Redescription of *Chrysilla lauta* Thorell 1887 (Araneae: Salticidae) based on the comparison with the holotype, and DNA barcoding

Takeshi Yamasaki1*, Marika Yamaguchi1, Luong Thi Hong Phung2, Pao-Shen Huang3 & I-Min Tso3

1 Department of Biological Sciences, Tokyo Metropolitan University, 1–1 Minami-osawa, Hachioji-shi, Tokyo 192-0397, Japan
2 Institute of Ecology and Biological Resources, Vietnam Academy of Science and Technology, Vietnam
3 Department of Life Science, Tunghai University, Taichung, Taiwan
*Corresponding author. E-mail: k0468874@kadai.jp

**Abstract** — *Chrysilla lauta* Thorell 1887 is the type species of the genus *Chrysilla*. Zhang & Wang (2017) formally recorded the female of *C. lauta* for the first time, but it does not include the description of important characters in spider taxonomy such as the palp of males and the epigyne of females. We here redescribe *C. lauta* in detail, on the basis of the comparison with the holotype, and DNA barcoding using mitochondrial CO1 fragment.

**Key words** — Chrysillini, taxonomy, mitochondrial DNA, Southeast Asia

---

**Introduction**

The genus *Chrysilla* Thorell 1887 (Araneae: Salticidae) is currently comprised of ten species, and widely distributed through South and Southeast Asia (World Spider Catalog 2017). The species of *Chrysilla* show distinct sexual dimorphism in proportion of body parts and coloration in the adult stage. Therefore, the recognition of conspecific male and female based on only morphology more or less includes uncertainty. Recent works based on DNA barcoding have revealed male/female combination in salticids showing distinct sexual dimorphism, and subsequently it has been solving synonymies (Suguro & Yahata 2014; Phung et al. 2016).

The type species of this genus, *Chrysilla lauta* Thorell 1887, has been described on the basis of a male specimen from Myanmar. The female has been recorded very recently in Zhang & Wang (2017), however, it does not include descriptions of taxonomically important characters such as the palp of males and the epigyne of females. Therefore, the detailed description of the both sexes is still necessary. In the present study, we redescribe *C. lauta* with detailed morphological descriptions based on the holotype and confirm the correct male/female combination by DNA barcoding.

**Materials and methods**

The holotype male of *Chrysilla lauta* was loaned from the Museo Civico di Storia Naturale “Giacomo Doria”, Genoa, Italy (MSNG). Additional specimens collected in Taiwan and Thailand are deposited in the Department of Life Sciences, Tunghai University, Taichung, Taiwan (THU), and Dr. Booppa Petcharad’s personal collection in the Thammasat University, Thailand (BP-TU) respectively. Their morphology was examined using a Nikon SMZ1270 microscope. Multi-focused montage images were produced using Helicon Focus ver. 4.2.9 from several series of source images. The source images were obtained by a Canon EOS 60D camera attached to a Nikon SMZ1270.

Specimens used in DNA barcoding are shown in Table 1. For the methodology of molecular analysis, we followed Phung et al. (2016) except PCR experiments. PCR experiments, with primer combination of CO1-TY-F1 (5’-TGC WAT TTT TTC TTT RCA TTT RGC-3’) and CO1-TY-R1 (5’-GCH ACH ACA TAA TAA GTA TCA TG-3’), included an initial 2-min denaturation at 94°C followed by 5 cycles of 10 s at 98°C, 30 s at 45°C and 45 s at 68°C, and then 40 cycles of 10 s at 98°C, 30 s at 48°C and 45 s at 68°C, with a final 7-min extension at 68°C. The sequences obtained were assembled using ChromasPro 1.7.6 (Technelysium Pty Ltd., Australia). These sequences, in addition to the homologue sequences of *Cosmophasis micarioides* (L. Koch 1880) (Accession No.: EU815580) and *Phintella versicolor* (C. L. Koch 1846) (Accession No.: LC105656) provided by other authors (Maddison et al. 2008; Phung et al. 2016), were aligned using MUSCLE (Edgar 2004) built in MEGA 6.06 (Tamura et al. 2013). The genetic divergence in the K2P model (Kimura 1980) was calculated by the pairwise comparison method, and the neighbor-joining tree was constructed using MEGA 6.06. The mitochondrial CO1 sequences obtained in the present study are deposited in the DNA Data Bank of Japan (DDBJ).
All measurements are given in millimeters. Abbreviations of morphological terms used in the present paper are as follows: ALE, anterior lateral eye; AME, anterior median eye; PLE, posterior lateral eye; PME, posterior median eye; RTA, retrolateral tibial apophysis on palp.

Results and discussion

The genetic divergence among specimens is shown in Table 2, and the constructed neighbor-joining tree is shown in Fig. 1. Females of *C. lauta* (TW_SAL_20170902B_4, TW_SAL_20170902B_5) made a cluster with males (TW_SAL_20170906_1, TW_SAL_20170907_1) identified as
Redescription of *Chrysilla lauta*

Figs. 2–5. *Chrysilla lauta*, holotype male. 2, habitus, dorsal view; 3, habitus, ventral view; 4, habitus, lateral view; 5, labels. Scales = 1 mm.

Figs. 6–8. *Chrysilla lauta*, holotype male. 6, left palp, ventral view; 7, left palp, retrolateral view; 8, left palp, dorsal view. Scales = 0.5 mm.
C. lauta on the basis of the holotype, without divergence. From this result, we confirmed the male/female combination proposed in Zhang & Wang (2017) (Fig.1). Although the cluster of C. lauta comprised of specimens from Taiwan and Thailand is highly supported, each cluster corresponding to the locality was not constructed in the present study. A specimen collected in Tunghai University, Taiwan (TW_SAL_20170907_2) presented the divergence value of 1.5% in K2P model from other specimens collected in the same locality (Table 2). However, no distinct morphological dif-

Figs. 9–12. Chrysilla lauta, male (TW_SAL_20170906_1). 9, habitus in living condition, dorsal view; 10, habitus, dorsal view; 11, habitus, lateral view; 12, habitus, ventral view. Scales = 1 mm.

Figs. 13–15. Chrysilla lauta, male (TW_SAL_20170906_1). 13, left palp, ventral view; 14, left palp, retrolateral view; 15, left palp, dorsal view. Scales = 0.5 mm.
ferences were recognized among them. In addition, the mean intraspecific divergence value is considered to be 2.15 % in spiders (Robinson et al. 2009). Therefore, we concluded the divergence value of 0–1.5 % among our specimens were the intraspecific divergence.

**Taxonomy**

*Chrysilla* Thorell 1887

Remarks. The delimitation of the genus *Chrysilla* has not been defined properly yet. Currently, *Chrysilla* is comprised of ten nominal species. However, seven species of them are known only on the basis of one sex (only female: 4 species; only male: 3 species). To establish correctly male/female combination, both morphology and molecular approaches are necessary.

*Chrysilla lauta* Thorell 1887

(Figs. 2–4, 6–24)

*Cosmophasis longiventris* Simon 1903: 732; Prószyński 1976: 154, f. 237; Prószyński 1983: 44, f. 4–6; Żabka 1985: 210, f. 81–82; Song & Chai 1991: 14, f. 2A–B; Song, Zhu & Chen 1999: 507, f. 29N–O; Prószyński & Deeleman-Reinhold 2010: 159, f. 36–37; Zhang & Wang 2017: 601, with unlabeled 5 pictures.

**Diagnosis.** Males are recognizable by slender body with iridescent bands of scale-like setae (Figs. 9–10); strong leg I compared with other legs; slender embolus with weakly curving; tegulum lobe weakly developed and reaching to anterior margin of palpal tibia; RTA extending antero-ventrally with slight curing inward. Females are easily recognizable by characteristic markings on abdomen (Figs. 16–17); copulatory duct running longitudinally without curving; round spermatheca.

**Measurements** (male / female; measurements of the holotype in parentheses). Carapace length 1.47–2.10 (1.70) / 1.77–1.82; width 1.08–1.52 (1.30) / 1.20–1.26. ALE–PLE 0.78–1.02 (0.85) / 0.88; ALE–PLE 0.41–0.52 (0.45) / 0.48. Width of eye row I 1.03–1.45 (1.23) / 1.23–1.25; II 0.97–1.35 (1.13) / 1.15–1.17; III 1.12–1.51 (1.27) / 1.30–1.35. Abdomen length 2.10–3.50 (2.63) / 2.80; width 0.85–1.13 (not measured for the holotype) / 1.28–1.40.

**Male** (Figs. 2–4, 6–15). Carapace shorter and wider than abdomen (Figs. 2, 9–10). Abdomen slender; almost 3 times longer than wide (Figs. 2, 9–10). Leg I strong compared with other legs.

Pulp (Figs. 6–8, 13–15). Cymbium strongly tapering toward apex. Bulb anteriorly divided into two portions as with other *Chrysilla* species, slender prolateral and retrorateral portions (Figs. 6, 13); posterior lobe of bulb roundly devel-
oped, slightly overlapping anterior venter of palpal tibia in ventral view and projecting ventrally in lateral view (Figs. 6–7, 13–14). Seminal duct beginning from inner margin of retrolateral bulb with strong curving, and running along margin of bulb toward base of embolus (Figs. 6, 13). Embolus extending anteriorly from apex of bulb, with slight curve at tip (Figs. 6, 13). RTA spine-shaped with weakly incurving, extending antero-ventrally in retrolateral view (Figs. 6–8, 13–15).

Coloration and setation in ethanol (Figs. 2–4, 10–12). Carapace densely covered with reddish setae, but sparsely in small specimens; two transversal bands of iridescent scale-like setae running on eye row I and III in dorsal view (Fig. 10); two longitudinal bands of iridescent scale-like setae running on each lateral surface, wider one below ALE to PLE and narrower one lateral margin of carapace in lateral view (Fig. 11). Abdomen covered with black setae; one longitudinal band of iridescent scale-like setae running medially on dorsum, and another band extending from anterior dorsum on each lateral surface (Figs. 10–11). Leg I tinged with black on femur, tibia and metatarsus. Legs II–IV cream. Coloration in living condition shown in Fig. 9.

**Female** (Figs. 16–24). Carapace longer, and slightly narrower than abdomen (Figs. 16–18). Abdomen oval (Figs. 16–17).

Epigyne (Figs. 20–24). Posterior margin of epigyne sclerotized along epigastric furrow (Fig. 20). Copulatory entrance opening posteriorly (Figs. 20–21, 23). Copulatory duct extending posteriorly and connected to round spermatheca (Figs. 21–24).

Coloration and setation in ethanol (Figs. 17–19). Carapace dorsally covered with white setae and laterally reddish setae (Figs. 17–18). Abdomen covered with white, black and reddish setae, and showing complex pattern on dorsum (Figs. 17–18). Legs cream. Coloration in living condition shown in Fig. 16.

**Distribution.** Taiwan (new record), China, Vietnam, Thailand (new record), Myanmar.

**Remarks.** Among *Chrysilla* species, *C. volupe* (Karsch 1879) is very close to *C. lauta*. Although they are very similar in the structure of male palp, the coloration in both species is different from each other (cf. figs. 122–125 in Żabka 1988; figs. 15–23 in Caleb & Mathai 2014).

**Acknowledgements**

We would like to thank Dr. Maria Tavano (MSNG, Italy) for loaning the type material, Dr. Noriaki Murakami & Dr. Katsuyuki Eguchi (both, Tokyo Metropolitan University, Japan) for offering laboratory equipment, Dr. Booppa Petcharat (Thammasat University, Thailand) & Mr. Tatsumi Suguro (Keio Yochisha Elementary School, Japan) for offering a valuable specimen and two anonymous referees for their critical readings of this manuscript. The field works in the Kending National Park were conducted under MOST 106-2621-B-029-004. Two of the authors, M. Yamaguchi & P.T.H. Luong, are supported by 25th Fujiwara Natural History Foundation (2017).

**References**

Caleb, J. T. D. & Mathai, M. T. 2014. Description of some interesting jumping spiders (Araneae: Salticidae) from South India. J. Entomol. Zool. Stud., 2: 63–71.

Edgar, R. C. 2004. MUSCLE: multiple sequence alignment with high accuracy and high throughput. Nucleic Acids Res., 32: 1792–1797.

Karsch, F. 1879. Arachnologische Beiträge. Zeitschr. Ges. Naturw., 52: 534–562.

Kimura, M. 1980. A simple method for estimating evolutionary rate...
Redescription of Chrysilla lauta

of base substitutions through comparative studies of nucleotide sequences. J. Mol. Evol., 16: 111–120.

Koch, C. L. 1846. Die Arachniden. Nürnberg, Dreizehnter Band, 234 pp., Vierzehnter Band, 88 pp.

Koch, L. 1880. Die Arachniden Australiens. Nürnberg 1, pp. 1157–1212.

Maddison, W. P., Bodner, M. R. & Needham, K. M. 2008. Salticid spiders phylogeny revised, with the discovery of a large Australian clade (Araneae: Salticidae). Zootaxa, 1893: 49–64.

Phung, T. H. L., Yamasaki, T. & Eguchi, K. 2016. Conspecificity of Phintella aequiperiformis Zabka, 1985 and P. lucai Zabka, 1985 (Araneae: Salticidae) confirmed by DNA barcoding. Rev. Suisse Zool., 123: 283–290.

Prószyński, J. 1976. Studium systematyczno-zoogeograficzne nad rodziną Salticidae (Aranei) Regionów Palearktycznego i Nearktycznego. Wyższa Szkoła Pedagogiczna Siedlcach, 6: 1–260.

Prószyński, J. 1983. Position of genus Phintella (Araneae: Salticidae). Acta Arachnol., 31: 43–48.

Prószyński, J. & Deeleman-Reinhold, C. L. 2010. Description of some Salticidae (Araneae) from the Malay Archipelago. I. Salticidae of the Lesser Sunda Islands, with comments on related species. Arthropoda Sel., 19: 153–188.

Robinson, E. A., Blagoev, G. A., Hebert, P. D. N. & Adamowicz, S. J. 2009. Prospects for using DNA barcoding to identify spiders in species-rich genera. ZooKeys, 16: 27–46.

Simon, E. 1903. Etudes arachnologiques. 33e Mémoire. LIII. Arachnides recueillis à Phuc-Son (Annam) par M. H. Fruhstorfer (nov-dec. 1899). Ann. Soc. Entomol. Fr., 71: 725–736.

Song, D. X. & Chai, J. Y. 1991. New species and new records of the family Salticidae from Hainan, China (Arachnida: Araneae). Pp. 13–30. In: Qian, Y. W., Zhao, E. M. & Zhao, K. T. (eds.) Animal Science Research. China Forestry Publ. House, Beijing, 248 pp.

Song, D. X., Zhu, M. S. & Chen, J. 1999. The Spiders of China. Hebei Univ. Sci. Technol. Publ. House, Shijiazhuang, 640 pp.

Suguro, T. & Yahata, K. 2014. Taxonomic notes on Japanese species of the genera Pseudicius and Tasa (Araneae: Salticidae). Acta Arachnol., 63: 87–97.

Tamura, K., Stecher, G., Peterson, A., Filipski, S. & Kumar, V. 2013. MEGA6: Molecular evolutionary genetics analysis version 6.0. Mol. Biol. Evol., 30: 2725–2729.

Thorell, T. 1887. Viaggio di L. Fea in Birmania e regioni vicine. II. Primo saggio sui ragni birmani. Ann. Mus. Civ. Stor. Nat. Genova, 25: 5–417.

World Spider Catalog 2017. World Spider Catalog. Natural History Museum Bern, online at http://wsc.nmbe.ch, version 18.5, accessed on 30 October, 2017.

Zabka, M. 1985. Systematic and zoogeographic study on the family Salticidae (Araneae) from Viet-Nam. Ann. Zool., Wars., 39: 197–485.

Zabka, M. 1988. Salticidae (Araneae) of Oriental, Australian and Pacific regions, III. Ann. Zool., Wars., 41: 421–479.

Zhang, Z.-S. & Wang, L.-Y. 2017. Chinese Spiders Illustrated. Chongqing Univ. Press, Chongqing, 954 pp.

Received November 1, 2017 / Accepted December 16, 2017