The new Southeast Asian goblin spider genus *Aposphragisma* (Araneae, Oonopidae): diversity and phylogeny

MARCO THOMA*,1, YVONNE KRANZ-BALTENSPERGER1, CHRISTIAN KROPF1,2, WERNER GRABER3, WOLFGANG NENTWIG2 & HOLGER FRICK1,4

1) Natural History Museum Bern, Department of Invertebrates, Bernastraße 15, CH-3005 Bern, Switzerland
2) Institute of Ecology and Evolution, University of Bern, Baltzerstrasse 6, CH-3012 Bern, Switzerland
3) Institute of Anatomy, Department of Topographic and Clinical Anatomy, University of Bern, Baltzerstrasse 2, CH-3012 Bern, Switzerland
4) Natural History Collection of Liechtenstein, Office of Environment, Messinastrasse 5, FL-9495 Trischen, Liechtenstein

*corresponding author
Email: thoemi@bluemail.ch

Magnolia Press
Auckland, New Zealand

Accepted by W. Fannes: 4 Mar. 2014; published: 22 May 2014
The new Southeast Asian goblin spider genus *Aposphragisma* (Araneae, Oonopidae): diversity and phylogeny (Zootaxa 3798)

86 pp.; 30 cm.

22 May 2014

Abstract

The new genus *Aposphragisma* (Araneae, Oonopidae, Oonopinae) comprising the new species *A. baltenspergerae*, *A. borgulai*, *A. brunomanserii*, *A. confluenz*, *A. dayak*, *A. dentatum*, *A. draconigenum*, *A. haussammanae*, *A. helvetiorum*, *A. kolleri*, *A. monoceros*, *A. nocturnum*, *A. retifer*, *A. rimba*, *A. salewskii*, *A. scimitar*, *A. seplik* and *A. stannum* is described. It is characterised by very hard bodied, strongly sclerotized species with completely armoured prosoma and strongly sclerotized ventral and dorsal abdominal scuta. *Aposphragisma* gen. nov. is placed within the *Gamasomorpha*-group sensu Saaristo (2001). Descriptions and illustrations are given for all new species. A phylogenetic analysis based on 40 characters using *Prethopalpus fosuma*, *Gamasomorpha asterobothros*, *G. cataphracta*, *G. seximpressa*, *Xestaspis bifolici*, *X. kandy* and *X. paulina* as outgroup-taxa and *Cortestina thaleri* (Oonopidae, Sulsulinae) as the root is presented and discussed. Furthermore it is shown that females of *Aposphragisma* gen. nov. possess complex internal genitalia. The members of the new genus are ground-dwelling litter inhabitants restricted to Southeast Asian lowland and montane forests, with more than 60% of the species only known from single localities. They are presumed to be negatively affected by the massive destruction of pristine forest habitats within their range. This work has been conducted within the framework of the Planetary Biodiversity Inventory (PBI) of Oonopidae (see http://research.amnh.org/oonopidae).

Key words: Oonopinae, Sulsulinae, *Cortestina*, *Gamasomorpha*, *Prethopalpus*, *Xestaspis*, new genus, new species, All-Biota Taxon Inventory ABTI, Planetary Biodiversity Inventory PBI, functional morphology, complex female genitalia, restricted species ranges

Introduction

Human activity is adversely affecting the earth’s biodiversity at an ever increasing rate (e.g. Dirzo & Raven 2003), particularly in tropical areas (Bradshaw *et al.* 2009). In this context, conservation initiatives are forced to identify and prioritize key elements of global biodiversity in order to effectively allocate limited resources (e.g. Brooks *et al.* 2006, Bradshaw *et al.* 2009). Areas of high endemism are considered of high priority concern for the protection of global biodiversity (e.g. Myers *et al.* 2000, Dirzo & Raven 2003). So far, identification of endemic areas and the

Table of contents

Abstract ................................................................. 3
Introduction ............................................................ 3
Material and methods ................................................ 5
Taxonomy .............................................................. 6
*Aposphragisma baltenspergerae* Thoma, sp. nov. ...... 9
*Aposphragisma borgulai* Thoma, sp. nov. ............... 15
*Aposphragisma brunomanserii* Thoma, sp. nov. ......... 20
*Aposphragisma confluenz* Thoma, sp. nov. ............. 25
*Aposphragisma dayak* Thoma, sp. nov. ................ 27
*Aposphragisma dentatum* Thoma, sp. nov. .......... 30
*Aposphragisma draconigenum* Thoma, sp. nov. ....... 30
*Aposphragisma haussammanae* Thoma, sp. nov. ..... 33
*Aposphragisma helvetiorum* Thoma, sp. nov. ........ 36
*Aposphragisma kolleri* Thoma, sp. nov. ............... 44
*Aposphragisma menzi* Thoma, sp. nov. ................. 46
*Aposphragisma monoceros* Thoma, sp. nov. .......... 53
*Aposphragisma nocturnum* Thoma, sp. nov. .......... 54
*Aposphragisma retifer* Thoma, sp. nov. ............... 57
*Aposphragisma rimba* Thoma, sp. nov. ............... 59
*Aposphragisma salewskii* Thoma, sp. nov. .......... 66
*Aposphragisma scimitar* Thoma, sp. nov. ............ 67
*Aposphragisma seplik* Thoma, sp. nov. ............... 69
*Aposphragisma stannum* Thoma, sp. nov. .......... 72
Phylogenetic analysis ............................................. 74
Character list ......................................................... 75
Results and discussion ........................................... 77
Acknowledgements ................................................ 82
References .......................................................... 82
formulation of other conservation strategies is largely based on distribution patterns of taxonomically well explored groups, such as vertebrates and some plants (e.g. Myers et al. 2000, Brooks et al. 2006). However, these tend to incorporate only a minor fraction of global biodiversity (Platnick 1999). By contrast, invertebrates represent the majority of earth’s biodiversity (e.g. May 2000), but are largely excluded from processes identifying regions of global conservation concern due to the lack of taxonomic information (Platnick 1999, Mace et al. 2000, Myers et al. 2000, Brooks et al. 2006). Targeting some mega-diverse invertebrate groups is expected to yield more detailed and fine-scaled information on global patterns of diversity and endemism, compared to distribution patterns of plants and vertebrates (Platnick 1999). Platnick (1999) highlighted the potential spiders have to serve as a target for an All-Biota Taxon Inventory (ABTI). Information provided by museum collections indicated that the spider family Oonopidae contains many micro-distributed species and a high species representation outside tropical biota (e.g. Platnick & Dupérré 2009a), making this a promising target for an ABTI. This led to the implementation of a planetary biodiversity inventory (PBI) on oonopids, with the aim of providing baseline taxonomic knowledge on this mega-diverse family for biodiversity research and conservation planning, applying an internationally coordinated and centralised data collection and data sharing approach (see http://research.amnh.org/oonopidae/).

The Oonopidae Simon, 1890, or ‘goblin spiders’, comprise a diverse group of small (1–4 mm), six-eyed, ecribellate, free hunting spiders with a predominantly tropical and subtropical range, found on all continents except the Antarctic (e.g. Saaristo 2001, Jocqué & Dippenaar-Schoeman 2007). The group currently comprises 1325 species placed within 97 genera (Platnick 2014).

Oonopids show a remarkable diversity of morphological characters, prompting for instance Saaristo (2001) to state: “I do not know any other spider family whose members have so many species specific somatic characters (…). Usually those characters are also common for both sexes.”

Although being mainly leaf-litter dwellers, oonopids occur in a variety of habitats including ant nests, bark, buildings, caves and deserts (e.g. Simon 1891, Simon 1893a, Deeleman-Reindhold 1987, Dias et al. 2005, Ubick et al. 2005, Harvey & Edward 2007, Jocqué & Dippenaar-Schoeman 2007, Knoflach et al. 2009). Recent findings suggest that oonopids also make up an important part of the tropical canopy fauna (Sørensen 2004, Fannes et al. 2008). Some species have been introduced to non-native areas where they may occur in green-houses (Korenko et al. 2007) or even became established and are now widely distributed (Platnick & Dupérré 2009a).

Oonopids belong to the Haplogyneae, forming part of the superfamily Dysderoidea, the latter being characterized by the forward shift of the posterior spiracles and commonality in internal structures of the tracheal system and female genitalia (Forster & Platnick 1985, Coddington & Levi 1991). Haplogyne spiders were conventionally defined by the lack of a genital plate (epigyne) in females and by simple male palpal organs (Simon 1893a). Wiehle (1967) refined this definition highlighting that in female haplogynes the receptacula seminis, the sperm storage organs, are ‘derivatives’ of the wall of the uterus externus, and that sperm moves to and from the receptacula via a single duct (described as “cul-de-sac spermathecae” by Austad 1984), whereas in entelegynes there are separate copulatory and fertilization ducts (described as “conduit spermathecae” by Austad 1984). Recently, however, it has been shown that the internal female genitalia of oonopids are very diverse and, in some cases, ‘complex’ (e.g. Burger et al. 2006a, Burger 2010a, Burger 2011a). They may even resemble the entelegyne-type of internal genital organisation (Burger 2009), contradicting the classical definition of haplogynes, being, for instance, in accordance with the view of Shear (1978), who described the haplogyne condition as a “grade, not a clade”, and Platnick et al. (1991). Nevertheless, characters other than genitalia have shown the unity of most haplogyne taxa including Oonopidae, underlining the validity of most of the Haplogyneae as a monophyletic taxon (Coddington & Levi 1991, Platnick et al. 1991, Ramírez 2000).

Oonopid monophyly has been corroborated only recently. Oonopidae are united by the male’s fused testes (Burger & Michalik 2010), a unique feature among spiders, and by a special type of tarsal organ with a longitudinal ridge and raised receptors on legs I–IV, a dimorphism in tarsal organ receptor number between anterior (I, II) and posterior legs (III, IV), and a reduced female palpal claw (Platnick et al. 2012a).

Simon (1893a) distinguished two informal groups of oonopids according to the degree of body surface sclerotization; the rather soft-bodied Oonopinae (‘Oonopidae molles’) and the hard-bodied Gamasomorphinae (‘Oonopidae loricatae’). Although Simon (1893a) clearly stated that neither of these groups was established to define distinct natural entities, Petrunkevitch (1920) assigned them a formal status. Subsequently, the monophyly of the oonopid ‘subfamilies’ sensu Petrunkevitch (1920) has been questioned (e.g. Platnick in Fannes & Jocqué 2008, Platnick et al. 2012a). A new subfamilial organisation was proposed recently: Platnick et al. (2012a)
recognized three subfamilies characterized by tarsal organ morphology, Orchestininae, Sulsulinae, and Oonopinae, the latter also containing all genera previously placed in the Gamasomorphinae.

The present study was conducted within the framework of the Goblin Spider PBI, analysing a sample of Southeast Asian loricate oonopids, resulting in the description of the new genus *Aposphragisma* (Oonopinae) comprising 19 species new to science placed within the ‘Gamasomorpha group’ sensu Saaristo (2001).

**Material and methods**

**Specimen examination.** Specimens were stored in 80% ethanol and analysed under a Leica MZ16 stereo microscope (Leica Microsystems Ltd.). Measurements were done using a 10 micrometer size reference (100x0.01 mm; Pyser-SGI Ltd.). For detailed studies, genitalia and legs were embedded in Hoyer’s mixture (Kraus 1984), slide-mounted and allowed to dry for at least 24 hours. Embedded samples were studied under a Zeiss Axioplan 2 compound microscope, photographed using a Zeiss AxioCam MRc digital camera and processed with the program Zeiss AxioVision (release 4.6.3.0, Carl Zeiss GmbH). Picture montage was done using the program Auto-MontagePro (version 5.01.0005, Synoptics Ltd.). Drawings were made on wrinkled paper using a technical pen for outlines and a grease pencil (Staedtler Omnichrom 108, STAEDTLER Mars GmbH & Co) for shading. Photographs of specimens were made using a Leica MZ16 stereo microscope with automatic autofocus and a Leica DFC420 digital camera (Leica Microsystems Ltd.). Picture montage was done with the program Image Access Standard 8 (Imagic Bildverarbeitung AG). For scanning electron microscopy the samples were mounted on a platelet coated with conductive carbon cement, air dried and gold sputtered. Pictures were taken with a Philips XL30 SEM (Philips Electronics N.V.). All illustrations were finalised with Adobe Photoshop CS4 (Adobe System Inc.). Colour estimates are based on specimens immersed in 80% ethanol using colour reference plates in Smithe (1975). The respective colour terminology is used in the specific descriptions throughout the text.

Measurements: carapace length was measured from anterior edge of clypeus to posterior edge of carapace (i.e. posterior rim). Length of abdomen was measured from anterior ventral edge of pedicellar tube to posterior edge of abdomen (excluding spinnerets).

Coordinates that were either indicated on the label or inferred from label data (via Google Earth: http://earth.google.com) are provided for all samples.

Number of specimens available per species was generally low, confining morphological analysis to stereomicroscopic examination of external structures in most cases.

**Taxonomy.** The first step of classification was done in a parataxonomic way by classifying specimens into morphotaxa according to somatic characters at the stereomicroscope level in order to facilitate further work. In a second step, morphotaxa were checked in detail. Character coding was conducted according to the PBI data matrix (http://research.amnh.org/oonopidae/). Species descriptions were generated directly from the PBI data matrix in a first step. Then, descriptions were modified, extended and/or rearranged where necessary. A total of 165 adult individuals were included. Species descriptions are presented in alphabetical order following the description of the genus.

**Nomenclature.** The first author is directly responsible for the naming of all newly described species as well as for the naming of the new genus.

**Phylogeny.** 40 informative morphological characters were scored for all 19 described species of *Aposphragisma* gen. nov. *Gamasomorpha asterobothros*, *G. cataphracta*, *G. fricki*, *G. seximpressa*, *Prethopalpus fosuma*, *Xestaspis biflocci*, *X. kandy* and *X. paulina* (Oonopidae, Oonopinae) were chosen as additional outgroup taxa. *Cortestina thaleri* (Oonopidae, Sulsulinae) was chosen to root the tree. Table 1 shows the character matrix.

Parsimony analyses were performed with TNT version 1.1 (Goloboff et al. 2008) using heuristic methods (“traditional search”). Characters were either weight ed equally or with implied weights. Traditional searches were used for both weighting schemes, with the following settings: tree bisection reconnection (tbr) and the standard setting for starting trees (commands: mult=tbr replic 1000 hold 1000); branches were collapsed if ambiguously supported (collapsing “rule 1”) during and after the tree search (commands: collapse 3; collapse {.}; characters were treated as unordered and multistate characters as non-additive (Fitch 1971). For implied weights, TNT weights homoplasies according to a concave function, whose strength (K) can be set by the user. The concavity constant (K) was set to 1–20 (commands: piwe=1; mult=tbr replic 1000 hold 1000.).

Characters were optimized using WinClada version 1.00.08 (Nixon 2002) for the strict consensus tree (implied
weights, K=1–5). Reversals or secondary loss were preferred over convergences for ambiguous character optimizations, i.e. ACCTRAN. Mesquite version 2.74 (Maddison & Maddison 2010) was used to calculate the ensemble consistency (CI) and ensemble retention index (RI). See Table 1 for character statistics (steps, ci and ri) for the strict consensus tree (implied weights, K=1–5). Bremer support values (Bremer 1988, Bremer 1994) were calculated by TNT for the strict consensus tree based on the original equal weights trees (Fig. 51). Subsequently, also trees with suboptimal length were kept, i.e. the suboptimal was increased stepwise by 1 up to 20 and so was the tree buffer by 5000 for 20 cycles (commands: `mult 50; sub 1; hold 5000; sub 2; hold 10000; sub 3; hold 15000;...; sub 20; hold 100000; bsupport`).

**Definitions**

*Chelicerae, promargin:* Anterior margin of the area under the fang.

*Papillae:* Circular structures in the dorsal wall of the female receptaculum. They are supposed to act as osmoregulatory organs and could therefore play a role in sperm activation (Burger 2010a; cf. Fig. 25H, ‘pa’).

*Sluice:* “U-shaped channel formed by the upwards curled ventral edge of the carapace” (Saaristo 2006; cf. Fig. 21H, ‘slu’).

**Abbreviations**

*Institutional abbreviations:*

- AMNH: American Museum of Natural History, New York, USA
- CAS: California Academy of Sciences, San Francisco, USA
- MHNG: Muséum d’histoire naturelle de la Ville de Genève, Switzerland
- MZT: Zoological Museum, University of Turku, Finland
- NMBE: Natural History Museum Bern, Switzerland
- NSMT: National Science Museum Tokyo, Japan
- RMNH: Nationaal Natuurhistorisch Museum Leiden, The Netherlands

*Character abbreviations used in the text*:

- ALE: Anterior lateral eyes
- PLE: Posterior lateral eyes
- PME: Posterior median eyes

*character abbreviations referring to figures are explained in the respective captions.*

*Additional abbreviations used in the text:*

- prov.: Exact coordinates provided by collector
- inf.: Coordinates inferred from location details indicated on specimen label
- SEM: Scanning electron microscopy / scanning electron microscope

**Taxonomy**

*Family Oonopidae* Simon, 1890
*Subfamily Oonopinae* Simon, 1890
*Genus Aposphragisma* Thoma, gen. nov.
*Type species Aposphragisma helvetiorum* Thoma, sp. nov.

**Etymology.** The generic name *Aposphragisma* is an Ancient Greek term meaning seal or signet ring, but primarily the impression made by a signet ring, and is neutral in gender. It refers to the pronounced sternal ornamentation and shape characteristic of the genus, being reminiscent of a seal engraving or the impression made by a seal.

**Diagnosis.** *Aposphragisma* gen. nov. is characterised by very hard bodied, strongly sclerotized species with a completely armoured prosoma and unfused, strongly sclerotized ventral and dorsal abdominal scuta, the latter covering the abdomen completely (Figs. 20A–B), and without leg spines. In resting position the male palps are partly turned under the prosoma (Fig. 20E). The male palps are characterized by a pyriform bulb apically bearing a laminar embolus (em) which is closely associated to a laminar conductor (con) of almost equal length (Figs.
Figures of 25C–F). Bulb and cymbium are fused but show a clearly visible seam between (Figs. 25A–B, E). The spermophor opening, situated subdistally on the retrolateral embolic surface, usually bears a spine-like structure, hereafter referred to as an ‘embolic spine’ (esp) (e.g. Figs. 4E, 8C, E, 12C, 31E). The sternum is strikingly patterned, showing blossom-shaped microsculptures (Figs. 20F, 22A), but reduced radial furrows (rf) (Figs. 5F, 6B, 20F). The labium is elongated, triangular and distally deeply incised, with the surface setae characteristically arranged in two rows of five needle-like setae (Fig. 22D).

Females do not show any special features on their epigastric area (Figs. 23C–D). The female internal genitalia are in general appearance reminiscent of those found in several ‘gamasomorphic’ species (Burger 2011b, Eichenberger et al. 2012).

The overall morphology of the members of Aposphragisma gen. nov. is reminiscent of the genus Gamasomorpha and morphologically similar genera such as Xestaspis (e.g. Eichenberger et al. 2012). Brignoli (1974) suggested that all onopids with “a small bulbus, a long laminar embolus intimately associated with a similarly long and laminar conductor”, “simple pedipalpi” and an overall similarity in morphology should be considered as “near” to the type species Gamasomorpha cataphracta. Saaristo (2001) adopted this view. Nevertheless, based on the above definition, Saaristo (2001) proposed the ‘Gamasomorpha group’, which also incorporates other spineless loricate genera (i.e. Dibienma, Grymeus, Patri, Plectoptilus, Prida, Xestaspis and Yumates). The features of Aposphragisma gen. nov. match not only Brignoli’s (1974) definition of being “near” to Gamasomorpha cataphracta, but also the properties of the ‘Gamasomorpha group’ as defined by Saaristo (2001).

Although gamasomorphic in appearance, the male secondary organs of Aposphragisma gen. nov. show two lamellar bulbal appendages. By contrast, Álvarez-Padilla et al. (2012) state that Gamasomorpha males have “an embolus complex that is (...) composed of three elongate, subequal divisions” such as depicted e.g. for G gershomii (Figs. 55A–B in Saaristo 2006), G barbifera (Figs. 34–36 in Tong & Li 2007), G lalana (Ono 2009, Figs. 42–43) and several Gamasomorpha species described in Eichenberger et al. (2012). However, according to Burger (2011b) G lutzi shows a two-part embolus-conductor morphology similar to Aposphragisma gen. nov. Other published figures of Gamasomorpha species, such as G mornensis (Fig. 3D in Benoit 1979), G deksom (Figs. 1–2 in Saaristo & van Harten 2002) and of the type species G cataphracta (Figs. 3–4 in Brignoli 1974) indicate a two-part morphology, however, the description and/or the quality of the figures do not allow for further assessment. Nevertheless, a three-part morphology seems to result from a subdistal division of the embolus (e.g. Eichenberger & van Harten 2012). Hence, one can hypothesize that this feature may well be developed to different degrees in different species of Gamasomorpha and other genera with similar gamasomorphic male palpal morphology.

Although Brignoli (1974) described the labium of G. cataphracta as triangular, it is in fact trapezoidal (R. Ott in litt.). This is also the case for other members of the genus, such as G insularis and G mornensis (Figs. 3A–B and Fig. 12, respectively, in Saaristo 2001), G barbifera (Fig. 29 in Tong & Li 2007) and several Gamasomorpha species described by Eichenberger et al. (2012).

A peculiar case within Aposphragisma gen. nov. is Aposphragisma rimba sp. nov., which shows several remarkable and unique features, and a relatively pronounced sexual dimorphism when compared to its presumed congeners. However, A. rimba sp. nov. shows several characters typical of Aposphragisma gen. nov. and is therefore included in the present study to provide a complete and fully accessible description of this taxon in order to facilitate further research.

**Description.** Very small to small (body length: 1.00–2.30 mm), six-eyed, spineless, strongly armoured Oonopinae without colour pattern. Prosoma (including mouthparts) and abdominal scuta equally strongly sclerotized. Unless stated otherwise, all setae appear light and needle-like when viewed under a stereomicroscope.

**Male. Cephalothorax.** Carapace ovoid in dorsal view, anteriorly narrowed to less than 0.5 times its maximum width (value of carapace maximum width divided by clypeus width lies between 0.4 and 0.5 for all specimens used in this study), with rounded posterolateral corners, without fovea (Fig. 20G); posterior margin not bulging below posterior rim (Fig. 21C); pars cephalica slightly elevated in lateral view, lateral margin straight (Fig. 21C), often with denticles i.e. modified hair bases (if present then each with a short, needle-like seta originating from anterior face, pointing anteriorly; Fig. 21H); non-marginal carapace setae arranged in a long u-shaped row, reaching posterior edge of pars cephalica (Fig. 20H, 21G), each originating from the centre of a pitlike structure with elevated rims, hereafter referred to as cephalic pits (cp) (Fig. 21G); cephalic pits especially pronounced at posterior edge of pars cephalica in some species, appearing denticle-like (pch) (Fig. 21G); one or two pairs of spikes on carapace posterior surface present in four species, representing strongly modified hair-bases (esp, msp).
(Figs. 9D, 9F); non-marginal setae on carapace lateral surface scarce or absent. Clypeus high (i.e. ALE separated from edge of carapace by their radius or more), vertical (or almost vertical) in lateral view (never clearly sloping forward, Fig. 21C), with two pairs of setae (the inner pair being usually slightly longer than the outer pair); clypeus margin rebordered (Fig. 5D), sinuous in frontal view, without median projection (Figs. 21E–F). Chilum absent. Eyes six, usually well developed, ovoid to circular; ALE never touching; posteriour eye row compact; PLE and PME usually touching or at least very close together; eye group trapezoid in dorsal view (Fig. 20G). Sternum longer than wide, fused to carapace, without hair tufts (Figs. 20D–F); anterior margin with straight continuous transverse groove (ctg) (Figs. 20D–F); lateral margin with weakly developed radial furrows (rf) between coxa I–II, II–III and III–IV, hence appearing indented in ventral view (Fig. 20F), with infra-coxal grooves (icg) (Figs. 5F, 6B, 9H, 20F); posterior margin extending posteriorly as single extension (Fig. 20F); sternum surface always ornamented with lobed (or blossom shaped) microsculptures (Figs. 20F, 22A); extension of sternum ornamentation differs, 13 species show smooth median stripe without setae (sms) (Fig. 20F); microsculptures always extending at least partly onto radial furrows causing a wrinkled impression on furrows’ surface (Fig. 6B); sternum setae rather sparse, originating from sternum lateral edges or singly from centre of lobed microsculptures (Fig. 22A), hence setae distribution rather even. Mouthparts: Chelicerae in frontal view straight (i.e. parallel; Figs. 21E–F) but sometimes artificially displaced and then appearing slightly divergent (Fig. 5H), distally not abruptly narrowed in front view, proximal part of anterior face convex in lateral view (Fig. 21C), promargin with row of flattened setae (rfs) (and, where details were visible on stereomicroscope level and / or SEM-level, always in combination with a row of plumose setae; Fig. 22G), paturon with scattered setae especially on anterior face. Fangs shaped normal, without processes or projections, directed posteriorly (Figs. 20D–E). Labium triangular and deeply incised, fused to sternum (Fig. 22D); labium ventral surface with typical setae pattern: two rather distal setae i.e. one on each side of incision (green dots in Fig. 22D) and a more or less transverse line of three more proximal setae posterior to incision (red dots in Fig. 22D). Anterolateral margin of outer surface of endites subdistally with a pair of long and needle-like special setae with inward bent tips (eds) (Figs. 22D–E).

ABDOMEN. Normally ovoid in dorsal view, rounded posteriorly (Fig. 20A). Setae present on sclerotized and soft portions (Fig. 23C). Dorsal scutum covering full length of abdomen (Fig. 23C); dorsal scutum surface smooth. Epigastric scutum surrounding pedicel, fused to postepigastric scutum (Fig. 23B); distance between dorsal margin of pedicel and dorsal margin of epigastric scutum less than 1–1.5 times the diameter of pedicel tube (Fig. 23A). Postepigastric scutum covering full length of abdomen (Fig. 23B). Posterior spiracles connected by groove (Fig. 23G). Pedicel tube short to medium, always ribbed (i.e. coarsely ribbed in most species) (Figs. 23F–H). Book lung covers usually large and ovoid, without setae, without surface modifications (Fig. 23A). Spinneret scutum present as incomplete ring with fringe of setae (Fig. 23E). Supra-anal scutum either absent (e.g. in A. brunomanseri sp. nov., not depicted here) or represented by a hardly visible, very thin and sickle-shaped structure (Fig. 16H, 23E), never obvious and large. Colulus present as small sclerite with a pair of setae (Fig. 16H). Visible soft portions whitish / pale (Fig. 23A).

LEGS. Without colour pattern, without spines; patella plus tibia I shorter than carapace. SEM imaging of the legs of six species (A. baltenespergerae sp. nov., A. borgulai sp. nov., A. brunomanseri sp. nov., A. helvetiorum sp. nov., A. menzi sp. nov. and A. rimba sp. nov.) revealed two types of special hairs: one type on ventral apex of tibia III & IV thin, plumose, distally flattened, with fringed lateral margins and spatulate tips (Figs. 3A, 7D, 11E, 24C–E, 30D, 40F); other type on ventral apex of metatarsi III & IV short, dagger-like, with finely serrated ridges on surface and coarsely serrated lateral margins (ms) (Figs. 3B–C, 7B–C, 11F–G, 24B, 30B–C; not examined in A. rimba sp. nov.); dorsal apex of metatarsi I–IV with a short, shieldlike appendage (ds) (Figs. 24B, F); tarsi I–IV with two claws, each with teeth (Figs. 7F, 24H). Trichobothria (examined for all species on compound microscope level): tibia I–IV each with three, metatarsi I–IV each with one. Base of Trichobothria (tb) examined by means of SEM imaging in six species (A. baltenespergerae sp. nov., A. borgulai sp. nov., A. brunomanseri sp. nov., A. helvetiorum sp. nov., A. menzi sp. nov. and A. rimba sp. nov.), showing the following characters: base longitudinally narrowed; internal texture of aperture grate-like; hood covered by numerous closely spaced ridges (Figs. 3D–E, 7E, 11H, 24F–G, 30E–F, 40G). Tarsal organ (to; examined by means of SEM imaging in two species, not all legs) exposed, not capsule, on tarsus 1 with 3 raised receptors (A. baltenespergerae sp. nov.: Fig. 3F; A. helvetiorum sp. nov.: Fig. 24H), on tarsus III with 2 raised receptors (A. baltenespergerae sp. nov.: Fig. 3G).

GENITALIA. Epigastric region: sperm pore small, with narrow ovoid opening and rebordered margin (Figs. 24A, 30A); epigastric furrow without any insertions. Palp not strongly sclerotized (Fig. 25A); femur two or more
times as long as trochanter, attaching to patella basally (Figs. 25A–B); patella shorter than femur; tibia with 3 trichobothria; cymbium ovoid in dorsal view, not extending beyond distal tip of bulb, distally with dense patch of short setae (dps) (Fig. 4D), fused with bulb but with clearly defined seam between (Figs. 25B, E); bulb in most species stout, tapering apically, 1–1.5 times as long as cymbium (Figs. 25A–B), anterodorsally with a more or less pronounced conical bulge (eb) (Fig. 25E–F), apically bearing two processes (i.e. embolus and conductor); embolus and conductor both long, laminar, tapering and closely associated over most of their length (Figs. 25E–F; except A. rimba where association restricted to embolus base, Fig. 41C). Embolus slender, dorsally with a comb (dc) (Figs. 4C–D), distally widened and flattened (Figs. 4C, 43C), entirely or partly much darker than bulb; embolus tip appearing spatulate or shovel-like in most species (Fig. 31E). Spermophor opening protruding from subdistal retrolateral surface of embolus (spo) (e.g. Figs. 8C, 33E); spine-like structure (‘embolic spine’) associated with spermophor opening (esp) (Figs. 4E, 31E). Conductor tapering apically, with pointed or blunt / snout-like tip (Fig. 25C), basally connected to retrolateral part of embolus (Fig. 25D). In dorsal view embolus-conductor-complex bent medially, in resting position fitting into transverse groove of the sternum’s anterior margin (Fig. 20E).

**FEMALE.** Concerning somatic characters resembling male to a high degree, in average body size slightly larger. With the characters of the male, except as noted.

**CEPHALOTHORAX.** Palp without claws or spines. Distal part of chelicerae without toothlike extension of paturon promargin (Figs. 21F, 22J, 36F, 46D; including those species where males do show such an extension).

**ABDOMEN.** Epigastric scutum not fused to postepigastric scutum (Figs. 23D, H); in most species posterolateral part of epigastric scutum with either a row of longitudinal ridges (lr) (Fig. 23H) or a single curved ridge (cr) (Fig. 11C).

**GENITALIA.** Ventral view: The genital opening is situated inside the epigastric furrow. Internal genital structures were analyzed for six species (A. baltenspergerae sp. nov., A. borgulai sp. nov., A. brunomanseri sp.nov., A. helvetiorum sp. nov., A. menzi sp. nov. and A. rimba sp. nov.). Except for A. rimba sp. nov. (cf. specific description), these structures strongly resemble those found in several Gamasomorpha and Xestaspis species (Burger 2011b, Eichenberger et al. 2012).

**Remarks.** The smooth median stripe on the sternum is an unaltered synomorphomy of 13 species within *Aposphragisma* gen. nov. which are hereafter referred to as the ‘stripe-clade’ (marked as dark grey in Figs. 50–51).

*Aposphragisma baltenspergerae* Thoma, sp. nov.

(Figs. 1–4)

**Type material.** **HOLOTYPE:** male (PBI_OON 00031365), Kalimantan (INDONESIA), Sepaku, 40 km NNW of Balikpapan [0°55′S 116°47′E; inf.], 2.VIII.1980, degraded primary forest, leg. C. Deeleman, deposited at RMNH. **PARATYPES:** 1 female (PBI_OON 00015856; abdomen used for examination of internal genitalia), Kalimantan (INDONESIA), Sotek [01°12′S 116°35′E; inf.], 31.XII.1980, leg. J. Aoki & H. Harada, deposited at NMBE; 1 female (PBI_OON 00015869), Kalimantan (INDONESIA), 2 km E of Camp Pemantus, 43 km W of Sotek [01°12′S 116°12′E; inf.], 17.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT; 1 male (PBI_OON 00015870), Kalimantan (INDONESIA), Sotek [01°12′S 116°35′E; inf.], 29.XII.1980, leg. J. Aoki, deposited at MZT; 1 male (PBI_OON 00015911), Kalimantan (INDONESIA), Camp Pemantus, 45 km W of Sotek [01°12′S 116°12′E; inf.], 19.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT; 1 female (PBI_OON 00015924), Kalimantan (INDONESIA), 2 km E of Camp Pemantus, 43 km W of Sotek [01°12′S 116°12′E; inf.], 18.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT; 1 male (PBI_OON 00015925), Kalimantan (INDONESIA), Camp Pemantus, 45 km W of Sotek [01°12′S 116°12′E; inf.], 24.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT; 1 male (PBI_OON 00015966), Kalimantan (INDONESIA), Calm Pemantus, 45 km W of Sotek [01°12′S 116°12′E; inf.], 26.XII.1980, leg. H. Harada, deposited at NMNH; 1 female (PBI_OON 00031376), Kalimantan (INDONESIA), Kampung Kali Mantu, 40 km NW of Sotek [01°12′S 116°35′E; inf.], 24.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT; 1 female (PBI_OON 00031362), Kalimantan (INDONESIA), Tenggarong [0°22′S 116°59′E; inf.], 4.VIII.1980, lichtbos, strooisel, leg. C. Deeleman, deposited at RMNH; 1 female (PBI_OON 00031376), Kalimantan (INDONESIA), Samboga, 40 km N of Balikpapan [0°55′S 116°52′E; inf.], 6.VIII.1980, leg. C. Deeleman, deposited at RMNH; 2 males (PBI_OON 00031399), Kalimantan (INDONESIA), 1 km E of Sotek [01°12′S 116°35′E; inf.], 31.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT; 2 females (PBI_OON
FIGURE 1. Aposphragisma baltenspergerae sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; F. prosoma ventral view, SEM; G. carapace lateral view; H. carapace front view. Ctg, continuous transverse groove; den, denticle; pmh, posterior modified cephalic hair bases; slu, sluice; tlp, toothlike projection of male chelicerae. Scale bars: A–E, G–H 500 μm; F 200 μm.
FIGURE 2. *Aposphragisma baltenspergerae* sp. nov. Male: A. detail of sternum with lobed microsculptures ventral view, SEM; B. sternum margin and pleura ventral view, SEM; C. chelicerae ventral view, SEM; D. distal part of endites lateral view, SEM; E. abdomen ventral view; G. abdomen lateral view; H. abdomen epigastric region ventral view, SEM. Female: F. abdomen ventral view. Bc, book lung covers; den, margin denticle (modified hair base); ebs, endites bent seta/setae (always a pair on outer margin of endites); icg, infracoxal groove; lap, postepigastric lateral apodemes; pfr, chelicerae posterior face ridges; pl, pleura; rfs, row of flattened setae; sli, slit; sp, sperm pore; sps, spatulate setae; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae; ws, wing-like setae. Scale bars: A, D 20 μm; B 20 μm; C, H 100 μm; E–G 500 μm.
FIGURE 3. *Aposphragisma baltenspergerae* sp. nov. Male: A. special hairs on ventral apex of tibia IV retrolateral view, SEM; B. apex of metatarsus IV retrolateral view, SEM; C. detail of retrolateral apex of metatarsus IV with special hairs, SEM; D. dorsal apex of metatarsus I, SEM; E. trichobothrium base, SEM; F. tarsal organ tarsus I (3 sensilla visible), SEM. G. tarsal organ tarsus III (2 sensilla visible), SEM. Ds, metatarsus dorsal shieldlike appendage; ms, metatarsus special setae; tb, trichobothrium base. Scale bars: A 20 μm; B 50 μm; C–E 10 μm; F–G 5 μm.
FIGURE 4. Aposphragisma baltenspergerae sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view; D. bulb with embolus-conductor-complex dorsal view, SEM; E. distal part of embolus-conductor-complex prolateral view, SEM; Female: F–G. epigastric region (internal genitalia) dorsal view. Ch, conical bulb; con, conductor; dc, embolus dorsal comb; esp, embolic spine; dps, cymbium distal patch of short setae; em, embolus; gap, globular appendix; lap, postepigastric lateral apodemes; lr, row of longitudinal ridges; lri, embolic longitudinal ridges; na, nail; pa, papillae; re, receptaculum; sa, sac; spp, spermophor; tsc, transverse sclerite. Scale bars: A–B, D–G 100 μm; C 50 μm.
Non-type material. 1 male (PBI_OON 00015855; partly used for SEM), collected together with paratypes (PBI_OON 00031399), deposited at NMBE.

Etymology. The species epithet is dedicated to Yvonne Kranz-Baltensperger (*1966), a NMBE arachnologist and PBI participant, mainly working on the revisions of the oonopid genera *Ischnothyreus* and *Xyphinus*.

Diagnosis. *A. baltenspergerae* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes (Fig. 1G); carapace margin with blunt denticles, sluice (slu) restricted to posterior margin (Fig. 1D); epigastric scutum in females posterolaterally with a row of longitudinal ridges (lr) (Fig. 4G). The new species closely resembles *A. borgulai* sp. nov. but shows a less pronounced sternum ornamentation (Fig. 1F), a different surface structure of the sternum setae (much less plumose, surface almost smooth; Fig. 2A) and more openings on the pleura (pl) surface (Fig. 2B); in males conical bulge (cb) on bulb less pronounced, cymbium anteriorly rounded in dorsal view, embolus subdistally without bend, embolic spine (esp) with pointed tip (Figs. 4D–E); in females postepigastric lateral apodemes (lap) shorter, internal genitalia slightly different e.g. showing different distribution of papillae (pa) (Figs. 4F–G); also differs in body size without overlap and has a disjunct distribution (Fig. 49).

Description. Description based on 9 males and 7 females.

Male. With the characters of the genus except as noted. Body length 1.47–1.61 mm (n=8), carapace length 0.68–0.73 mm (n=8). Sclerotized parts uniformly coloured orange-brown, approaching colour 340 ‘Robin Rufous’; legs slightly paler than body. Habitus: Figs. 1A–C.

Cephalothorax. Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate partly interrupted by small smooth areas (Figs. 1D, G); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases (pmh), appearing as small pointed denticles (Fig. 1G); non-marginal pars thoracica setae present; carapace margin with sluice (slu) restricted to posterior margin, with blunt denticles (Figs. 1D–E, 2B). Eyes: posterior eye-row straight from above, procured from front (Figs. 1D, H); ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum coarsely ornamented except smooth median stripe (Figs. 1E–F); surface setae only slightly plumose (surface almost smooth; Fig. 2A); infracoxal grooves (icg) anteriorly and posteriorly with openings (Fig. 2B); posterior margin with broad single extension, covered with blunt denticles (Fig. 1F). Pleura (pl) surface smooth with scattered pits (Fig. 2B). Mouthparts: chelicerae posterior margin of inner surface along proximal half upfolded to a ridge with median slit (sli) (Fig. 2C); promargin with row of flattened setae (rfs) in combination with plumose setae, distally extending into a short inwards pointing tooth-like projection (tip) (Figs. 1F, 2C); posterior face medially densely ribbed, with a pair of long spatulate setae (spss) (Fig. 2C). Endites: inner margin distally with brush of special wing-like setae (ws) with broad and deeply fringed tips (Fig. 2D), outer margin subdistally with a pair of rather long plumose setae bent inwards (ebs) (Fig. 2D).

Abdomen. Book lung covers (bc) large, elliptical to dumbbell or pear-shaped (i.e. sides concave), about 3 times longer than wide (Fig. 2G); book lung cover margins slightly elevated (Fig. 2H). Epigastric scutum dorsally with a widely oval subterminal ridge (sr) (Fig. 2G); scuto-pedicel region with slightly swollen hair bases (Fig. 2H). Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 2E). Setae appearing slightly plumose at SEM level (Fig. 2H).

Genitalia. Epigastric region: sperm pore (sp) situated at level of posterior spiracles (Fig. 2E). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb stout (Figs. 4A–B). Embolus (em) medially with longitudinal ridges (lri) on prolateral surface (Fig. 4D), tip widened and spatulate (Fig. 4E); embolic spine with pointed tip (esp) (Fig. 4E). Conductor (con) with broad tip (on stereomicroscope level tip appears ‘snout’-like in lateral view; Figs. 4C, E). Embolus-conductor-complex about as long as bulb (Figs. 4A–B).

Female. As in male except as noted. Body length 1.46–1.77 mm (n=6), carapace length 0.67–0.77 mm (n=6). Book lung covers about 4–5 times as long as wide. Epigastric scutum posterolaterally with a row of longitudinal ridges (lr) (Figs. 4F–G). Postepigastric scutum with short posteriorly directed lateral apodemes (lap) (Figs. 2F, 4F–G).

Genitalia. Dorsal view (Figs. 4F–G): receptaculum (re) large, oval, containing an oval sac-like structure (sa), lateral and median part dorsally covered with papillae (pap), laterally framed by elongated, posteriorly pointed sclerites (apodemes, lap); globular appendix (gap) lying dorsally of receptaculum about 1/5 as long as receptaculum; a transverse sclerite (tsc) lies anteriorly to the receptaculum and bears medially a nail-like structure (na).
**Intraspecific variation.** Body size variable (see above); the following characters show slight variation: body colour, number of denticles on carapace margin and extension of smooth median stripe on sternum. One female (PBI_OON 00031362) large (body length 1.79 mm, carapace length 0.81 mm; not included in size measurements above), in dorsal view with rather broad carapace and posterior edge of pars cephalica with a pair of large blunt denticles.

**Distribution.** E-Kalimantan, INDONESIA (Fig. 49).

*Aposphragisma borgulai* Thoma, sp. nov.

(Figs. 5–8)

**Type material.** **HOLOTYPE:** male (PBI_OON 00031400), Sumatra (INDONESIA), Jambi W of Mt. Tujuh Lake, 1400 m [01°42′20″S 101°23′0″E; inf.], 14.XI.1989, leg. D. Agosti, D. Burckhardt & I. Löbl, deposited at MHNG. **PARATYPES:** 1 male (PBI_OON 00012111), collected together with holotype, deposited at MHNG; 1 male (PBI_OON 00012126), Sumatra (INDONESIA), West Sumatra Province, Palopo Nat. Res., N of Bukittinggi, 900 m [0°18′20″S 100°22′09″E; inf.], 18.–20.XI.1989, leg. I. Löbl, D. Agosti & D. Burckhardt, deposited at MHNG; 1 male & 1 female (PBI_OON 00012402), Sumatra (INDONESIA), West Sumatra Province, old secondary forest above Taman Hutan Raya Bung Hatta, near road Padang to Lubukatingsih, 1100 m [0°56′45″S 100°32′37″E; prov.], 29./30.V.2006, leg. P. Schwendinger, deposited at NMBE; 1 female (PBI_OON 00012407), Sumatra (INDONESIA), West Sumatra Province, old secondary forest above Harau Canyon, N of Payakumbuh, 750 m [0°05′46″S 100°32′37″E; prov.], 7.VI.2006, leg. P. Schwendinger, deposited at MHNG; 1 female (PBI_OON 0012439), Sumatra (INDONESIA), West Sumatra Province, Anai Valley, 6 km S of Padangpanjang, 500 m [0°28′38″S 100°21′14″E; prov.], 1.VI.2006, primary forest, leg. P. Schwendinger, deposited at MHNG.

**Non-type material.** 1 male (PBI_OON 00031401; used for SEM), collected together with paratypes (PBI_OON 00012402), deposited at NMBE.

**Etymology.** The species epithet is dedicated to Adrian Borgula (*1959), a Swiss biologist and politician who had an important influence on the development of the first author’s natural history skills since they first met in August 1993.

**Diagnosis.** *A. borgulai* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes (Fig. 5D); carapace margin with blunt denticles, sluice (slu) restricted to posterior margin (Figs. 5D–E); epigastric scutum in females posterolaterally with a row of longitudinal ridges (lr) (Fig. 8F). It closely resembles *A. baltenspergae* (see there for differences).

**Description.** Description based on 5 males and 4 females.

**MALE.** With the characters of the genus except as noted. Body length 1.73–1.86 mm (n=4), carapace length 0.79–0.84 mm (n=4). Sclerotized parts uniformly coloured orange-brown, very close to colour 36 ‘amber’; legs slightly paler than body. Habitus: Figs. 5A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate, partly interrupted by small smooth areas (Fig. 5D); posteralateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles (pmh) (Fig. 5D); carapace margin with sluice (slu) restricted to posterior margin, with blunt denticles (den) (Fig. 6A). Eyes: posterior eye-row straight from above, procured from front (Figs. 5A, H); ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum coarsely ornamented except smooth median stripe (sms) (Figs. 5E–G, 6B); posterior margin with broad single extension, covered with blunt denticles (Fig. 5F); setae appearing plumose at SEM level (Fig. 6B). Pleura surface smooth with scattered pits. Mouthparts: chelicerae posterior margin of inner surface proximally modified to a ridge with faint median slit (sli), covering about 2/3 of margin length, distally ending in small pointed bulge (Fig. 6C); promargin with a row of flattened setae (rfs) with serrated lateral margin in combination with plumose setae (Fig. 6E), distally extending into a short inwards pointing tooth-like projection (tlp) (Figs. 6C–D), base of tooth-like projection posteriorly with a large plumose seta (lps) (about as long as fang;
FIGURE 5. *Aposphragisma borgulai* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view, SEM; E. prosoma ventral view; F. prosoma ventral view (chelicerae removed), SEM. Female: G. prosoma ventral view; H. carapace front view (chelicerae artificially slightly displaced). Ctg, continuous transverse groove; icg, infracoxal groove; pmh, modified hair bases (appearing as denticles); rf, faint radial furrow; slu, sluice; tlp, tooth-like projection of male chelicerae. Scale bars: A–C, E, G–H 500 μm; D, F 200 μm.
**FIGURE 6.** *Aposphragisma borgulai* sp. nov. Male: A. carapace posterolateral margin dorsal view, SEM; B. sternum anterolateral part ventral view, SEM; C. chelicerae prolateral view, SEM; D. chelicerae tip prolateral view; E. detail of row of flattened setae; F. abdomen ventral view, SEM; G. abdomen ventral view. Female: H. abdomen ventral view. Bc, book lung covers; den, margin denticle (modified hair base); icg, infracoxal groove; lap, postepigastric lateral apodemes; lps, single long plumose seta; rf, faint radial furrow; rfs, row of flattened setae; sli, slit; sms, smooth median stripe; sp, sperm pore; slu, sluice; tlp, tooth-like projection of male chelicerae. Scale bars: A–C 100 μm; D 50 μm; E 20 μm; F 200 μm; G–H 500 μm.
FIGURE 7. *Aposphragisma borgulai* sp. nov. Female: A. abdomen lateral view. Male: B. apex of metatarsus IV prolateral view, SEM; C. detail of prolateral apex of metatarsus IV with special hairs, SEM; D. trichobothrium base, SEM; tarsus IV prolateral, SEM. Bc, book lung cover; ct, claw tooth; ds, metatarsus dorsal shieldlike appendage; lr, row of longitudinal ridges; ms, metatarsus special setae; sr, subterminal widely oval scutal ridge. Scale bars: A 500 μm; B 50 μm; C–D 10 μm; E 20 μm.

Figs. 6D–E); anterior face of paturon in lateral view subbasally slightly indented. Endites distally with brush of special setae with broad and deeply fringed tips on inner margin, outer margin subdistally with a pair of rather long, plumose setae bent inwards.

**ABDOMEN.** Book lung covers (bc) large, elliptical to dumbbell or pear-shaped (i.e. sides concave), about 3 times longer than wide (Fig. 7A). Epigastric scutum dorsally with a widely oval subterminal ridge (sr) (Fig. 7A); scuto-pedicel region with slightly ‘swollen’ hair bases. Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 6G). Setae appearing slightly plumose at SEM level (Fig. 6F).

**GENITALIA.** Epigastric region: sperm pore (sp) situated between anterior and posterior spiracles (Fig. 6F). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb stout (Figs. 8A–B). Embolus (em) medially with longitudinal ridges (lri) on prolateral surface (Fig. 8D); embolus tip spatulate and twisted (Figs. 8C, E); embolic spine (esp) with fringed tip (Fig. 8E). Conductor (con) with broad tip, distally with lateral comb (on stereomicroscope level tip appears ‘snout’-like in lateral view; Fig. 8C). Embolus-conductor-complex about as long as bulb.
FIGURE 8. Aposphragisma borgulai sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view; D. bulb with embolus-conductor-complex dorsal view, SEM; E. distal part of embolus-conductor-complex prolateral view, SEM. Female: F–G. epigastric region (internal genitalia) dorsal view (F: epigastric scutum together with transverse sclerite artificially displaced). Cb, conical bulge; con, conductor; dps, cymbium distal patch of short setae; em, embolus; esp, embolic spine; gap, globular appendix; lap, postepigastric lateral apodemes; lc, lateral comb; lr, row of longitudinal ridges; lri, embolic longitudinal ridges; na, nail; pa, papillae; re, receptaculum; sa, sac; tsc, transverse sclerite; spp, spermophor; spo, spermophor opening. Scale bars: A–B, D, F–G 100 μm; C 50 μm; E 10 μm.
**FEMALE.** As in male except as noted. Body length 1.72–2.06 mm (n=4), carapace length 0.76–0.88 mm (n=4). Epigastric scutum posterolaterally with a row of longitudinal ridges (Ir) (Fig. 8F).

**GENITALIA.** Dorsal view (Figs. 8F–G): receptaculum (re) oval, containing an oval sac-like structure (sa), laterally framed by long, posteriorly pointed sclerites (apodemes; lap); globular appendix (gap) lying dorsally of receptaculum about 1/3 as long as receptaculum; posterior part of receptaculum dorsally covered with papillae (pap); a transverse sclerite (tsc) lies anteriorly to the receptaculum and bears medially a nail-like structure (na).

**Intraspecific variation.** Body size variable (see above); colour shows very slight variation; one rather small female shows irregular posterior eye row; number of denticles on carapace margin variable (around 20 each side); one female with reduced smooth median stripe on sternum.

**Distribution.** W-Sumatra, INDONESIA (Fig. 49).

**Aposphragisma brunomanseri Thoma, sp. nov.** (Figs. 9–12)

**Type material.** HOLOTYPE: male (PBI_OON 00031369), Sarawak (MALAYSIA), Bako National Park [01°42′N 110°27′E; inf.], 29./30.III.1985, leg. C.L. & P.R. Deeleman, deposited at RMNH. PARATYPES: 1 male & 1 female (PBI_OON 00015245), Sarawak (MALAYSIA), 12 km E of Bau, 20 m [01°25′N 110°02′E; inf.], 14.V.1994, riverain forest, on fungi, leg. I. Löbl & D. Burckhardt, deposited at NMBE; 1 male (PBI_OON 00016214), Sarawak (MALAYSIA), route Kuching to Matang, Gunung Serapi, 670 m [01°35′N 110°11′E; inf.], 9.XII.1987, prélèvement du sol dans la fôret le long de la route vers la station TV (Berlese à Kuching, Sarawak), leg. B. Hauser, deposited at MHNG; 1 female (PBI_OON 00031367), Sarawak (MALAYSIA), Semengoh arboretum [01°21′N 110°21′E; inf.], 6.IV.1985, litter and humus, leg. C.L. Deeleman, deposited at RMNH; 1 female (PBI_OON 00031368), Sarawak (MALAYSIA), Semengoh arboretum, lower track [01°21′N 110°21′E; inf.], 23.III.1985, litter and humus, leg. C.L. Deeleman & P.R. Deeleman, deposited at RMNH; 1 male (PBI_OON 00031372), Semengoh arboretum [01°21′N 110°21′E; inf.], 27.III.1985, leg. C.L. Deeleman, deposited at RMNH; 1 female (PBI_OON 00031369), Sarawak (MALAYSIA), Semengoh arboretum, lower track [01°21′N 110°21′E; inf.], 23.III.1985, litter and humus, leg. C.L. Deeleman & P.R. Deeleman, deposited at RMNH; 1 male (PBI_OON 00031372), Semengoh arboretum [01°21′N 110°21′E; inf.], 6.IV.1985, litter, leg. C.L. Deeleman, deposited at RMNH; 1 female (PBI_OON 00031372), Semengoh arboretum [01°21′N 110°21′E; inf.], 6.IV.1985, litter, leg. C.L. Deeleman, deposited at RMNH; 1 female (PBI_OON 00031373), collected with male holotype, deposited at RMNH; 1 female (PBI_OON 00031372), collected with male holotype, deposited at RMNH.

**Non-type material.** 1 female (PBI_OON 00031347), Sarawak (MALAYSIA), Semengoh [01°21′N 110°21′E; inf.], 6.IV.1985, litter, leg. C.L. Deeleman, deposited at RMNH; 1 female (PBI_OON 00031366; partly used for SEM), Sarawak (MALAYSIA), Semengoh arboretum [01°21′N 110°21′E; inf.], 10.I.1984, litter, leg. C.L. Deeleman, deposited at RMNH; 1 male (PBI_OON 00031402; partly used for SEM), collected together with paratype (PBI_OON 00015254), deposited at RMNH. 1 female (PBI_OON 00031392), collected with male holotype, deposited at RMNH; 1 female (PBI_OON 00031393), collected together with paratype (PBI_OON 00015254), deposited at RMNH.

**Etymology.** The species epithet is dedicated to Bruno Manser (*1954, missing, presumed dead), a Swiss environmental activist and ethnologist, most famous for his support of the nomadic indigenous Penan people against the destruction of pristine rain forest in the Malaysian state of Sarawak (see www.bmf.ch).

**Diagnosis.** A. brunomanseri sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace with two pairs of spikes (Figs. 9E–F); carapace margin with pointed denticles (den) and sluice (slu) restricted to posterior margin (Figs. 9F, 10A); epigastric scutum in females posterolaterally with a single curved ridge (cr) (Fig. 11C). It resembles A. dayak sp. nov. and A. kolleri sp. nov., but A. dayak sp. nov. (only known from one female) lacks spikes and shows a row of longitudinal ridges on the epigastric scutum. Among other differences A. kolleri sp. nov. only has one pair of spikes, differs in sternum ornamentation and shows a pointed embolic spine.

**Description.** Description based on 5 males and 8 females.

**MALE.** With the characters of the genus except as noted. Body length 1.80–1.90 mm (n=5), carapace length 0.86–0.88 mm (n=5). Sclerotized parts uniformly coloured red-brown, approaching colour 32 ‘chestnut’; legs more orangish coloured, paler than rest of body. Habitus: Figs. 9A–C.
THE NEW GENUS APOSPHRAGISMA

FIGURE 9. *Aposphragisma brunomanseri* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace lateral view; E. carapace dorsal view; F. carapace dorsal view, SEM; G. prosoma ventral view; H. prosoma ventral view, SEM. Csp, posterior cephalic spikes (modified hair bases); ctg, continuous transverse groove; icg, infracoxal groove; ka, knob-like apophysis; msp, posterolateral margin spikes (modified hair bases); rf, faint radial furrow; slu, sluice. Scale bars: A–E, G 500 μm; F, H 200 μm.
FIGURE 10. *Aposphragisma brunomanseri* sp. nov. Male: A. carapace posterolateral margin dorsal view, SEM; B. sternum lateral part ventral view, SEM; C. detail of sternum posterior extension, SEM; D. chelicerae prolateral view, SEM; E. chelicerae tip prolateral view, SEM; F. mouthparts ventral view (chelicerae removed), SEM; G. distal part of endite ventral view; H. detail of endite tip inner margin, SEM. Ctg, continuous transverse groove; den, margin denticle (modified hair base); ebs, endites bent setae; icg, infracoxal groove; ka, knob-like apophysis; lps, single long plumose seta; msp, posterolateral margin spikes (modified hair bases); pl, pleura; rf, faint radial furrow; rfs, row of flattened setae; ser, serrula; ri, ridge with median slit; slu, sluice; tlp, tooth-like projection of male chelicerae; ws, wing-like setae. Scale bars: A–B, D, F 100 μm; C, E, G 50 μm; H 10 μm.
FIGURE 11. Aposphragisma brunomanseri sp. nov. Male: A. abdomen ventral view; E. special hairs on ventral apex of tibia IV retrolateral view, SEM; F. apex of metatarsus IV retrolateral view; G. detail of retrolateral apex of metatarsus IV with special hairs, SEM; H. trichobothrium base, SEM. Female: B. abdomen ventral view; C. abdomen epigastric region ventral view, SEM; D. detail of abdomen front view, SEM. Cr, curved ridge; das, dorsal abdominal scutum; ds, metatarsus dorsal shieldlike appendage; lap, postepigastric lateral apodemes; lds, special long dorsal setae; ms, metatarsus special setae; sr, subterminal widely oval scutal ridge. Scale bars: A–B 500 μm; C 100 μm; D–F 50 μm; G 10 μm; H 5 μm.
FIGURE 12. *Aposphragisma brunomanseri* sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view; D. bulb with embolus-conductor-complex dorsal view, SEM; E. embolus-conductor-complex prolateral view, SEM. Female: F-G. epigastric region (internal genitalia) dorsal view (nail partly covered by transverse sclerite). *Cb*, conical bulge; *con*, conductor; *cr*, curved ridge; *dc*, dorsal comb; *dps*, cymbium distal patch of short setae; *em*, embolus; *esp*, embolic spine; *gap*, globular appendix; *lap*, postepigastric lateral apodemes; *lc*, lateral comb; *na*, nail; *pa*, papillae; *re*, receptaculum; *sa*, sac; *spp*, spermophor; *tsc*, transverse sclerite. Scale bars: A–B, D, F–G 100 μm; C, E 50 μm.
CEPHALOTHORAX. Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate (dorsal part more striated; Figs. 9D–F); posterior edge of pars cephalica with one pair of spikes (csp) (Figs. 9C–F); carapace margin with pointed denticles (den), sluice (slu) restricted to posterior margin, posterolateral corners with one pair of spikes (msp) (Figs. 9E–F, 10A); Eyes: posterior eye-row recurved from above, procurved from front (Fig. 9E); ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum coarsely ornamented except smooth median stripe and broadly smooth edges (ornamentation arranged in an ovoid band; Figs. 9G–H); posterior margin expands into narrow single extension, posteriorly with a knob-like apophysis (ka) (Figs. 9H, 10C); setae appearing slightly plumose at SEM level. Pleura: (pl) surface smooth with pairs of large pits dorsally of each coxa I, II and III (Fig. 10B).

Mouthparts: chelicerae posterior margin of inner surface proximally modified to a ridge with grooved surface (ri), covering about 2/3 of margin length, distally ending in a rounded knob (Fig. 10D); promargin with row of flattened setae (rfs) in combination with plumose setae, distally extending into a short inwards pointing tooth-like projection (tlp) (Figs. 10D–E); base of tooth-like projection posteriorly with a large plumose seta (lps) (about as long as fang; Fig. 10E). Endites: inner margin distally with a brush of special wing-like setae (ws) (Figs. 10G–H); outer margin subdistally with a pair of rather long, inward bent plumose setae (ebs) (Figs. 10F–G).

ABDOMEN. Book lung covers large, elongated elliptical to dumbbell shaped (i.e. sides concave), about 5–6 times longer than wide. Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Figs. 11A–B, D), Postepigastric scutum long, semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 11A). Setae appearing slightly plumose at SEM level (Fig. 11C); dorsal abdominal setae very long (lds) (Figs. 9C–D, 11D).

GENITALIA. Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 11A). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb stout (Figs. 12A–B). Embolus tip spatulate (Figs. 12C–E); embolic spine with fringed tip (esp) (Fig. 12C). Conductor (con) with pronounced lateral comb (lc) and broad tip (Figs. 12C, E). Embolus-conductor-complex about as long as bulb.

FEMALE. As in males except as noted. Body length 1.88–2.21 mm (n=8), carapace length 0.88–0.97 mm (n=8). Epigastric scutum posterolaterally with a curved ridge (cr) (Figs. 11B–C, 12F). Postepigastric scutum almost semicircular (Fig. 11B).

GENITALIA. Dorsal view (Figs. 12F–G): receptaculum (re) triangular shaped with rounded posterior edge, laterally framed by short almost rectangular sclerites (apodemes; lap) and containing a triangular sac-like structure (sa); globular appendix (gap) lying dorsally of receptaculum short, only about 1/4 of receptaculum length; lateral and median part of receptaculum dorsally covered with papillae (pap); a transverse sclerite (tsc) lies anteriorly to the receptaculum and bears medially a nail-like structure (na) (the latter being superimposed by globular appendix and therefore hardly visible on the figures).

Intraspecific variation. Body size variable (see above); except for two yellowish coloured females body colour shows only very slight variation; the following characters are slightly variable as well: size of ‘spikes’ at posterior edge of pars cephalica, number of denticles on carapace margin, extension of smooth median stripe on sternum.

Distribution. W-Sarawak, MALAYSIA (Fig. 49).

*Aposphragisma confluens* Thoma, sp. nov. (Fig. 13)

**Type material.** HOLOTYPE: female (PBI_OON 00015238), Sarawak (MALAYSIA), E of Kapit, Tr. Narwin at confluence of Suan Oyen River and Mujong River, 150 m [02°02′N 113°01′E; inf.], 19.V.1994, secondary mixed dipterocarp forest along ridge, sifting of vegetational debris, leg. I. Löbl & D. Burckhardt, deposited at MHNG.

**Etymology.** The species epithet is a noun in apposition meaning ‘confluence’ in Latin. It refers to the type locality at the confluence of Suan Oyen River and Mujong River on Borneo.

**Diagnosis.** *A. confluens* sp. nov. is only known from one female and does not belong to the stripe clade and thus shows a completely ornamented sternum. It can be distinguished from other species with a completely ornamented sternum by the combination of the following traits: carapace margin with blunt denticles (Fig. 13D), sluice (slu) reaching from posterior margin to level of coxa I (Fig. 13C), epigastric scutum dorsally without a widely oval subterminal ridge and sides posterolaterally with a single curved ridge (cr) (Fig. 13H). It highly
resembles allopatric *A. draconigenum* but can be distinguished among others by the larger posterior eyes and the larger body size.

**FIGURE 13.** *Aposphragisma confluens* sp. nov. Female: A. habitus dorsal view; B. habitus lateral view; C. carapace dorsal view; D. prosoma ventral view; E. carapace lateral view; F. carapace front view; G. abdomen lateral view; H. abdomen ventral view. *Be*, book lung cover; *cr*, curved ridge; *ctg*, continuous transverse groove; *lap*, postepigastric lateral apodemes; *slu*, sluice. Scale bars: A–H 500 μm.
**Description.** Description based on 1 female.

**FEMALE.** With the characters of the genus except as noted. Body length 1.65 mm, carapace length 0.74 mm. Sclerotized parts uniformly coloured yellow-brown, very close to colour 123A ‘cinnamon’; legs only slightly paler than body. Habitus: Figs. 13A–B.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides finely reticulate (Figs. 13C, E); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles; carapace margin with sluice (slu) reaching from posterior margin to level of coxa I, with blunt denticles (Fig. 13C); non-marginal pars thoracica setae scattered.

**Eyes:** posterior eye-row straight or slightly procured from above, procured from front (Figs. 13C, F); ALE largest, separated by less than their radius; ALE-PLE separated by less than ALE radius; PME touching for less than half their length; PLE-PME separated by less than PME radius. Sternum completely finely ornamented (Fig. 13D). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III (Fig. 13E).

**ABDOMEN.** Book lung covers (bc) large, elongated elliptical to slightly pear-shaped (i.e. sides concave), about 4 times longer than wide (Fig. 13G). Epigastric scutum dorsally without widely oval subterminal ridge (Fig. 13G), posterolaterally with a single curved ridge (cr) (Fig. 13H). Postepigastric scutum long, semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 13H).

**Distribution.** Central Sarawak, MALAYSIA (Fig. 49).

*Aposphragisma dayak* Thoma, sp. nov.

*(Fig. 14)*

**Type material.** **HOLOTYPE:** female (PBI_OON 00016222), Belait District (BRUNEI), Labi Hills Forest Reserve, Teraja, 42 km S of Sungai Liang, 12 km S of Labi, 40 m [04°17′N 114°25′E; inf.], 22.XI.1988, forêt primaire (mixed dipterocarp forest), prélèvement de sol au pied d’un grand arbre, leg. B. Hauser, deposited at MHNG.

**Etymology.** The species epithet is a noun in apposition and the general term for the indigenous peoples of Borneo.

**Diagnosis.** *A. dayak* sp. nov. is only known from one female. It belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes (Figs. 14C, E); carapace margin with blunt denticles, sluice restricted to posterior margin (Fig. 14C); epigastric scutum posterolaterally with a row of longitudinal ridges. The new species resembles *A. baltenspergae* sp. nov., *A. borgulai* sp. nov. and *A. brunomanseri* sp. nov. It differs from *A. baltenspergae* sp. nov. and *A. borgulai* sp. nov. amongst others in sternum pattern and shape of postepigastric scutum. Sympatric *A. brunomanseri* sp. nov. has two pairs of spikes, longer abdominal setae, a knob-like apophysis projecting from the posterior margin of the sternum and (in females only) a pair of single curved ridges on the epigastric scutum.

**Description.** Description based on 1 female.

**FEMALE.** With the characters of the genus except as noted. Body length 1.69 mm, carapace length 0.73 mm. Sclerotized parts uniformly coloured orange-brown close to colour 136 ‘raw sienna’; legs pale orange, much paler than body. Habitus: Figs. 14A–B.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate, partly interrupted by small smooth areas (Figs. 14C, E); posterolateral surface without spikes; posterior edge of pars cephalica with a pair of modified hair bases (pch), appearing as small ‘horns’ (Figs. 14E); carapace margin with sluice restricted to posterior margin, with large blunt denticles (Fig. 14C). Eyes: posterior eye-row straight from above, procured from front (Figs. 14C, F); ALE largest, separated by less than their radius; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum coarsely ornamented except smooth median stripe and broadly smooth edges (ornamentation arranged as oval band; Fig. 14D); posterior margin expanded as broad single extension, covered with blunt denticles, posteriorly without knob-like apophysis (Fig. 14D, cf *A. brunomanseri* sp. nov.). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III.

**ABDOMEN.** Book lung covers (bc) large, elongated elliptical to egg-shaped (i.e. sides convex), about 3 times longer than wide (Fig. 14G). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 14G), posterolaterally with a row of longitudinal ridges. Postepigastric scutum long, semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 14H).

**Distribution.** Belait District, BRUNEI (Fig. 49).
FIGURE 14. *Aposphragisma dayak* sp. nov. Female: A. habitus dorsal view; B. habitus lateral view; C. carapace dorsal view; D. prosoma ventral view; E. carapace lateral view; F. carapace front view; G. abdomen lateral view; H. abdomen ventral view. Bc, book lung cover; ctg, continuous transverse groove; lap, postepigastric lateral apodemes; pch, posterior modified cephalic hair bases; sr, subterminal widely oval scutal ridge. Scale bars: A–H 500 μm.
FIGURE 15. *Aposphragisma dentatum* sp. nov. Female: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. carapace ventral view; F. abdomen anterolateral view; G. abdomen ventral view; H. tarsus I retrolateral view. Bc, book lung cover; cr, curved ridge; csp, cephalic spikes; den, margin denticles (modified hair bases); sr, subterminal widely oval scutal ridge. Scale bars: A–G 500 μm, H 50 μm.
Aposphragisma dentatum Thoma, sp. nov.  
(Fig. 15)

**Type material.** **HOLOTYPE:** female (PBI_OON 00031645), Kalimantan (INDONESIA), Berau District, Hutan Mayan Mangurai, c. 15 km SW of Tanjungredeb, 20 m [02°06’13”N 117°24’05”E; prov.], 30.IX.2008, secondary forest, leg. P. Schwendinger, deposited at MHNG.

**Etymology.** The species epithet is an adjective meaning ‘toothed’ in Latin and refers to the special denticles of the carapace margin.

**Diagnosis.** *A. dentatum* sp. nov. is only known from one female. It belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace with one pair of spikes (Fig. 15D); carapace margin with cogwheel-like denticles (den), sluice restricted to posterior margin (Figs. 15D–E); epigastic scutum posterolaterally with a single curved ridge (cr) (Fig. 15G). It differs from similar but allopatric *A. kollerii* sp. nov. by the shape of the denticles on the carapace margin, the very long claws (almost as long as tarsi; Fig. 15H) and the shorter body length.

**Description.** Description based on 1 female.

**FEMALE.** With the characters of the genus except as noted. Body length 1.95 mm, carapace length 0.90 mm; sclerotized parts uniformly coloured orange-brown approaching colour 340 ‘robin rufous’; legs slightly paler than body, pale orange. Habitus: Figs. 15A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate, partially interrupted by small smooth areas (Figs. 15C–D); posterior edge of pars cephalica with one pair of spikes (csp) (Figs. 15C–D); carapace margin with sluice restricted to posterior margin (Fig. 15D); denticles (den) on carapace margin blunt, becoming more and more two-lobed (and thus rather heart-shaped) on posterior half of margin (carapace margin appears cogwheel-like; Figs. 15D–E). Eyes: posterior eye-row straight from above, procurved from front; ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum finely ornamented except short smooth median stripe (Fig. 15E); posterior margin with broad single extension, covered with blunt denticles (Fig. 15E). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III.

**ABDOMEN.** Book lung covers (bc) large, elongated, dumbbell-shaped (i.e. sides concave), about 6 times longer than wide (Fig. 15F). Epigastic scutum dorsally with widely oval subterminal ridge (sr) (Fig. 15F), posterolaterally with a single curved ridge (cr) (Fig. 15G); scuto-pedicel region with slightly swollen hair bases. Postepigastric scutum almost semicircular, with short posteriorly directed lateral apodemes (Fig. 15G).

**LEGS.** Tarsi I–IV with very long claws (almost as long as tarsi; Fig. 15H).

**Distribution.** NE-Kalimantan, INDONESIA. (Fig. 49).

---

Aposphragisma draconigenum Thoma, sp. nov.  
(Figs. 16–17)

**Type material.** **HOLOTYPE:** male (PBI OON 00015669), Pahang (MALAYSIA), Tioman Island, westside of Mount Kajang, 2 km E of Kampung Genting, 400 m [02°47’N 104°08’E; prov.], 2.VII.2001, leg. A. Schulz & K. Vock, deposited at MHNG. **PARATYPE:** 1 female (PBI OON 00031385), collected together with holotype, deposited at MHNG.

**Etymology.** The species epithet is a Latin adjective meaning ‘to be descended from a dragon’. It refers to a legend saying that Tioman Island, on which lies the type locality, represents a resting dragon princess.

**Diagnosis.** *A. draconigenum* sp. nov. does not belong to the stripe clade and thus shows a completely ornamented sternum. It can be distinguished from other species with a completely ornamented sternum by the combination of the following traits: carapace margin with blunt denticles, sluice (slu) reaching from posterior margin to level of coxa I (Fig. 16D); epigastic scutum dorsally with a widely oval subterminal ridge (sr) (Fig. 16G), sides posterolaterally with a pair of single curved ridges (cr) (in female only; Fig. 17B) and a distally widened spinneret scutum (in male only; Fig. 16H). It highly resembles allopatric *A. confluens* sp. nov. but can be distinguished among others by smaller posterior eyes, broader posterior extension of the sternum and smaller body size.
FIGURE 16. *Aposphragisma draconigenum* sp. nov. Female: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; F. prosoma ventral view. Male: E. prosoma ventral view (sternum damaged); G. abdomen lateral view; H. abdomen posterior view (with enlarged spinneret scutum). Bc, book lung cover; ctg, continuous transverse groove; slu, sluice; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae. Scale bars: A–C 500 μm; D–H 200 μm.
FIGURE 17. *Aposphragisma draconigenum* sp. nov. Male: A. abdomen ventral view; C–D. palp prolateral view (D: hairs omitted except trichobothria). Female: B. abdomen ventral view. Cb, conical bulge; con, conductor; cr, curved ridge; em, embolus; lap, postepigastric lateral apodemes; spp, spermophore. Scale bars: A–B. 200 μm; C–D. 100 μm.

Description. Description based on 1 male and 1 female.

**MALE.** With the characters of the genus except as noted. Body length 1.08 mm, carapace length 0.52 mm. Sclerotized parts uniformly coloured yellow-brown approaching colour 121C ‘mikado brown’; legs slightly paler than body. Habitus: Figs. 16A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides finely reticulate (Figs. 16C–D); posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles; carapace margin with sluice (slu) reaching from posterior margin to level of coxa I, with blunt denticles (Fig. 16D); non-marginal pars thoracica setae present but sparse and scattered. Eyes: posterior eye-row straight from above, procurred from front; ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME tiny and circular, separated by less than PME radius. Sternum completely finely ornamented (Figs. 16E–F). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III. Mouthparts: chelicerae promargin distally extending into a short inwards
pointing tooth-like projection (tlp) (Fig. 16E); anterior face of paturon in lateral view subbasally slightly indented (Fig. 16C).

ABDOMEN. Book lung covers (bc) large, elongated elliptical, with parallel sides, about 3 times longer than wide (Fig. 16G). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 16G). Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 17A). Pedicel tube finely ribbed. Spinneret scutum distally widened (Fig. 16H).

GENITALIA. Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 17A). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb stout (Figs. 17C–D). Embolus (em) tip elongated and spatulate (Figs. 17C–D); embolic spine not observed. Conductor (con) with slender tip (Figs. 17C–D). Embolus-conductor-complex slightly shorter than bulb.

FEMALE. Body length 1.19 mm, carapace length 0.54 mm. As in male except as noted. Lighter coloured than male, more yellowish, close to colour 123B ‘clay colour’. Proximal part of chelicerae posterior margin of inner surface upfolded to a ridge, covering about 2/3 of margin-length, distally ending in tooth-like projection (not possible to be examined in male). Epigastric scutum posterolaterally with a pair of single curved ridges (cr) (Fig. 17B). Postepigastric scutum with short posteriorly directed lateral apodemes (lap) (Fig. 17B). Spinneret scutum distally not widened (Fig. 17B).

Intraspecific variation. Body size variable (see above). Body colouration variable (see above).

Distribution. Tioman Island, MALAYSIA (Fig. 49).

Aposphragisma hausammannae Thoma, sp. nov. (Figs. 18–19)

Type material. HOLOTYPE: male (PBI_OON 00012212), Dong Nai Province (VIETNAM), Cat Tien National Park, 25 km NW of Tan Phu, 130 m [11°25′22.3″N 107°25′42.5″E; prov.], 26.–29.VIII.2003, evergreen rain forest between HQ and Mr. Dong redwood tree, leg. P. Schwendinger, deposited at MHNG. PARATYPES: 2 females (PBI_OON 00015468) collected together with male holotype, deposited at MHNG.

Etymology. The species epithet is dedicated to Brigitt Hausammann (*1981), a Swiss environmental scientist and globetrotter who has spent several months conducting research in Vietnam. Her philosophy of life and friendship has not left the first author’s own life untouched.

Diagnosis. A. hausammannae sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes (Figs. 18A, C); carapace margin with blunt denticles, sluice reaching from posterior margin to level of coxa I (Fig. 18A); epigastric scutum in females posterolaterally with a row of longitudinal ridges. It closely resembles allopatric A. retifer sp. nov. but body length is much shorter, posterior eye row straight from above (recurved in A. retifer sp. nov.) and ALE-ALE interdistance is greater. The new species also shows structural differences of the male palp if compared to A. retifer sp. nov.

Description. Description based on 1 male and 2 females.

MALE. With the characters of the genus except as noted. Body length 1.30 mm, carapace length: 0.61 mm. Carapace uniformly coloured honey-yellow, very close to colour 118 ‘warm buff’, abdomen uniformly coloured brown-yellowish, very close to colour 123 ‘raw umber’; legs paler than body, yellowish. Habitus: Figs. 18A–C.

CEPHALOTHORAX. Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate, partly interrupted by small smooth areas (Figs. 18D, G); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles; carapace margin with sluice (slu) reaching from posterior margin to level of coxa I, with blunt denticles (Fig. 18D); very few non-marginal pars thoracica setae. Eyes: posterior eye-row straight from above, procurred from front; ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum finely ornamented except smooth median stripe (Figs. 18E–F); posterior margin with broad single extension, covered with blunt denticles (Figs. 18E–F). Mouthparts: chelicerae posterior margin of inner surface proximally modified to a ridge, covering about 2/3 of margin length; promargin with row of flattened setae, distally extending into a short inwards pointing tooth-like projection (tlp) (Fig. 18E); posterior face with a pair of spatulate setae, more than half as long as fang; anterior face of paturon in lateral view subbasally slightly indented (ind) (Fig. 18G).
FIGURE 18. Aposphragisma hausammannae sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; G. carapace lateral view. Female: F. prosoma ventral view; H. abdomen lateral view. Bc, book lung cover; ctg, continuous transverse groove; ind, chelicerae anterior face subbasal indentation; slu, sluice; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae. Scale bars: A–C, H 500 μm; D–G 200 μm.
The new genus *Aposphragisma*

**Figure 19.** *Aposphragisma hausammanae* sp. nov. Male: A. abdomen ventral view; C–D. palp prolateral view (D: hairs omitted except trichobothria); E. embolus-conductor-complex prolateral view. Female: B. abdomen ventral view. Cb, conical bulge; con, conductor; cr, curved ridge; dc, dorsal comb; em, embolus; esp, embolic spine; lap, postepigastric lateral apodemes; spp, spermophor; spo, spermophor opening. Scale bars: A–B 200 μm; C–D 100 μm; E 50 μm.

**ABDOMEN.** Book lung covers (bc) large, elliptical or rather pear-shaped (sides slightly convex), about 4 times longer than wide (Fig. 18H). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 18H). Postepigastric scutum long, semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 19A).

**GENITALIA.** Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 19A). Palp: basal segments lighter in colour than rest of body, yellowish; bulb rather slender (Figs. 19C–D). Embolus (em) tip spatulate (Figs. 19C–D); embolic spine with fringed tip (esp) (Fig. 19D). Conductor with slender tip (con) (Figs. 19C–D). Embolus-conductor-complex slightly shorter than bulb.

**FEMALE.** As in male except as noted. Body length 1.50–1.52 mm, carapace length 0.64 mm. Carapace colour slightly more orange-brownish, towards colour 136 ‘raw sienna’, abdomen slightly browner, towards colour 139 ‘true cinnamon’. Epigastric scutum posterolaterally with a row of longitudinal ridges (similar as in *A. helvetorium* sp. nov.).

**Intraspecific variation.** Body size variable (see above); colour shows slight variation (see above); carapace margin with variable number of denticles.

**Distribution.** Dong Nai Province, VIETNAM; all specimens collected at the type location (Fig. 49).
**Type material.** **HOLOTYPE:** male (PBI_OON 00031384), Sabah (MALAYSIA), Mt. Kinabalu, Bukit Ular Trail, 1760 m [06°01′27″N 116°32′35″E; inf.], 22.III.1983, prélèvement de sol près d’un ruisseau et de sol suspendu retenu dans des fougeres (*Asplenium*) (appareil Berlese), leg. B. Hauser, deposited at MHNG. **PARATYPES:** 1 female (PBI_OON 00012113), Sabah (MALAYSIA), Mt. Kinabalu, Bukit Ular Trail, sentier reliant “Kambarangan Road” à “Power Station”, 1790 m [06°01′27″N 116°32′35″E; inf.], 28.IV.1982, tamisage de feuilles mortes et de bois pourri, forêt de *Lithocarpus-Castanopsis* (appareil Winkler-Moczarski à Sepilok), leg. B. Hauser, deposited at AMNH; 1 female (PBI_OON 00012195), Sabah (MALAYSIA), Kibongoi Valley 7 km N of Tambunan, 700 m [05°44′N 116°21′; inf.], 20.V.1987, leg. D. Burckhardt & I. Löbl, deposited at NMBE; 1 female (PBI_OON 00012203), Sabah (MALAYSIA), Poring Hot Springs, 500 m [06°02′20″N 116°42′44″E; inf.], 8.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male & 1 female (PBI_OON 00012208), Sabah (MALAYSIA), Mt. Kinabalu, 1500 m [06°04′N 116°34′E; inf.], 25.IV.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male & 1 female (PBI_OON 00012258), Sabah (MALAYSIA), Mt. Kinabalu, 1550–1650 m [06°04′N 116°34′E; inf.], 24.IV.1987, leg. D. Burckhardt & I. Löbl, deposited at NSMT; 1 male & 2 females (PBI_OON 00012261), Sabah (MALAYSIA), Mt. Kinabalu, 1500 m [06°04′N 116°34′E; inf.], 30.IV.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 2 males & 3 females (PBI_OON 00012262), Sabah (MALAYSIA), Crocker Range, km 63 on road Kota Kinabalu to Tambunan, 1200 m [05°50′N 116°18′E; inf.], 19.V.1987, leg. D. Burckhardt & I. Löbl, deposited at NHM; 1 male & 2 females (PBI_OON 00012269), Sabah (MALAYSIA), Poring Hot Springs, 500 m [06°02′20″N 116°42′44″E; inf.], 6.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male & 1 female (PBI_OON 00012274), Sabah (MALAYSIA), Mt. Kinabalu, 1500 m [06°04′N 116°34′E; inf.], 21.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male & 1 female (PBI_OON 00012278), Sabah (MALAYSIA), Poring Hot Springs, Langanan Falls, 900–950 m [06°02′20″N 116°42′44″E; inf.], 12.V.1987, leg. D. Burckhardt & I. Löbl, deposited at NMBE; 1 male & 2 females (PBI_OON 00012284), Sabah (MALAYSIA), Crocker Range, km 60 on road Kota Kinabalu to Tambunan, 1270 m [05°50′N 116°18′E; inf.], 17.V.1987, leg. D. Burckhardt & I. Löbl, deposited at NMBE; 1 male (PBI_OON 00012292), Sabah (MALAYSIA), Mt. Kinabalu, 1430 m [06°04′N 116°34′E; inf.], 22.V.1987, leg. D. Burckhardt & I. Löbl, deposited at AMNH; 1 female (PBI_OON 00012296; abdomen used for examination of internal genitalia), Sabah (MALAYSIA), Mt. Kinabalu, 1550 m [06°04′N 116°34′E; inf.], 29.IV.1987, leg. D. Burckhardt & I. Löbl, deposited at NHM; 1 male & 3 females (PBI_OON 00012315), Sabah (MALAYSIA), Mt. Kinabalu, 1550 m [06°04′N 116°34′E; inf.], 28.IV.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 2 males & 1 female (PBI_OON 00012345), Sabah (MALAYSIA), Poring Hot Springs, 500 m [06°02′20″N 116°42′44″E; inf.], 6.V.1987, leg. D. Burckhardt & I. Löbl, deposited at NMBE; 1 male (PBI_OON 00012366), Sabah (MALAYSIA), Crocker Range, km 60 Kota Kinabalu to Tambunan, 1350 m [05°50′N 116°18′E; inf.], 17.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 female (PBI_OON 00012601), Sabah (MALAYSIA), Mt. Kinabalu, Poring Hot Springs, 495 m [06°02′20″N 116°42′44″E; inf.], 24.VIII.1988, sifting fermenting fruits of *Ficus* sp., leg. A. Smetana, deposited at MHNG; 1 male (PBI_OON 00012657), Sabah (MALAYSIA), Mt. Kinabalu, HQ at Liwagu River, 1500 m [06°00′35″N 116°32′27″E; inf.], 4.VIII.1988, sifting leaf litter, leg. A. Smetana, deposited at MHNG; 1 female (PBI_OON 00015280), Sabah (MALAYSIA), route de Kimanis à 16 miles de Keningau: hêliport, forêt brumeuse, 1380 m [05°30′N 116°E; inf.], 14.III.1983 (appareil Berlese), leg. B. Hauser, deposited at MHNG; 1 female (PBI_OON 00015798), Sabah (MALAYSIA), Mt. Kinabalu N.P., Summit Trail Pondok Ubah, 2050 m [06°1′15″N 116°32′60″E; inf.], 26.4.III.1987, leg. A. Smetana, deposited at MHNG; 1 female (PBI_OON 00015909), Sabah (MALAYSIA), Mt. Kinabalu N.P., Silau Silau trail, 1500 m [06°00′35″N 116°32′33″E; inf.], 10.XI.1976, rain forest and bush, leg. P. Lehtinen, deposited at MZT; 1 male & 4 females (PBI_OON 00031394) collected together with male holotype, deposited at MHNG; 1 male (PBI_OON 00031395), collected together with paratypes (PBI_OON 00012315) deposited at MHNG; 1 male & 3 females (PBI_OON 00031396), collected together with paratypes (PBI_OON 00012274), deposited at MHNG; 1 male (PBI_OON 00031397), collected together with male holotype, deposited at AMNH; 1 female (PBI_OON 00031398; abdomen used for examination of internal genitalia), Sabah (MALAYSIA), Crocker Range, 1550–1650 m, 16.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male & 5 females (PBI_OON 00032090), collected together with paratype (PBI_OON 00031398), deposited at MHNG; 1 male & 1 female (PBI_OON 00032091), collected together with paratype (PBI_OON 00031398), deposited at AMNH; 1 male (PBI_OON 00032092).
00032092), collected together with paratypes (PBI_OON 00012366), deposited at NMBE; 1 male & 1 female (PBI_OON 00032093), collected together with paratypes (PBI_OON 00012274), deposited at NMBE.

**Non-type material.** 1 female (PBI_OON 00012167), Sabah (MALAYSIA), Kibongoi Valley 7 km N of Tambunan, 700 m [05°44′N 116°21′; inf.], 20.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 3 males & 1 female (PBI_OON 00032094; partly used for SEM), collected together with paratype (PBI_OON00012296), deposited at NMBE; 1 female (PBI_OON 00012316), Sabah (MALAYSIA), Poring Hot Springs, 550–600 m [06°02′20″N 116°42′44″E; inf.], 9.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male (PBI_OON 00012327; used for SEM), Sabah (MALAYSIA), Mt. Kinabalu, 1550–1650 m [06°04′N 116°34′E; inf.], 24.IV.1987, leg. D. Burckhardt & I. Löbl, deposited at NMBE; 1 male (PBI_OON 00012339; used for SEM), collected together with paratype (PBI_OON 00031398), deposited at NMBE; 2 females (PBI_OON 00012371), Sabah (MALAYSIA), Poring Hot Springs, 500 m [06°02′20″N 116°42′44″E; inf.], 11.V.1987, leg. D. Burckhardt & I. Löbl, deposited at MHNG; 1 male (PBI_OON 00015277; used for SEM), Sabah (MALAYSIA), collected together with male holotype, deposited at NMBE; 1 female (PBI_OON 00032089), collected together with non-type (PBI_OON 00012327), deposited at MHNG.

**Etymology.** Expressing the fact that the majority of the specimens of *A. helvetiorum* sp. nov. were collected by Swiss (Latin: *helvetii*) or Swiss-based researchers, the species epithet is dedicated to the Swiss entomologist Dr. Daniel Burckhardt (*1953) as well as the Swiss-based Slovakian entomologist Dr. Ivan Löbl (*1937) and Swiss-based Austrian entomologist Dr. Bernd Hauser.

**Diagnosis.** *A. helvetiorum* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes (Fig. 20G); carapace margin with blunt denticles, sluice (slu) reaching from posterior margin to level of coxa I (Fig. 20G); epigastric scutum in females posterolaterally with a row of longitudinal ridges (lr) (Fig. 25G). It resembles allopatric *A. hausammanae* sp. nov. and *A. retifer* sp. nov. but differs amongst others in sternum ornamentation (coarsely ornamented in *A. helvetiorum* sp. nov.) and male palp.

**Description.** Based on 30 males and 46 females.

**MALE.** With the characters of the genus except as noted. Body length 1.32–1.52 mm (n=25), carapace length 0.61–0.69 mm (n=25). Sclerotized parts uniformly coloured orange-brown close to colour 136 ‘raw sienna’; legs slightly paler than body (pale orange). Habitus: Figs. 20A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephaliaca smooth, sides strongly reticulate, partly interrupted by small smooth areas (Figs. 20G–H); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, partly appearing as small denticles (pch) (Figs. 21C–D, G); carapace margin with sluice (slu) reaching from posterior margin to level of coxa I, with blunt denticles (den) (Figs. 20G–H, 21H). Eyes: posterior eye-row straight from above, procurved from front (Figs. 20G, 21E–F); ALE largest, separated by their radius to diameter; ALE-PME separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum coarsely ornamented except smooth median stripe (sms) (Figs. 20D–F, 21A–B, 22A); infracoxal grooves (icg) anteriorly and posteriorly with a pair of openings (Figs. 20F, 22B–C); posterior margin with broad single extension, covered with blunt denticles (Fig. 20F); setae appearing slightly plumose at SEM level (Fig. 22A). Pleura (pl): surface smooth with scattered pits (Fig. 22B). Mouthparts: chelicerae posterior margin of inner surface proximally modified to a ridge with median slit (sli), covering about 2/3 of margin length, distally possessing a knob-like apophysis (ka) (Fig. 22F–G); promargin with row of flattened setae (rfs) in combination with plumose setae, distally extending into a short inwards pointing tooth-like projection (tlp) (Figs. 20E, G, 22F–H); base of tooth-like projection posteriorly with a thick and long plumose seta (lps) (about as long as fang; Figs. 22G–H). Endites: inner margin distally with brush of broad and deeply fringed wing-like setae (ws) (Fig. 22E); outer margin subst dially with a pair of rather long, inward bent plumose setae (ebs) (Figs. 22D–E).

**ABDOMEN.** Book lung covers large, elliptical to dumbbell or pear-shaped (sides concave to almost parallel), about 4 times longer than wide (Figs. 23A, C). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Figs. 23A, C, 23F); scuto-pedicel region with slightly swollen hair bases (Figs. 23G–H). Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 23B). Setae appearing slightly plumose at SEM level (Figs. 23G–H, 24A).
FIGURE 20. *Aposphragisma helvetiorum* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D–E. prosoma ventral view (variable length of smooth median stripe on sternum); F. prosoma ventral view, SEM; G. carapace dorsal view; H. carapace dorsal view, SEM. Ctg, continuous transverse groove; icg, infracoxal groove; rf, faint radial furrow; slu, sluice; sms, smooth median stripe; spe, sternum posterior extension; tlp, tooth-like projection of male chelicerae; ur, U-shaped row of cephalic setae. Scale bars: A–E & G 500 μm; F, H 200 μm.
THE NEW GENUS APOSPHRAGISMA

FIGURE 21. Aposphragisma helvetiorum sp. nov. Female: A–B. prosoma ventral view (B: aberrant female with reduced smooth median stripe on sternum); F. carapace front view. Male: C. carapace lateral view; D. carapace posterior view; E. carapace front view; G. detail of posterior part of pars cephalica in dorsal view, SEM; H. carapace posterolateral margin dorsal view, SEM. Cp, cephalic pit (modified hair base); ctg, continuous transverse groove; den, margin denticle (modified hair base); pch, posterior modified cephalic hair base; slu, sluice; tlp, tooth-like projection of male chelicerae. Scale bars: A–F 500 μm; G 200 μm; H 50 μm.
FIGURE 22. *Aposphragisma helvetiorum* sp. nov. Female: A. sternum with lobed microsculptures ventral view, SEM; C. detail of sternum margin ventral view, SEM; I. endite distal part lateral view, SEM; J. chelicerae distal part lateral view, SEM. Male: B. sternum margin ventral view, SEM; D. mouthparts ventral view, SEM; endite distal part ventral view, SEM; F–G. chelicerae prolateral view, SEM. H. chelicerae distal part ventral view, SEM. Ctg, continuous transverse groove; ebs, endites bent seta/setae (always a pair on outer margin of endites); icg, infracoxal groove; ka, knob-like apophysis; lps, single long plumose seta; pl, pleura; rfs, row of flattened setae; ser, serrula; sli, slit; slu, sluice; sms, sternum smooth median stripe; tlp, tooth-like projection of male chelicerae; ws, wing-like setae. Scale bars: A–B, G 50 μm; C, H–J 20 μm; D, F 100 μm; E 10 μm.
FIGURE 23. Aposphragisma helvetiorum sp. nov. Male: A. abdomen lateral view; B. abdomen ventral view; E. abdomen posterior view; F. abdomen front view, SEM; G. epigastric region ventral view, SEM. Female: C. abdomen lateral view; D. abdomen ventral view. Bc, book lung cover; lr, row of longitudinal ridges; lap, postepigastric lateral apodemes; sr, subterminal widely oval scutal ridge; sp, sperm pore. Scale bars: A–E 500 μm; F–H 100 μm.
FIGURE 24. *Aposphragisma helvetiorum* sp. nov. Male: A. epigastric region ventral view, SEM; B. apex of metatarsus IV retrolateral view, SEM; D–E. special hairs on ventral apex of tibia IV ventral view, SEM; F. dorsal apex of metatarsus I dorsal view, SEM; G. trichbothrium base dorsal view, SEM; H. tarsal organ dorsal view (3 sensilla visible), SEM. Female: C. special hairs on ventral apex of tibia IV prolateral view; I. apex of tarsus I with claws and tarsal organ (3 sensilla visible), SEM. Ds, metatarsus dorsal shieldlike appendage; ms, metatarsus special setae; tb, trichobothrium base; to, tarsal organ; tibia special setae. Scale bars: A, C 100 μm; B, D–E, F, I 20 μm; G 10 μm; H 5 μm.
THE NEW GENUS APOSPHRAGISMA

FIGURE 25. *Aposphragisma helvetiorum* sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view; D. embolus-conductor-complex retrolateral view E. bulb with processes prolateral view, SEM; F. embolus-conductor-complex prolateral view, SEM; Female: G–H. epigastric region (internal genitalia) dorsal view.Cb, conical bulge; con, conductor; dc, dorsal comb; dps, cymbium distal patch of short setae; em, embolus; esp, embolic spine; lap, postepigastric lateral apodemes; lr, row of longitudinal ridges; na, nail; pa, papillae; re, receptaculum; sa, sac; spp, spermophore; tsc, transverse sclerite. Scale bars: A–B, E, G–H 100 μm; C–D 50 μm; F 20 μm.
ENITALIA. Epigastric region: sperm pore (sp) situated at level of posterior spiracles (Figs. 23B, G, 24A). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body (pale orange to honey-yellow); bulb rather stout, tapering apically (Figs. 25A–B, E–F). Conical bulge (cb) with ripped surface (Fig. 25F). Embolus (em) tip spatulate (Figs. 25C–D, F); embolic spine (esp) with fringed tip (Fig. 25C). Conductor (con) with slender tip (Figs. 25C–D). Embolus-conductor-complex about half as long as bulb.

FEMALE. As in male except as noted. Body length 1.39–1.69 mm (n=40), carapace length 0.62–0.72 mm (n=44). PME touching for less than half their length. Endites: serrula (ser) present in a single row of denticles (Fig. 22I; no information about serrula in males). Epigastric scutum posterolaterally with a row of longitudinal ridges (Ir) (Figs. 23H, 25F). Postepigastric scutum with short posteriorly directed lateral apodemes (lap) (Fig. 23D, referring to strongly sclerotized parts shining through the postepigastric scutum, cf Fig. 25H).

ENITALIA. Dorsal view (Figs. 25G–H): receptaculum (re) triangular shaped with rounded posterior edge, laterally framed by long rectangular sclerites (apodemes) (lap); apodemes distally rather thin and thus looking rather short in ventral view at stereomicroscope level; globular appendix (gap) lying dorsally of receptaculum about half as long as receptaculum; lateral and median part of receptaculum dorsally covered with papillae (pap); a transverse sclerite (ts) lies anteriorly to the receptaculum and bears medially a nail-like structure (na).

Intraspecific variation. Body size variable (see above), one female (PBI_OON 00012167) with body length of only 1.26 mm (and with pale yellowish colour) not included in measurements shown above; colour shows slight variation but is always brown-orangish, only few specimens show lighter yellowish colour maybe as a result of bleaching; number of denticles on carapace margin variable (normally around 15–20 denticles on each side); extension of smooth median stripe on sternum variable but normally not less than about a third of sternum length (Figs. 20D–F, 21A); two females (PBI_OON 00012371) show an almost completely ornamented sternum (Fig. 21B).

Distribution. N-Sabah, MALAYSIA; all specimens were collected within the Crocker range, between 500 and 2050 m a.s.l. (Fig. 49).

Aposphragisma kollerii Thoma, sp. nov.
(Figs. 26–27)

Type material. HOLOTYPE: male (PBI_OON 00031373), Sarawak (MALAYSIA), Bako National Park [01°42′N 110°27′E; inf.], 30.III.1985, lowland forest, litter, leg. C. Deeleman, deposited at RMNH. PARATYPE: 1 male (PBI_OON 00031386), collected together with holotype, deposited at RMNH.

Etymology. The species epithet is dedicated to Markus Koller-Furrer (*1958), a Swiss teacher, naturalist and conservationist who promoted the first author’s ornithological and natural history skills from an early age.

Diagnosis. A. kollerii sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace with one pair of spikes (csp) (Figs. 26C–D); carapace margin with blunt denticles, sluice restricted to posterior margin (Fig. 26D). The new species resembles A. brunomanseri sp. nov. and A. dentatum sp. nov. but differs from A. brunomanseri sp. nov. among others by the lack of a second pair of spikes on the carapace, by the sternum shape and the pointed embolic spine (esp) (Fig. 27C), from A. dentatum sp. nov. among others by the shape of the carapace margin denticles, shorter claws (almost as long as tarsi in A. dentatum sp. nov.) and greater body length.

Description. Description based on 2 males.

MALE. With the characters of the genus except as noted. Body length 2.08–2.16 mm, carapace length 0.96 mm. Sclerotized parts uniformly coloured red-brown, approaching colour 32 ‘chestnut’; legs paler, orangish. Habitus: Figs. 26A–C.

CEPHALOTHORAX. Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate (Fig. 26D); posterior edge of pars cephalica with one pair of spikes (csp) (Figs. 26C–D); carapace margin with sluice restricted to posterior margin, with blunt denticles (Figs. 26D–E). Eyes: posterior eye-row straight from above, procured from front (Figs. 26D, F); ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PLE-PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum finely ornamented except smooth median stripe (Fig. 26E); posterior margin with narrow single extension, covered with blunt denticles (Fig. 26E; cf A. brunomanseri sp. nov.). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III. Mouthparts: chelicerae posterior margin of inner
FIGURE 26. *Aposphragisma kollerii* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; F. carapace front view (left fang artificially displaced); G. abdomen anterolateral view; H. abdomen ventral view. Bc, book lung cover; csp, posterior cephalic spikes (modified hair bases); ctg, continuous transverse groove; lap, postepigastric lateral apodemes; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae. Scale bars: A–F, H 500 μm; G 200 μm.
surface proximally modified to a ridge with median slit, covering about 2/3 of margin length, distally ending in a rounded bulge; promargin with row of flattened setae, distally extending into a short inwards pointing tooth-like projection (tlp) (Fig. 26F); posterior face with a pair of long, spatulate setae.

**ABDOMEN.** Book lung covers (bc) large, elongated, elliptical to rather dumbbell shaped (sides concave), about 4–5 times longer than wide (Fig. 26G). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 26G); scuto-pedicel region with slightly swollen hair bases. Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (Fig. 26H). Dorsal abdominal setae shorter than in *A. brunomanseri* sp. nov. (Fig. 26G, cf fig. 9C).

**GENITALIA.** Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 26H). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb stout (Figs. 27A–B). Embolus (em) medially with longitudinal ridges on prolateral surface, tip spatulate (Fig. 27C); embolic spine (esp) with pointed tip (Fig. 27C). Conductor (con) with broad tip (appearing ‘snout’-like in lateral view; Fig. 27C). Embolus-conductor-complex as long as bulb.

**Intraspecific variation.** Body size variable (see above); male paratype slightly paler and with slightly longer spikes on carapace.

**Distribution.** W-Sarawak, MALAYSIA (Fig. 49).

*Aposphragisma menzi* Thoma, sp. nov. (Figs. 28–31)

**Type material.** HOLOTYPE: male (PBI_OON 00031389), Kalimantan (INDONESIA), Berau District, near Kampung Suaran, c. 40 km S of Tanjungredeb, 50 m [01°59′42″N 117°36′03″E; prov.], 1.X.2008, primary forest on limestone, leg. P. Schwendinger, deposited at MHNG. PARATYPES: 2 males & 1 female (PBI_OON 00031380), collected together with male holotype, deposited at MHNG; 1 male (PBI_OON 00031381), Kalimantan.
(INDONESIA), Berau District, Hutan Wisata Sei Tangap, c. 8 km W of Tanjungredeb, 30 m [02°08′04″N 117°24′39″E; prov.], 2.X.2008, primary forest, leg. P. Schwendinger, deposited at AMNH; 1 male & 1 female (PBI_OON 00031388), collected with paratype PBI_OON 00031381, deposited at MHNG; 1 female (PBI_OON 00031390; abdomen used for examination of internal genitalia), Kalimantan (INDONESIA), Berau District, 1 km off road Tanjungredeb to Tanjungseler, c. 45 km N of Tanjungredeb, 190 m [02°29′33″N 117°28′46″E, prov.], 29.IX./3.X.2008, primary forest, leg. P. Schwendinger, deposited at MHNG; 2 males & 1 female (PBI_OON 00031391), collected together with paratype (PBI_OON 00031390), deposited at NMBE; 1 male (PBI_OON 00031403), collected together with paratype (PBI_OON 00031390), deposited at MHNG.  

**Non-type material.** 1 male (PBI_OON 00031382; used for SEM), collected together with paratype (PBI_OON 00031390), deposited at MHNG.  

**Etymology.** The species epithet is dedicated to Dr. Myles H. M. Menz (*1982), an Australian zoologist, botanist and conservation biologist whose friendship and scientific work is highly admired by the first author.  

**Diagnosis.** *A. menzi* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes; carapace margin with blunt denticles, sluice (slu) restricted to posterior margin (Fig. 28D); epigastric scutum in females posterolaterally with a row of longitudinal ridges (lr) (Fig. 31F). It is the only species of the stripe-clade showing a completely smooth carapace surface (Figs. 28D, H).  

**Description.** Description based on 9 males and 4 females.  

**MALE.** With the characters of the genus except as noted. Body length 1.27–1.38 mm (n=9), carapace length 0.61–0.65 mm (n=9). Sclerotized parts uniformly coloured orange-brown, close to colour 340 ‘robin rufous’; legs slightly paler than body, pale orange. Habitus: Figs. 28A–C.  

**CEPHALOTHORAX.** Carapace: entire surface smooth (Figs. 28A–D, H); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles (Fig. 28D); carapace margin with sluice (slu) restricted to posterior margin, with blunt denticles (Fig. 28D). Eyes: posterior eye-row straight from above, procured from front; ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum coarsely ornamented except rather broad smooth median stripe (Figs. 28E–G); posterior margin with broad single extension, covered with blunt denticles (Figs. 28E–G); setae appearing slightly plumose at SEM level (Fig. 29A). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III (as in *A. brunomanseri* sp. nov., cf fig. 10B). Mouthparts: chelicerae posterior margin of inner surface proximally modified to a ridge with median slit, covering about 2/3 of margin length, distally ending in a rounded ‘knob’ (Fig. 29D); promargin with row of flattened setae (dfs) in combination with plumose setae (Figs. 29D–E), distally extending into a short inwards pointing tooth-like projection (tip) (Figs. 28H, 29D); anterior face of paturon in lateral view subbasally with slight indentation (ind) (Fig. 28C). Endites distally with brush of special wing-like setae (ws) on inner margin (Figs. 29B–C), outer margin subdistally with a pair of rather long inward bent plumose setae (ebs) (Fig. 29B).  

**ABDOMEN.** Book lung covers (bc) large, elliptical to dumbbell or pear-shaped (sides slightly concave), about 3–4 times longer than wide (Fig. 29F). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 29F). Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 29G). Setae appearing slightly plumose at SEM level.  

**GENITALIA.** Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 29G). Palp: basal segments lighter in colour than rest of body; bulb rather stout, tapering apically (Figs. 31A–D). Embolus (em) tip spatulate (Figs. 31C, E); embolic spine (esp) with fringed tip (Fig. 31E). Conductor (con) with slender tip (Figs. 31C, E). Embolus-conductor-complex about half as long as bulb.  

**FEMALE.** As in male except as noted. Body length 1.47–1.52 mm (n=4), carapace length 0.66–0.67 mm (n=4). Epigastric scutum posterolaterally with a row of longitudinal ridges (lr) (Fig. 31F).  

**GENITALIA.** Dorsal view (Figs. 31F–G): receptaculum (re) triangular shaped with rounded posterior edge, laterally framed by long rectangular sclerites i.e. lateral apodemes (lap); apodemes distally weakly sclerotized and thus looking rather short in ventral view at stereomicroscope level; globular appendix (gap) lying dorsally of receptaculum about half as long as receptaculum; lateral and median part of receptaculum dorsally covered with papillae (pap); a transverse sclerite (ts) anteriorly to the receptaculum not observed, maybe lost during preparation.
FIGURE 28. *Aposphragisma menzi* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view, SEM; E. prosoma ventral view; F. prosoma ventral view, SEM (chelicerae removed); H. carapace front view. Female: G. prosoma ventral view. Ctg, continuous transverse groove; icg, infracoxal groove; ind, chelicerae anterior face subbasal indentation; rf, faint radial furrow; slu, sluice; tlp, tooth-like projection of male chelicerae. Scale bars: A–C 500 μm; D–H 200 μm.
FIGURE 29. *Aposphragisma menzi* sp. nov. Male: A. sternum anterolateral part ventral view, SEM; B. mouthparts ventral view (chelicerae removed), SEM; C. endite distal part ventral view, SEM; D. chelicerae prolateral view, SEM; E. detail of chelicerae distal part prolateral view, SEM; G. abdomen ventral view. Female: F. abdomen lateral view; H. abdomen ventral view. Be, book lung cover; ctg, continuous transverse groove; ebs, endites bent setae; icg, infracoxal groove; lap, postepigastric lateral apodemes; lps, single long plumose seta; rf, faint radial furrow; rfs, row of flattened setae; sli, slit; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae; ws, wing-like setae. Scale bars: A, D 50 μm; B 100 μm; C, E 20 μm; F–H 200 μm.
**FIGURE 30.** *Aposphragisma menzi* sp. nov. Male: A. sperm pore, SEM; B. apex of metatarsus IV retrolateral view, SEM; C. detail of retrolateral apex of metatarsus IV with special hairs, SEM; D. special hairs on ventral apex of tibia IV retrolateral view, SEM; E. dorsal apex of metatarsus I, SEM; F. trichobothrium base, SEM. Ds, metatarsus dorsal shieldlike appendage; ms, metatarsus special setae; tb, trichobothrium base. Scale bars: A–B, D 20 μm; C, E 10 μm; F 5 μm.

**Intraspecific variation.** Body size variable (see above). Three males show honey-yellow colouration. Number of denticles on carapace margin varies. Extension of smooth median stripe on sternum slightly variable but never less than about 2/3 of sternum length.

**Distribution.** NE-Kalimantan, INDONESIA (Fig. 49).
FIGURE 31. Aposphragisma menzi sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view; D. bulb with embolus-conductor-complex dorsal view, SEM; E. embolus-conductor-complex distal region prolateral view, SEM. Female: F–G. epigastric region (internal genitalia) dorsal view (transverse sclerite and nail not observed). Cb, conical bulge; con, conductor; dps, cymbium distal patch of short setae; em, embolus; esp, embolic spine; gap, globular appendix; lap, postepigastric lateral apodemes; lr, row of longitudinal ridges; pa, papillae; re, receptaculum; spp, spermophor. Scale bars: A–B, F–G 100 μm; C–D 50 μm; E 5 μm.
FIGURE 32. *Aposphragisma monoceros* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; F. carapace lateral view; G. carapace front view. Dts, double-toothed spike; tlp, tooth-like projection of male chelicerae; ho, horn (modified hair-base). Scale bars: A–G 500 μm.
Aposphragisma monoceros Thoma, sp. nov.
(Figs. 32–33)

Type material. **HOLOTYPE**: male (PBI_OON 00036324), Temburong District (BRUNEI), Ashton Trail near Kuala Belalong Field Studies Centre, 21 km SSW of Bangar, 150 m [04°32′30.78″N 115°09′18″E; prov.], 1.X.2009, primary mixed dipterocarp forest, sifting leaf litter, leg. C. Griswold & N. Chousou Polydouri, deposited at CAS (UT003, CASENT 9029917). **PARATYPES**: 2 males (PBI_OON 00032178), collected together with holotype, deposited at CAS (UT004, CASENT 9036043).

Etymology. The species epithet, a noun in apposition, is a Greek term meaning ‘unicorn’. It refers to the single 'horn' the species bears on the posterior part of its carapace.

Diagnosis. *A. monoceros* sp. nov. belongs to the stripe-clade and can be distinguished from other species of...
this clade by the combination of the following traits: carapace with one pair of lateral double-toothed spikes (dts) (Figs. 32D–E); carapace margin with pointed denticles, sluice restricted to posterior margin (Fig. 32D). It is the only species of the stripe-clade possessing a single ‘horn’ (ho) at the posterior edge of pars cephalica (Figs. 32D, F).

Description. Description based on 3 males.

MALE. With the characters of the genus except as noted. Body length 1.66–1.71 mm (n=3), carapace length 0.79 mm (n=3). Sclerotized parts uniformly coloured orange brown, close to colour 36 ‘amber’; legs slightly paler than body. Setae especially on abdominal scutae slightly longer and darker if compared to most congeners. Habitus: Figs. 32A–C.

CEPHALOTHORAX. Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate, partly interrupted by small smooth areas (Fig. 32F); posterior edge of pars cephalica with a single ‘horn’ (ho) (Figs. 32D, F); carapace margin with pointed denticles, sluice restricted to posterior margin (Figs. 32D–E), posterolateral corners with a pair of double-toothed spikes (dts) (Fig. 32D, E). Eyes: posterior eye-row recurved from above, procurred from front; ALE largest, separated by their radius to diameter; ALE-PLE touching; PME touching throughout most of their length; PLE-PME touching (Figs. 32D, G). Sternum coarsely ornamented except smooth median stripe and broadly smooth edges (ornamentation arranged in an ovoid band; Fig. 32E); posterior margin with a rather narrow single extension, covered with few blunt denticles (Fig. 32E). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III (as in A. brunomanseri sp. nov., cf fig. 10B). Mouthparts: chelicerae promargin distally extending into a short inwards pointing tooth-like projection (tp) (Fig. 32E).

ABDOMEN. Book lung covers large, elongated elliptical (sides slightly concave), about 3 times longer than wide, darker in colour than surroundings (Fig. 33A). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 33A, partly covered by dorsal abdominal scutum in this case). Postepigastric scutum long, semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 33B). Dorsal abdominal setae very long and darkish.

GENITALIA. Epigastric region: sperm pore (sp) situated at level of posterior spiracles (Fig. 33A–B). Palp: basal segments same colour as body but bulb and cymbium much lighter (pale orange); bulb rather stout, tapering apically (Figs. 33C–D). Embolus (em) tip spatulate (Fig. 33C, E); embolic spine (esp) with fringed tip (Fig. 33E). Conductor (con) with broad tip (appearing ‘snout’-like in lateral view; Fig. 33E). Embolus-conductor-complex about as long as bulb (Figs. 33C–D).

Intraspecific variation. Body size variable (see above). Number of denticles on carapace margin varies. One paratype male much lighter in colour, yellow to pale-orange.

Distribution. Temburong District, Brunei (Fig. 49).

**Aposphragisma nocturnum** Thoma, sp. nov. (Figs. 34–35)

Type material. HOLOTYPE: male (PBI_OON 00015995), Kalimantan (INDONESIA), Kutal District, Lempake Tanah Merah [00°30′S 117°09′E; inf.], 24.X.1979, rain forest, leg. P. T. Lehtinen, deposited at MZT. PARATYPES: 1 male (PBI_OON 00032179), Kalimantan (INDONESIA), Berau District, 1 km off road Tanjungredeb to Tanjungselor, c. 45 km N of Tanjungredeb, 190 m [02°29′33″N 117°28′46″E; prov.], primary forest, 29.IX./3.X.2008, leg. P. Schwendinger, deposited at MHNG.

Etymology. The species epithet is a Latin adjective meaning nocturnal. It refers to the many hours the first author spent working at night on the first draft of the present paper during the final stage of his master thesis.

Diagnosis. *A. nocturnum* sp. nov. does not belong to the stripe clade and thus shows a completely ornamented sternum. It can be distinguished from other species with a completely ornamented sternum by the combination of the following traits: carapace margin with very small blunt denticles, sluice reaching from posterior margin to level of coxa I (Fig. 34D); cheliceral promargin distally without toothlike projection; epigastric scutum dorsally without a widely oval subterminal ridge. (Fig. 34G). The new species resembles *A. scimitar* sp. nov. but can easily be distinguished by the presence of denticles on the carapace margin (absent in *A. scimitar* sp. nov.) and by the shape of the postepigastric lateral apodemes (Fig. 34H, cf fig. 44H).

Description. Description based on 2 males.
FIGURE 34. Aposphragisma nocturnum sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; F. carapace lateral view; G. abdomen lateral view; H abdomen ventral view. Bc, book lung cover; ctg, continuous transverse groove; ind, chelicerae anterior face basal indentation; lap, postepigastric lateral apodemes. Scale bars: A–H 500 μm.
MALE. With the characters of the genus except as noted. Body length 2.15–2.23 mm (n=2), carapace length 0.98–1.00 mm (n=2). Sclerotized parts uniformly coloured orange-brown, approaching colour 240 ‘kingfisher rufous’; legs only very slightly paler than body. Habitus: Figs. 34A–C.

CEPHALOTHORAX. Carapace: surface of elevated portion of pars cephalica very slightly wrinkled, sides finely reticulate (Figs. 34D, F); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as very small denticles; carapace margin with narrow sluice reaching from posterior margin to level of coxa I, with small blunt denticles (Fig. 34D); non-marginal pars thoracica seate few and very scattered. Eyes: posterior eye-row straight from above, procured from front; ALE well developed; PLE and PME tiny (Fig. 34D); ALE and PLE oval; PME asymmetric, roundish to ovoid; ALE separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching for less than half their length; PLE-PME separated by less than PME radius. Sternum completely finely ornamented (Fig. 34E); posterior margin with broad single extension, covered with blunt denticles (Fig. 34E). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III (Fig. 34F). Mouthparts: chelicerae paturon anterior face in lateral view subbasally with strong indentation (ind) (Fig. 34F); promargin with row of flattened setae, distally without a short inwards pointing tooth-like projection.

ABDOMEN. Book lung covers (bc) large, ovoid (sides slightly convex; fig. 34G). Epigastric scutum dorsally without widely oval subterminal ridge (Fig. 34G); scuto-pedicel region with slightly swollen hair bases. Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 34H).

GENITALIA. Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 34H). Palp: basal segments as well as bulb and cymbium slightly lighter in colour than rest of body; bulb stout, only slightly longer than cymbium, anterodorsally with very faint conical bulge (cb) (Figs. 35A–B). Embolus (em) subdistally

FIGURE 35. Aposphragisma nocturnum sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus distal part retrolateral view (partly ruptured). Cb, conical bulge; con, conductor; em, embolus; esp, embolic spine; spp, spermophor; spo, spermophor opening. Scale bars: A–B 100 μm; C 50 μm.
narrowed, dorsally without comb (Figs. 35A–B); embolus tip widened and pennant-like (Figs. 35A–B); embolic spine (esp) with pointed tip (Fig. 35C). Conductor (con) with slender tip (Figs. 35A–B). Embolus-conductor-complex about as long as bulb.

**Intraspecific variation.** Body size variable (see above). Number of denticles on carapace margin varies. Paratype lighter coloured, pale orange.

**Distribution.** E-Kalimantan, INDONESIA (Fig. 49).

*Aposphragisma retifer* Thoma, sp. nov. (Figs. 36–37)

**Type material.** **HOLOTYPE:** male (PBI_OON 00016080), Sarawak (MALAYSIA), Gunung Gading National Park near Lundu, primary forest, 250–500 m [01°41′17″N 109°51′05″E; prov.], 30.V.–1.VI.2007, leg. A. Schulz, deposited at MHNG. **PARATYPE:** 1 female (PBI_OON 00032177), collected together with male holotype, deposited at MHNG.

**Etymology.** The species epithet, a noun in apposition, is a combination of the Latin words for net (retis) and carry (ferre), referring to the net-like reticulation of the carapace surface.

**Diagnosis.** *A. retifer* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes; carapace margin with blunt denticles, sluice (slu) reaching from posterior margin to level of coxa I (Fig. 36D); epigastric scutum in females posterolaterally with a row of longitudinal ridges. It closely resembles allopatric *A. hausammannae* sp. nov. but see there for differentiation.

**Description.** Description based on 1 male and 1 female.

**MALE.** With the characters of the genus except as noted. Body length 1.57 mm, carapace length 0.74 mm. Sclerotized parts uniformly coloured orange brown, close to colour 123A ‘cinnamon’; legs slightly paler than body.

**Habitus:** Figs. 36A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides strongly reticulate, partly interrupted by small smooth areas (Fig. 36G); posterolateral surface without spikes (Figs. 36D, G); posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles; carapace margin with sluice (slu) reaching from posterior margin to level of coxa I, with blunt denticles (Fig. 36D). Eyes: posterior eye-row straight from above, procured front; ALE largest, separated by less than their radius; ALE-PLE touching; PME touching throughout most of their length; PLE-PME touching. Sternum finely ornamented except smooth median stripe (Figs. 36E–F); posterior margin with broad single extension. Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III (Fig. 36G). Mouthparts: chelicerae promargin with row of flattened setae, distally extending into a short inward pointing tooth-like projection (tlp) (Fig. 36E); paturon anterior face in lateral view subbasally with angular indentation (ind) (Fig. 36G).

**ABDOMEN.** Book lung covers large, elongated ovoid (sides almost parallel), about 3 times longer than wide (Fig. 36H). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 36H). Postepigastric scutum long, semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 37A).

**GENITALIA.** Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 37A). Palp: colouration of basal segments about as rest of body but bulb and cymbium lighter (Fig. 37C); bulb rather stout (Figs. 37C–D), Embolus (em) tip spatulate (Fig. 37E); embolic spine (esp) with fringed tip (Fig. 37E). Conductor (con) with broad tip (appearing ‘snout’-like in lateral view; Fig. 37E). Embolus-conductor-complex about as long as bulb (Figs. 37C–D).

**FEMALE.** As in male except as noted. Body length 1.69 mm, carapace length 0.75 mm. Colouration darker, close to colour 136 ‘raw sienna’. Epigastric scutum posterolaterally with a row of longitudinal ridges (as in *A. helvetiorum* sp. nov., Fig. 23H).

**Intraspecific variation.** Body size and colour variable (see above).

**Distribution.** W-Sarawak, MALAYSIA (Fig. 49).
FIGURE 36. *Aposphragisma retifer* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; G. carapace lateral view; H. abdomen lateral view. Female: F. prosoma ventral view. Ind, chelicerae anterior face basal indention; sr, subterminal widely oval scutal ridge; slu, sluice; tlp, tooth-like projection of male chelicerae. Scale bars: A–H 500 μm.
FIGURE 37. Aposphragisma reifer sp. nov. Male: A. abdomen ventral view; C–D: palp prolateral view (D: hairs omitted except trichobothria); E. embolus-conductor-complex prolateral view. Female: B. abdomen ventral view. Cb, conical bulge; con, conductor; dc, dorsal comb; em, embolus; esp, embolic spine; lap, postepigastric lateral apodemes; lc, lateral comb; sp, sperm pore; spp, spermophor. Scale bars: A–B 500 μm; C–D 100 μm; E 50 μm.

Aposphragisma rimba Thoma, sp. nov.  
(Figs. 38–41)

Type material. HOLOTYPE: male (PBI_OON 00031408), Sarawak (MALAYSIA), Mulu N.P., 100 km SEE of Miri, 200 m [04°00′N 114°49′E; prov.], 19.–24.VIII.2003 (Winkler extraction), leg. A. Schulz, deposited at MHNG. PARATYPES: 2 males (PBI_OON 00012526), collected together with holotype, deposited at NMBE; 1 female (PBI_OON 00031406; abdomen used for examination of internal genitalia), collected together with holotype, deposited at MHNG; 4 males & 1 female (PBI_OON 00031407), collected together with holotype, deposited at MHNG.
FIGURE 38. *Aposphragisma rimba* sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view, SEM; E. prosoma ventral view; F. prosoma ventral view, SEM; H. carapace front view. Female: G. prosoma ventral view. Ctg, continuous transverse groove; tlp, tooth-like projection; icg, infracoxal grooves. Scale bars: A–B 500 μm; D–H 200 μm.
FIGURE 39. *Aposphragisma rimba* sp. nov. Male: A. carapace lateral view (with thickend setae on chelicerae anterior face, compare with female); C. sternum anterolateral part ventral view, SEM; D. detail of pleura anterodorsal of coxa I (cluster of openings), SEM; E. prosoma anterior part / mouthparts ventral view, SEM; F. endites modified bent setae, SEM; G. chelicerae prolateral view, SEM. Female: B. carapace lateral view (setae on chelicerae anterior face not thickened). Cpo, cluster of pleural openings; ctg, continuous transverse groove; ebs, endites bent setae; tlp, tooth-like projection; icg, infracoxal grooves; lpg, single long plumose seta; pl, pleura; rf, faint radial furrow; rfs, row of flattened setae; sli, slit; sps, spatulate setae; ws, wing-like setae. Scale bars: A–B 200 μm; C, E, G 100 μm; D, F 10 μm.
FIGURE 40. *Aposphragisma rimba* sp. nov. Male: A. abdomen ventral view; C. abdomen lateral view; D. abdomen scutopedicel region ventral view, SEM; F. special hairs on ventral apex of tibia III ventral view, SEM; G. trichobothrium base, SEM. Female: B. abdomen ventral view; E. abdomen ventral view, aberrant female. Bc, book lung cover; lap, postepigastric lateral apodemes; sp, sperm pore; tub, tubercle. Scale bars: A–C, E 200 μm; D 100 μm; F 10 μm; G 5 μm.
FIGURE 41. Aposphragisma rimba sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria). C. embolus-conductor-complex prolateral view; D. bulb with embolus-conductor-complex dorsal view, SEM; E. embolus-conductor-complex prolateral view, SEM. Female: F–G. epigastric region (internal genitalia) dorsal view. Cb, conical bulge; con, conductor; dps, cymbium distal patch of short setae; em, embolus; lap, postepigastric lateral apodemes; na, nail; re, receptaculum; spp, spermophor; spo, spermophor opening; tsc, transverse sclerite. Scale bars: A–B, F–G 100 μm; C 50 μm; E 20 μm.
**Non-type material.** 2 males (PBI_OON 00031404; used for SEM), collected together with holotype, deposited at MHNG; 2 aberrant females (PBI_OON0 0031405), collected together with holotype, deposited at MHNG.

**Etymology.** The species epithet is a noun in apposition meaning ‘pristine forest’ or ‘jungle’ in the Malay language.

**Diagnosis.** *A. rimba* sp. nov. does not belong to the stripe clade and thus shows a completely ornamented sternum. It can be distinguished from congeners with a completely ornamented sternum by the combination of the following traits: entire carapace surface smooth (Fig. 38D); carapace margin with blunt denticles, sluice reaching from posterior margin to level of coxa I (Fig. 38D); epigastric scutum dorsally without a widely oval subterminal ridge (Fig. 40C); booklung covers (bc) small (Figs. 40C–E).

**Description.** Description based on 9 males and 4 females.

**MALE.** With the characters of the genus except as noted. Body length 1.18–1.45 mm (n=9), carapace length 0.59–0.66 mm (n=9). Sclerotized parts uniformly coloured orange-brown close to colour 36 ‘amber’; legs paler than body, yellowish. Males show several remarkable modifications compared to congeners. Habitus: Figs. 38A–C.

**CEPHALOTHORAX.** Carapace: entire surface smooth, pars thoracica with 3 pairs of pronounced narrow depressions along margin (Fig. 38D); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles; carapace margin with narrow sluice reaching from posterior margin to level of coxa I, with blunt denticles (Fig. 38D). Eyes: posterior eye-row straight from above, procured from front; ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PLE-PME separated by less than PME radius. Sternum completely coarsely ornamented (Figs. 38E–G); infracoxal grooves (icg) at both ends with depressions (presence or absence of openings can not be verified on available SEM images) (Fig. 39C); posterior margin with broad single extension, covered with blunt denticles (Fig. 38F); setae darkish, appearing slightly plumose at SEM level (Fig. 39C). Pleura (pl): surface smooth with cluster of openings (cpo) (Figs. 39C–D). Mouthparts: chelicerae posterior margin of inner surface proximally modified to a ridge with median slit (sli), covering about 1/2 of margin length (Fig. 39G); promargin with row of flattened setae (rfs) in combination with plumose setae (Fig. 39G), distally extending into a long tooth-like projection (tip) (Figs. 38H, 39G); anterior face with few thickened and darkish needle-like setae (Figs. 38H, 39A, G; cf female, fig. 39B); posterior face with two spatulate setae (sps), about as long as fang (Fig. 39G). Labium longitudinally slightly compressed and not as long as in females (Fig. 39E). Endites distally with brush of special wing-like setae (ws) on inner margin (Fig. 39F), outer margin subdistally with a pair of remarkably modified, darkish and thick setae (ebs) which resemble the blossom of a bird of paradise flower (*Strelitziaceae: Strelitzia* sp.; Fig. 39F): a rather long and flat distal part covered with little spines and filaments is subbasally attached in a 90 degree bend to an unmodified but rather thick basal part (Figs. 39E–F).

**ABDOMEN.** Book lung covers (bc) small, ovoid (Figs. 40C, E). Epigastric scutum dorsally without subterminal ridge (Fig. 40C). Postepigastric scutum almost semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 40A). Setae appearing slightly plumose at SEM level (Fig. 40D).

**GENITALIA.** Epigastric region: sperm pore (sp) situated between anterior and posterior spiracles (Fig. 40A, D). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb slider with a faint conical bulge (cb) posterior of embolus-conductor-complex (compared to congeners shifted towards prolateral surface; Figs. 41D–E). On stereo-microscope level embolus-conductor-complex pincer-like in lateral view, dark (Figs. 41A–B). Embolus (em) basally broad, subbasally with an angular dent on ventral part (thus proximal part appearing rhomboid in lateral view), medially abruptly narrowed, without dorsal comb (Fig. 41C); embolus (em) tip flattened, elongated spatulate, basally with hook (Fig. 41C); conductor (con) slender, attached basally to ventral part of embolus (Figs. 41C, E).

**FEMALE.** As in males except as noted. Body length 1.38–1.44 mm (n=3), carapace length 0.65–0.66 mm (n=4). Chelicerae anterior face with scattered needle-like (and not thickend) setae (Fig. 39B). Labium elongated triangular, not compressed. Anterolateral margin of outer surface of endites subdistally with a pair of unmodified long, needle-like setae with tips bent inwards.

**GENITALIA.** Dorsal view (Figs. 41F–G): area containing small circular structures laterally framed by short rectangular sclerites (apodemes, lap); receptaculum (re) small, elongated; a transverse sclerite (ts) lies anteriorly to the receptaculum, medially bearing a nail-like structure (na).

**Intraspecific variation.** Body size variable (see above); colour shows only very slight variation, one female pale; number of denticles on carapace margin variable. Two females (PBI_OON 00031405) show a pair of tubercles (tub) at the ventral base of the pedicel tube and faint ridges on book lung covers (bc) (Fig. 40E).

**Distribution.** NE-Sarawak, MALAYSIA; all specimens collected at type locality (Fig. 49).
FIGURE 42. Aposphragisma salewskii sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; F. carapace front view; G. abdomen anterolateral view; H. abdomen ventral view. Bc, book lung cover; ctg, continuous transverse groove; lap, postepigastric lateral apodemes; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae. Scale bars: A–F, H 500 μm; G 200 μm.
FIGURE 43. Aposphragisma salewskii sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view. Cb, conical bulge; con, conductor; dc, dorsal comb; em, embolus; esp, embolic spine; spp, spermophor; spo, spermophor opening. Scale bars: A–B 100 μm; C 50 μm.

Aposphragisma salewskii Thoma, sp. nov. (Figs. 42–43)

Type material. HOLOTYPE: male (PBI_OON 00031387), Bukit Timah Nature Reserve (SINGAPORE) [01°21′N 103°47′E; inf.], 21.II.1983, leg. C. Deeleman, deposited at RMNH. PARATYPE: 1 male (PBI_OON 00031351), collected together with holotype, deposited at RMNH.

Etymology. The species epithet is dedicated to Dr. Volker Salewski (*1964), a German biologist and naturalist, whose scientific work, attitude and friendship have been an inspiration for the first authors’ own work and life.

Diagnosis. *A. salewskii* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: elevated portion of pars cephalica granulate (Fig. 42F); carapace without spikes; carapace margin with pointed denticles, sluice restricted to posterior margin (Fig. 42D).

Description. Description based on 2 males.

**MALE.** With the characters of the genus except as noted. Body length 1.90–1.91 mm (n=2), carapace length 0.91–0.92 mm (n=2). Sclerotized parts uniformly coloured red-brown, approaching colour 132A ‘brick red’; legs paler than body, orange-brown. Habitus: Figs. 42A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica granulate (Fig. 42F), sides strongly reticulate, partly interrupted by small smooth areas (Fig. 42D); posteriorlateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as pointed denticles; carapace margin with sluice restricted to posterior margin, with pointed denticles (Fig. 42D). Eyes: posterior eye-row recurved from above, procurved from front (Figs. 42D, F); ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME touching throughout most of their length; PME-PME separated by less than PME radius. Sternal surface finely ornamented except smooth median stripe (Fig. 42E); posterior margin with narrow single extension, covered with blunt denticles (Fig. 42E). Pleura: surface smooth with pairs of large
pits dorsally of each coxa I, II and III (as in *A. brunomanseri* sp. nov., Fig. 10B). Mouthparts: chelicerae promargin with row of flattened setae, distally extending into a short inwards pointing tooth-like projection (tlp) (Fig. 42E).

**ABDOMEN.** Book lung covers (bc) large, elliptical, slightly dumbbell shaped (sides slightly concave to parallel), about 3–4 times longer than wide, much darker than surroundings (Fig. 42G). Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 42G). Postepigastric scutum almost semicircular, with short posteriorly directed lateral apodemes (lap) (Fig. 42H).

**GENITALIA.** Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 42H). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb stout (Figs. 43A–B). Embolus (em) tip spatulate (Figs. 43A–C); embolic spine (esp) with pointed tip (Fig. 43C); conductor (con) with broad tip (Fig. 43C). Embolus-conductor-complex about as long as bulb.

**Distribution.** Bukit Timah, SINGAPORE (Fig. 49).

*Aposphragisma scimitar* Thoma, sp. nov. (Figs. 44–45)

**Type material.** Holotype: male (PBI_OON 00016129), Kalimantan (INDONESIA), 1 km N of Camp Pemantus, 45 km W of Sotek [01°12′S 116°12′E; inf.], 23.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT. Paratype: 1 male (PBI_OON 00016133), Kalimantan (INDONESIA), Sotek [01°11′S 116°35′E; inf.], 31.XII.1980, leg. J. Aoki & H. Harada, deposited at MZT.

**Etymology.** The species epithet is a noun in apposition and is the general term for a sword with a curved blade. It refers to the species' very long and curved abdominal apodemes.

**Diagnosis.** *A. scimitar* sp. nov. does not belong to the stripe clade and thus shows a completely ornamented sternum. It can be distinguished from other species with a completely ornamented sternum by the combination of the following traits: carapace margin without denticles, sluice reaching from posterior margin to level of coxa I (Fig. 44D); epigastric scutum dorsally without subterminal ridge. The very long and curved postepigastric lateral apodemes (lap) separate this species from all congeners (Fig. 44H).

**Description.** Description based on 2 males.

**MALE.** With the characters of the genus except as noted. Body length 1.71–1.77 mm, carapace length 0.75–0.78 mm. Sclerotized parts uniformly coloured pale orange-yellow, very close to colour 123C ‘yellow ocher’; legs only very slightly paler than body. Habitus: Figs. 44A–C.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides finely reticulate (Figs. 44D, F); posterolateral surface without spikes; non-marginal pars cephalica setae not originating from pits; carapace margin with narrow sluice reaching from posterior margin to level of coxa I, without denticles (Fig. 44D); few scattered non-marginal pars thoracica setae. Eyes: ALE well developed, PLE and PME tiny (Fig. 44D); posterior eye-row straight from above, recurved from front; ALE separated by less than their radius; ALE-PLE separated by less than ALE radius; PME touching for less than half their length; PLE-PME separated by less than PME radius. Sternum completely finely ornamented (Fig. 44E); posterior margin with broad and short single extension (Fig. 44E). Pleura: surface smooth, presence of pits could not be assessed on stereomicroscope level. Mouthparts: chelicerae anterior face of paturon in lateral view subbasally with strong indentation (ind) (Fig. 44F).

**ABDOMEN.** Cylindrical in dorsal view, rounded posteriorly. Book lung covers (bc) large, ovoid (i.e. sides convex; Fig. 44G). Epigastric scutum dorsally without subterminal ridge (Fig. 44G). Postepigastric scutum long, almost rectangular (Fig. 44H), posteriorly directed lateral apodemes (lap) very long, slightly curved, almost reaching posterior margin of postepigastric scutum (Figs. 44B, H). Pedicel tube finely ribbed.

**GENITALIA.** Epigastric region: sperm pore situated at level of anterior spiracles (Fig. 44H). Palp: basal segments as well as bulb and cymbium only very slightly lighter in colour than rest of body; bulb stout, only slightly longer than cymbium (Figs. 45A–B). Embolus (em) distal half very narrow, tip spatulate (Fig. 45B); embolic spine (esp) with pointed tip (Fig. 45C). Conductor (con) with very narrow distal part and pointed tip (Figs. 45A–B). Embolus-conductor-complex about as long as bulb.

**Intraspecific variation.** Body size variable (see above); paratype very pale.

**Distribution.** E-Kalimantan, INDONESIA (Fig. 49).
FIGURE 44. Aposphragisma scimitar sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. carapace dorsal view; E. prosoma ventral view; F. carapace lateral view; G. abdomen lateral view; H. abdomen ventral view. Bc, book lung cover; ctg, continuous transverse groove; ind, chelicerae anterior face basal indentation; lap, postepigastric lateral apodemes. Scale bars: A–F, H 500 μm; G 200 μm.
**FIGURE 45.** Aposphragisma scimitar sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex retrolateral view. Cb, conical bulge; con, conductor; em, embolus; esp, embolic spine; spp, spermophore; . Scale bars: A–B 100 μm; C 50 μm

*Aposphragisma sepilok* Thoma, sp. nov.  
(Figs. 46–47)

**Type material.** **HOLOTYPE:** male (PBI_OON 00012112), Sabah (MALAYSIA), 24 km W of Sandakan, Kabili-Sepilok forest reserve [05°50′N 117°56′E; inf.], 23.IV.1982, secondary lowland forest, “forêt près du ‘pond’ (étang formant la reserve d’eau pour Sepilok), tamisage de feuilles mortes et de bois pourri”, leg. B. Hauser, deposited at MHNG; **PARATYPES:** 1 female (PBI_OON 00015274), Sabah (MALAYSIA), Kabili-Sepilok-Forest reserve [05°50′N 117°56′E; inf.], 12.III.1983, forêt près de l’Orang-Utan Rehabilitation Station, *Eusideroxylon zwangeri* et *Pometia pinnata*, leg. B. Hauser, deposited at MHNG; 1 female (PBI_OON 00031409), collected together with holotype, deposited at MHNG.

**Etymology.** The species epithet refers to the type locality at Kabili-Sepilok-Forest reserve, on Borneo.

**Diagnosis.** *A. sepilok* sp. nov. belongs to the stripe-clade and can be distinguished from other species of this clade by the combination of the following traits: carapace without spikes; carapace margin with blunt denticles, sluice restricted to posterior margin (Fig. 46B); epigastric scutum in females posterolaterally with a pair of single curved ridges (cr) (Fig. 47E). The granulate surface of the carapace sides and the tiny eyes separate the new species from all congeners.

**Description.** Description based on 1 male and 2 females.

**MALE.** With the characters of the genus except as noted. Body length 1.39 mm, carapace length 0.61 mm. Sclerotized parts uniformly coloured light orange-brown, close to colour 38 ‘tawny’; legs slightly paler than body, pale orange-yellowish.
FIGURE 46. *Aposphragisma sepilok* sp. nov. Male: A. carapace dorsal view; C. prosoma ventral view; E. carapace lateral view; G. carapace front view; H. carapace lateral view. Female: B. carapace dorsal view; D. prosoma ventral view; F. carapace lateral view. Bc, book lung cover; ctg, continuous transverse groove; sr, subterminal widely oval scutal ridge; tlp, tooth-like projection of male chelicerae. Scale bars: A–H 200 μm.
THE NEW GENUS *APOSPHRAGISMA*

**FIGURE 47.** *Aposphragisma sepilok* sp. nov. Male: A–B. palp prolateral view (B: hairs omitted except trichobothria); C. embolus-conductor-complex prolateral view; D. abdomen ventral view. Female: E. abdomen ventral view. Cb, conical bulge; con, conductor; cr, curved ridge; em, embolus; esp, embolic spine; lap, postepigastric lateral apodemes; spp, spermophor; spo, spermophor opening. Scale bars: A–B 100 μm; C 50 μm; D–E 200 μm.

**CEPHALOTHORAX.** Carapace: surface of elevated portion of pars cephalica smooth, sides granulate (Figs. 46A, E); posterolateral surface without spikes; posterior edge of pars cephalica with slightly stronger modified hair bases, appearing as small denticles; carapace margin with sluice restricted to posterior margin, with blunt denticles (Fig. 46A); few non-marginal pars thoracica setae on carapace sides, very scattered. Eyes: tiny, especially PME and PLE (Fig. 46A); posterior eye-row straight from above, procured from front (Figs. 46A, G); ALE largest, separated by their radius to diameter; ALE-PLE separated by less than ALE radius; PME separated by their radius to diameter; PLE-PME separated by less than PME radius. Sternum finely ornamented except smooth median stripe which is about half as long as sternum (Fig. 46C); infracoxal grooves present; posterior margin with broad single extension, covered with few blunt denticles (Fig. 46C). Pleura: surface smooth with pairs of large pits dorsally of each coxa I, II and III. Mouthparts: chelicerae promargin with row of flattened setae, distally extending into a short inwards pointing tooth-like projection (tlp) (Fig. 46C).
ABDOMEN. Book lung covers (bc) large, elliptical to pear-shaped (sides slightly concave), about 3 times longer than wide (Fig. 46H). Epigastric scutum dorsally with a widely oval subterminal ridge (sr) (Fig. 46H); scuto-pedicel region with slightly swollen hair bases. Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 47D).

GENITALIA. Epigastric region: sperm pore situated between anterior and posterior spiracles (Fig. 47D). Palp: basal segments as well as bulb and cymbium lighter in colour than rest of body; bulb rather stout (Figs. 47A–B). Embolus (em) tip spatulate (Fig. 47C); embolic spine (esp) with pointed tip (Fig. 47C). Conductor (con) with broad tip (appearing ‘snout’-like in lateral view; Fig. 47C). Embolus-conductor-complex about as long as bulb.

FEMALE. As in male except as noted. Body length 1.52–1.54 mm, carapace length 0.70–0.71 mm. PME separated by less than their radius. Epigastric scutum posterolaterally with a single curved ridge (cr) (Fig. 47E). Postepigastric scutum with short posteriorly directed lateral apodemes (lap) (Fig. 47E).

Intraspecific variation. Body size variable (see above); one female slightly darker; number of denticles on carapace margin variable.

Distribution. NE-Sabah, MALAYSIA; all specimens collected at Kabili-Sepilok forest reserve (Fig. 49).

*Aposphragisma stannum* Thoma, sp. nov. (Fig. 48)

**Type material.** HOLOTYPE: male (PBI_OON 00012551), Bukit Timah Nature Reserve (SINGAPORE) [01°21′N
103°47′E; inf.], 19.XII.1968, forest litter, leg. Dennis H. Murphy, deposited at MHNG.

Etymology. The species epithet is a noun in apposition meaning ‘tin’ in Latin. It refers to Bukit Timah, the type locality, which means ‘tin bearing hill’ in the Malay language.

Diagnosis. *A. stannum* sp. nov. does not belong to the stripe clade and thus shows a completely ornamented sternum. It can be distinguished from other species with a completely ornamented sternum by the combination of the following traits: carapace margin with pointed denticles, sluice restricted to posterior margin; cheliceral promargin distally with tooth-like projection; epigastric scutum dorsally with a widely oval subterminal ridge.

Description. Description based on 1 male.

MALE. With the characters of the genus except as noted. Body length 1.21 mm, carapace length 0.56 mm. Sclerotized parts uniformly coloured yellow-brown, close to colour 23A ‘cinnamon’; legs slightly paler than body, more yellowish. Habitus: Figs. 48A–C.

CEPHALOTHORAX. Carapace: surface of elevated portion of pars cephalica smooth, sides finely reticulate; posterolateral surface without spikes; carapace margin with sluice restricted to posterior margin, with pointed denticles; few non-marginal pars thoracica setae present, very scattered. Eyes: ALE well developed, PLE and PME tiny, all oval; posterior eye-row straight from above, procurred from front; ALE separated by less than their radius; ALE-PLE separated by less than ALE radius; PME separated by less than their radius; PLE-PME separated by less than PME radius. Sternum completely finely ornamented; single lobed elements hardly visible on stereomicroscope level, surface appears rather reticulate; posterior margin with broad single extension. Pleura: surface smooth, presence of pits could not be assessed on stereomicroscope level. Mouthparts: cheliceral promargin with row of flattened setae in combination with plumose setae, distally extending into a short inwards pointing tooth-like projection; anterior face of paturon in lateral view subbasally with slight indentation.

ABDOMEN. Book lung covers large, elliptical to rather pear-shaped (sides slightly convex), about 3–4 times longer than wide. Epigastric scutum dorsally with widely oval subterminal ridge (sr) (Fig. 48C). Postepigastric scutum long, semicircular, with long posteriorly directed lateral apodemes (lap) (Fig. 48B).

GENITALIA. Epigastric region: Sperm pore situated between anterior and posterior spiracles. Palp: basal segments as well as bulb and cymbium slightly lighter in colour than rest of body; bulb rather stout, tapering apically (Fig. 48D). Embolus (em) tip spatulate; embolic spine with pointed tip. Conductor (con) with slender tip (Fig. 48D). Embolus-conductor-complex about half as long as bulb.

Distribution. Bukit Timah, SINGAPORE (Fig. 49).
FIGURE 48. Aposphragisma stannum sp. nov. Male: A. habitus dorsal view; B. habitus ventral view; C. habitus lateral view; D. palp prolateral view (hairs omitted except trichobothria). Cb, conical bulge; em, embolus; lap, postepigastric lateral apodemes; sr, subterminal widely oval scutal ridge; vp, conductor. Scale bars: A–C 500 μm; D 100 μm.
FIGURE 49. Distribution of *Aposphragisma* gen. nov. in Southeast Asia. Stripe clade: 1) *A. baltenspergae* sp. nov., 2) *A. borgulai* sp. nov., 3) *A. brunomanseri* sp. nov., 4) *A. dayak* sp. nov., 5) *A. dentatum* sp. nov., 6) *A. hausammannae* sp. nov., 7) *A. helvetiorum* sp. nov., 8) *A. kollerii* sp. nov., 9) *A. menzi* sp. nov., 10) *A. monoceros* sp. nov., 11) *A. retifer* sp. nov., 12) *A. salewskii* sp. nov., 13) *A. sepilok* sp. nov. Non-stripe clade species: 14) *A. confluens* sp. nov., 15) *A. draconigenum* sp. nov., 16) *A. nocturnum* sp. nov., 17) *A. rimba* sp. nov., 18) *A. scimitar* sp. nov., 19) *A. stannum* sp. nov. Scale bars: 500 km.

Phylogenetic analysis

**Taxa.** According to morphological features presumed closely related species plus *Prethopalpus fosuma* were chosen as additional outgroup taxa. *Cortestina thaleri* (Oonopidae, Sul sulinae) has been chosen to root the tree.


**Ingroup taxa.** Aposphragisma baltensepergae sp. nov., A. borgulai sp. nov., A. brunomanseri sp. nov., A. confluens sp. nov., A. dayak sp. nov., A. dentatum sp. nov., A. draconigenum sp. nov., A. hausammannae sp. nov., A. helvetiorum sp. nov., A. kolleris sp. nov., A. menzi sp. nov., A. monoceros sp. nov., A. nocturnum sp. nov., A. retifer sp. nov., A. rima sp. nov., A. salewskii sp. nov., A. scimitar sp. nov., A. seplok sp. nov., A. stannum sp. nov.

**Character list (refers to table 1)**

**Characters of males and females**

<table>
<thead>
<tr>
<th>Character</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ch 1: Carapace lateral margin, sluice, dorsal view.</td>
<td>(0) sluice restricted to posterior margin (Figs. 1D, 6A), (1) sluice reaching level of coxa 1 (Fig. 20G), (2) sluice absent (cf. C. thaleri, Figs. 11, 13 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 2: Carapace lateral margin, denticles (shape).</td>
<td>(0) without denticles (Fig. 44D), (1) with blunt denticles (Figs. 20G, 21H), (2) with sharply pointed denticles (Fig. 9E), (3) with blunt denticles becoming more and more two-lobed on posterior half of lateral margin (Fig. 15D).</td>
</tr>
<tr>
<td>Ch 3: Carapace, postero-lateral corner, spikes.</td>
<td>(0) without spikes (Fig. 1G), (1) with a pair of spikes (Figs. 9E–F), (2) with a pair of double-toothed spikes (Fig. 32D), (3) with two pairs of spikes (cf. G. asterobothros, Figs. 1F–G in Eichenberger et al. 2012).</td>
</tr>
<tr>
<td>Ch 4: Carapace, pars cephalica, elevation in lateral view.</td>
<td>(0) only in radial furrows (cf. X. biflocci, Fig. 43C in Eichenberger et al. 2012), (2) flat (cf. C. thaleri, Figs. 5–6, 13 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 5: Carapace, pars cephalica, setae bases.</td>
<td>(0) surroundings of setae bases unmodified (cf. A. scimitar sp. nov.), (1) surroundings of setae bases forming pit-like depressions with elevated rims (‘cephalic pits’, cf. Figs. 20H, 21G).</td>
</tr>
<tr>
<td>Ch 6: Carapace, pars cephalica, postero-lateral margin, setae bases.</td>
<td>(0) setae bases unmodified (cf. A. scimitar sp. nov.), (1) setae originating from pits with partly elevated rims (may even appear as small denticles, e.g. Fig. 21G), (2) with a pair of strongly modified, spike-like hair bases (Fig. 9D), (3) with a single central spike (‘horn’, Figs. 32D, F).</td>
</tr>
<tr>
<td>Ch 7: Carapace, surface sides.</td>
<td>(0) smooth (Fig. 28D), (1) granulate (Figs. 46E–F), (2) finely reticulate (e.g. A. confluens sp. nov., hardly visible on pictures), (3) coarsely reticulate (Figs. 20H, 21C), (4) striated (cf. G. fricki, Figs. 27E, G in Eichenberger et al. 2012), (5) surface ornamentation restricted to lateral furrows, scaly (cf. P. fosuna, Figs. 1–3, 15–16, 24 in Burger et al. 2002, Figs. 19–20 in Baehr et al. 2012).</td>
</tr>
<tr>
<td>Ch 8: Carapace, postero-lateral pair of pits.</td>
<td>(0) absent (Fig. 20H), (1) present (cf. G. asterobothros; Fig. 1H in Eichenberger et al. 2012).</td>
</tr>
<tr>
<td>Ch 9: Carapace, clypeus shape, frontal view.</td>
<td>(0) sinuous (Figs. 21E–F), (1) straight (cf. G. asterobothros, Figs. 2A in Eichenberger et al. 2012), (2) “narrow and arched upwards, thereby forming a small, slightly pointed protuberance” (cf. C. thaleri, Fig. 14 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 10: Carapace, eyes, ALE-ALE interdistance.</td>
<td>(0) ALE-ALE separated by less than their radius (Fig. 13C), (1) separated by their radius to diameter (Figs. 21E–F).</td>
</tr>
<tr>
<td>Ch 11: Carapace, eyes, relative size of PME.</td>
<td>(0) minute, PME diameter equal ALE radius or less (Fig. 16D), (1) PME not minute if compared to ALE (Fig. 20G).</td>
</tr>
<tr>
<td>Ch 12: Sternum, radial furrows.</td>
<td>(0) lateral margin with weakly developed radial furrows, sternum margin appaers indented in ventral view (Figs. 5F, 20F), (1) radial furrows pronounced, sternum margin clearly indented (cf. G. asterobothros, Fig. 1D in Eichenberger et al. 2012), (2) radial furrows pronounced between coxae I–II and II–III, only weakly developed between coxae III–IV (cf. X. biflocci, Fig. 43G in Eichenberger et al. 2012), (3) covering entire surface (Fig. 13D), (4) sternum weakly sclerotized without any ornamentation (cf. C. thaleri, Figs. 9–10 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 13: Sternum, microsculpture distribution.</td>
<td>(0) only in radial furrows (cf. G. asterobothros, Figs. 1D–E in Eichenberger et al. 2012), (1) medially and in furrows (only in G. catusphragisma), (2) everywhere but middle (sternum shows smooth middle stripe; Figs. 20E–F), (3) covering entire surface (Fig. 13D), (4) sternum weakly sclerotized without any ornamentation (cf. C. thaleri, Figs. 9–10 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 14: Sternum, ornamentation, (0) finely ornamented (Fig. 13D), (1) coarsely ornamented (Figs. 20D–F), (2) sternum weakly sclerotized without any ornamentation (cf. C. thaleri, Figs. 9–10 in Knoflach et al. 2009).</td>
<td></td>
</tr>
<tr>
<td>Ch 15: Sternum, ornamentation microstructure.</td>
<td>(0) blossom-shaped or lobed depressions (Fig. 22A), (1) rows of drop-like pits (cf. G. asterobothros, Figs. 1D–E in Eichenberger et al. 2012), (2) sternum weakly sclerotized without any ornamentation (cf. C. thaleri, Figs. 9–10 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 16: Sternum, anterior margin.</td>
<td>(0) unmodified (cf. P. fosuna, Fig. 21 in Baehr et al. 2012), (1) with continuous transverse groove (Figs. 20D–F), (2) with interrupted transverse groove (cf. G. asterobothros, Fig. 1E in Eichenberger et al. 2012).</td>
</tr>
<tr>
<td>Ch 17: Labium, shape.</td>
<td>(0) rectangular / trapezoidal (cf. G. asterobothros, Fig. 2F in Eichenberger et al. 2012), (1) triangular (Figs. 20F, 21A), (2) wider than long with evenly rounded anterior border (cf. C. thaleri, Figs. 12, 15, 17, 27, 39 in Knoflach et al. 2009).</td>
</tr>
<tr>
<td>Ch 18: Labium, anterior margin.</td>
<td>(0) indented at middle (cf. G. asterobothros, Fig. 2F in Eichenberger et al. 2012), (1) deeply incised (Figs. 20F, 21A), (2) convex and evenly rounded (cf. C. thaleri, Fig. 15 in Knoflach et al. 2009).</td>
</tr>
</tbody>
</table>
Ch 19: Labium, ventral surface, setae arrangement. (0) 2:3 arrangement i.e. two rather distal setae (one on each side of incision / indention) and a more or less transverse line of three more proximal setae posterior to incision (Figs. 10F, 22D), (1) 4:2 arrangement i.e. a pair of setae on each side of indention and a more proximal pair of setae posterior to indention (cf. G. asterobothros, Fig. 2F in Eichenberger et al. 2012), (2) 4:3 arrangement i.e. a pair of needle-like setae on each side of incision and three more proximal setae (being more or less in a row) posterior to indention (cf. X. biflocci), (3) 5 setae in a more or less transverse line on posterior half (cf. C. thaleri, Figs. 15, 27, 39 in Knoflach et al. 2009).

Ch 20: Chelicerae, patroon, proximal part of anterior face, lateral view. (0) not or only slightly indented (Fig. 1G), (1) with strong, angular indention (Fig. 34F).

Ch 21: Chelicerae, outer margin of posterior face, subbasal denticle (den). (0) absent, (1) present (Fig. 1G).

Ch 22: Abdomen, book lung covers, size and shape. (0) small (Figs. 40C–D), (1) large, elongated, pear or dumbbell shaped (Figs. 7A, 23A, C), (2) large, broadly ovoid to round(-ish) (sides convex; Fig. 34G), (3) absent, book lungs being transformed to tracheae (cf. C. thaleri, Knoflach et al. 2009).


Ch 24: Abdomen, scuto-pedicel region, ridges. (0) sclerotized, but ridges absent (Fig. 40C), (1) with paired curved scutal ridges (cf. G. asterobothros, Fig. 2C in Eichenberger et al. 2012), (2) with widely oval scutal ridge (Figs. 23C, F), (3) with paired median scutal ridge and widely oval dorsal ridge (cf. X. paulina, Fig. 39A in Eichenberger et al. 2012), (4) abdomen not sclerotized (cf. C. thaleri, Knoflach et al. 2009).

Ch 25: Abdomen, pedicel, dorsal modifications. (0) without modifications (Fig. 23F), (1) with small, dorsolateral spikes (cf. G. asterobothros, Fig. 2C in Eichenberger et al. 2012).

Ch 26: Abdomen, dorsal scutal hairs. (0) short (Fig. 23C), (1) long (Fig. 9C).

Characters of males

Ch 27: Chelicerae, toothlike projection of promargin. (0) absent (Fig. 34F), (1) short (Figs. 20D–E), (2) long (Fig. 38H).

Ch 28: Palp, cymbium length, dorsal view. (0) not covering entire bulb (i.e. appearing shorter than bulb if viewed from above; Figs. 25A–B, D), (1) covering entire bulb if viewed from above (cf. G. asterobothros, Fig. 4A in Eichenberger et al. 2012).

Ch 29: Palp, bulb, anterodorsal conical bulge. (0) absent (cf. C. thaleri, Figs. 18, 22–24 in Knoflach et al. 2009), (1) bulge very faint (Figs. 35A–B), (2) bulge pronounced (Figs. 25B, E).

Ch 30: Palp, embolus-conductor complex. (0) bulb extending into a slender, filamentous, medially bent embolus (cf. P. fosuma, Burger et al. 2002, Baehr et al. 2012), (1) bulb extending into a “short, stout and slightly curved and twisted embolus” (cf. C. thaleri, Figs. 22–24 in Knoflach et al. 2009), (2) bulb extending into an embolus and a conductor (usually about as long as embolus), both laminar, closely touching and apically tapering (Figs. 4B–C), (3) bulb extending into an embolus and a conductor, embolus split into two parts half way to distal tip (cf. G. asterobothros, Fig. 4D in Eichenberger et al. 2012), (4) bulb extending into a pincer-like embolus-conductor-complex (Fig. 41B).

Ch 31: Male palp, embolus, distal part. (0) regularly tapering (cf. G. asterobothros, Fig. 4E in Eichenberger et al. 2012), (1) tip widened and spatulate / shovel-like (Fig. 31E), (2) tip widened and halberd-like (Fig. 35C), (3) tip widened, elongated spathulate, basally with hook (Fig. 41C), (4) regularly tapering with snout-like tip (cf. C. thaleri, Figs. 18–24 in Knoflach et al. 2009), (5) regularly tapering but showing complex tip (cf. P. fosuma, Fig. 9 in Burger et al. 2002, Figs. 39–40 in Baehr et al. 2012).

Ch 32: Palp, embolus, embolic spine. (0) absent, (1) present, with pointed tip (Fig. 4E), (2) present, with fringed tip (Figs. 31C, E).

Ch 33: Palp, conductor, lateral view. (0) conductor absent (cf. P. fosuma, Burger et al. 2002, Baehr et al. 2012), (1) conductor with slender tip (Fig. 19D), (2) conductor with broad tip (Fig. 4C).

Ch 34: Abdomen, sperm pore position, ventral view. (0) at level of posterior spiracles (Fig. 2E), (1) between anterior and posterior spiracles (Fig. 11A), (2) at level of anterior spiracles (Fig. 44H).

Ch 35: Abdomen, strongly sclerotized parts of posteriorly directed lateral apodemes, ventral view. (0) short, not or only slightly exceeding connecting groove of posterior spiracles (Fig. 11A), (1) long, clearly exceeding connecting groove of posterior spiracles (Fig. 2E), (2) very long, almost reaching posterior edge of postepigastric scutum (Fig. 44H).

Characters of females

Ch 36: Abdomen, epigastic scutum, postmedian ridges. (0) absent (cf. G. asterobothros, Eichenberger et al. 2012), (1) row of ridges (Figs. 4F–G), (2) u-shaped ridge (Fig. 11C), (3) abdomen not sclerotized (cf. C. thaleri, Knoflach et al. 2009).

Ch 37: Abdomen, strongly sclerotized parts of posteriorly directed lateral apodemes, ventral view (“A1” in Gamasomorpha and Xestaspis species described by Eichenberger et al. 2012), (0) short, not or only slightly exceeding connecting groove of posterior spiracles (Fig. 11B), (1) long, clearly exceeding connecting groove of posterior spiracles (Figs. 8F–G).

Ch 38: Abdomen, internal female genitalia, size and shape of receptaculum. (0) small (not exceeding connecting groove of posterior spiracles), cylindrical or elongated ovoid (Fig. 41G; cf. P. fosuma, Figs. 21–23 in Burger et al. 2002), (1) small (not exceeding connecting groove of posterior spiracles), triangular (Figs. 25H, 31G), (2) large (exceeding connecting groove of posterior spiracles), circular to almost circular (cf. G. asterobothros, Fig. 4G in Eichenberger et al. 2012), (3) large (exceeding connecting groove of posterior spiracles), ovoid (Figs. 4Q, 8G), (4) large (exceeding connecting groove of posterior spiracles), sides emarginated, posterior part therefore less wide than anterior part (cf. X. biflocci, Fig. 47B in Eichenberger et al. 2012), (5) large (exceeding connecting groove of posterior spiracles), triangular (Fig. 12G), (6) small, bipartite (cf. C. thaleri, Knoflach et al. 2009).

Ch 39: Abdomen, internal female genitalia, localisation of papillae on the receptaculum. (0) restricted to small central area (cf. G. asterobothros, Fig. 4G in Eichenberger et al. 2012), (1) concentrated on wider central area, around globular appendix, not
reaching margins (cf. X. biflocci, Fig. 47B in Eichenberger et al. 2012), (2) arranged in a central, more or less transverse field of triangular shape, reaching (or almost reaching) lateral margins (Figs. 12G, 25H, 31G), (3) covering anterior two thirds, reaching lateral margins (Fig. 4G), (4) covering posterior two thirds, reaching lateral margins (Fig. 8G).

Ch 40: Abdomen, internal female genitalia, size of globular appendix. (0) about twice as long as wide (e.g. Fig. 4G), (1) about three to four times as long as wide (cf. G. fricki, Fig. 29G in Eichenberger et al. 2012), (2) about four to five times as long as wide (cf. X. biflocci, Fig. 47B in Eichenberger et al. 2012).

TABLE 1. Character matrix giving the characters (rows) and taxa (columns). The last three columns give the length (steps), consistency index (ci), and retention index (ri) assigned to the characters. Calculations are based on the strict consensus tree of the implied weighted analysis using K=1–5.

<table>
<thead>
<tr>
<th>Character</th>
<th>Taxon 1</th>
<th>Taxon 2</th>
<th>Taxon 3</th>
<th>Taxon 4</th>
<th>Taxon 5</th>
<th>Length</th>
<th>CI</th>
<th>RI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palp</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Length</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Shape</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Size</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Consistency Index</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Retention Index</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Results and discussion

Alpha taxonomy

The species hypotheses were well supported on multiple levels. Inter-specific variation was well-defined in all cases and all species could be characterised by a unique set of somatic features. Further, intraspecific variation was low for those species represented by several specimens. This applied both for somatic and sexual characters. For example, the palps of 19 of the 30 males of A. helvetiorum sp. nov. were examined and intraspecific variation was found to be negligible. Furthermore, male palp morphology generally appears to be species-specific. However, the male palps and internal female genitalia of the two allopatric Bornean species A. helvetiorum sp. nov. and A. menzi sp. nov. are morphologically very similar. In this case, species separation based on male palps would be difficult. However, the somatic characters allow these two species to be easily distinguished. In spiders and other invertebrate taxa with internal fertilization, male genitalia are often regarded as being species-specific and therefore a clue for determining closely related or cryptic species (see Huber 2003 and references therein). However, Huber (2003) cautioned that the use of male genital characters as an a priori characteristic for species delimitation might create a circular argument. This study avoided the potential for creating a circular argument
regarding species delimitation by using both somatic and sexual characters, without a priori prioritization of importance.

Sexual dimorphism in somatic characters was very low and mostly involved body size. Females therefore provide an equally rich set of somatic characters for species identification.

**Phylogeny**

The main goal of the phylogenetic analysis was to determine whether the new genus emerges as monophyletic compared to a limited number of putatively related genera or not. An analysis including a wider range of genera, especially those with gamasomorphic appearance, was beyond the scope of this paper.

*Aposphragisma* gen. nov. appears monophyletic no matter the analysis. It emerges either as sister to *P. fosuma* (using equal weights) or to a clade including representatives of the genera *Gamasomorpha* and *Xestaspis* (using implied weights). Among the outgroups, the selected *Gamasomorpha* species appear paraphyletic with respect to the monophyletic *Xestaspis* species group (Figs. 50–51).

Under equal weights 14 most parsimonious trees were found (L=149, CI=0.64, RI=0.77) of which none was fully resolved since branches were collapsed if supported ambiguously.

Using implied weights, we found the same 7 trees (of which, again, none was fully resolved) for each of the K-values 1–5 and consequently the same strict consensus tree for each of these K-values (L=149, CI=0.63, RI=0.77).

Using K-values above 5 resulted in 7 trees no matter the value of K. These trees are all different from those found using lower K-values. However, they were also found under equal weights. Their strict consensus tree equals the strict consensus tree of the equally weighted analyses except for a minor difference concerning the positioning of *A. draconigenum* sp. nov.

The strict consensus tree of the implied weights analysis (K=1–5) only differs from the strict consensus tree under equal weights by the positions of *P. fosuma*, *G. cataphracta*, *A. confluens* sp. nov. and *A. scimitar* sp. nov. (Fig. 51). The strict consensus tree resulting from the implied weights analysis using K=1–5 is our preferred tree (L=149, CI=0.63, RI=0.77) on which the character optimisations are plotted (Fig. 50). Our preference is based on presumed sister group relationships of *Aposphragisma* gen. nov. It appears as sister to a group including *Gamasomorpha* and *Xestaspis* in the implied weights analyses using K=1–5 but sister to *P. fosuma* in all other analyses including equal weights. However, the overall similarity especially of the secondary male sexual organs and internal female genitalia of *Aposphragisma* gen. nov. with both *Gamasomorpha* and *Xestaspis* appears considerably higher than to *Prethopalpus*, but is blurred by highly homoplastic somatic characters when analysed using equal weights or very low implied weights. Furthermore, the relationship between *Aposphragisma* gen. nov. and *P. fosuma* as potential sister taxa is weekly supported in the equal weights analyses (i.e. showing a Bremer support of 1, Fig. 51). Moreover, forcing changes of the position of *P. fosuma* as either sister to *Aposphragisma* gen. nov. or basal to all other Oonopinae changes the treelength by only one step.

Terminal taxa are, if resolved at all, only weakly supported with respect to the Bremer support values under equal weights (Fig. 51). However, *Aposphragisma* gen. nov. emerges as a monophyletic group in all analyses.

The monophyly of *Aposphragisma* gen. nov. is further supported by four unambiguous synapomorphies. The triangular labium (ch17, state 1) and its deeply incised anterior margin (ch18, state 1) are present in all taxa of *Aposphragisma* gen. nov. The long lateral abdominal apodemes in males (ch35, state 1) appears as a synapomorphy but the character states vary within the new genus. Those species of *Aposphragisma* gen. nov. where the relevant character was available show a widened and shovel-like embolus tip (ch31, state 1), with the exceptions of *A. rimba* sp. nov. and *A. nocturnum* sp. nov.

The clades within *Aposphragisma* gen. nov. are not well structured, i.e. not resolved. However, one character is a valuable synapomorphy defining a distinct intrageneric clade, comprising *A. sepilok* sp. nov. and the taxa in its sister group (including the type species *A. helvetiorum* sp. nov.; Figs. 50–51). The sterna of all taxa in this clade medially present a smooth stripe surrounded by microsculptures (hence the name ‘stripe-clade’; marked as dark grey in Figs. 50–51). All other species of *Aposphragisma* gen. nov. lack this glabrous middle stripe. Instead, their sternum is fully covered by microsculptures (marked as light grey in Figs. 50–51).

As already mentioned in the generic diagnosis paragraph, we included *A. rimba* sp. nov. based on the fact that the species shows several somatic features typical of the new genus. However, considering sexual characters, the species clearly deviates. More research is needed in order to further resolve its relationship with respect to the new genus.
FIGURE 50. Preferred topology with ACCTRAN character optimisations. Strict consensus tree from 7 trees using implied weights $K=1–5$ ($L=149$, $CI=0.63$, $RI=0.77$). Squares show synapomorphic (black) and homoplastic (white) character state changes. Numbers above the squares correspond to the character numbers, those below to character state changes. The ingroup *Aposphragisma* gen. nov. is marked in shades of grey: species showing completely ornamented sternum in light grey and those possessing sternum with a glabrous middle stripe (‘stripe-clade’) in dark grey.

### Functional morphology

#### Ornamentation of the sternum

The Oonopidae offer a wide variety of conspicuous body features that raise questions as to their function. One of the most striking features of *Aposphragisma* gen. nov. is the ornamentation of the sternum. We do not yet know the function(s) of these structures. We hypothesized that they may harbour pores or serve as reservoirs for secretions. However, our analyses revealed neither pores nor any other obvious structures on the sternal surface.

#### Male tooth-like cheliceral projections

Males of most species of *Aposphragisma* gen. nov. show a peculiar tooth on the tip of the paturon (tlp) (e.g. Figs. 2C, 6D). Male cheliceral modifications of both the paturon and fang are known in other haplogyne spider families, such as Pholcidae and Tetrablemmidae. In these families, certain corresponding structures like pockets, grooves or rims, can be found associated with the female genital area, indicating their involvement in copulatory coupling and/or sexual selection processes (e.g. Huber 1999, Burger et al. 2006b). In Oonopidae, male cheliceral modifications occur in *Predatoroonops* (Brescovit et al. 2012), *Cavisternum* (Baehr et al. 2010), some species of *Orchistina* (Simon 1893b, Dalmas 1916, Saaristo 2001, Saaristo & van Harten 2006, Henrard & Jocqué 2012), *Scaphiella*
(Platnick & Dupérré 2010 with further references therein), *Escaphiella* (Burger 2009 sub *Scaphiella*; Platnick & Dupérré 2009b with further references therein), and *Ischnothyreus* (Kranz-Baltensperger 2011, 2012 with further references therein).

However, in most Oonopidae including *Aposphragisma* gen. nov., no clear corresponding female structures were identified that could come into contact with the male’s cheliceral modifications (but consider the peculiar posterior receptaculum in *Predatoroonops*, Brescovit et al. 2012). Therefore, an involvement in copulatory locking cannot yet be assumed. Kranz-Baltensperger (2011) suggested a stridulatory function for male cheliceral modifications in some *Ischnothyreus* species with corresponding elements on the male palps. However, similar male palpal elements could not be found in *Aposphragisma* gen. nov. (but see discussion on male embolic ridges below). In *Escaphiella hespera* the female genital region shows posterior openings where the male apophyses of the fangs might lock during copulation (Burger 2009) and in *Scaphiella cymbalaria* and *S. simla* females show a modified epigastric area (Platnick & Dupérré 2010), which is not seen in species with unmodified male chelicerae.

**FIGURE 51.** Comparison between the strict consensus trees resulting from the implied (left) and the equal (right) weighting analyses. The ingroup *Aposphragisma* gen. nov. is marked in shades of grey: species showing completely ornamented sternae are marked in light grey and those possessing sternae with a glabrous middle stripe (‘stripe-clade’) in dark grey. Compared to the results of the implied weights analysis (left), the position of *G. fricki* and *G. cataphracta* is interchanged under equal weights (indicated by double arrow).

**Embolus**
Males of some species of *Aposphragisma* gen. nov. show longitudinal ridges on the embolus (lri) (Figs. 4D, 8D). Similar structures are known in males of other oonopid genera, such as *Gamasomorpha*, *Silouettella*, *Pelicinus*, *Grymeus* and *Lionneta* where they could serve as copulatory courtship devices and/or to remove previously deposited sperm from other males (Burger 2007, 2010a, 2011b). A stridulatory function of the ridges in
cooperation with the male cheliceral projections of Aposphragisma gen. nov. (as proposed for superficially similar structures in Ischnothyreus, Kranz-Baltensperger 2011) seems unlikely due to the relative position of the two structures (Fig. 5E), though this cannot be completely ruled out.

Female genitalia
Oonopid female genitalia cannot be fully understood by simply slide-mounting and figuring them. However, the necessary histological sectioning and 3D-reconstructions were beyond the scope of this paper. Nevertheless, it can be shown that the general morphology of the female genitalia of Aposphragisma gen. nov. correspond to the type found in several Gamasomorpha and Xestaspis species (Burger 2011b, Eichenberger et al. 2012). Among others, a secretory sac inside the receptaculum can be found (e.g. Figs. 4F–G, 8F–G). It was shown that such a secretory sac encloses all sperm of a certain male in Silhouettella loricatula and that it can be dumped by the female, probably in cooperation with a subsequent male (Burger et al. 2006b, 2007, Burger & Carrera 2011). Dumping of sperm enclosed in a secretory sac has been suggested to be common in Oonopidae, such as in species of Gamasomorpha, Silhouettella, Pelcinus, Grymeus and Lionmeta (Burger 2010a, 2011b).

Another typical feature of the female genitalia of Aposphragisma gen. nov. is the presence of a sclerite (tsc), bearing a nail-like structure (na) (e.g. Figs. 4F–G, 8–G). This sclerite is associated with muscles (cf. Burger et al. 2006a) and probably serves to lock the uterus externus, thus preventing sperm from entering the uterus and coming directly into contact with the eggs (which could be advantageous for the male). It may also assist in egg-laying (Burger 2010a) and was found in numerous oonopid genera such as Brignolia, Dysderina, Gamasomorpha, Grymeus, Heteroonops, Ischnothyreus, Lionmeta, Melchisedec, Ne oxyphimus, Opopaea, Pelcinus, Prethopalpus, Silhouettella, Stenoonops, Trieraeus, Xy phonius and Zygooonops (Burger et al. 2003, Platnick & Dupérré 2009c, Burger 2009, 2010a, b, 2011b, c, Fannes 2010, Baehr et al. 2012, Platnick et al. 2012b). Locking of the uterus via sclerites associated with muscles may also occur in Orchestina (Burger et al. 2010, Henrard & Jocqué 2012), Antoonops (Fannes & Jocqué 2008) and Coxapophia (Ott & Brescovit 2004), and potentially other genera given the still incomplete knowledge on oonopid diversity.

Biogeography
Members of Aposphragisma gen. nov. are leaf litter dwellers restricted to Southeast Asian lowland and montane forests (either primary or secondary) west of the Wallace line, reaching their highest diversity on Borneo (Fig. 49). With the exception of Java they occur on all major sundaic and indochinese landmasses that were connected during the last glacial maximum (i.e. c. 19–26000 years ago) and several times before when sea-levels dropped considerably, providing forested connections between currently separated areas (Woodruff 2010). Despite the wide geographic range of the genus, overall interspecific variation is remarkably low, especially within the stripe-clade that may influence statements about degree of endemism. However, a comprehensive collection of oonopid specimens from previous and ongoing sampling efforts of forest litter arthropods in different parts of Southeast Asia has been compiled within the framework of the goblin spider PBI in order to circumvent this problem.

Due to the presumed high level of local endemism and restriction to forested habitats, it seems plausible to assume that many members of Aposphragisma gen. nov. will be negatively affected by anthropogenic disturbance. Deforestation rates of tropical humid forests in Southeast Asia are amongst the highest in the world (Achard et al. 2002; also see Fig. 1 in Bradshaw et al. 2009 depicting the immense loss of forest cover in the whole of the range.
of *Aposphragisma* gen nov.). Bornean forests in particular are affected by systematic, concession-based logging, habitat conversion and land-use change (McMorrow & Talip 2001, Achard *et al.* 2002, Curran *et al.* 2004). Furthermore, logging has encroached into protected areas (Curran *et al.* 2004). Conversion of logged areas into plantations, especially oil palm, has increased significantly (e.g. McMorrow & Talip 2001, Turner & Foster 2009). A study in northern Borneo showed that leaf-litter dwelling arthropod abundance and biomass was more than 70% lower in oil palm plantations compared to primary forests (Turner & Foster 2009). Some areas in Southeast Asia experiencing high losses of pristine habitats have shown high rates of regional extinction. For example in Singapore, Brook *et al.* (2003) detected an overall loss of biodiversity of at least 28%, but estimated a possible total loss of 73%, with species restricted to forested habitats being particularly affected. The status of many leaf-litter dwelling arthropods in large parts of Southeast Asia can therefore be assumed as critical, as is the case for overall biodiversity (Brook *et al.* 2003, Sodhi *et al.* 2004, Woodruff 2010).

Given the presumably large proportion of undescribed arthropod taxa (May 2000, Hamilton *et al.* 2010), many, including oonopids, may go extinct before being formally described. This highlights the importance of existing museum collections in providing a baseline for the assessment of historical arthropod diversity and a basis for All-Biota Taxon Inventories such as the oonopid PBI. Inventories such as this provide a sound footing for current and future taxonomy, biodiversity research and conservation priority setting.

**Acknowledgements**

We would like to thank Norman I. Platnick (AMNH) for the opportunity to participate on the PBI Project. We are grateful to the following curators providing us with the specimens examined in this work: Norm Penny and Charles Griswold (CAS), Peter J. Schwendinger (MHNG), Seppo Koponen (MZT), Jeremy Miller and Karen van Dorp (RMNH). Norman I. Platnick and Peter J. Schwendinger also commented on the Manuscript. We thank Ricardo Ott (Museu de Ciências Naturais do Rio Grande do Sul Porto Alegre, Brazil) for providing additional information on *Gamasomorpha cataphracta* and Andreas Ammann and Katharina Roettig (Institute of Classical Philology, University of Bern) for linguistic advice. Myles H. M. Menz (Institute of Ecology and Evolution, University of Bern) greatly improved our English. We are very grateful to Mark Harvey (WAM) and an anonymous referee for their critical reviews and valuable comments and suggestions. The support of Salome Steiner for the first author during an earlier stage of this work was invaluable.

**References**


http://dx.doi.org/10.1206/766.1

http://dx.doi.org/10.2476/asjaa.25.73

http://dx.doi.org/10.1038/424420a


http://dx.doi.org/10.1111/j.1469-7998.2007.00300.x

http://dx.doi.org/10.1111/j.1096-0031.2009.00181.x

http://dx.doi.org/10.1016/j.zool.2009.04.002

http://dx.doi.org/10.1002/jmor.10857

http://dx.doi.org/10.1111/j.1463-6395.2011.00053.x

http://dx.doi.org/10.1111/j.1744-7410.2011.00227.x

http://dx.doi.org/10.1016/j.jcz.2010.12.003

http://dx.doi.org/10.13156/arac.2010.15.5.173

http://dx.doi.org/10.1002/jmor.10435

http://dx.doi.org/10.1016/j.jmor.10857

http://dx.doi.org/10.1636/s04-60.1

http://dx.doi.org/10.1002/jmor.10435

http://dx.doi.org/10.1206/654.1

http://dx.doi.org/10.1146/annurev.ecolsys.22.1.565

http://dx.doi.org/10.1126/science.1091714


http://dx.doi.org/10.1016/j.tree.2004.09.006

http://dx.doi.org/10.1023/b:bioc.000006510.49496.1e


http://dx.doi.org/10.1017/s0266467408005658


http://dx.doi.org/10.1007/s10531-010-9783-3