A new species of the *miranda*-group of the genus *Loepa* from Taiwan (Lepidoptera: Saturniidae)

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Abstract: Loepa mirandula n. sp., a new species of the miranda-group of the genus Loepa, is described from Taiwan, with biological, phenological and biogeographical information provided (holotype \eth in Senckenberg-Museum, Frankfurt am Main). It appears to be endemic to the island of Taiwan. It differs from the continental species L. miranda ATKINSON in MOORE, 1865 mainly in smaller size and genitalia morphology; external habit is similar. In addition, advances in taxonomic problems of some congeneric members are also discussed. First, Loepa yunnana Mell, 1939 is revised and treated as a species separate from *L. miranda* (stat. rev.). Second, Loepa sakaei Inoue, 1965 from the Japanese Ryukyu Archipelago is confirmed as a separate species belonging to the katinka-group of the genus. Last, the systematic status of Loepa formosensis Mell, 1939 (the second Loepa species inhabiting the island of Taiwan, provisionally treated as a separate species here; syn. formosibia BRYK, 1944) is discussed; its relationship to L. kuangtungensis Mell, 1939 from adjacent S.E. China is not yet clear.

Eine neue Art aus der *miranda*-Gruppe der Gattung *Loepa* von Taiwan (Lepidoptera: Saturniidae)

Zusammenfassung: Eine neue Art aus der miranda-Gruppe der Gattung Loepa wird beschrieben: Loepa mirandula n. sp. (Holotypus \eth im Senckenberg-Museum, Frankfurt am Main). Es handelt sich nach bisherigem Kenntnisstand um einen Endemiten der Insel Taiwan. Die neue Art unterscheidet sich von L. miranda Atkinson in Moore, 1865 hauptsächlich in der geringeren Größe sowie in der Genitalmorphologie; habituell sind beide Arten sehr ähnlich. Weiterhin wird Loepa yunnana Mell, 1939 revidiert und als separate Art interpretiert (stat. rev.). Loepa sakaei Inoue, 1965 vom japanischen Ryukyu-Archipel ist eine separate Art und gehört zur katinka-Gruppe der Gattung. Die zweite Loepa-Art von Taiwan, Loepa formosensis Mell, 1939 (Syn. formosibia Bryk, 1944), ist entweder eine eigene Art oder konspezifisch mit der kontinentalen L. kuangtungensis Mell, 1939 von den benachbarten Provinzen Südostchinas; der Status ist nicht entschieden, sie wird vorläufig als separate Art geführt.

Introduction

The genus *Loepa* Moore, 1859 contains more than 20 species of colourful yellowish saturniids in South, Southeast and East Asia. Early revisionary work was provided by Mell (1939), Roepke (1953) and Holloway (in Barlow 1982: 192). During a series of studies on its species, which intend to lead to an overall revision of the genus, the second author has attempted to clarify the *Loepa* faunas of specific geographical regions of Southeast Asia, e.g.

the Philippines (Nässig & Treadaway 1988, 1997, 1998), Java (Nässig & Suhardjono 1989), and Sumatra (Nässig et al. 1989, 1996). Additional studies from continental Asia have been conducted by Pinratana & Lampe (1990) for Thailand, by Brechlin (1997) for northern Vietnam, by Naumann (1998) for China and by Brosch et al. (1999, together with a lectotype designation) for Laos and Cambodia.

According to our present knowledge of the genus (Naumann 1995: 83, Nässig & Treadaway 1998: 389), a provisional infrageneric grouping of the species of *Loepa* is helpful for diagnosis and further phylogenetic investigation. Three species-groups are here recognized though their monophylies are to be proved in the future:

- 1. The *oberthuri*-group is possibly the most basal lineage within the genus. Two species are known: oberthuri (LEECH, 1890) (nec "oberthueri", misspelling by several authors), known from different areas of continental China (Naumann 1998), and anthera Jordan, 1911 from N.E. India (Jordan 1911, Seitz 1926), China (Naumann 1998), Laos (Brosch et al. 1999), and northern Vietnam (Nässig 1994). This group, comprising the probably two largest species of the genus, is characterised by the salmon-reddish pattern elements on the wings unknown from all other species. Larval morphology and foodplant association is still unknown (except for some unverified remarks by Zhu & Wang 1983, who claimed that L. oberthuri feeds on Rutaceae: Citrus reticulatus). The genitalia of the two species are quite different, but show largely plesiomorphic conditions (uncus shorter, not much fused, etc.). Presently we think that this group may be a paraphyletic residue rather than a monophyletic assembly.
- 2. The *miranda*-group, according to our present knowledge consisting of about 8–10 species. The monophyly of this group is clearly demonstrated by the nearly complete fusion of the uncus to its top and some pattern elements; the larval morphology is only known of *L. miranda* Atkinson in Moore, 1865 itself (Ragus, unpublished). Its species are distributed mainly in mountains of continental Asia, but including Taiwan. Two subgroups, not necessarily both of them monophyletic, may be distinguished: the *miranda*-subgroup to the South and the *damartis*-subgroup to the North.

¹ 54th contribution to the knowledge of the Saturniidae.

² 5th contribution to the Saturniidae fauna of China (4th contribution: 1999, Galathea, Berichte des Kreises Nürnberger Entomologen, Suppl. 6: 72-80).

3. The *katinka*-group, named after the oldest taxon in the genus (*Saturnia katinka* Westwood, 1848) and richest in species (ca. 15–20 species known presently, not all of which already described) and most widely distributed from S. India to China, across the Indochinese Peninsula to Sundaland, Sulawesi, the Philippines and the Ryukyu Archipelago. The monophyly of this group can possibly be demonstrated by some preimaginal characters. At least two subgroups, differing mainly in genitalia morphology and again not necessarily both of them monophyletic, can be distinguished: the *katinka/megacore*-subgroup and the *sikki-ma*-subgroup (Nässig & Treadaway 1998: 390).

It has been well-known that two species of *Loepa*, provisionally identified as *Loepa miranda* Atkinson in Moore, 1865 and *Loepa megacore formosensis* Mell, 1939, are native to Taiwan. However, due to the unresolved interrelationships between and within each species complex, their taxonomic status has been open to question for a period. In their checklist for Taiwan Lepidoptera, Owada & Wang (1992) enumerated these two species for Taiwan and lumped *formosensis* (with its synonym *formosibia* Bryk, 1944) as a subspecies of *megacore* Jordan, 1911. They also stated (Owada & Wang 1992: 205, note 31) that the taxonomic problems of Taiwan *Loepa* were yet to be resolved. Later, Wang (1994; also 1988) and Peigler & Wang (1996) still followed the provisional nomenclatural treatment.

The present study attempts to solve some of these questions. Having compared the external and genitalic morphology based also on examination of some of the types, we have concluded that the species known as *L. miranda* from Taiwan for a long period may represent an unnamed new species. In the present study, we intend to elucidate the identity of the Taiwanese *Loepa* species of the *miranda*-group and discuss the systematic relationships with its relatives. Some unsolved taxonomic problems of this genus from Taiwan, the Ryukyus (= Nanseishoto) and China are also discussed.

Abbreviations and conventions refer to Nässig & Tread-AWAY (1998: 229–230), except for the following:

CSHY Collection of Shen-Horn Yen, Taipei, Taiwan.

MAKB Museum Alexander Koenig, Bonn, Germany.

NMNS National Museum of Natural Science, Taichung,

TFRI Department of Forest Protection, Taiwan Forestry

Research Institute, Taipei, Taiwan.

The new Loepa species from Taiwan

The species of the *miranda*-group from Taiwan has a habitus closely resembling its most probable sister-species *miranda*, but is distinct especially in some characters of genitalia morphology. We describe this species here:

Loepa mirandula n. sp.

Holotype: &, [Taiwan]: "Nengkaoshan [now as Hohuanshan], Nantou [= Nantou Hsien], Formosa, VIII. 1972, ex T. Shimonoya", "Loepa miranda Moore, det H. Inoue, 1984", "Genitalpräparat Nr. 501/86 W. Nässig, Ffm.", "coll. W. A. Nässig, Mühlheim/Main", in CWAN in SMFL. SMFL-no. 4188. (This specimen was kindly donated to W.A.N. by H. Inoue in the mid-1980ies.) Figs. 1, 10.

Paratypes (in total 51 ♂♂ and 1 ♀), all from Taiwan: I-Lan Hsien (= County): 1 ♂, Da-Tong (= Ta-tong), Chih-Duan forests (= Mingchih, Mingcher, Chih-tuan), 7. x. 1983, B. S. Chang leg. (no. NMNS-1282-134); 1 &, same collecting data (NMNS-1282-333) (both in NMNS). 7 みみ, same locality (mislocated in Taoyuan on labels), 1160 m, 5.-6. x. 1996; 3 ♂♂, same locality, 30. x. 1996, all 10 specimens leg. G. Fábián & F. Nemes (CMWM). 1 ♂, Taipingshan, 1375 m, 25. viii. 1990, Y. B. Fan leg. (TFRI). 2 ♂, Taipingshan, 1250 m, 30. viii. 1998, leg. H. Y. Lee, c/o S.-H. Yen, GP-nos. 1261/00, 1262/00 CWAN (SMFL, SMFL-nos. 4189-4190). 1 Q, Yuenshan, Fushan Botanic Garden, 27. x. 1995, Y. B. FAN (Fig. 3); 1 &, same collecting data, A. Warneke leg. (TFRI). 1 ♂, same collecting data, S.-H. YEN leg.; 2 ♂♂, same locality, 27./28. viii. 1995, W. T. Jou leg. (all 4 ♂♂, 1 ♀ in TFRI). 1 3, same locality, 27. x. 1995, leg. S.-H. YEN (Fig. 2) (SMFL, SMFL-no. 4191). Tao-Yuen Hsien (= Taoyuan): 2 37, Fushin, Shan-Ba-Ling (= Upper Baling, Upper Paling), 15. vii. 1992, S.-H. Yen leg. (CSHY); 3 &&, 14 km E Fuhsing, 800 m, 28. x. 1995, 121,23°E, 24,50°N, leg. T. Csováry & P. Stéger, GU-Nr. 085-1999 RBP (2× CRBP, CMWM). Hua-Lien Hsien: 1 ♂, Guan-Yuen (= Kuanyuan), 14. viii. 1983, B. S. Chang leg. (NMNS-1282-168) (NMNS). 1 &, Lo-shao, 20. ix. 1988, Y. C. SEN leg.; 2 みみ, Bi-Lu-Si (= Pilushi, Pilueshi) (mislabeled as "Taichung Co."), 12. viii. 1987, Y. C. Sen leg. (TFRI). Taichung Hsien: 1 &, Tung-shih, Si-Jao-Lin, 14. vii. 1992, Y. B. Fan leg. (TFRI). Nantou Hsien: 6 みみ, Mei-Fong (= Meifeng), 13./14. vii. 1990, C. S. Lin (NMNS-658-12, 658-14, 658-17, 658-18, 658-19, 658-21), in NMNS. 1 ♂, same locality, 6. VIII. 1986, leg. Hsiau Yue Wang, "Loepa miranda Moore, det. R. S. Peigler 1990", GP 459/00 SNB (CPSA). 1 &, Meifeng, 2250 m, 121°10'E, 24°04'N, 17./18. іх. 1999, leg. G. Csorba & В. Herczig (in coll. Löffler, Lichtenstein). 1 \eth , Meifong, 2250 m, 121°10′ E, 24°05′ N, 17.-18. ix. 1999, leg. G. Csorba & B. Herczig; 5 & d, 3 km SW Tsuifeng, 2100 m, 7. viii. 1996, 121,10°E, 24,06°N, leg. T. Csováry & L. Mikus (all 6 in CRBP). 3 みみ、3 km SW Tsuifeng, 121°10′E, 24°06′N, 2100 m, 4.-5. viii. (2×), 7. viii. 1996, leg. T. Csováry & L. Mikus (CMWM). 1 &, same data as holotype, INOUE slide 5231; 1 o, Kunugikaoka, Formosa, 18. viii. 1936, [leg.] S. Asahina (both in Inoue coll., BMNH). Exact locality unknown: 1 ♂, "Taiwan, ca. 1985, via S. K. Ong, Loepa miranda", GP 202/97 SNB; 1 &, "Collection of Richard S. Peigler, no data, received 1970 from Mrs. Chang Pi-Tzu, Taiwan", "Loepa sakaei Inoue, det. R. S. Peigler 1982", receivd 10/99, GP 458/00 SNB (both in CSNB). - Some additional material (no paratypes) in private collections in Taiwan.

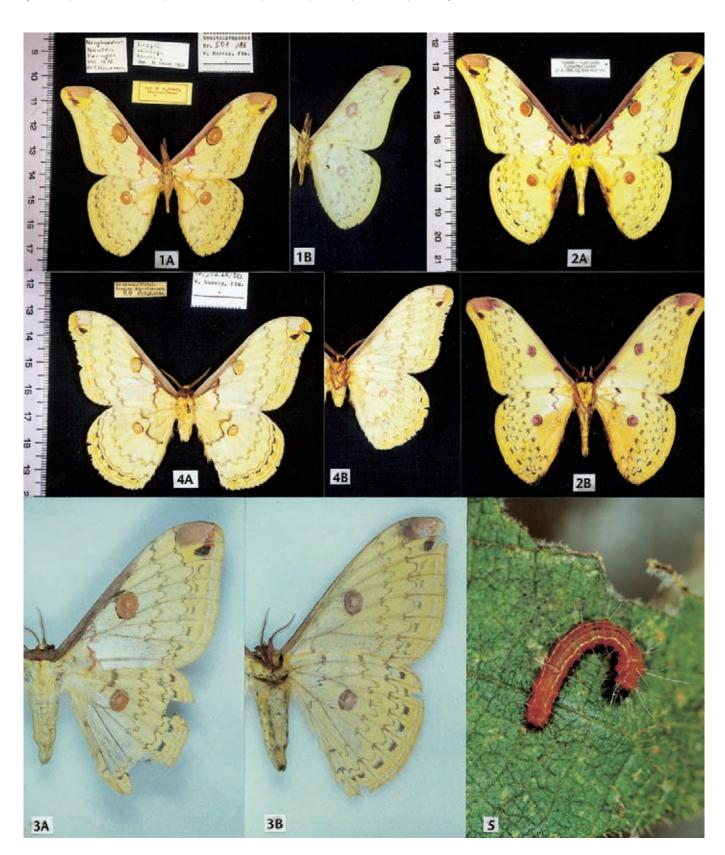
Etymology: "mirandula" is derived from "small miranda" (formed in analogy to Latin "mus" = mouse and "musculus" = small mouse), which refers to the smaller size of the Taiwanese specimens compared to that of the Himalayan *L. miranda*.

Description and diagnosis

3.3 C: Lfw.: HT 50 mm, average 54.1 mm \pm 2.68 s.d. (n = 28, minimum = 49 mm, maximum = 61 mm) for specimens in European collections; for specimens in Taiwanese collections: 54.9 mm \pm 2.40 s.d. (n = 20, minimum = 50.3)

mm, maximum = 57.2 mm). For comparison: *L. miranda* from N. India/Himalaya area: average 57.4 mm \pm 3.00 s.d. (n = 28, min. = 51 mm, max. = 65 mm; CWAN, CSNB, CRBP), from N. Thailand: average 56.2 mm \pm 3.38 s.d. (n = 36, min. = 51 mm, max. = 63 mm; CWAN, CSNB,

CRBP); from northern Vietnam: average 62,2 mm \pm 3.53 (n = 16, min. = 57 mm, max. = 70 mm; data from Brechlin 1997: 80 and CRBP); from China, W-Yunnan: average 54.6 mm \pm 4.10 s.d. (n = 5, min. = 51 mm, max. = 61 mm; CSNB, CRBP).



Colour plate, Fig. 1: Loepa mirandula n. sp., holotype $\[\]$. Fig. 2: $\[\]$ paratype of L. mirandula. Fig 3: $\[\]$ paratype of L. mirandula. — Fig. 4: L. yunnana, syntype, MAKB. — A = upperside, B = underside. — Figs. 1–2, 4: photographs W.A.N. from material in CWAN/SMFL and MAKB, scale in cm with subdivisions in mm. Fig. 3: photograph S.-H.Y. from material in TFRI, Ifw. = 55 mm. — Fig. 5: Probable larva (L₂) of L. mirandula, rearing and photograph S.-H.Y. (see text).

Antennae quadrupectinate with ca. 30–32 segments, ca. 12–15 mm (CWAN, CSNB) in length, longest pectines approximately 1.5–1.7 mm (CWAN) in length.

The new species is externally very similar to *L. miranda*, which was described from Darjeeling (N. India, Nepal, Sikkim) and ranges through the Nepalese and Indian Himalaya to Thailand, Laos, and Vietnam and reaches to southwestern China (W-Yunnan: CRBP, CSNB). In general, L. mirandula is smaller than the nominotypical Himalayan population of L. miranda. However, these two species are considerably variable in size and have measurements of fwl. overlapping. Such variability in size seems not to be correlated with seasonal differences since both of smaller and larger specimens could be collected at the same period and locality. Geographically, the population of *L. miranda* from Thailand is on average smaller in wingspan than that from the Himalaya, while the Vietnamese material tends to be even larger than the Himalayan population.

Although the characters of wing shape, pattern and colouration of male specimens of L. mirandula do not reliably and constantly differ from L. miranda, the \eth genitalia provide reliable characters for determination.

♂ genitalia: The copulatory apparatus is in typical style of the *miranda*-group with the uncus totally fused to the apex. The shape is similar to that of *L. miranda*, but constantly much smaller in size (compare Figs. 10 & 11 [*mirandula*] to Figs. 7-9 [*miranda*]; see Tab. 1; see also Brechlin 1997: 84 and Naumann 1998: 55). These differences in size are constant; the variability in size of the specimens does not remarkably influence the size of the ♂ genitalia.

The shape of the valve, saccus, and harpe is different, compare Figs.: the sacculus is more rounded in mirandula, giving the valves a broader appearance. The uncus has a narrower base in mirandula, but it is on average much steeper tapering than in miranda, where the narrow tip of the uncus tends to be less clearly separated. L. mirandula can also be distinguished from L. miranda by the aedeagus: In mirandula, the right basal cornutus is separated or nearly separated from the sclerotised tube and smaller, while in miranda it is usually connected by a strongly sclerotised ridge, sometimes topped with little teeth, to the tube. The left apical cornutus is largely reduced in both species. There may be some scobination in the right bulb of the vesica in miranda, less so in mirandula. The cephal basis of the aedeagus, where the retractor muscles insert, tends to be more rounded and bulbous in miranda, while it is more flattened, but laterally bifurcate, in *mirandula*.

The $\[\mathcal{S} \]$ genitalia of the externally distinct L. roseomarginata Brechlin, 1997 are also smaller than those of L. miranda, but show a different shape: due to the fact that the ventral bulge of the valves (the sacculus) and the saccus are more massive in roseomarginata, the valves appear to be ventrally much narrower when opened (see

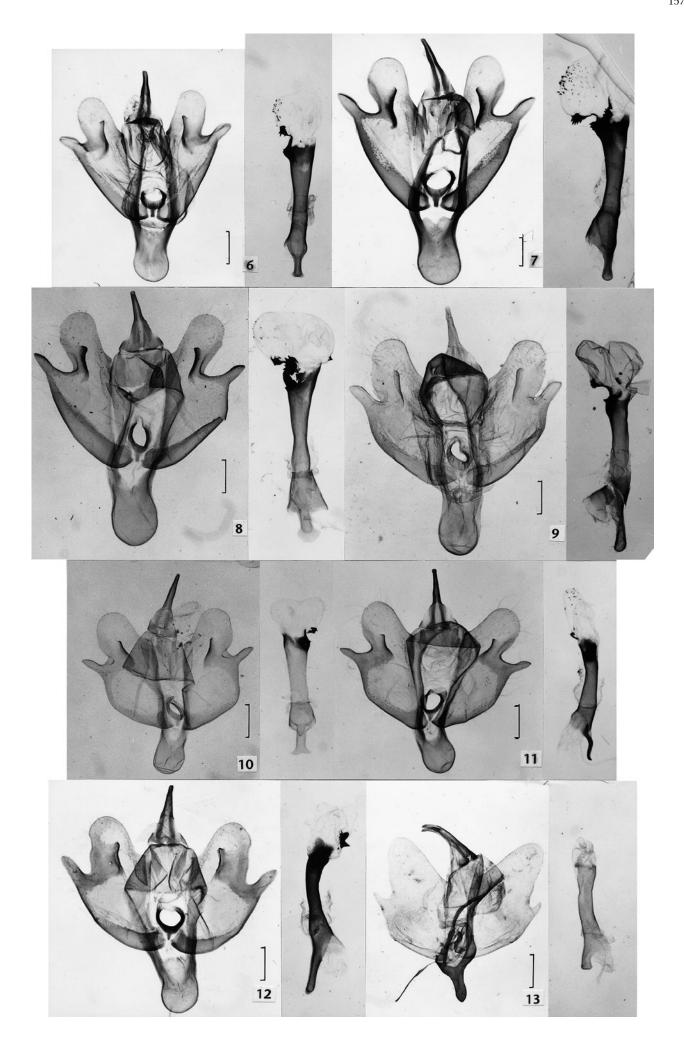
Fig. 6 and illustrations in Brechlin 1997: 84) than in L. mirandula. L. mirandula is in comparison broader (when opened) and appears to be more fragile. The \eth genitalia of the externally very different L. obscuromarginata are in size similar to L. miranda (Naumann 1998; see illustrations there).

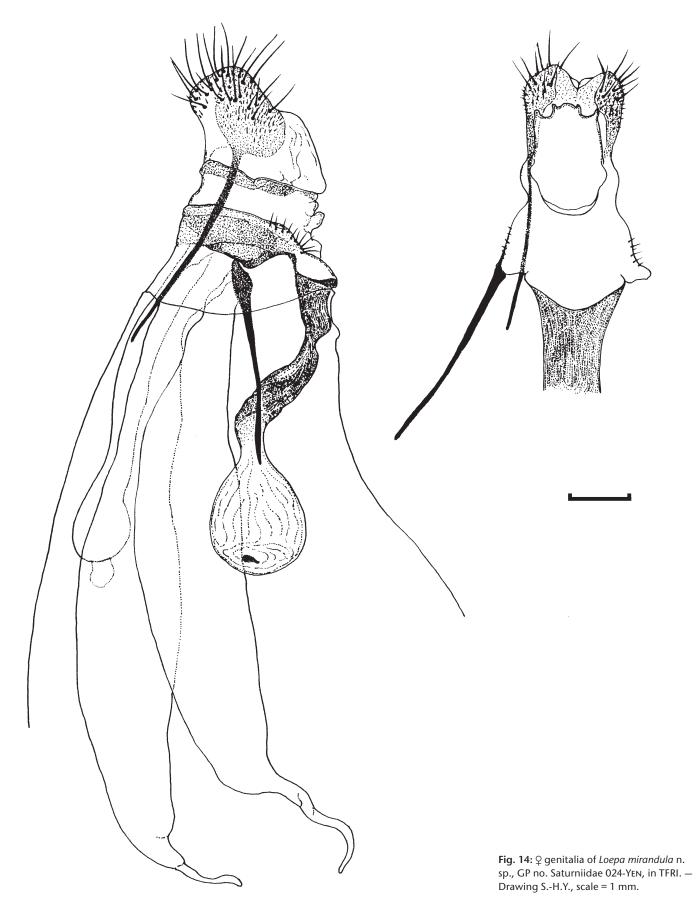
Table 1: Some measurements of the male genitalia of *Loepa miranda* and *L. mirandula*.

	L. mirandula	L. miranda
Character (measured on the slides)	GP 501/86, 1261/00 (CWAN), 202/97, 458/00, 459/00 (CSNB), n = 5 [average ± s.d.]	GP 499/86 Thailand, 986/96 Himalaya (CWAN), 41/97 Sikkim, 42/97 Thailand, 460/00, 461/00 Yunnan (CSNB), 479-UPW Vietnam (c/o SNB), n = 7
total height (tip of uncus to tip of saccus)	6.16 mm ± 0.11, min. 6.0 mm, max. 6.3 mm	8.06 mm ± 0.26, min. 7.6 mm, max. 8.4 mm
total width (harpe of the left valve to harpe of the right valve)	5.54 mm ± 0.30, min. 5.2 mm, max. 6.0 mm	6.89 mm ± 0.46, min. 6.1 mm, max. 7.5 mm
total length of aedeagus (sclerotized parts only)	3.56 mm ± 0.24, min. 3.3 mm, max. 3.8 mm	5.50 mm ± 0.40, min. 5.0 mm, max. 6.0 mm
width of aedeagus at the proximal half close to the entrance of the ejaculatory duct	0.46 mm ± 0.055, min. 0.4 mm, max. 0.5 mm	0.63 mm ± 0.049, min. 0.6 mm, max. 0.7 mm

Q: Lfw.: 55 mm (n = 3; 2 of these are no paratypes, but have been measured). For comparison: L. miranda from the Himalaya (CSNB): 60 mm, 61 mm (n = 2); from Thailand: 62 mm, 63 mm (n = 2, CSNB, CRBP); from northern Vietnam: average 64.3 mm \pm 0.96 s.d. (n = 4, minimum = 63 mm, maximum = 65 mm; CRBP). Antennae bipectinate with 28 segments, 11 mm in length, pectines approximately 1.2-1.5 mm in length (3 specimens in Taiwan collections; S.-H.Y.). Vertex and fronto-clypeus covered by yellow scales. Prothorax, patagia and tegulae covered by dark brown scales. Forewing and hindwing broader than ♂, forewing termen straight. Upperside of forewing having an apical patch pinkish brown with white slim outline, slightly incised at outer margin, area between the patch and sub-marginal white line tinged reddish brown; out margin of forewing slightly black with fringed scales yellow; submarginal line straight, white, parallel to termen and extending to tornus; postmedial line consisting of two undulate elements, outer one arising from R5 and ending at hind margin, inner one starting near apex, parallel to inner margin of apical patch, curved outwards between R2+3 and R4, then par-

Fig. 6–13: ♂ genitalia of *Loepa* species for comparison. Fig. 6: ♂ genitalia of *L. roseomarginata*, HT, GP 954/96 W.A.N. Fig. 7: ♂ genitalia of *L. miranda*, northern Vietnam, GP 985/96 W.A.N. Fig. 8: ♂ genitalia of *L. miranda*, northern Thailand, GP 499/86 W.A.N. Fig. 9: ♂ genitalia of *L. miranda*, northern India, Darjeeling, GP BMNH Sat. 308, BMNH. — Fig. 10: ♂ genitalia of *L. mirandula* n. sp., HT, GP 501/86 W.A.N. Fig. 11: ♂ genitalia of *L. mirandula* n. sp., PT, GP 1262/00 W.A.N. — Fig. 12: ♂ genitalia of *L. yunnana*, ST, GP 1265/00 W.A.N., MAKB. — Fig. 13: ♂ genitalia of *L. sakaei*, GP 471/86 W.A.N. — Photographs W.A.N., scale = 1 mm, not all pictures to the same size (Fig. 7 is stronger reduced in size).





allel to outer one till hind margin; medial line undulate, initiating near end of Sc and extending across forewing; discoidal patch orbicular, reddish brown with inner and dorso-anterior margins tinged black; subbasal line slightly undulate, color darker than discoidal patch. Upperside

of hindwing with similar wing pattern arrangement, but with subbasal line black. Underside of forewing and hindwing similar to that of upperside, but with more obscure stripes and lacking of black patches near base of R and upper angle of discoidal cell.

Q genitalia: Papillae anales somewhat rectangular laterally, ventral part below ovipore having a rectangular projection with a trifid process as shown on Fig. 14; apophyses posteriores reaching beyond hind margin of the 7th abdominal segment as ovipositor fully extended; 8th tergite present with dorso-anterior part weakly sclerotized, posterior margin of the 8th segment setose sub-ventro-laterally; apophyses anteriores extending to middle of the 7th abdominal segment, disconnected to main body of the 8th tergite; antrum concave in ventral view; lamella postvaginalis present, connecting to lateral margin of the 8th tergite; ostium bursae strongly sclerotized; ductus bursae strongly sclerotized, compressed dorso-ventrally at middle, slightly spiraled and grooved near corpus bursae; corpus bursae rather small, membranous, with a single signum; ductus seminalis rather short, arising at base; accessory glands short, with reservoirs rather large, extending beyond the 7th segment; rectum slightly longer than ductus bursae + corpus bursae.

Immature stages

Unlike the sympatric species L. formosensis, which has been very well explored in biology, the understanding of the immature stages of L. mirandula is still very scarce and not yet completely elucidated. The only known rearing record of the young instars of larvae was made by S.H.Y. in 1995. A very worn ♀ most likely representing mirandula was found laying eggs on the leaves and stems of Actinidia rufa (Sieb. & Zucc.) Planch. ex Miq. (Actinidiaceae) at a primary forest between the villages Li-Dao and Li-Yuen along the South Cross-Island Highway in S. Taiwan. The ♀ and the laid eggs were brought back to the laboratory in the Department of Biology, National Sun Yat-Sen University in Kaohsiung. (This ♀ was destroyed during the big 1999 earthquake and cannot be dissected therefore.) The first instar larva was light brown in colouration with long white setae. The second instar (Fig. 5) was darker in colouration with supraspiracular white stripes along the abdomen. Unfortunately all the third instar larvae died for unknown reason. The larva illustrated, however, resembles very closely the larva of L. formosensis (see below) and differs significantly from the young larva of L. miranda from Thailand (RAGUS, unpublished), and a confirmation of this observation by a successful rearing through the full life cycle of L. mirandula would be helpful.

Since the most closely related species in the *miranda*-group (i.e., *miranda* itself: RAGUS, unpublished) is Vitaceae-feeding (as are most other species of the genus, where the foodplants are known), it seems association with Vitaceae of *Loepa* is a commonly shared ecological preference. But it is not clear if the Actinidiaceae-feeding behavior of *L. mirandula* plays the role as primary selection of oligophagy, or a derived selection of the Vitaceae-feeding behavior, or a part of its unexplored polyphagy. In the wild, *Loepa* caterpillars of different species were mainly recorded on Vitaceae, Dilleniaceae, Saxifragaceae, and Actinidiaceae (Nässig et al. 1996: 137–138). A

larval foodplant family combination Vitaceae + Actinidiaceae (often in combination with some more families) is also observed in other species with known preferences for Vitaceae, e.g., in several macroglossine Sphingidae (Holloway 1987, Pittaway 1993).

Distribution

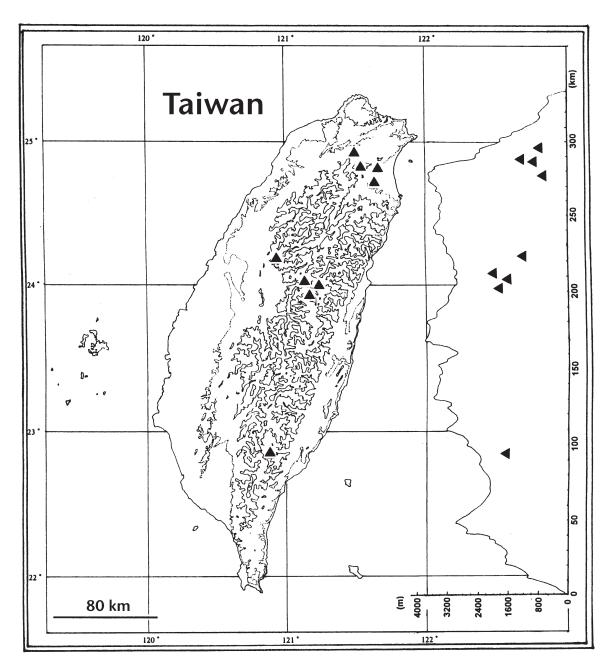
The new species appears to be an endemic of the island of Taiwan. L. mirandula is ranging through the low to medium elevations of the whole island (Fig. 15) though the population in the southern part is less investigated. In the North and South of Taiwan, a remarkable floristic compression with subalpine and lowland vegetation zones below 1000 m has been recognized. Therefore, it is not surprising to collect insect species which have a usual range above 1000-2200 m, below 1000-500 m in northern or southern Taiwan. At Fushan Botanical Garden in I-Lan Hsien and some other localities, L. mirandula has been found sympatric with the second Loepa species, which ranges from 200-1000 m. However, these two species are phenologically different (see below), with L. formosensis on the wing in spring and, in a second generation, in summer and autumn.

Phenology

The new species is supposed to be univoltine with slight phenological differences by localities. The earliest specimens fly in July, and flight lasts to late October. Due to lacking of sufficient female material, differences of emergence time between both sexes is unclear.

Habitat

According to the presently known collecting sites mapped on Fig. 15, L. mirandula is more restricted to primary forests with typical vegetation zone at medium elevation. The canopy and subcanopy layers usually contain the following plant species: Pinus morrisonicola HAYATA (Pinaceae), Cunninghamia konishii HAYATA (Araucariaceae), Acer morrisonense Hayata (Aceraceae), Alangium chinense (Lour.) Rehder (Alangiaceae), Daphniphyllum himalaense (Benth.) Muell.-Arg. subsp. macropodum (MIQ.) HUANG (Daphniphyllaceae), Rhododendron formosanum Hemsl. (Ericaceae), Cyclobalanopsis gilva (Blume) Oerst., Pasania hancei (Benth.) Schottky var. ternaticupula (HAYATA) LIAO (both Fagaceae), Illicium tashiroi Maxim. (Illiciaceae), Litsea cubeba (Lour.) Per-SOON, Neolitsea konishii (Hayata) Kanehira & Sasaki (both Lauraceae), Phoebe formosana (HAYATA) HAYATA, Prunus phaeosticta (HANCE) MAXIM. (both Rosaceae), Schizophragma integrifolium Oliv. var. fauriei (Hayata) HAYATA (Saxifragaceae), and Schima superba GARD. & CHAMP. (Theaceae). The shrub layer of the habitat is abundant with the following plant species: *Ilex peduncu*losa Miq. (Aquifoliaceae), Dendropanax dentiger (Harms ex Diels) Merr., Fatsia polycarpa Hayata, Sinopanax formosana (Hayata) Li (all three Araliaceae), Viburnum plicatum Thunb. var. formosanum Y. C. Liu & C. H. Ou (Caprifoliaceae), Celastrus punctatus Thunb. (Celastra-



 $\textbf{Fig. 15:} \ \textbf{Distribution map of} \ \textit{L. mirandula}. \ \textbf{Inserted diagram at the right: altitudinal distribution across the island.} \ -\ \textbf{Map S.-H. Y.}$

ceae), Helwingia japonica (Thunb.) Dietr. subsp. formosana (Kanehira & Sasaki) Hara & Kurosawa (Cornaceae), Lyonia ovalifolia (Wall.) Drude (Ericaceae), Debregeasia orientalis C. J. Chen (Urticaceae), and Ampelopsis cantoniensis (Hook. & Arn.) Planch. (Vitaceae).

Zoogeography

Endemism of *L. mirandula* to Taiwan represents the only confirmed case (however, there is not much data available about the Saturniidae fauna of Hainan island; see Naumann 1999) of insular distribution among the *miranda*-group, which probably originated from continental Asia and never reached to any of the Pacific islands further apart from the continent. In contrast, the species of the *katinka*-group are much more widely distributed, ranging from the Indian subcontinent to Sundaland, northeasternly across most of China to Taiwan, the

Philippines, and the Ryukyus, and southeasternly to Bali, Sulawesi and the Banggai Archipelago of the Indonesian islands.

A typical biogeographical disjunction between the subalpine area of Taiwan and the Himalaya (and other SE Asian high mountains) is revealed again by the present new species and its sister species. It will be necessary to prove whether the apparent absence of a closely related taxon of the *miranda*-group from SE. Chinese provinces (Guangdong and Fujian) is due to insufficient faunistic study at higher elevation and lacking of material examined, or caused by a secondary extinction event of the common ancestor of *L. miranda* and *L. mirandula* during evolutionary history. Although the distribution of the species of the *miranda*-subgroup of the *miranda*-group (including *L. miranda*, *L. mirandula*, *L. yunnana*, *L. roseomarginata*, and *L. obscuromarginata* and possibly

further species) species is somewhat parallel with that of the more northernly distributed *damartis*-subgroup (*L. damartis* and others), they are actually two different infrageneric lineages with a more or less parallel pattern of geographical distribution.

Additional information about other taxa

Loepa yunnana MELL, 1939

The identity of *Loepa miranda yunnana* Mell, 1939, was surveyed during the preparation of the present study (3 ♂ syntypes examined, in MAKB, from Lijiang in N. Yunnan, China; illustrated here for the first time, Fig. 4).

It appears that *yunnana* is better treated as a distinct species within the *miranda*-group according to external (wing shape, pattern and colouration) as well as genitalic morphology (especially the aedoeagus is differently shaped, and the vesica shows two big cornuti, GP 676/93, 1265/00 WAN; Fig. 12), and not as a synonym of *miranda* as suggested by Owada & Wang (1992): *Loepa yunnana* Mell, 1939 stat. rev. as a separate species.

Loepa sakaei INOUE, 1965

Loepa sakaei Inoue, 1965 (colour illustration see in Inoue et al. 1982: plate 123; larval description in Arita et al. 1993) from the Ryukyu Archipelago is a separate species (Naumann 1995: 82, Nässig et al. 1996: 137), not a subspecies of the Himalayan L. katinka as often dealt with, and a member of the katinka-group of the genus Loepa (GP 471/86 WAN of L. sakaei, see Fig. 13). It is surely not closely related to L. miranda or L. mirandula although they are phenotypically somewhat similar. This superficial external similarity lead to repeated misidentifications of specimens in various collections.

Notes on the second *Loepa* species from Taiwan:

The problem of *Loepa formosensis* Mell, 1939 and *Loepa kuangtungensis* Mell, 1939

The taxonomic status of the Taiwanese population of the katinka/megacore-subgroup (Loepa megacore formosensis sensu Owada & Wang 1992) has received different arguments and combinations by different authors although it is quite common in Taiwan and has been well documented in various publications (e.g., Peigler & Wang 1996: 121-124; see there also for the external differences between imagines of the two Taiwanese species). Previously, it was always associated either with L. katinka (Westwood, 1848) from the Himalayan region or with L. megacore Jordan, 1911 from Neomalaya (northern Sundaland; see Nässig & Treadaway 1998: 231). However, these three taxa are rather different in appearance and genitalic morphology. A sibling species of L. megacore, L. diversiocellata BRYK, 1944, which has a very wide distribution across N. India, the Indochinese Peninsula to south Thailand and S.W. China, was brought into comparison in the present paper, but it is also distinct from the Taiwanese population in genitalic morphology. Although *L. sakaei* has the geographically closest distribution to the Taiwanese species, these two taxa are less likely closely related.

Within the katinka/megacore-group, L. kuangtungensis Mell, 1939, a small-sized taxon from S.E. China (Fujian and Guangdong Prov. and probably adjacent areas), might be the best candidate to be the most closely allied taxon to the Taiwanese population. L. kuangtungensis was regarded as a subspecies of *L. katinka* in the original description, but NAUMANN (1998: 52, 54) raised it to species rank. Although the Taiwanese formosensis has been revised as an independent species from L. megacore, L. diversiocellata or L. katinka (see also Nässig & Treadaway 1998: 393, footnote 60), its relationships with L. kuangtungensis is not yet clear. Further examination of enough material from S.E. China will be necessary to determine if kuangtungensis and formosensis are conspecife or not. Both taxa, kuangtungensis and formosensis, have been described by Mell within the same publication.

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