticular wall on ventral surface of genital plate almost circular *stimpsonii*
- 13. Ventral surface of genital plate with a Y-shaped depression *crucifer*
- Ventral surface of genital plate with a paramedian, slightly curved depression *tarnanii*
- 14. Paramedian depression on ventral surface of genital plate broad 15
- Paramedian depression on ventral surface of genital plate narrow 16
- 15. 3rd opisthosomal sternite with a median, small, circular sensillar field *harmandi*
- Hind margin of genital plate distinctly projecting in a pair of paramedian lobes *kasnakowi*
- 16. Anteroventral side of pedipalp trochanter with a pair of large teeth 17
- Anteroventral side of pedipalp trochanter without pair of large teeth, genital plate slightly excavated at hind margin, ventral surface with a long median groove and a short paramedian depression *soidaoensis*
- 17. Eye tubercle well-delimited, dorsal view of trochanter with five teeth, ventral surface of genital plate with a narrow paramedian groove *cantonensis*
- Eye tubercle with a gently arising median ridge, dorsal view of trochanter more lengthy, with six teeth, ventral surface of genital plate with an oval, only slightly depressed, paramedian groove, excavation at hind margin only indicated *guangxiensis*

Discussion

The systematics of Uropygi dates back mainly to the last century [Pocock, 1894; Kraepelin, 1897, 1899], though a more recent revision has been published by Rowland & Cooke [1973]. As many generic definitions were fixed with a rather limited knowledge of South East Asian species, a revision has become even more important also from a viewpoint of classical taxonomy. Nevertheless, this task meets various obstacles.

Although whip scorpions are rather large, it is surprising that comparatively few records exist from China [Wu, 1936] and vast areas in South East Asia (Laos, Vietnam, Cambodia, many provinces of Thailand). Other areas are hardly accessible for the need of new collections from ecological viewpoints, or it turns out that type material is not available. In

consequence, all biogeographical statements must be judged under this aspect, and with great care. The scarce material of most species does not permit a substantial study on variability either.

Characters often used in classical studies include a keel between the median and lateral eyes, the presence of a ridge between the median eyes, pedipalp morphology, division of tergites, shape of the genital plate, and ommatoids. Even genera have been based on one or some of these characters, yet all of them must be critically reconsidered: The so-called ommatoids on the third basal article of the whip correspond to the whip organs, translucent cuticular zones which cover areas of resorption epithelium possibly involved in solute and water regulation [Haupt et al., 1980]. Such characters may be used at the species level at most, since their existence and shape may turn out to be closely related to moisture conditions and the regulatory abilities of the species concerned.

Several characters are not restricted to the nominal genus, as was supposed earlier (e.g. keel and median terminal process on male second sternite). For these reasons, progress in the study of Uropygi may again improve the present key.

Pocock [1899] subdivided Thelyphonidae into the subfamilies Thelyphoninae and Hypoconinae, according to the presence or absence of a keel between the median and lateral eyes. At present, species are known in which the keel is present only on half of the distance; possibly they represent a plesiomorphic group of *Typopeltis*.

From a phylogenetic viewpoint, it is much more likely that the genera possessing a modified male patellar apophysis (*Labochirus*, *Typopeltis* and *Hypoconus*) are closely related, as pointed out by Weygoldt [1979], while *Hypoconus* is not closely related to the South American *Thelyphonellus* [see Weygoldt, 1988], as believed by Rowland and Cooke [1973]. An elaborate patellar apophysis is connected with a highly specialized mating behaviour. The females of these genera do not have any specialized structures at the tarsal articles of their tactile legs, but may acquire special marks during mating [Haupt, 1996].

Apparently, whip scorpions are a rather conservative group of arachnids, this holding true for many morphological characters as well as for chemical products of the defense glands, which are identical in North American and Japanese species [Yogi & Haupt, 1977; Itokawa et al., 1981, 1985]. On the other hand, there is a rather large diversity of species in South East Asia, which allows to refine a key to continental Asian genera and to species of the genus *Typopeltis* in particular.

While the attempt to link the chemical composition of their defense spray to phylogenetic relationships [Itokawa et al., 1981, 1985] seems to be premature [Haupt et al., 1994], possibly due to the poor knowledge of whip scorpion systematics, and

the few species obtained for chemical investigation, studies on mating behaviour and the internal morphology of sexual organs can add important arguments to the discussion on the taxonomy of whip scorpions [Weygoldt 1978, 1979, 1988]. From these viewpoints also the subdivision of Thelyphonidae into further families, as proposed by Rowland & Cooke [1973], has been critically discussed [Weygoldt, 1988]. As a consequence, and until a more convincing solution can be found on the basis of a phylogenetic analysis, it seems to be preferable to consider Thelyphonidae as a single family containing the subfamilies Hypoctoninae, Thelyphoninae, and Typopeltinae.

Concerning biogeography, the East Asian species must clearly be considered as northern offshoots of the South East Asian tropical fauna: only a single representative of the genus *Hypoctonus* is known from Yunnan, while all other species have been shown to belong to the genus *Typopeltis*, which is distributed from southwestern Thailand to central China and Kyushu in the north. Reports on the occurrence of Uropygi in Siberia are clearly erroneous.

Acknowledgements. The study was supported by invitations to the Zoological Museum of St. Petersburg (Russian Academy of Science) and to the Muséum National d'Histoire Naturelle, Paris. Prof. Dr. K. Yamazato promoted studies of Uropygi on the Ryukyu Islands. The following colleagues have kindly supported the present work with loans of material from their institutions, by the facilitation of studies on their collections, by valuable suggestions and/or the identification of localities. We are grateful to: Y. Coineau and Mme J. Heurtault (Muséum National d'Histoire Naturelle, Paris), M. Grasshoff (Senckenberg-Museum Frankfurt/M.), C.E. Griswold and V.F. Lee (California Academy of Science), J. Gruber (Naturhistorisches Museum Wien), P.D. Hillyard (The Natural History Museum, London), H. Levi and Mrs Leibensperger (Museum of Comparative Morphology, Cambridge, Mass.), M. Moritz (Zoologisches Museum der Humboldt-Universität Berlin), J. Nabhitabhata, Thailand Institute of Scientific and Technological Research, Bangkok, V. Ovtsharenko (Zoological Institute, Russian Academy of Sciences, St. Petersburg), N. Platnick (American Museum of Natural History, New York), J. Prószyński and W. Jedryczkowski (Instytut Zoologii, Polska Akademia Nauk, Warszawa), P. Schwendinger (Zoologisches Institut der Universität Innsbruck) and Frau G. Rack (Zoologisches Institut und Zoologisches Museum der Universität Hamburg). We thank Mr. W. Roloff for the completion of drawings, and Mark Judson for the careful revision of the English text.

References

- Arseniev, V.K. 1921. [Across the Ussuri region]. Vladivostok: Ekho Publ. P.118-119 [in Russian].
- Butler, A.G. 1872. A monograph of the genus *Thelyphonus* // Ann. Mag. Nat. Hist. Ser.4. Vol.10. P.200-206.
- Gravely, F.H. 1916. The evolution and distribution of the indo-australian Thelyphonidae, with notes on the distinctive characters of various species // Rec. Ind. Mus. Calcutta. Vol.12. P.59-86.
- Haupt, J. 1996. A self-made taxonomic character in whip scorpions (Arachnida, Uropygi: Thelyphonida) // Proc. 16th Europ. Coll. Arachnol. Siedlce, July 8th-13th, 1996 (in press).
- Haupt, J., Emde, W. & Weygoldt, P. 1980. Die Geißelorgane des Geißelskorpions *Mastigoproctus giganteus* (Lucas) (Arachnida: Uropygi): Transportepithel // Zoomorphologie. Bd.96. S.205-213.
- Haupt, J., Hühne, G., Schwarz, H., Chen Baoshan, Zhao Wenbao & Zhang Yungchiang 1988. Chinese whip scorpion using 2-ketones in defense secretion (Arachnida: Uropygi) // J. Comp. Physiol. B. Vol.157. P.883-885.
- Haupt, J., Hühne, G. & Weiske, T. 1994. Defense secretion products — a mean of chemical taxonomy? Analysis of defense secretion products of two further whip scorpions (Arachnida: Uropygi) // C.R. XIV Coll. Soc. europ. Arachnol. 1993. Boll. Acc. Gioenia Sci. Nat. Catania. Vol.26 (345). P.175-180.
- Heurtault, J. 1984. Identité d'*Hypoctonus africanus* Hentschel et d'*Hypoctonus clarki* Cooke et Shadab (Arachnides, Uropyges) // Rev. Arachnol. T.5. P.115-123.
- Itokawa, H., Kano, R., Kaneko, S., Nakajima, T., Yasuhara, T. & Yonabaru, S. 1981. Chemical investigation of the spray of the Asian whip scorpion *Typopeltis crucifer* Pocock, 1894 // Jap. J. Sanit. Zool. Vol.32. P.67-71.
- Itokawa, H., Kano, R. & Nakajima, T. 1985. Chemical investigation of the spray of the Asian whip scorpion *Typopeltis stimpsoni* (Wood, 1862) // Ibid. Vol.36. P.65-66.
- Iwakawa, T. 1908. On the specific identity of the scorpion spider of the Loochoos and Formosa // Annot. Zool. Jap. Vol.6. P.287-291.
- Klingel, H. 1963. Paarungsverhalten bei Pedipalpen (*Thelyphonus caudatus* L., *Holopeltidia*, Uropygi, und *Sarax sarawakensis* Simon, Charontidae, Amblypygi) // Verh. Dtsch. Zool. Ges. 1962. S.452-459.
- Kraepelin, K. 1897. Revision der Uropygi // Abh. Geb. Naturwiss. Bd.15. S.3-60.
- Kraepelin, K. 1899. Scorpiones und Pedipalpi // Das Tierreich. (Hrsg. Deutsche Zoologische Gesellschaft, F.E. Schulze): 8. Lief. Berlin: R. Friedländer & Sohn.
- Kraepelin, K. 1901. Über einige neue Gliederspinnen // Abh. Geb. Naturwiss. Bd.16. S.1-8.
- Millot, J. 1949. Ordre des Uropyges // Traité de Zoologie (P.P. Grassé ed.): T.6. Paris: Masson & Cie.
- Moritz, M. & Fischer, S.-C. 1980. Die Typen der Arachniden-Sammlung des Zoologischen Museums Berlin. II. Uropygi, Amblypygi, Schizomida, Ricinulei, Solifuga // Mitt. Zool. Mus. Berlin. Bd.56. S.137-154.
- Pocock, R. I. 1894. Notes on the Thelyphonidae contained in the collection of the British Museum (Natural History) // Ann. Mag. Nat. Hist. Ser.6. Vol.14. P.120-134.
- Pocock, R. I. 1899. The geographical distribution of the Arachnida of the orders Pedipalpi and Solifugae // Nat. Sci. London. Vol.14. P.213-231.
- Pocock, R.I. 1900. Some new and little known Thelyphonidae and Solifugae // Ann. Mag. Nat. Hist. Ser.7. Vol.5. P.294-306.
- Pocock, R. I. 1902. A contribution to the systematics of the Pedipalpi // Ibid. Ser.7. Vol.9. P.157-165.
- Rowland, J.M. & Cooke, J.A.L. 1973. Systematics of the arachnid order Uropygida (=Thelyphonida) // J. Arachnol. Vol.1. P.55-71.
- Schwangart, F. 1906. Über zwei Formen der Pedipalpengattung *Typopeltis* Pocock von Formosa // Zool. Anz. Bd.30. S.331-337.
- Shimojana, M. 1974. Sasorimodoki ni tsuite (About whip scorpions): Okinawa no rikunodobutsu. (eds. S. Ikehara & M. Shimojana): Naha: Hudokisha. P.136-139 [in Japanese].
- Snodgrass, R.E. 1948. The feeding organs of Arachnida including

- mites and ticks // Smithsonian Misc. Coll. Vol.110. P.1-93.
- Speijer, E.A.M. 1933. Verslag 66ste wintervergadering Ned. Ent. Verslag // Tijdschr. Entomol. Vol.76. P.IV-V.
- Speijer, E.A.M. 1934. Note préliminaire sur le nouveau genre *Gipopeltis* (Arach., Pedipalpi) // Bull. Mus. Hist. Nat. Paris Sér.2. Vol.6. Fasc.5. P.421-422.
- Speijer, E.A.M. 1936. Die orientalischen Pedipalpen des Zoologischen Museums der Universität Berlin // Mitt. Zool. Mus. Berlin. Bd.21. S.49-263.
- Tarnani, J. 1889. Sur les collections de Thélyphonides de quelques musées russes // Zool. Anz. Bd.12. S.118-122.
- Tarnani, J. 1890. Über die Thelyphoniden aus den Sammlungen einiger russischer Museen // Horae Soc. ent. Ross. T.24. P.511-539.
- Tarnani, J. 1894a. Quelques nouvelles espèces de Thélyphonides // Zool. Anz. Bd.17. S.30-32.
- Tarnani, J. 1894/95b. Über die Thelyphoniden aus den Sammlungen einiger russischer Museen. II // Horae Soc. ent. Ross. T.29. P.111-121.
- Tarnani, J. 1900. Deux nouvelles espèces de Thélyphonides // Zool. Anz. Bd.23. P.481-482.
- Tarnani, J. 1901. Über die Thelyphoniden aus den Sammlungen einiger russischer Museen. III // Annu. Mus. Zool. St. Pétersbourg. T.6. P.207-219.
- Weygoldt, P. 1978. Paarungsverhalten und Spermatophorenmorphologie bei Geißelskorpionen: *Thelyphonellus amazonicus* Butler und *Typopeltis crucifer* Pocock (Arachnida, Uropygi) // Zoomorphologie. Bd.89. S.145-156.
- Weygoldt, P. 1979. *Thelyphonellus ruschii* n.sp. und die taxonomische Stellung von *Thelyphonellus* Pocock 1894 // Senckenberg. biol. Bd.60. S.109-114.
- Weygoldt, P. 1988. Sperm transfer and spermatophore morphology in the whip scorpion *Thelyphonus linganus* (Arachnida: Uropygi: Thelyphonidae) // J. Zool. Vol.215. P.189-196.
- Wood, H.C. 1862. Description of a new species of the genus *Thelyphonus* // Proc. Acad. Nat. Sci. Philadelphia, 1861. P.312.
- Wu, H.W. 1936. A review of the scorpions and whip scorpions of China // Sinensia. Vol.7. P.113-126.
- Yogi, S. & Haupt, J. 1977. Analyse des Wehrsekretes bei dem Geißelskorpion *Typopeltis crucifer* Pocock // Acta Arachnol. Vol.27. P.53-56.