A cladistic analysis reveals an eastern Tibetan occurrence of *Taiwanoserica* (Coleoptera: Scarabaeidae)

**Abstract.** The systematic position of some newly discovered *Serica* species from the eastern margin of the Tibetan Plateau (Sichuan, China) is explored through a phylogenetic analysis based on 117 morphological characters using the parsimony criterion. The resulting consensus tree of this analysis reveals that three of these taxa belong to the lineage of *Taiwanoserica* as supposed initially due to their general external appearance. Based on the occurrence of related taxa and on the topology of *Taiwanoserica* taxa as well, it must be assumed that *Taiwanoserica* originated also in the eastern Tibetan mountains. Four new species are described: *Serica* (sensu lato) *silviae* n. sp., *Serica (Taiwanoserica) wenchuanensis* n. sp., *Serica (Taiwanoserica) sigipinensis* n. sp., *Serica (Taiwanoserica) chengtuensis* n. sp.

**Keywords:** Parsimony analysis, Sichuan, China, Taiwan, Sericini, biogeography.

Beside the Japanese archipelago, Taiwan is for Scarabs one of the best explored regions in East Asia. Due its richness of endemism and huge biodiversity due to the altitudinal and climatological variety it have been also an attractive object for biogeography (e.g. Mey 1997; Choi 2000; Lin et al. 2002). This study of the chafer group *Taiwanoserica* Nomura 1974 illustrates, indeed, how much species classification and biogeographical investigation of Taiwan’s fauna rely on the exploration of the so far only poorly studied neighbouring areas of East and South-East Asia. *Taiwanoserica* was established for a couple of species (Nomura 1974), which was believed so far to be entirely endemic to Taiwanese archipelago even after numerous taxa have been discovered additionally (Kobayashi 1983; 1988; 1993; Kobayashi & Yu 2000; Ahrens 2002). Currently it contains 20 species inhabiting all the higher elevations in Taiwan. Recently it has been shown (Ahrens 2007a) that they are very closely related to the genus *Serica* MacLeay 1819. In consequence of its systematic position between clades assigned so far to *Serica, Taiwanoserica* was downgraded to a subgenus of *Serica* (Ahrens 2007b). Among a rich material that I received form the Smithsonian Institution (USNM) for identification four new forms have been discovered from Sichuan. These individuals are in external appearance very similar to the species of *Taiwanoserica* originating from a survey in 1930ies that covered also altitudes below 2500 meters. In the present study I explore more in detail the systematic position of these new species described below in order to test whether they are truly members of the *Taiwanoserica* lineage and to explore the origin of *Taiwanoserica* more in detail.

**Material and methods**

**Taxon sampling and characters**

Character coding was based on 68 species belonging to seven genera (Appendix 2). The taxon sampling based mainly on the data set of Ahrens (2007a) with great part of the included genera represented exemplarily with a few species (*Callosserica* Brenke 1894, *Gastroserica* Brenke 1897, *Lasioserica* Brenke 1896, *Neoserica* Brenke 1894, *Pachyserica* Brenke 1897, and...
Serica (subgenus *Taiwanoserica* Nomura 1974). In order to examine the systematic position of the newly discovered species for *Serica* a wider range of species have been included. *Pleophylla* sp. was chosen as outgroup taxon due to its close relationship to the ingroup taxa but being a more ancestral lineage of Sericini (Ahrens 2006). Material studied for this analysis originated mainly from the author’s collection or it was borrowed from the other public or private collections (for material depository see Ahrens 1999, 2005). In total, 117 adult characters were scored. Character states are principally those as used by Ahrens (2007a) and are described in Appendix 1. Illustrations of the character states are given in Ahrens (2007a). The data matrix is presented in Appendix 3. In describing character states, I refrained from formulating any hypothesis about their transformation. In particular, coding does not imply whether a state is derived or ancestral.

### Phylogenetic analysis

The parsimony analysis was performed in NONA 2.0 (Goloboff 1999) using the parsimony ratchet (Nixon 1999) implemented in NONA, run with WINCLADA vs. 1.00.08 (Nixon 2002) as a shell program. Two hundred iterations were performed (one tree held per iteration). The 117 characters (68 binary and 49 multistate) were all unordered and equally weighted. Inapplicable characters were coded as “-”, while missing character states were coded as “?” (Strong & Lipscomb 1999). All searches were performed under the collapsing option “ambiguous” which collapses every node with a minimum length of 0. Bootstrap values (Felsenstein 1985) were evaluated using NONA as an estimate of the robustness of the data set. Bootstrap analyses of data were performed with 100 replicates using TBR branch swapping.

### Results

The analysis of 117 adult characters with the parsimony ratchet and the above mentioned settings repeating the search ten times yielded 37 equally most parsimonious trees of 765 steps (ensemble consistency index (CI): 0.24; ensemble retention index (RI): 0.61). The strict consensus of these trees (Fig. 1, 812 steps CI = 0.22, RI = 0.58) based on equally weighted characters exhibits a few polytomies, most of them in the subgenus *Serica*.

*Serica* as well as the subgenus *Serica* were found monophyletic in the strict consensus tree; the same was

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**Figure 1**

Strict consensus tree of the 37 most parsimonious trees. Bootstrap value above 50% are given above branches.
the case for the subgenus *Taiwanoserica* at least when *S. sigipinensis* and *S. wenchuanensis* sp. n. from Sichuan are included. The monophyly of *Pachyserica* was not supported by this analysis. The newly discovered taxa which were supposed to be members of the subgenus *Taiwanoserica* grouped together the other two species of *Taiwanoserica* included in this analysis (*S. (T.) anmashanica* and *S. (T.) gracilipes*). However, the species *Serica silviae* which is in external appearance very similar to the other new species clustered as a sister of *Taiwanoserica + Serica panchaseana*, thus not being directly associated with the subgenus. The topology of the strict consensus tree is not fully resolved for *Taiwanoserica* resulting in a polytomy for four of the five taxa included of this analysis and thus leaving some uncertainty regarding the relationship of the species. The majority of the maximum parsimonious trees (MPTs) (Fig. 4A) have the Eastern Tibetan taxa grouped within the Taiwanese taxa, with *S. anmashanica* being sister to *S. sigipinensis*, and *S. wenchuanensis* being sister to *S. sigipinensis + S. anmashanica*.

**Descriptions of the new taxa**

*Serica (Taiwanoserica) chengtuensis* n. sp.

**Type material.** Holotype: ♂ "Beh Luh Din 30 mi N Chengtu Jul-Aug 1933/Szechwan China DC Graham Alt. 6000ft./Loan from USNMNH 2023982" (USNM), [ca. 30°58’N, 103°55’E] Paratypes: 3 ♂♂, 2 ♀♀ “Beh Luh Din 30 mi N Chengtu Jul-Aug 1933/Szechwan China DC Graham Alt. 6000ft.” (USNM), 1 ♂ “Beh Luh Din 30 mi N Chengtu VII-VIII,18 1933/Szechwan China DC Graham 6000ft.” (USNM), 1 ♂ “Beh Luh Din 30 mi N Chengtu VII-VIII,1933/Szechwan China DC Graham 6000ft.” (USNM), 7 ♂♀ “Beh Luh Din 30 mi N Chengtu VII-VIII,1933/Szechwan China DC Graham 6000ft.” (USNM), 7 ♂♀ “Beh Luh Din 30 mi N Chengtu VII-VIII,1933/Szechwan China DC Graham 6000ft.” (USNM), 7 ♂♀ “Beh Luh Din 30 mi N Chengtu VIII-1933/Szechwan China DC Graham 6000ft.” (USNM), 1 ♂ "Shi

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**Figure 2**

Kai Si Mt. Omei 4–6000 feet/Szechuen China DC Graham Jl-Ag 23” (USNM).

**Description.** Length: 9.0 mm, width: 5.6 mm, length of elytra: 6.9 mm. Body oblong, reddish brown, antenna and elytra yellow with dark spots, dorsal surface dull, except a few fine hairs on head and elytra almost glabrous.

Labrocyceus transversely subtrapezoidal, widest at base, lateral margins weakly convex and slightly convergent, anterior angles moderately rounded, margins weakly reflected, anteriorly deeply and widely sinuate medially; surface weakly convex and opaque shiny, moderately and irregularly partly densely punctate, with numerous fine erect hairs, some finer punctures bare; frontoclypeal suture feebly incised and strongly angled medially; smooth area in front of eye approximately 1.5 times as wide as long; ocular canthus very short and triangular, completely smooth but with a terminal hair. Frons dull, with fine, moderately dense punctures, anteriorly with a few single setae, on posterior half densely hairy. Eyes small, ratio diameter/interocular width: 0.49. Antenna yellowish, with ten antennomeres; club composed by three antennomeres, as long as the remaining antennomeres combined. Mentum weakly elevated, anteriorly flattened.

Pronotum transverse, widest in posterior third, lateral margins basally strongly curved, anteriorly weakly convex and strongly narrowed to protruding and right-angled anterior angles, posterior angles strongly rounded, anterior margin medially with broad marginal line and weakly convexly produced; surface densely and finely punctate, punctures partly with minute setae and a very few with small white scale-like setae; anterior and lateral border setose. Scutellum slender, triangular, with fine and dense punctures, mediadly smooth on basal half.

Elytra oblong, feebly widened posteriorly, striae finely impressed, finely and densely punctate, intervals flat, with fine and sparsely scattered irregular punctures close to the striae, intervals with a few moderately long, white hairs; epipleural edge fine, ending at bluntly rounded external apical angle of elytra; epipleura densely setose; apical border membranous, covered with very short microtrichomes.

Ventral surface dull, finely and not densely punctate, sparsely hairy, metacoxal plates laterally with a few long hairs; each abdominal sternite with a transversal row of coarse punctures bearing short hairs between fine and dense punctuation. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.25. Pygidium moderately convex, finely and densely punctate, without smooth midline, with few fine, long and dense hairs.

Legs slender; femora with two longitudinal rows of hairs, finely and moderately densely punctate between the rows; metaturnur shiny, anteriorly sharply edged, behind anterior edge with an undulated and partly continuously serrated line, posterior margin in apical half dorsally serrated, ventrally completely serrated, in basal half with a few long hairs. Metatibia slender and long, widest at apex, ratio of width/length: 1/4.0, dorsally sharply edged, with two groups of spines, basal at one at third, apical one at two third of metatibial length, basally with a row of a few single hairs in punctures with a serrated margin; outside longitudinally convex, with sparse, fine punctures, glabrous, on dorsal portion with some strong longitudinal wrinkles; ventral edge with two widely separated fine hairs, basal one at one third, apical one at two third of metatibial length, medial face sparsely scattered, finely punctate, apex interiorly near tarsal articulation shallowly concavely truncate. Tarsomeres dorsally shallowly and sparsely punctate, ventrally with sparse, minute setae; metatarsomeres laterally weakly edged and ventrally with a strongly serrated ridge, first metatarsome distinctly shorter than the two following tarsomeres combined and more than one third longer than the upper tibial spur. Protibia long, bidentate, external edge behind middle bluntly widened, protarsal claws symmetrical, normally developed.

Aedeagus: Fig. 2 A–C.

**Variation.** Length: 8.0–9.0 mm, width: 4.5–5.6 mm, length of elytra: 5.9–6.9 mm. In females antennal club little shorter than the remaining antennomeres combined, pronotum narrower than in male, metatibia slightly shorter (ratio of width/length: 1/3.9).

**Diagnosis.** This species differs from all other Serica species of the Asiatic mainland by the strongly convex posterior angles of pronotum which is one of the characteristics of the subgenus Taiwanoerica. From all other Taiwanoerica species it may be easily distinguished by the lacking basal process in the left paramere and the widely incised dorsal apex of phallobasis.

**Etymology.** The species is named after its occurrence close to the town Chengtu.

**Remark.** The exact location of the type locality „Beh Luh Din” could not be determined. I have provided the coordinates of the next larger village (P’eng Hsien) about 45 km north of Chengtu.

**Serica (Taiwanoerica) sigipinensis** n. sp.

**Type material.** Holotype: ♂ „Szechuen China DC Graham/Si Gi Pin Mt. Omei viii-8: 29 8,000ft./Loan from USNMNH 2023982” (USNM), [29°30’N, 103°30’E].

**Description.** Length: 8.4 mm, width: 5.0 mm, (length of elytra inapplicable; posterior half of both elytra lacking). Body oblong, reddish brown, antenna and elytra yellow with dark spots, dorsal surface dull, except a few fine hairs on head and elytra almost glabrous.

Labrocyceus transversely subtrapezoidal, widest at base, lateral margins straight and slightly convergent, anterior angles moderately rounded, margins weakly reflected, anteriorly deeply and widely sinuate medially; surface weakly convex and shiny, moderately and irregularly partly densely punctate, with numerous fine erect hairs, some finer punctures bare; frontoclypeal suture feebly incised and strongly angled medially; smooth area in front of eye approximately 1.5 times as wide as long; ocular canthus moderately long and slender, sparsely punctate, with a single terminal hair. Frons dull, with coarse, dense punctures, anteriorly and posteriorly densely hairy. Eyes small, ratio diameter/interocular width: 0.5. Antenna yellowish, with ten antennomeres; club composed by three antennomeres, as long as the remaining antennomeres combined. Mentum weakly elevated, anteriorly flattened.

Pronotum strongly transverse, widest in posterior third, lateral margins uniformly and strongly curved, anteriorly strongly narrowed to protruding and right-angled anterior angles, posterior angles strongly rounded, anterior margin medially with broad marginal line and weakly convexly produced; surface densely and finely punctate, punctures partly with minute setae and a very few with small white scale-like setae; anterior and lateral border setose. Scutellum slender, triangular, with fine and dense punctures, mediadly smooth on basal half.

Elytra oblong, feebly widened posteriorly, striae finely impressed,
finely and densely punctate, intervals flat, with fine and sparsely scattered irregular punctures close to the striae, intervals with a few moderately long, white hairs; epipleural edge fine; epipleura densely setose.

Ventral surface dull, finely and not densely punctate, sparsely hairy, metacoxal plates laterally with a few long hairs; each abdominal sternite with a transversal row of coarse punctures bearing short hairs between fine and dense punctuation. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.43. Pygidium apically strongly convex, finely and densely punctate, with a slightly elevated smooth midline, with few fine, long and dense hairs.

Legs slender; femora with two longitudinal rows of hairs, finely and moderately densely punctate between the rows; metatelson shiny, anteriorly sharply edged, behind anterior edge with a continuously serrated line, posterior margin in apical half dorsally serrated, ventrally completely serrated, in basal half with a few long hairs. Metatibia slender and long, widest at apex, ratio of width/length: 1/4.6, dorsally moderately edged, with two groups of spines, basal one shortly before the half of metatibia, apical one at three quarter of metatibial length, basally with a row of a few single hairs in punctures with a serrated margin; outside longitudinally convex, with sparse, fine punctures, glabrous; ventral edge with four setae, medially smooth, sparsely scattered, finely punctate, apex interiorly near tarsal articulation shallowly concavely truncate. Tarsomeres dorsally shallowly and sparsely punctate, ventrally with sparse, minute setae; metatarsomeres laterally weakly edged and ventrally with a strongly serrated ridge, first metatarsomere more than one third longer than the upper tibial spur (metatarsomeres 3-5 of left leg lacking, metatarsomeres of right leg lacking all). Protibia moderately long, bidentate, external edge behind middle bluntly widened, protarsal claws symmetrical, normally developed.

Aedeagus: Fig. 2 D–F.

Diagnosis. This species differs from Serica chengtuensis n. sp. by the hairy frons and the more transverse pronotum. The parameres are similar to all other Taiwanese species with a long dorsal lobe which is lacking in S. chengtuensis.

Etymology. The species is named after the type locality Si Gi Pin.

Serica (Taiwanoserica) wenchuanensis n. sp.

Type material. Holotype: ♂ “China: Szechwan Wen-Ch’uan 4–6000’ VIII-1938 DC Graham” (USNM), [31°22’N, 103°32’E]. Paratypes: 1 ♂ “China: Szechwan Alt. 6,300-7,000 ft. VIII-1938 D.C. Graham leg.” (USNM), 1 ♂, 3 ♀♀ “China: Szechwan Wen-Ch’uan 4–6,000 ft. VIII-1938 D.C. Graham leg.” (USNM), 1 ♂ “China: Szechwan Wen-Ch’uan 1938 August D.C. Graham leg.” (USNM), 1 ♂ “Szechuan China Alt. 6800 ft. DC Graham/Loan from USNMNH 2023982” (USNM), 3 ♂♂, 3 ♀♀ “Szechwan China DC Graham” (USNM), 1 ♂ “Beh Luh Din 30 mi N Chengtu VII-VIII,1933/Szechwan China DC Graham Alt. 6000ft.” (USNM).

Description. Length: 7.3 mm, width: 4.3 mm, length of elytra: 5.7 mm. Body oblong, reddish brown, antenna and elytra yellow with dark spots, dorsal surface dull, almost glabrous.

Labroclypeus transversely subtrapezoidal, widest at base, lateral margins straight and slightly convergent, anterior angles moderately rounded, margins weakly reflexed, anteriorly moderately and widely sinuate medially; surface weakly convex and shiny, moderately and densely superficially punctate, before frontoclypeal suture with numerous fine erect hairs; frontoclypeal suture feebly incised and strongly angled medially; smooth area in front of eye approximately 1.5 times as wide as long; ocellar canthus moderately long and slender, sparsely punctate, terminal hair lacking. Frons dull, with fine, sparse punctures, behind frontoclypeal suture and beside eyes sparsely setose. Eyes small, ratio diameter/intercostal width: 0.55. Antenna yellowish, with ten antennomeres; club composed by three antennomeres, slightly longer than the remaining antennomeres combined. Mentum weakly elevated, anteriorly flattened.

Pronotum strongly transverse, widest in posterior third, lateral margins uniformly and strongly curved, anteriorly strongly narrowed to the slightly protruding and blunt anterior angles, posterior angles strongly rounded, anterior margin medially with broad marginal line and weakly convexly produced; surface behind the middle with a distinct transverse impression, densely and coarsely punctate, punctures partly with minute setae and a very few with small white scale-like setae; anterior and lateral border setose. Scutellum slender, triangular, with fine and dense punctures, medially smooth on basal half.

Elytra oblong, feebly widened posteriorly, striae finely impressed, finely and densely punctate, intervals flat, with fine and sparsely scattered irregular punctures close to the striae, intervals with a few moderately long, white hairs; epipleural edge fine, ending at bluntly rounded external apical angle of elytra; epipleura sparsely setose; apical border membranous, covered with very short microtrichomes.

Ventral surface dull, finely and not densely punctate, sparsely hairy, metacoxal plates laterally with a few long hairs; each abdominal sternite with a transversal row of coarse punctures bearing short hairs between fine and dense punctuation. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.3. Pygidium apically strongly convex, finely and densely punctate, with a slightly elevated smooth midline, with few fine, long and dense hairs.

Legs slender; femora with two longitudinal rows of hairs, finely and moderately densely punctate between the rows; metatelson shiny, anteriorly sharply edged, behind anterior edge with a continuously serrated line, posterior margin in apical half dorsally serrated, ventrally completely serrated, in basal half with a few long hairs. Metatibia slender and long, widest at apex, ratio of width/length: 1/4.6, dorsally moderately edged, with two groups of spines, basal one shortly before the half of metatibia, apical one at three quarter of metatibial length, basally with a row of a few single hairs in punctures with a serrated margin; outside longitudinally convex, with sparse, fine punctures, glabrous, on dorsal portion almost smooth; ventral edge serrated, with two widely separated setae, medial face with a few coarse punctures, apex interiorly near tarsal articulation shallowly concavely truncate. Meso- and metatarsomeres in holotype lacking. Protibia long, bidentate, external edge behind middle bluntly widened, protarsal claws symmetrical, normally developed.

Aedeagus: Fig. 2 G–I.

Variation. Length: 7.3–8.7 mm, width: 4.3–4.4 mm, length of elytra: 5.7–6.3 mm. Tarsomeres dorsally shallowly and sparsely punctate, ventrally with sparse, minute setae; metatarsomeres laterally weakly edged and ventrally with a strongly serrated ridge, first metatarsomere distinctly shorter than the two following Tarsomeres combined and more than one third longer than the upper tibial spur. In females eyes smaller (ration diameter/intercostal distance: 0.46).

Diagnosis. This species differs is in genital shape most similar to S. sigipinensis. Beside the distinct differences in shape of parameres (right paramere in S. wenchuanensis with three extended sharp lobes, one dorsal, one ventral and one lateral), it
differs in both sexes significantly by the transversely impressed and less wide pronotum.

**Etymology.** The species is named after the type locality Wen-Ch’uan.

**Remarks.** Possibly the year on the collection labels might be erroneous since according to the material in the archive of the Smithsonian Institute DC Graham list his trip to the Wen Chuan region for the year 1933.

**Serica (sensu lato) silviae n. sp.**

**Type material.** Holotype: ♂ “Beh Luh Din 30 mi N Chengtu Jul-Aug 1933/Szechwan China DC Graham 6000ft./Loan from USNMNH 2023982” (USNM), [ca. 30°58’N, 103°55’E].

**Description.** Length: 8.7 mm, width: 5.4 mm, length of elytra: 6.9 mm. Body oblong, reddish brown, antenna and elytra yellow with dark spots, dorsal surface dull, sparsely setose. Labroclypeus transversely subtrapezoidal, widest at base, lateral margins convex and strongly convergent, anterior angles weakly rounded, margins weakly reflexed, anteriorly distinctly sinuate medially; surface weakly convex and slightly opalescent, moderately and densely punctate, with several erect hairs; frontoclypeal suture feebly incised and strongly curved; smooth area in front of eye approximately 2.5 times as wide as long; ocular canthus moderately long and slender, smooth, terminal hair lacking. Frons dull, with fine, sparse punctures, behind frontoclypeal suture, on posterior third and beside eyes with a few larger punctures bearing each a long seta directed posteriorly. Eyes moderately large, ratio diameter/interocular width: 0.56. Antenna yellowish, with ten antennomeres; club composed by three antennomeres, as long as the remaining antennomeres combined. Mentum weakly elevated, anteriorly flattened.

Pronotum moderately transverse, widest at middle, lateral margins in basal half straight and weakly narrowed posteriorly, in anteriorly half margins weakly convex and moderately narrowed to the protruding anterior angles, anterior angles slightly rounded in the tip, posterior angles blunt, anterior margin medially with an indistinct marginal line and weakly convexly produced; surface little densely and finely punctate, punctures partly with minute setae and a few with white long setae; anterior and lateral border finely setose. Scutellum slender, triangular, with fine and dense punctures, medially smooth on basal half.

Elytra oblong, feebly widened posteriorly, striae finely impressed, finely and densely punctate, intervals flat, with fine

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**Figure 3**

Distribution of the new species, known so far, and the cumulative range of *Taiwanoserica* species (dotted line) included before this study (e.g. Ahrens 2007b).
and sparsely scattered irregular punctures close to the striae, intervals with a few moderately long, white hairs; epipleural edge fine, ending at strongly rounded external apical angle of elytra; epipleura densely setose; apical border membranous, covered with very short microtrichomes. Ventral surface dull, finely and not densely punctate, sparsely hairy, metacoxal plates laterally with a few long hairs; each abdominal sternite with a transversal row of coarse punctures bearing short hairs between fine and dense punctation. Mesosternum between mesocoxae half as wide as mesofemur. Ratio of length of metepisternum/metacoxa: 1/1.43. Pygidium apically strongly convex, finely and densely punctate, with a slightly elevated smooth midline, with few fine, long and dense hairs.

Legs slender; femora with two longitudinal rows of hairs, finely and moderately densely punctate between the rows; metasternum shiny, anteriorly sharply edged, behind anterior edge without serrated line, posterior margin in apical half dorsally serrated, ventrally completely serrated, in basal half with a few long hairs. Metatibia slender and moderately long, widest before

Figure 4
A, Majority rule consensus tree of the MPTs. For all nodes collapsed in the strict consensus tree the percentage of node frequency is given for the sum of all MPTs. B, Part of the strict consensus tree depicting apomorphies (all ambiguous) regarding the nodes of *Taiwanoserica*. 

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apex, apically slightly narrowed, ratio of width/length: 1/3.6, dorsally moderately edged, with two groups of spines, basal one at one third, apical one at two third of metatibial length, basally with a row of a few single hairs in punctures; outside longitudinally convex, with sparse, fine punctures, glabrous, on dorsal portion superficially wrinkled; ventral edge serrated, with two widely separated setae, medial face with a few coarse punctures, apex interiorly near tarsal articulation very shallowly truncate. Tarsomerses dorsally impunctate; metatarsomerses laterally not edged and ventrally with a strongly serrated ridge, first metatarsomere as long as the two following tarsomerses combined and more than one third longer than the upper tibial spur. Protibia moderately long, bidentate, external edge behind middle bluntly widened, protarsal claws symmetrical, normally developed.

**Aedegus: Fig. 2 J–L.**

**Diagnosis.** This species is in external shape rather similar to the species of the *Serica nigroguttata* group and both share the strongly sclerotized dorsomedian lobe of endophallus, however the dark distal elytral spot is lacking in *S. silviae*. From the species of the *Taiwanoserica* complex it differs significantly by its blunt posterior angles of pronotum. From all so far known Asian *Serica* species it distinguishes by the particularly formed parameres.

**Etymology.** The species is dedicated to my wife Silvia Fabrizi.

**Discussion**

The major monophyletic lineages retrieved from the strict consensus tree are largely consistent with those found by Ahrens (2007a). The ensemble CI is relatively low which indicates the high level of homoplasy in many characters (see also Fig. 4B). The close relation of *Taiwanoserica* to the representatives of *Serica* mainly occurring in the eastern margin of the Tibetan plateau (Ahrens 2007a) provide some certain evidence about the geographical origin (i.e. Asian mainland) of the lineage since *Serica* as well as the related lineages (*Pachyserica, Lasioserica* etc.) are entirely lacking in Philippines and Indonesia while on Japanese archipelago occur only not directly related taxa of the subgenus *Serica* (Ahrens 2007a) (Fig. 3). Furthermore, the tree topology of this analysis reveal that the *Taiwanoserica* lineage must have originated in the east of the Tibetan highland and character evolution suggests that ancestral *Taiwanoserica* representatives already have showed most of its significant morphological features (see Fig. 4B, 45:1; 22:1) before occupying successfully the Taiwanese archipelago where it obviously performed a very successful radiation. Here it occurs presently with the majority of so far known species (18 taxa, Ahrens 2007b). The fact that not all Taiwanese members of *Taiwanoserica* have been included in the analysis and that there is a polytomy of the strict consensus makes it difficult to identify how many times Taiwan was occupied by the lineages of *Taiwanoserica*. The majority rule consensus (Fig. 4A) would suggest at least two independent dispersals to the island. A single dispersal is known for a species of the subgenus *Serica, S. fusifemorata* Nomura 1974, occurring on the Taiwanese mountains and having its closest relatives in SE Tibet (*Ahrens 2007*; *S. mupinensis* clade). This species is derived from a more ancestral node of that clade being sister to a bunch of SE Tibetan taxa. However, on contrast to *Taiwanoserica*, on Taiwan it has apparently not diversified further.

Dispersals of lineages of mountain faunas from Asiatic mainland to Taiwan are commonly reported in literature (e.g. Choi 2000), however, according to the different extent of radiations on Taiwan we have possibly to expect some significant differences in the timing of these events. The great distance of separation between the related lineages is a matter of the ecological and altitudinal preferences of these groups whose dispersals were consequently also linked to colder climates with lower sea levels in which they could conquer the lowlands of East Asia (Tsukada 1967; Lin *et al.* 2002).

A second issue what the results of this analysis raise is the diagnostic characterisation of the subgenus and the question, how useful it is at all to maintain this subgeneric category. Fig. 4B depicts the apomorphies supporting the clades around *Taiwanoserica*. One major diagnostic feature (*Nomura 1974*), the metatarsomur having a submarginal serrated line beside anterior margin, is identified as a plesiomorphy as already present in the ancestral node with the Himalayan *S. panchaseena* Ahrens 2004. This character occurs in many other lineages, such as *Lasioserica, Neoserica* etc. It lacks completely in *S. silviae*, which is in the habitus very similar to the other *Taiwanoserica* taxa. Consequently, only characters of the subsequent node might be suitable for the definition of the subgenus, namely the strongly rounded posterior angles of pronotum (Char 22:1), the long apical setae of metatarsomerses (69:1), the phallobase, being ventroapically produced at middle (74:1), and the right paramere having a narrow basal lobe directed medially (which can be subsequently also further modified) (83:1). All of these are homoplastic what means that they occur elsewhere in the tree.

The problem of the genus level classification in Sericini was already underlined by Ahrens & Vogler (2008) showing that many genus groups that have been erected on a too limited geographical horizon having just a few outstanding apomorphies. That practise excluded many other taxa of the same lineage without these distinct characters resulting in numerous paraphyletic or even polyphyletic genera. The same with *Serica*, were the established well definable subgenera, *Serica* and *Taiwanoserica*, leave a bulk of species without any subgeneric assignment. At the other hand, a setup of independent subgenera for all these remaining lineages would result in an oversplitting of hardly diagnosable units (e.g. genera or subgenera) lacking any unambiguous global apomorphies and thus being not recognizable by help of characters beyond morphology. A third
difficulty is the global definition of the genus Serica on global scale, being in most analyses (Ahrens 2007a) with low branch support and without unambiguous apomorphies, what makes it little convenient to synonymize simply morphologically very evident existing subgenera, like Serica or T'aiwanoserica. The only reasonable solution (for long term nomenclatural stability) would be a redefinition of generic classification of the whole tribe (see Ahrens & Vogler 2008) and thus I retain it for practical and communicational reasons possible to keep so far names for well defined clades, such as T'aiwanoserica, although being subgeneric category or a name for a species group.

Acknowledgements. A number of people have generously given time, advice, encouragement and valuable information in the course of this research. I am particularly thankful to Chun-Lin Li (Taipei) for sending me his rich Sericini material in the course of this research. I am particularly thankful to the author.

References


Goloboff P. 1999. NONA (NO NAME) ver. 2.0. Published by the author, Tucumín.


Appendix 1. Characters and character states

In describing character states, I refrained from formulating any hypothesis about their transformation. In particular, coding does not imply whether a state is derived or ancestral. The data matrix is presented in Appendix 2.

1. Body, dorsal face: (0) dull, with tomentum made of minute trichomes; (1) simply shiny, without tomentum; (2) shiny, with small patches of tomentum.

2. Body, coloration of dorsal face: (0) multicoloured; (1) monochrome.

Head

3. Labrum anteriorly beside median situation: (0) not toothed; (1) toothed.

4. Labrum ventrally: (0) not widened vertically; (1) widened vertically; (2) widened vertically, but strongly concave ventropetally.

5. Labroclepy, anterior margin medially: (0) weakly sinuate; (1) deeply sinuate; (2) not sinuate.

6. Labroclepy, lateral margin: (0) simply shiny, without tomentum; (1) strongly convex.

7. Labroclepy, lateral margin: (0) weakly convex; (1) strongly convex.

8. Labroclepy, basic: (0) shiny, without tomentum; (1) dull, with tomentum.

9. Frontus posterior to frontoclypeal suture: (0) plane; (1) impressed.

10. Frontus in male: (0) complete; (1) complete shiny; (2) shiny, posteriorly dull only; (3) polymorphic states 0&2.

11. Head behind eyes: (0) short; (1) long.

12. Postocular groove: (0) present; (1) absent.

13. Labrum anteriorly: (0) convex; (1) flat; (2) flat and longitudinally impressed; (3) weakly convex, apically concave.

14. Angle of gales in relation to axis of maxilla: (0) ~ 90° or smaller; (1) > 90°.

15. Maxilla: (0) with four visible teeth ventrally; (1) with three visible teeth ventrally.

16. Antenna, number of antennomeres: (0) ten; (1) nine; (2) 0&1.

17. Antennal club in male, number of antennomeres: (0) four; (1) three; (2) six.

18. Antennal club in male, in relation to remainder of antennomeres: (0) as long or little longer (at maximum 1,5 times); (1) at least twice as long.

Thorax

19. Hypomeron ventrally: (0) not carinate; (1) carinate; (2) 0&1.

20. Pronotum, anterior angles: (0) distinctly produced and sharp; (1) weakly produced and moderately rounded; (2) not produced and strongly rounded.

21. Pronotum, anterior marginal line medially: (0) complete; (1) widely interrupted.

22. Pronotum, posterior angles: (0) sharp or blunt; (1) strongly rounded.

23. Pronotum, longer pilosity on disc: (0) directed posteriorly; (1) directed anteriorly; (2) absent; (3) 0&2.
24. Pronotum, shorter pilosity on disc: (0) absent; (1) present.
25. Metasternum, setae between mesocoxae: (0) evenly dispersed; (1) on a semicircular carina.
26. Metasternum anteriorly: (0) evenly elevated; (1) abruptly and strongly elevated.
27. Elytra: (0) with dark or light spots; (1) uniformly yellowish brown; (2) uniformly reddish brown; (3) uniformly black.
28. Elytra, a large dark spot before apex: (0) absent; (1) present.
29. Elytra, long pilosity: (0) thin, seta-like; (1) thick, seta-like; (2) scale-like; (3) thin and thick, seta-like.
30. Elytra, long pilosity: (0) on all intervals throughout entire elytral surface; (1) on odd intervals exclusively; (2) on sutural interval exclusively; (3) on base exclusively; (4) on base, sides and apical declivity.
31. Elytra, short pilosity: (0) thinly seta-like and long; (1) thickly seta-like and short; (2) reduced (or minute; 100 x magnification); (3) largely scale-like; (4) largely scale-like and thickly seta-like.
32. Elytra, short pilosity: (0) slightly erect but bent posteriorly; (1) strongly adpressed; (2) erect and adpressed (0&1).
33. Elytra, short pilosity: (0) dense, setae separated by much less than one length of a seta; (1) sparse, setae separated by more than one length of a seta.
34. Elytra, microtrichomes on apical margin: (0) present; (1) absent; (2) 0&1.
35. Body, pilosity of ventral face: (0) setose; (1) scale-like, at least partly.
36. Metafurca, lateral lamina posteriorly: (0) curved dorsally; (1) almost straight.
37. Metafurca, lateral lamina anteriorly: (0) curved dorsally; (1) straight directed ventrally; (2) shortened, not reaching the anterior lamina.

Legs
38. Metacoxa (ratio of length of metepisternum/ length of metacoxa): (0) not enlarged (1/1.2-1.6); (1) enlarged (1 < 1.7).
39. Metacoxa on lateral half: (0) not impressed; (1) impressed.
40. Metacoxa ventrally: (0) glabrous except a few setae laterally; (1) all punctures setose (with setae or scales).
41. Metafurca ventrally: (0) between the two longitudinal rows of setae densely setaceous; (1) between the two longitudinal rows of setae glabrous or very sparsely setose.
42. Metafurca, posterior ventral margin apically: (0) not serrate; (1) serrate.
43. Metafurca, posterior dorsal margin apically: (0) not serrate; (1) serrate.
44. Metafurca, posterior marginal edge on ventral side before: (0) behind basal quarter of metafurca; (1) behind basal half of metafurca.
45. Metafurca, submarginal serrated line beside anterior margin: (0) absent; (1) present.
46. Protibia: (0) long (more than four times as long as wide); (1) short (maximally three times as long as wide).
47. Protibia, external lateral margin medially: (0) straight; (1) bluntly widened.
48. Protibia, external lateral margin: (0) smooth; (1) finely toothed.
49. Metatibia, apical spur: (0) straight; (1) curved ventrally.
50. Metatibia (ratio of length/ width): (0) short (1/3.9-4.4); (1) long (1/ > 4.6).
51. Metatibia, apex interiorly near tarsal articulation: (0) weakly truncate (less deep than wide); (1) sharply truncate (as deep as wide or deeper than wide).
52. Metatibia, setae of ventral margin: (0) robust (their longitudinal grooves visible with 100x magnification; compare to small apical spines of metastibia); (1) fine (their longitudinal grooves invisible with 100x magnification).
53. Metatibia, setae of ventral margin: (0) weakly separate (the two apical setae in apical half of metatibia); (1) widely separate (the two apical setae in apical two thirds of metatibia); (2) polymorphic 0&1.
54. Metatibia, dorsal margin: (0) sharply carinate; (1) longitudinally convex.
55. Metatibia, longitudinal serrated line on dorso lateral face: (0) completely absent; (1) present throughout basal three quarter of metatibial length; (2) present throughout in basal half of metatibial length.
56. Metatibia, interior spines on apical face: (0) present; (1) absent.
57. Metatibia, pilosity of lateral face composed of: (0) fine setae; (1) scales (and fine setae); (2) absent.

58. Metatibia, basal third dorso laterally: (0) longitudinally convex; (1) weakly carinate.
59. Protatarse, V, setae ventrally: (0) fine; (1) robust and short.
60. Protatarse, V, ratio (r) of length/ width: (0) 2.9 ≤ r < 3.3; (1) 2.5 ≤ r < 2.9; (2) r < 2.5; (3) 3.3 ≤ r < 3.9; (4) 3.9 ≤ r < 4.6; (5) r ≥ 4.6.
61. Protatarse, claw, basal tooth of interior claw: (0) sharply pointed, similar to the basal tooth of the meso- and metatarsal claw; (1) lobiform; (2) s-shaped curved and sharply pointed ventrally; (3) completely absent; (4) bluntly truncate.
62. Protatarse, claw, basal tooth of external claw: (0) sharply pointed, similar to the basal tooth of the meso- and metatarsal claw; (1) lobiform; (2) bluntly truncate.
63. Ratio (r) of length of elytra/ length of all metastaria combined: (0) t ≤ 2.5; (1) 2.25 ≤ r < 2.5; (2) 2.0 < r ≤ 2.25; (3) 1.6 ≤ r < 2.0; (4) r ≤ 1.6.
64. Metatarsomera dorsally: (0) smooth, impunctate; (1) punctate; (2) longitudinally wrinkled; (3) 0&1.
65. Metatarsomera laterally: (0) not carinate; (1) carinate.
66. Metatarsomera laterally: (0) not carinate; (1) carinate.
67. Metatarsomera I, supplementary ventrolateral carina beside serrated ventral carina: (0) robust, visible with 50 x magnification; (1) very fine or completely absent; (2) fused with ventral carina.
68. Metatarsomera, apical setae: (0) short and robust (at maximum one quarter of the length of the subsequent tarsomere); (1) long (~ one third of the length of the subsequent tarsomere).

Abdomen
69. Abdomen, pilosity except for transverse rows of robust setae: (0) dense; (1) sparse.
70. Sixths abdominal sternite medially: (0) as long as the preceding sternite; (1) strongly shortened, half as long as the preceding sternite.
71. Abdomen, last visible abdominal sternite (VIII): (0) shorter or of the same length as preceding sternite; (1) longer than the preceding sternite.
72. Abdomen, penultimate abdominal sternite: (0) flat, not elevate; (1) transversely elevate medially; (2) bituberculate.

Male genitalia
73. Phallobase, at middle ventrally: (0) concavely sinuate; (1) produced.
74. Phallobase, at middle dorsoapically: (0) concavely sinuate; (1) median sinuation in parts sclerotized and mediadly produced triangularly; (2) diagonally truncate, between insertion of parameres with an evenly straight margin.
75. Phallobase, median sinuation (dorsal view): (0) shallow; (1) deep; (2) strongly asymmetric, with sinuation left side shallow and right side deep.
76. Phallobase, before apex ventrally: (0) without tubercles; (1) with convex elevation; (2) with two tubercles.
77. Phallobase, before apex dorsoapically: (0) without tubercles; (1) with two tubercles.
78. Phallobase, insertion of left paramere: (0) at the same level as the left one; (1) weakly displaced basally; (2) strongly displaced basally (by more than maximal distal width of phallobase); (3) displaced apically.
79. Parameres: (0) not subdivided into a long dorsal and ventral lobe, or only one of both subdivided into a long dorsal and ventral lobe; (1) both subdivided into a long dorsal and ventral lobe.
80. Parameres (lateral view): (0) both straight; (1) both curved ventrally at middle; (2) apex of the right paramere curved ventrally; (3) right paramere curved ventrally at middle; (4) right paramere curved dorsally at middle.
81. Parameres: (0) equal in length; (1) left paramere moderately shortened; (2) left paramere strongly shortened (more than half as long as the right paramere).
82. Right paramere, narrow basal lobe directed medially: (0) absent; (1) present.
83. Right paramere, in cross section: (0) dorsoventral extension and mediolateral extension equal; (1) mediolateral extension distinctly greater than dorsoventral extension.
86. **Right paramere apically (dorsal view):** (0) straight; (1) curved (directed medially (inward)); (2) curved (directed) laterally (outward).
87. **Right paramere in basal three quarter:** (0) narrowed distally; (1) subequal in width; (2) widened distally.
88. **Right paramere apically (0) not widened; (1) widened internally; (2) widened laterally; (3) widened internally and laterally.
89. **Right paramere, lateral preapical teeth:** (0) absent; (1) present.
90. **Right paramere, lateral preapical teeth:** (0) small and blunt; (1) large and sharply triangular; (2) very large, long, fork-like produced; (3) small, triangularly sharply pointed; (4) large and blunt.
91. **Right paramere, lateral preapical teeth:** (0) before apex of paramere; (1) displaced basally (its position about at middle of the paramere).
92. **Right paramere, dorsoventral margin medially (dorsal view):** (0) not produced; (1) bluntly produced.
93. **Right paramere, blunt dorsoventral extension:** (0) at the middle of paramere; (1) in distal half of paramere; (2) in basal half of paramere.
94. **Right paramere, lateral/ external margin:** (0) straight; (1) concavely sinuate.
95. **Right paramere, narrow spine on exterior/ lateral face of base:** (0) absent; (1) present.
96. **Right paramere, narrow spine on exterior/ lateral face of base:** (0) very short, shorter than maximal width of ultimate maxillary palpomere; (1) long, distinctly longer than maximal width of ultimate maxillary palpomere; (2) very long, almost half as long as right paramere.
97. **Left paramere, apex:** (0) straight; (1) curved inward; (2) curved outward; (3) curved dorally.
98. **Venteromedial membrane of right paramere:** (0) membranous; (1) its margin sclerotized from insertion of right paramere to the apex of left paramere; (2) its margin sclerotized from insertion of right paramere to the base of left paramere.
99. **Left paramere:** (0) major part of its surface directed laterally; (1) major part of its surface directed dorsally; (2) surface directed laterally and dorsally in the same proportion.
100. **Left paramere in cross section at basal third:** (0) arched, dorsoventral extension and mediolateral extension equal; (1) flattened, mediolateral extension distinctly greater than dorsoventral extension; (2) round, dorsoventral extension and mediolateral extension equal.
101. **Left paramere, apically:** (0) abruptly pointed; (1) evenly pointed from base; (2) convexly rounded.
102. **Left paramere, at base laterally:** (0) without blunt extension; (1) with a large blunt extension.
103. **Left paramere, before apex interiorly:** (0) not widened; (1) bluntly widened.
104. **Left paramere, over most of its length:** (0) straight; (1) weakly curved outward; (2) strongly curved outward (sickle-shaped); (3) bent at base and straight; (4) weakly curved inward; (5) bent at base and weakly curved outward.
105. **Left paramere, apically:** (0) without elevated lamella; (1) with a small elevated lamella.
106. **Left paramere, interior margin basally:** (0) not widened; (1) lobiform widened; (2) with a narrow basal process.
107. **Left paramere, basal process or lobe:** (0) short, distinctly shorter than left paramere; (1) long, at least half as long as left paramere.
108. **Left paramere, its basal lateral margin and the sclerotization of the medial membrane of right paramere:** (0) separate; (1) fused.
109. **Left paramere and medial membrane of right paramere:** (0) shortly fused (at maximum its length half of width of left paramere); (1) widely fused (its length equal to the width of left paramere); (2) more than half of left paramere fused with sclerotization of medial membrane.
110. **Endophallus:** (0) without sclerotized dorsal lobe; (1) with sclerotized dorsal lobe.

**Female genitalia**

111. **Ductus bursae:** (0) short; (1) elongate.
112. **Ductus bursae:** (0) straight; (1) coiled-shaped wound.
113. **Ductus bursae:** (0) not sclerotized, also not partly; (1) simply partly sclerotized; (2) with a sclerotization on left and right side.
114. **Ductus bursae:** (0) without dorsal sacculus; (1) with dorsal membrane sacculus; (2) with dorsal internally sclerotized sacculus.
115. **Spermasthecal duct before spermastheca:** (0) not bent; (1) bent.
116. **Spermastheca basally:** (0) without sclerotized anellus; (1) with a sclerotized anellus.
117. **Spermasthecal gland:** (0) much longer than spermastheca; (1) at maximum three times longer than spermastheca.

**Appendix 2. List of the species included into the cladistic analysis.**

- **Pleophylla sp.**
- **Caldovera tigrina** Brenske 1894
- **Caldovera langangica** Ahrens 1999
- **Gastroserica marginalis** (Brenske 1894)
- **Lasioserica medibola** Ahrens 1996
- **Lasioserica brevipilosa** Moser 1919
- **Neomerica serina** Brenske 1894
- **Pachyserica citopunctata** Ahrens 2005
- **Pachyserica xantosus**, Kobayashi & Yu 1993
- **Pachyserica oaf** Ahrens 2005
- **Serica (Taiwanoserica) anmashanica** Kobayashi 1993
- **Serica (Taiwanoserica) chengtuensis** n. sp.
- **Serica (Taiwanoserica) gnucilipes** Nomura 1974
- **Serica (Taiwanoserica) rigipennis** n. sp.
- **Serica (Taiwanoserica) wenchuanensis** n. sp.
- **Serica albitarsis** Ahrens 2005
- **Serica almorar** Ahrens 1999
- **Serica angustatobialis** Ahrens 1999
- **Serica hailingshancica** Ahrens 2005
- **Serica hauamtiensis** Ahrens 2005
- **Serica bhukre** Ahrens 1999
- **Serica bhutanica** Ahrens 2005
- **Serica tsering** Ahrens 2005
- **Serica hidertata** Ahrens 1999
- **Serica knop** Waterhouse 1875
- **Serica brunnea** (L. 1758)
- **Serica chazlabahae** Ahrens 1999
- **Serica dashti** Ahrens 2005
- **Serica devei** Ahrens 2005
- **Serica eberti** (Frey 1965)
- **Serica emethania** Ahrens 2005
- **Serica erectovena** Ahrens 1999
- **Serica fiasava** Ahrens 1999
- **Serica fulupubens** (Reitter 1896)
- **Serica fursata** Ahrens 2005
- **Serica fusiformata** Nomura 1974
- **Serica heydeni** (Reitter 1896)
- **Serica hirrella** Ahrens 2005
- **Serica honglingensis** Ahrens 2005
- **Serica karathobialis** Ahrens 1999
- **Serica kingdor** Ahrens 1999
- **Serica kohli** Ahrens 1999
- **Serica kumaonensis** Ahrens 1999
- **Serica lijiangensis** Ahrens 2005
- **Serica liangensis** Ahrens 2005
- **Serica maculata** Moser 1915
- **Serica montreuxi** Ahrens 2005
- **Serica mospurina** (Fairmaire 1889)
- **Serica nanguangana** Ahrens 2005
- **Serica nepalensis** (Frey 1969)
- **Serica nigrotygata** Brenske 1897
- **Serica nigromaculata** Fairmaire 1891
- **Serica nigrotygata** Lewis 1895
- **Serica olivacea** Brenske 1896
- **Serica palaea** Ahrens 2005
- **Serica pencasaana** Ahrens 2005
- **Serica polita** (Gebler 1832)
- **Serica pommeranzii** Ahrens 1999
- **Serica puetti** Ahrens 2005
- **Serica ramu** Ahrens 1999
- **Serica ruinae** ruinae Pic 1904
- **Serica suwadai** (Nomura 1959)
- **Serica septentrionalis** Murayama 1935
- **Serica sherpa** (Sabatinielli & Migliazzo 1982)
- **Serica silviae** n. sp.
- **Serica umahatangana** Ahrens 1999
- **Serica thibetana** Brenske 1897
- **Serica velutina** Arrow 1946
- **Serica zerechi** Ahrens 2005
### Appendix 3. Data matrix for the cladistic analysis.

Inapplicable characters were coded as “-”, while missing character states were coded as “?”.

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D. Ahrens