

On a new *Phyxioschema* (Araneae, Mygalomorphae, Dipluridae) from Thailand and its biology

Robert J. Raven

Queensland Museum,
P.O. Box 300,
South Brisbane, Q. 4101, Australia
and

Peter J. Schwendinger

Institute of Zoology,
University of Innsbruck,
Technikerstr. 25,
A-6020 Innsbruck, Austria

Summary

The genus *Phyxioschema* Simon, 1889 is reviewed and *P. lindbergi* (Roewer, 1960) and *P. striatipes* (Roewer, 1960) are synonymised with *P. raddei* Simon, 1889. A new species of *Phyxioschema* from Thailand, *P. suthepia*, is described and notes on its mating behaviour and biology are given.

Introduction

Until now, *Phyxioschema* was known only from the southern U.S.S.R. and Afghanistan by the type species *Phyxioschema raddei* Simon, 1889 (see Raven, 1981), and *P. lindbergi* (Roewer, 1960) and *P. striatipes* (Roewer, 1960), both transferred from *Afghanothele* Roewer, 1960 by Raven (1985). Coyle (1988) convincingly demonstrated that *Euagrus* is the sister group of *Phyxioschema* but was unable to establish a synapomorphy for *Euagrus*. One possible explanation is that *Euagrus* may be paraphyletic and should include some species presently included in *Phyxioschema*. Hence, upon recognising a new species of *Phyxioschema* from the eastern corner of Eurasia, both the biogeographic and phylogenetic enigmas posed by the genus demanded attention.

Materials and methods

These are standard for the Araneae and may be found in Raven (1984). All measurements are in millimetres except eyes which are given in graticule units. Spermathecae were dissected off, mounted dorsal side up on an excavated slide in lactic acid, and drawn with a Wild M5 microscope and camera lucida.

Genus *Phyxioschema* Simon, 1889

Phyxioschema Simon, 1889: 385. Type species by monotypy, *Phyxioschema raddei* Simon, 1889 (female type in MNHP, examined).

Afghanothele Roewer, 1960: 32. Type species by original designation, *Afghanothele lindbergi* Roewer, 1960 (immature syntypes in Göteborg Naturhistoriske Museet and Senckenberg Museum, Frankfurt, examined). First synonymised by Raven, 1985: 148.

Characters of genus: Euagrine spiders with hirsute low carapace and pit-like fovea. Eight eyes on distinct tubercle. Chelicerae geniculate, teeth only on promargin of furrow. Serrula present as broad band. Spines present or absent on leg tarsi of males and females; male cymbium aspinose. Relative leg lengths of males 4321 or 413=2, and of females 4312 or 4321.

Preening combs present or absent. Paired claws with S-shaped row of several teeth; third claw with about 3-5 fine teeth sessile on claw. Four spinnerets; posterior medians widely separated; apical segment of posterior laterals slender, sometimes pseudosegmented or whip-like. Australotheline crescent (see Raven, 1984) absent. Tarsal organ a low dome with concentric ridges; trichobothrial bases corrugiform; cuticle of legs smooth.

Males: Tibia I incrassate, spinose; tibia II with large spine-bearing spur medially; metatarsus II forms two or three ridges. Palpal bulb simple pyriform with elongate embolus; cymbium with one apically pointed lobe and one short lobe.

Females: Spermathecae consist of two or more divided lobes, inner lobes joined to outer by partially or fully sclerotised coils; hairs absent from genital aperture (Coyle, 1988).

Diagnosis: *Phyxioschema* differs from *Euagrus* in the long band of curved setae on the prolateral face of tibia II (Fig. 2), and probably also the bilobed spatulate tip of the megaspines on tibia II of males (Coyle, 1988).

Remarks: Raven (1981) stated that the male of *Phyxioschema raddei* had cymbial spines and only two ridges on metatarsus II, but although the apical setae on the cymbium are enlarged they are not spines and a low third ridge is present on metatarsi II (Coyle, 1988). In *P. suthepia*, only two low mounds are present on metatarsi II.

Phyxioschema raddei Simon, 1889

Phyxioschema raddei Simon, 1889: 385.

Phyxioschema raddei: Simon, 1892: 185; Simon, 1903: 968; Raven, 1981: 255.

Afghanothele lindbergi Roewer, 1960:33. NEW SYNONYMY.

Afghanothele striatipes Roewer, 1960:34. NEW SYNONYMY.

Types

Phyxioschema raddei: Holotype, female, Ain-Dor, Transcaspia, southern U.S.S.R. (Muséum National d'Histoire Naturelle, Paris, no. 17.889, examined).

Afghanothele lindbergi: Syntypes, immature sex indeterminate, Afghanistan: 1, Kouh-Zarmast, A365, 19 October 1957, K. Lindberg; 1, Tchidjn, 7 April 1958, K. Lindberg; 1, Maimaneh, 27 October 1957, K. Lindberg; (in Göteborg Naturhistoriske Museet, examined). 1, juvenile, Reg. No. 12995 (Senckenberg Museum, Frankfurt, examined).

Afghanothele striatipes: Holotype, immature specimen desiccated almost beyond recognition, Darreh-Chakh, Afghanistan, A392, K. Lindberg, 30 October 1957 (in Göteborg Naturhistoriske Museet, examined).

Diagnosis

Males of *P. raddei* differ from those of *P. suthepia* by lacking a third megaspine on the spur of tibia II and having three sharp keels (see Coyle, 1988) rather than two rounded keels proximally on metatarsus II. Both males and females of *P. raddei* differ from those of *P. suthepia* by the absence of preening combs on metatarsi II-IV and the presence of foveal setae on the carapace. Spermathecae typical of genus.

Remarks

All of the characters discernible in the types of *Afghanothele lindbergi* and *Afghanothele striatipes* are also present in *Phyxioschema raddei* and in the absence of mature material that could be confidently recognised as either of the junior synonyms, both are placed in synonymy.

***Phyxioschema suthepia*, sp. nov.** (Figs. 1-10)**Types**

Holotype male, allotype female, 2 male and 2 female paratypes, Chiang Mai, 18°46'N, 98°58'E, northern Thailand, altitude 320 m, pitfall trap, 4 January-17 February 1986, P. J. Schwendinger, QM S 3077-3079. Other paratypes: Thailand, coll. P. J. Schwendinger. First "generation": Chiang Mai, 350 m: S 4156, 1♀, 20-27 February 1987; S 4160, 1♂ 1♀, 24 January-5 February 1988; S 4152, 2♂ 1♀, 14-28 December 1987. Fang, 750 m: S 4151, 1♂, 29 October 1987; S 6199, 2♀, 30 September 1987. Second "generation": Chiang Mai, 350 m: S 4154, 1♂ 1♀, 23-30 June 1987, lodged in Museum of Natural History, Vienna; S 4155, 1♀, 2-9 June 1987; S 4157, 1♀, 7-13 July 1987; S 4158, 1♂, 1

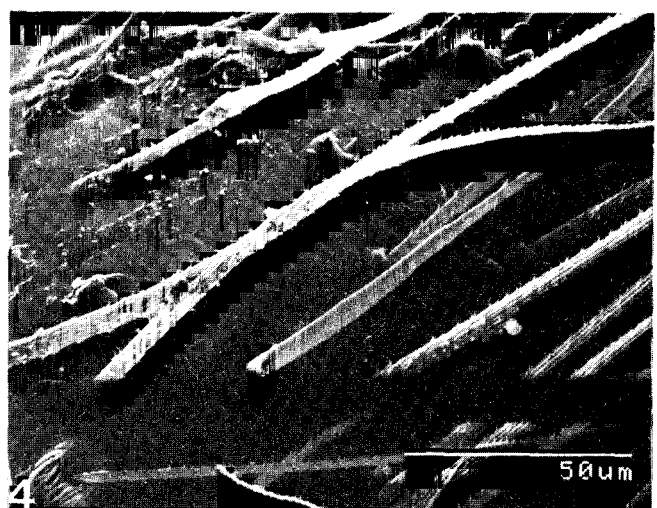
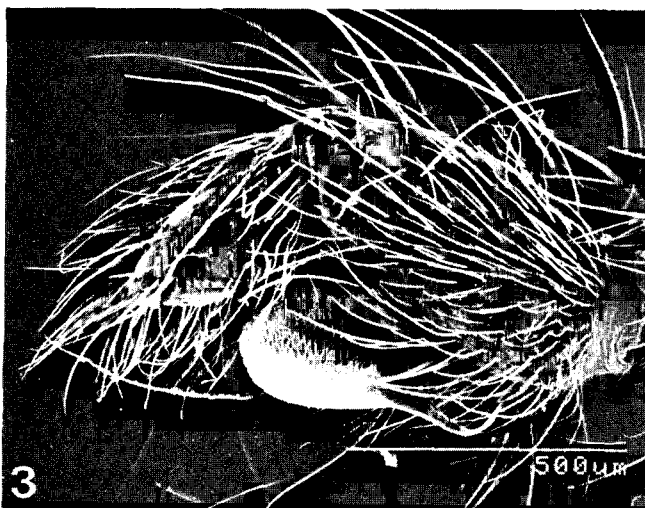
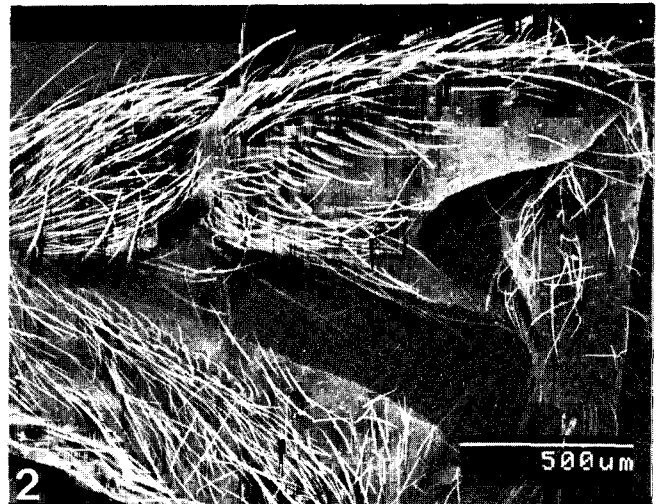
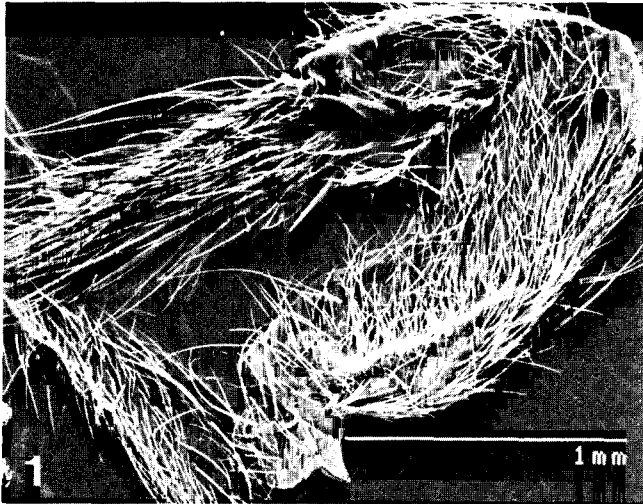
June 1987; S 4159, 1♂, 14-19 July 1987. Fang, 750 m: S 4165, 1♀, 29 October 1987. "Generation" unspecified: S 4153, 1♀, Chiang Mai, 350 m, 1 December 1985; S 4161, 3 juveniles, Ramkamhaeng National Park, 200 m, 27 July 1987; S 4162, 2♀, Lan Sang National Park, 200 m, 25 July 1987; S 4163, 1♂, Samkamphaeng, 400 m, 9 January-18 February 1986; S 4164, 1♀, Pha Yao, 450 m, 12 January 1986.

Diagnosis

Males of *P. suthepia* differ from those of *P. raddei* by having a third megaspine on the spur of tibia II and only two rounded keels rather than three sharp keels (see Coyle, 1988) proximally on metatarsus II. Both males and females of *P. suthepia* differ from those of *P. raddei* by the presence of preening combs on metatarsi II-IV and the absence of foveal or other setae noticeably thicker than the hairs on the carapace.

Etymology

The specific epithet derives from the type locality of this species, the Doi Suthep, a mountain and national park with an exceptionally rich flora and fauna, over-



Figs. 1-4: Scanning electron micrographs. *Phyxioschema suthepia*, paratype male. 1 Leg I, retrolateral view; 2 Leg II, pro-lateral view; 3 Palpal tibia and cymbium, retrolateral view; 4 Tarsal organ, cuticle, and trichobothria with bothrial cup.

looking the city of Chiang Mai, northern Thailand.

Holotype male QM S 3077

Carapace 2.16 long, 1.70 wide. Abdomen 2.40 long, 1.40 wide. Total length 5.0.

Colour in alcohol: Carapace yellow-brown with fine brown lines radiating laterally from fovea; sternum, maxillae, labium and legs light yellow-brown. Abdomen dorsally with irregular pallid area anteriorly with four paired transverse oval patches; ventrally yellow-brown with darker areas near spinnerets which are brown.

Carapace (Fig. 5): Oval, almost flat, highest near fovea, with light pile of long fine brown hairs. Fovea a small pit. No distinctly thicker setae evident.

Eyes: Tubercle distinct, short, raised. Group wider behind (24/21) than in front, much wider behind than long (24/12). Front row procurved, back row more or less straight. Ratio of AME:ALE:PME:PLE, 5:7:4:6. MOQ front width:back width:length, 12:15:10. Eye interspaces (as AME diameters): AME-AME 0.4, AME-ALE 0.0, ALE-PLE 0.2, PME-PLE 0.2, PME-PME 1.8.

Chelicerae: Small, geniculate, with group of 6-8 long thick setae projecting anteriorly. Promargin with four thick and four smaller teeth; no intermediate granules evident.

Labium (Fig. 6): 0.12 long, 0.36 wide. Cuspules absent; anterior edge setose with transverse glabrous tumid region.

Maxillae (Fig. 6): 0.54 long, 0.30 wide. Cuspules absent; intercheliceral tumescence absent; anterior lobe absent; serrula evident as wide ridge.

Sternum (Fig. 6): 1.14 long, 0.98 wide. Cordate; margins with long setae; sigilla very small, marginal.

Legs (Figs. 1, 2, Table 1): Leg formula 413=2. Covered with fine grey hairs and brown bristles. Femora I retrodorsally with teardrop-shaped group of short, hooked setae from mid-femora for one-quarter of their length towards distal end. Patellae I with 4 sigmoid spines set closely on retroventral edge. Tibiae I slightly incrassate with nine long thick spines prolaterally. Femora II with long oval area of short, hooked setae. Tibiae II incrassate with medial spur and two large and one smaller megaspines; largest spine pro-lateral, sigmoid, apically spatulate, tip touching that of retrolateral megaspine also originating from tip of spur; third, smallest megaspine straight, posterior to larger pair; diagonal band of long curved setae on pro-lateral face. Metatarsi II short with incrassate rounded mounds or keels located ventrally on pro-lateral and retrolateral edges.

	I	II	III	IV	Palp
Femur	1.56	1.48	1.36	1.84	0.88
Patella	1.00	0.88	0.80	1.00	0.52
Tibia	1.12	1.08	1.04	1.36	0.48
Metatarsus	1.08	0.92	1.20	1.80	
Tarsus	0.76	0.72	0.68	1.04	0.44
Total	5.52	5.08	5.08	7.04	2.32

Table 1: Leg measurements of *Phyxioschema suthepia*, male holotype.

	I	II	III	IV	Palp
Femur	1.72	1.52	1.60	1.80	1.08
Patella	1.08	1.04	1.04	1.04	0.68
Tibia	1.12	1.00	1.00	1.36	0.60
Metatarsus	1.00	0.88	1.28	1.48	
Tarsus	0.60	0.60	0.84	0.72	0.88
Total	5.52	5.04	5.76	6.40	3.24

Table 2: Leg measurements of *Phyxioschema suthepia*, female allotype.

Spines: No spines on leg tarsi. Group of 3-4 setae ventrally on metatarsi II-IV form preening combs. Leg I: femur d4, patella v4, tibia p1, v8, metatarsus v2. Leg II: femur d4, patella 0, tibia p1 + 3 megaspines + 20-25 thorn spines, metatarsus v6. Leg III: femur d2, patella p3, r1, tibia p2, d1, r2, v5, metatarsus p2, d1, r3, v5. Leg IV: femur d3, patella p1, tibia p2, r3, v4, metatarsus p4, r3, v6. Palp: femur d2, elsewhere 0.

Palp (Fig. 3): Tibia incrassate. Cymbium dissimilarly bilobed, one lobe much longer. Bulb large, pyriform, cuticle reticulated. Setae on cymbial tip slightly thicker and numerous, giving effect of spines.

Trichobothria (Fig. 4): Discernible only with difficulty. 6-8 in each of two rows for half length of tibiae, about 10 on metatarsi, about 8 on tarsi.

Claws: 8-10 long teeth in curving sigmoid row on paired claws; 3-4 long sessile teeth on third claw with heel-like process below claw.

Spinnerets: Australotheline crescent absent. Posterior medians 0.28 long, 0.08 wide (=0.36 of basal PLS), 0.30 apart. Basal, middle, apical articles of posterior laterals 0.72, 0.98, 1.28, long respectively; mid-diameter of apical article 0.3 of diameter of basal.

Allotype female QM S 3078

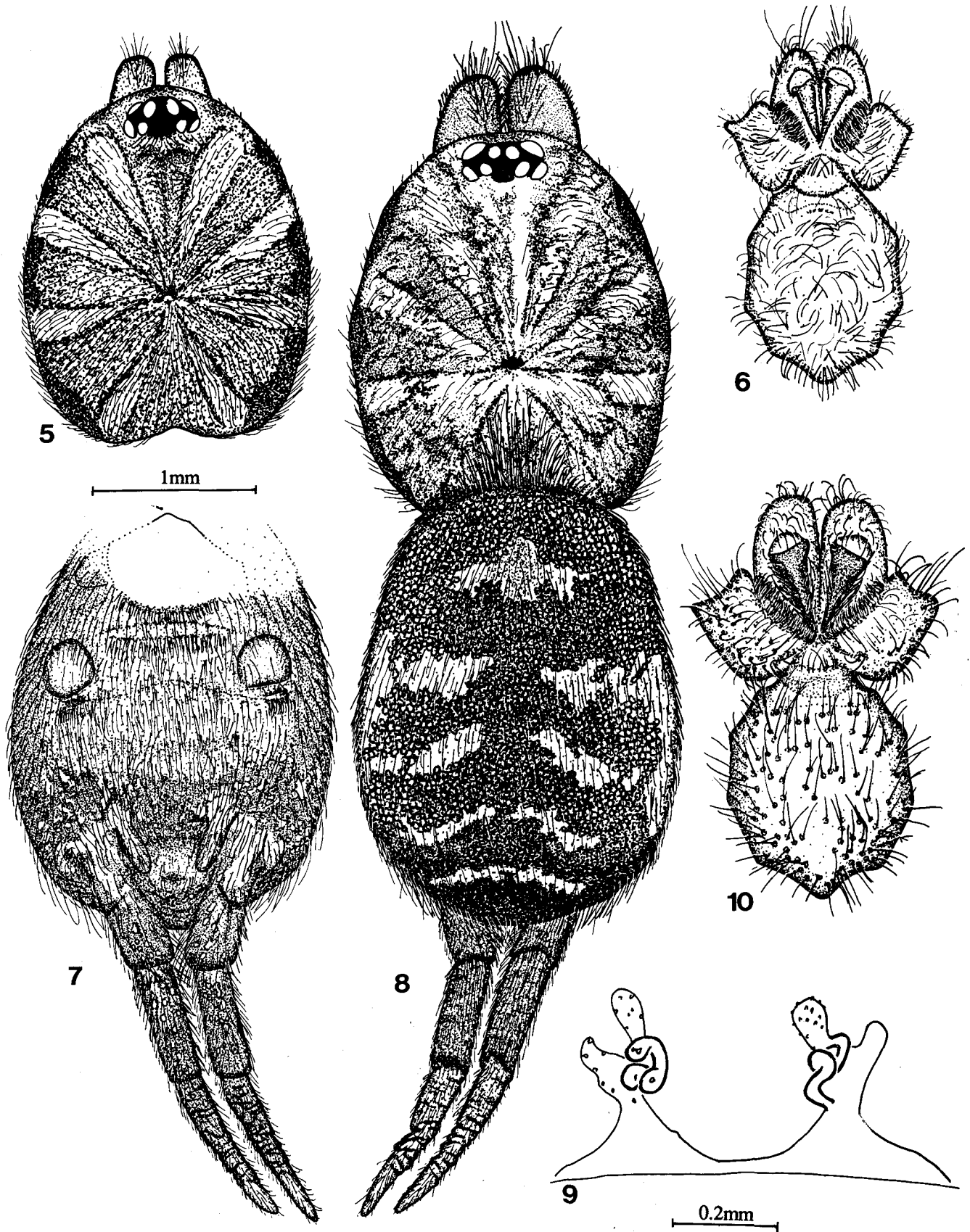
Carapace 2.60 long, 2.00 wide. Abdomen 3.28 long, 2.32 wide. Total length 6.4.

Colour in alcohol: Carapace orange-brown with brown areas on caput, interstitial ridges and margins; coxae, sternum, maxillae and labium yellow with brown areas behind maxillary lobes; labium and anterior part of maxillae with pallid zone posterior to leading edge. Abdomen dorsally with irregular pallid area anteriorly and with three paired transverse oval patches; ventrally yellow-brown with brown area near and including spinnerets; booklung covers reddish brown with brown "bull's eye"; tibiae with dorsal and lateral brown longitudinal areas; metatarsi and tarsi with brown dorsal line; legs otherwise yellow to orange-brown.

Carapace (Fig. 8): Uniformly covered with fine brown hairs; no thick setae evident. Fovea small, shallow. Caput as high as fovea.

Eyes: Tubercle distinct, short, raised. Group wider behind (29/25) than in front, much wider behind than long (29/13). Front row procurved, back row straight. Ratio of AME:ALE:PME:PLE, 5:7:5:7. MOQ front width: back width: length, 12:18:11. Eye interspaces (as AME diameters): AME-AME 0.4, AME-ALE 0.2, ALE-PLE 0.4, PME-PLE 0.2, PME-PME 2.2.

Chelicerae: Small, geniculate with broad band of



Figs. 5-10: *Phyxioschema suthepia*. 5-6 Holotype male. 5 Carapace and chelicerae, dorsal view; 6 Sternum, maxillae and labium, ventral view. 7-10 Paratype female. 7 Abdomen, ventral view, showing spinnerets; 8 Carapace, chelicerae, abdomen, spinnerets, dorsal view; 9 Spermathecae, dorsal view; 10 Sternum, maxillae and labium, ventral view.

several long curved erect setae projecting anteriorly. Promargin with four thick and six smaller teeth, a band of 15–20 small teeth basally.

Labium (Fig. 10): 0.22 long, 0.52 wide. Separated from sternum by deep broad groove.

Maxillae (Fig. 10): 0.70 long, 0.46 wide. As in male, serrula evident as a curved band.

Sternum (Fig. 10): 1.48 long, 1.08 wide. As in male.

Legs (Table 2): Leg formula 4312. Coxae covered with fine grey hairs; femora laterally bristle-free but with uniform pile of fine prostrate, grey hairs. Few grey hairs on patellae and tibiae, very sparse or absent on metatarsi and tarsi.

Spines: Group of 3–4 setae on pro- and retroventral surfaces of metatarsi II–IV form preening combs; one such comb ventrally on metatarsi I. Leg I: femur d4, patella p1, tibia p2, v3, metatarsus v7. Leg II: femur d4, patella p3, tibia p2, v5, metatarsus p2, v6. Leg III: femur p1, d1, r5, patella p3, r1, tibia p2, d2, r2, v4, metatarsus p5, r2, v7. Leg IV: femur p1, d5, r1, patella p2, r1, tibia p2, r5, v3, metatarsus p7, r3, v6; tarsus r1. Palp: femur d4, patella p2, tibia v4, tarsus v6.

Palp: 10–12 long teeth on claw.

Trichobothria: About 8 in each of two rows for half length of tibiae, and on metatarsi, about 6–8 on tarsi.

Claws: 10–12 long teeth in curving sigmoid row on paired claws; 3–4 long sessile teeth on third claws.

Spinnerets (Fig. 8): Australotheline crescent absent. Posterior medians 0.36 long, 0.14 wide (=0.54 of basal PLS), 0.66 apart. Basal, middle, apical articles of posterior laterals 0.72, 0.76, 0.94 long respectively.

Spermathecae (Fig. 9): Spermathecae consist of two divided lobes, inner lobes joined to outer by sclerotised coils; hairs absent from genital aperture.

Distribution and habitat

Phyxioschema suthepia is known only from secondary forests at Chiang Mai, Fang, Ramkamhaeng National Park, Lan Sang National Park, Sankamphaeng, and Pha Yao, northern Thailand.

Material examined

Only the types.

Relationships and biogeography

Coyle (1988) discussed the proposed synapomorphies between *Phyxioschema* and *Euagrus*. He concluded that synapomorphies of *Phyxioschema* were, in males, the long band of curved setae on the prolateral face of tibia II (Fig. 2), and probably also the bilobed spatulate tip of the megaspines on tibia II; both hypotheses are supported by this new species. Coyle (1988) also added three more synapomorphies to the two that were suggested for *Phyxioschema* and *Euagrus* by Raven (1985): (1) longitudinal ventral keels on male metatarsus II; (2) spinule patches on femora I and II of males; (3) sclerotised spermathecal stalks. All three characters are present in *Phyxioschema suthepia*, thus supporting the intergeneric hypothesis. However, no synapomorphy was identified for *Euagrus*. The absence

of a third or median keel on metatarsus II of males in *P. suthepia* and its presence in *P. raddei* (Coyle, 1988) reduces the question of its origin in *Euagrus* to that of parsimony within the genus.

Phyxioschema raddei has one pair of foveal bristles; *P. suthepia* has none; *Euagrus* has one pair, or two or more pairs; *Namirea* has one pair.

Previously, *Phyxioschema* was known only from Afghanistan and adjacent regions in southern U.S.S.R. (Raven, 1981) and its sister group, *Euagrus*, is known only from Central and North America (Coyle, 1988). The sister group of *Euagrus* plus *Phyxioschema* is putatively a group of six Gondwanan genera, five Australian and one African. The distribution of *Phyxioschema* now almost spans the Palaearctic region and with the essentially Nearctic distribution of *Euagrus*, the distribution of the Euagrini complements that of its sister group.

Natural History and Mating

Peter J. Schwendinger

Phyxioschema suthepia lives in crevices, where it builds an irregular silken retreat tube (about 5 cm long) which extends into an aerial capture web of about 30 cm². The web closely resembles that of *Euagrus* (Coyle, 1986). The spiders are fairly numerous along roadsides and earth banks, under fallen wood and in leaf litter. In a 19 m² area of forest floor 56 webs were counted during the climax of the rainy season. The spiders ambush from inside the retreat tube and emerge only to strike at prey; they feed mostly on ants.

Two "groups" differing in a number of behaviours (see below) were recognised. There are insufficient data to allow significance to be placed upon differences between the two groups. Nevertheless, data for each group are given separately, as observed. Group A is the commonest mygalomorph in northern Thailand, being found in the provinces Tak, Sukhothai, Chiang Mai, and Pha Yao, widely distributed in the lowland up to an altitude of 700 m. Group B has hitherto been collected at only one locality in Fang District (750 m, Chiang Mai Province).

In Group A apparently two parallel "generations" are present. In the first "generation", males matured in early December and were trapped in pitfalls until the end of February. The following observations were taken from laboratory studies at Chiang Mai University. Two to four egg sacs were produced successively from mid-February to May; offspring hatched about three weeks later and dispersed after a few days. Females moulted in late July and again in late November. Second "generation" males matured at the beginning of May and in the field were trapped until late July. Egg sacs were laid from early June to mid-July and hatched after about 2 weeks. At least two broods were produced and embryonic development was shorter than in the previous period. Females moulted in late September, and a second moult is presumed as one female moulted in late January.

Incomplete data on Group B indicate a similar phenology: males matured in mid-November, females

oviposited 2 months after mating.

Egg sacs of both groups are hemispherical, flat at the top, about 5 mm in diameter and 3 mm high in Group A ($n=4$) and slightly larger, 6 and 4 mm respectively ($n=1$) in Group B. In June/July (rainy season), egg sacs are suspended in the centre of the capture web, often camouflaged with interwoven soil particles, whereas from February to May (dry season) they are stored inside the retreat tube, sheltered from desiccation. In webs which are screened from rain and dust, empty sacs remain suspended for about half a year. Egg sacs of Group A contain 12 to 40 eggs (diameter 0.73–0.87 mm). Larva measurements (*sensu* Vachon, 1958): body length 1.15, carapace length 0.50, width 0.47 mm. The first nymphs (body length 1.40, carapace 0.53, width 0.50 mm) abandon the egg sac. No further data on post-embryonic development were taken. Mature males died within 3 months, females lived for at least two years and produced several broods annually in either reproductive period.

Copulation in both groups was similar to that in *Euagrus* (Coyle, 1983). Only one observation on each Group was made. The male lifts the female into an upright position with his anterior legs and holds her by clasping her femora II with his modified tibiae and metatarsi II. Interlocking of the male's femora I and II was not observed. In Group A the male inserted his palps whilst his prosoma bent backwards, whereas the male of Group B kept his body stretched. Copulation lasted 5 seconds (probably incomplete, Group A) and 16 minutes (Group B), and both females subsequently reproduced. Mating pairs separated abruptly, and the females instantly lunged at the escaping males. In the field, males were seen courting in webs of females during the early afternoon on January 22, June 9, and June 26.

Acknowledgements

We are most grateful to Ms T. B. Churchill, Queens-

land Museum, and Drs F. A. Coyle and N. I. Platnick for useful criticisms of the manuscript; figures were skillfully drawn by Ms B. Mitchell. This paper was produced with the assistance of funds from an Australian Research Grants Committee grant to the senior author. The second author thanks the Biology Department, Chiang Mai University for providing facilities and Dr Konrad Thaler for discussion. Field work was supported by a scholarship from the Department of Technical and Economic Cooperation (Bangkok).

References

- COYLE, F. A. 1983: Courtship, mating, and the function of male-specific leg structures in the mygalomorph spider genus *Euagrus* (Araneae, Dipluridae). *Proc. 9th Int. Congr. Arachnol., Panama*: 33-38.
- COYLE, F. A. 1986: The role of silk in prey capture by non-araneomorph spiders. In W. A. Shear (ed.), *Spiders, webs, behavior, and evolution*. Stanford Univ. Press: 269-305.
- COYLE, F. A. 1988: A revision of the American funnel-web mygalomorph genus *Euagrus* (Araneae, Dipluridae). *Bull. Am. Mus. nat. Hist.* **187**: 203-292.
- RAVEN, R. J. 1981: The mygalomorph spider genera *Phyxioschaema* Simon and *Stenygrocerus* Simon (Dipluridae: Ischnothelinae). *Bull. Br. arachnol. Soc.* **5**: 225-231.
- RAVEN, R. J. 1984: Systematics of the Australian curtain-web spiders (Ischnothelinae: Dipluridae: Chelicerata). *Aust. J. Zool. (Suppl. Ser.)* **93**: 1-102.
- RAVEN, R. J. 1985: The spider infraorder Mygalomorphae (Araneae): Cladistics and systematics. *Bull. Am. Mus. nat. Hist.* **182**: 1-180.
- ROEWER, C. F. 1960: Solifugen und Opilioniden — Araneae Orthognatha, Haplogynae und Entelegynae (Contribution à l'étude de la faune d'Afghanistan 23). *Göteborgs K. Vetensk.-o. vitterhSamh. Handl.* **8**: 1-53.
- SIMON, E. 1889: Arachnidae transcaspicae ab ill. Dr G. Radde, Dr A. Walter et A. Conchin inventae (annis 1886-1887). *Verh. zool.-bot. Ges. Wien* **39**: 373-386.
- SIMON, E. 1903: *Histoire naturelle des araignées* **2**(4): 669-1080. Paris.
- VACHON, M. 1958: Contribution à l'étude du développement post-embryonnaire des araignées. Deuxième note. *Bull. Soc. zool. Fr.* **83**: 429-461.