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On the Discovery of *Hasora mixta limata* ssp. nov. (Lepidoptera: Hesperiidae: Coeliadinae) from Lanyu, Taiwan, with Observations of Its Unusual Immature Biology

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Yu-Feng Hsu and Hang-Chi Huang (2008) On the discovery of *Hasora mixta limata* ssp. nov. (Lepidoptera: Hesperiidae: Coeliadinae) from Lanyu, Taiwan, with observations of its unusual immature biology. *Zoological Studies* **47**(2): 222-231. A fairly large skipper, *Hasora mixta*, was discovered on Lanyu (Orchid I.), off the southeastern coast of Taiwan. Samples of this species from Lanyu were compared with those from other regions, revealing that the wing pattern and male genitalia consistently differ from those of other subspecies, and this is herein described as *H. mixta limata*, ssp. nov. This skipper is crepuscular or on the wing under cloudy conditions. An investigation of the immature biology of *H. mixta limata* revealed that it demonstrates an oviposition behavior unusual in skippers, in that it conceals its ova between leaflets of its larval host with spumaline. The papillae anales of the female genitalia are modified so that they can insert ova into tightly attached leaflets of young buds. The specific larval host of *H. mixta limata* is a legume that requires taxonomic clarification. http://zoolstud.sinica.edu.tw/Journals/47.2/222.pdf

Key words: New subspecies, Immature biology, Ovum concealment, Philippines.

It has been well-documented that the fauna and flora of Lanyu (Orchid I.), a small volcanic island off the southeastern coast of Taiwan, contains organisms that originated from the biota of both Taiwan and the Philippines (Sonan 1939, Fukuda and Hashimoto 1975, Cheng and Lu 2000). The Philippine components on the island include magnificent life forms such as a famous birdwing butterfly *Troides magellanus* (C. and R. Felder 1865), which is otherwise endemic to the Philippines (Haugum and Low 1985). Additional relevant examples include pachyrrhynchine weevils, which are very diverse in the Philippines and absent from the main island of Taiwan, but there are 6 species inhabiting Lanyu (Kano 1941). This Philippine influence is so impressive that early naturalists emphasized the significance of the Philippine influence on Lanyu. For instance, Kano (1941), based upon observations of geology, climate, and biota, proposed to modify Dickerson and Merrill's line (Dickerson et al. 1928) to run through the waters between Taiwan and Lanyu, and termed it the Neo-Wallace line. Cheng and Lu (2000) pointed out that some 110 of the 800 or so vascular plants growing on Lanyu are also found in the Philippines but not in Taiwan, although some 650 species are shared with Taiwan (of which some 500 species also grow in the Philippines). Although no detailed analysis has been performed to determine the composition of the lepidopteran fauna of Lanyu, new taxa recently found on Lanyu were mostly shared with the Philippines rather than the less-distant Taiwan, showing that the island has received considerable influence from the

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Philippines in spite of a larger distance between them. For instance, *Nacaduba berenice* (Herrich-Schäffer, 1869) (confirmed on Lanyu in 1987, see Hsu 1990) and *Catopyrops ancyra* (C. Felder, 1860) (found on Lanyu in 1998, see Lu and Hsu 2002) are both found in the Philippines (Tite 1963) but not on the main island of Taiwan (Shirôzu and Ueda 1992).

During a trip to investigate lepidopterous insects and their host associations, we found a fairly large-sized skipper that was previously unrecorded from Lanyu. The skipper turned out to be *Hasora mixta* (Mabille, 1876), a species distributed in Sundaland, the Philippines, Sulawesi and the Moluccas (Evans 1949, Tsukiyama 1981). After comparing the samples collected from Lanyu with those from these other regions, we concluded that the population on Lanyu possesses diagnostic characters distinct from those of the other regions and warrants a subspecific status. We describe this new subspecies herein, and perform a preliminary investigation into its larval host specificity.

MATERIALS AND METHODS

Field observations and rearing tests

Immatures of *Hasora mixta* were collected from the hostplant, a woody legume vine with an uncertain taxonomic identity (see below). Rearing was performed in plastic containers (15 x 8 x 4.5 cm). Rearing codes followed the system developed by Powell and De Benedictis (1995). Each collection of immatures was labeled according to the collecting year and month: e.g., HSU 06C16 refers to the 16th collection (16) of Hsu (HSU) in Mar. (C) 2006 (06), with the month indicated by a letter. Leaves of its natural host were given to the immatures in captivity. In Taiwan, *H. badra* (Moore 1858) was the only member of the Celaenus group (sensu Evans 1949) in the genus *Hasora* prior to the discovery of *H. mixta*. The known host plants of *H. badra* in Taiwan include *Derris laxiflora* Benth. (Hsu 03G5) and *Milletia pachycarpa* Benth. (Hsu 2002), both of which are woody vines with foliage similar to the legume utilized by *H. mixta* as a larval host on Lanyu. Foliage of both plants was provided to the larvae to test whether they were acceptable to the larvae.

Taxonomic methods

Specimens of *H. mixta* from Lanyu, including field-collected and reared individuals, were compared with samples of *H. mixta* from other regions to confirm their taxonomic status, including *Hasora m. mixta* (5 ♂♂, 5 ♀♀, Babuyan Is, NTNU; 1 ♂, Luzon, NTNU; 6 ♂♂, 3 ♀♀, Marinduque, NTNU; 1 ♂, Leyte, NTNU; 3 ♂♂, 3 ♀♀, Mindoro, NTNU), *H. m. prabha* Fruhstorfer, 1911 (1 ♂, Borneo, NTNU; 2 ♂♂, Palawan, NTNU), *H. m. fenestrata* Fruhstorfer, 1911 (17 ♂♂, 14 ♀♀, Sulawesi, BMNH), and *H. m. simplicissima* (Mabille, 1876) (17 ♂♂, 13 ♀♀, Moluccas, BMNH). Dissections of genitalia followed the protocol by Hsu and Powell (2005). Terminology for wing patterns followed Nijhout (1991), for genitalia followed Evans (1949) and Klots (1970), and for the chaetotaxy of larvae followed Stehr (1987). Vouchers are deposited in the following institutes or collections: BMNH: Natural History Museum, London; IOZ: Institute of Zoology, Chinese Academy of Sciences, Beijing, China; NMNS: National Museum of Natural Science, Taichung, Taiwan; NTNU: Department of Life Sciences, National Taiwan Normal University, Taipei, Taiwan; HTC: Hiroshi Tsukiyama Collection, Funabashi, Japan; HCC: Hideyuki Chiba Collection, Japan; TARI: Taiwan Agricultural Research Institute, Wufeng, Taichung, Taiwan. Several visits to the NMNS and TARI were made in an attempt to evaluate the possibility that *H. mixta* may have been confused with other congeneric species in the past. The NMNS represents the largest modern entomology collection in Taiwan, whereas TARI represents the most important local historical butterfly collection (Shih et al. 2002).

RESULTS

SYSTEMATIC ACCOUNTS

***Hasora mixta limata*, subsp. nov.**
(Figs. 1, 2, 5, 6, 9-11, 18-21)

Diagnosis: This new subspecies is distinguished from other subspecies by the following characters. (1) Both wings covered with prominent metallic pale green scalings tinged with yellow proximally on underside in *m. limata* (Figs. 5, 6). Besides *m. limata*, such scalings found only on *m. mixta* of the Philippines, but the metallic scaling of *m. mixta* much less extensive, limited

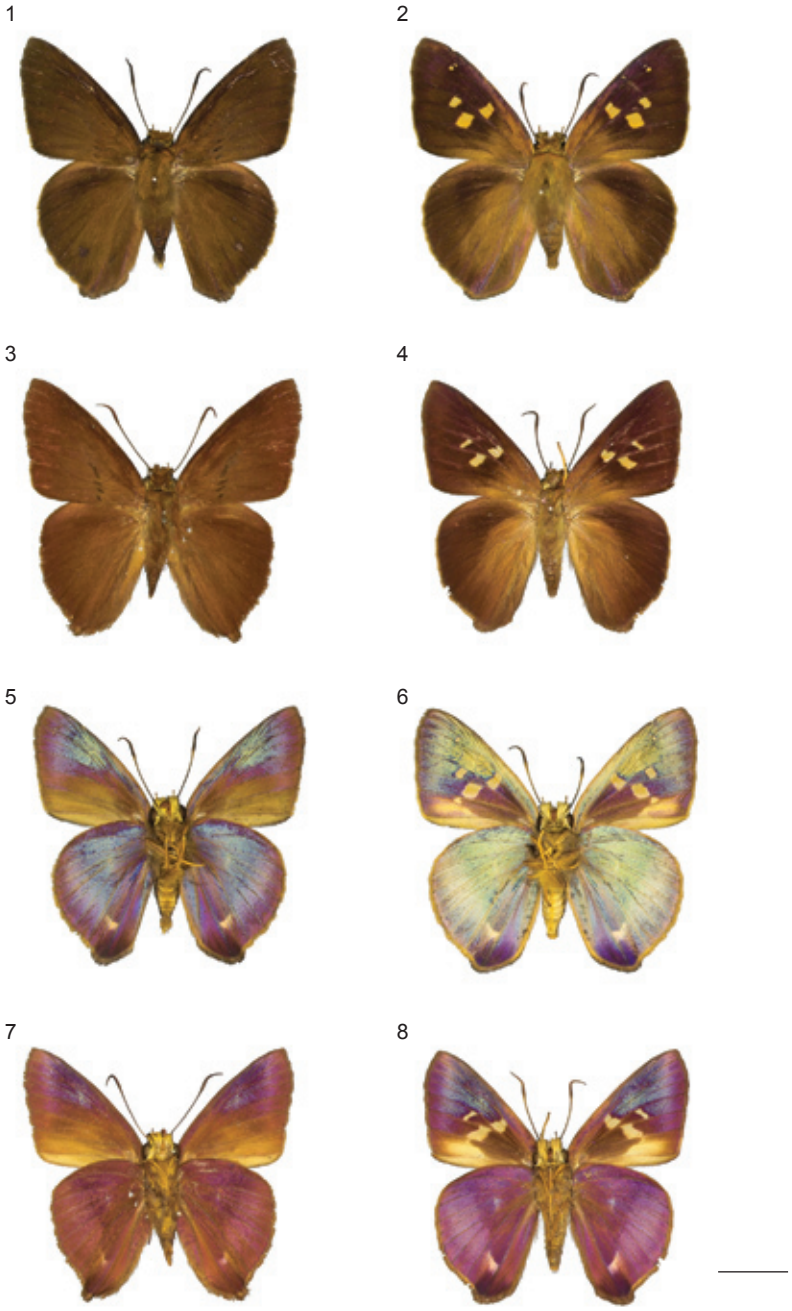
to forewing (Fig. 8), and frequently vestigial (Fig. 7). (2) Style of *m. limata* possessing a short, axe-shaped ventral extension (Fig. 10), whereas that of *m. mixta* elongate and digitate in shape (Fig. 12-14). One subspecies, *m. prabha*, occurring in Palawan, the Philippines, possessing an additional bump between dorsal and ventral extension of style (Fig. 15).

Description: Male (Figs. 1, 5). Forewing length 19.2-24.3 (22.01 ± 1.33) mm (*n* = 23); length of antenna 11.8-13.5 (11.33 ± 0.47) mm (*n* = 23). Head: Hairy, brown on vertex, chaetosemata on vertex presenting as brown, piliform hair tufts; additional chaetosemata behind antennae forming a deep depression within which dark brown, lamellar scales present along with broad, fan-like scales in back. Antennae covered with brown scalings dorsally, creamy-yellow ventrally, 27-30 segments of nudum present at swollen part of flagellum (*n* = 10). Eyes semioval, smooth. Labial palpus porrect, with short, thick 1st segment and long, stout 2nd segment, both covered with brown scales dorsally, with creamy-white scales ventrally; 3rd segment minute, digitate, covered by yellowish-brown scales. Thorax covered with brown hair-like scales tinged with yellow. Legs covered with brown hair-like scales. Epiphysis prominent, brown. Tibial spur formula 0-2-4. Mesotibia bearing 1 pair of spurs, metatibia bearing 2 pairs of spurs. Forewing: Costa nearly straight, slightly convex; termen convex anteriorly, length subequal to that of dorsum; dorsum straight. Ground color of upperside uniformly glossy-brown. Fringe brown tinged with yellow. Ground color of underside brown, overlaid with a wash of purple tinged with deep blue anteriorly and distally. A patch of metallic pale green tinged with yellow scales present at distal 1/3 along costa. Basal symmetry system reduced to a small, faint, creamy yellowish-white dash at distal end of discoidal cell. A linear, dark brown sexual band present from basal 1/3 of dorsum to cell Cu1. Hindwing: Configuration oval but produced caudad, straight along dorsum. Ground color of upperside uniformly brown. Long, brown hair-like scales present on wings proximally. Fringe brown tinged with yellow. Ground color of underside brown, overlaid with a wash of purple tinged with deep blue, metallic pale green scales tinged with yellow of various extents present proximally. A prominent, oval, brown patch present at tornal lobe. Parafocal elements forming a small creamy yellowish-white dash in cell Cu2. Basal symmetry system reduced to a small, faint, creamy yellowish-white dash at distal end of discoidal cell. Abdomen covered with brown hairs dorsally, brown hairs tinged with yellow ventrally. Genitalia (Figs. 9-11): Tegumen broad at base, extending cephalad into a vault-like structure. Caudal end of uncus forming elongate, lateral, straight, digitate arms. Socii forming a pair of horns with distal end slightly beyond terminal end of uncus. Gnathos strongly bent upwards, sclerotized, ventral surface densely covered with minute hairs. Valva elongate, with bifid style, slightly serrate dorsally; dorsal extension elongate, digitate, ventral extension broad, axe-like; harpe elongate, tapering toward caudal end, with circular, serrate distal end. Phallus straight, shorter than length of valva, with phallobase approximately 2x length of aedeagus.

Female (Figs. 2, 6). Forewing length 19.4-24.2 (21.99 ± 1.38) mm (*n* = 26); length of antennae approximately 10.5-12.5 (11.31 ± 0.61) mm (*n* = 26), 28-30 segments of nudum present at swollen part of flagellum (*n* = 10). Head: Structure and color pattern similar to that of male, but 2nd pair of chaetosemata without a depression, bearing only piliform and lamellar scales narrower than those of male. Color of hairs paler than those of male. Thorax: Structure and color pattern as described for male but with paler hairs. Wings: Configuration and ground color similar to those of male. Markings much more prominent than those of male; central symmetry system of forewing represented by 2 conspicuous, creamy-yellow, semitransparent spots in cells Cu1 and Cu2, a spot of same color in discoidal cell, and a series of 3 or 4 small subapical dots of same color arranged in a line. Long, brown hairs tinged with yellow present on wings proximally. Parafocal elements of forewing underside diffused into a broad, creamy-white patch posteriorly. Proximal metallic pale-green scales on underside of wing much more extensive than those of male, forming a broad patch on forewing and covering most of hindwing. Sexual band absent. Abdomen covered with brown hairs dorsally, creamy-yellow hairs ventrally. Genitalia (Figs. 16, 17): Papillae anales setose, sclerotized, shovel-like, pointed at caudal end. Apophyses posteriores slender, elongate, approximately as long as papillae anales. Apophyses anteriores vestigial. Abdominal segment VIII with strongly sclerotized tergite, bearing long setae; sternite heavily sclerotized, dome-shaped with a deep caudal cleft, forming prominent sinus vaginalis. A ventral, lobe-like plate with narrow caudal cleft present posterior to abdominal segment VIII, presumably derived

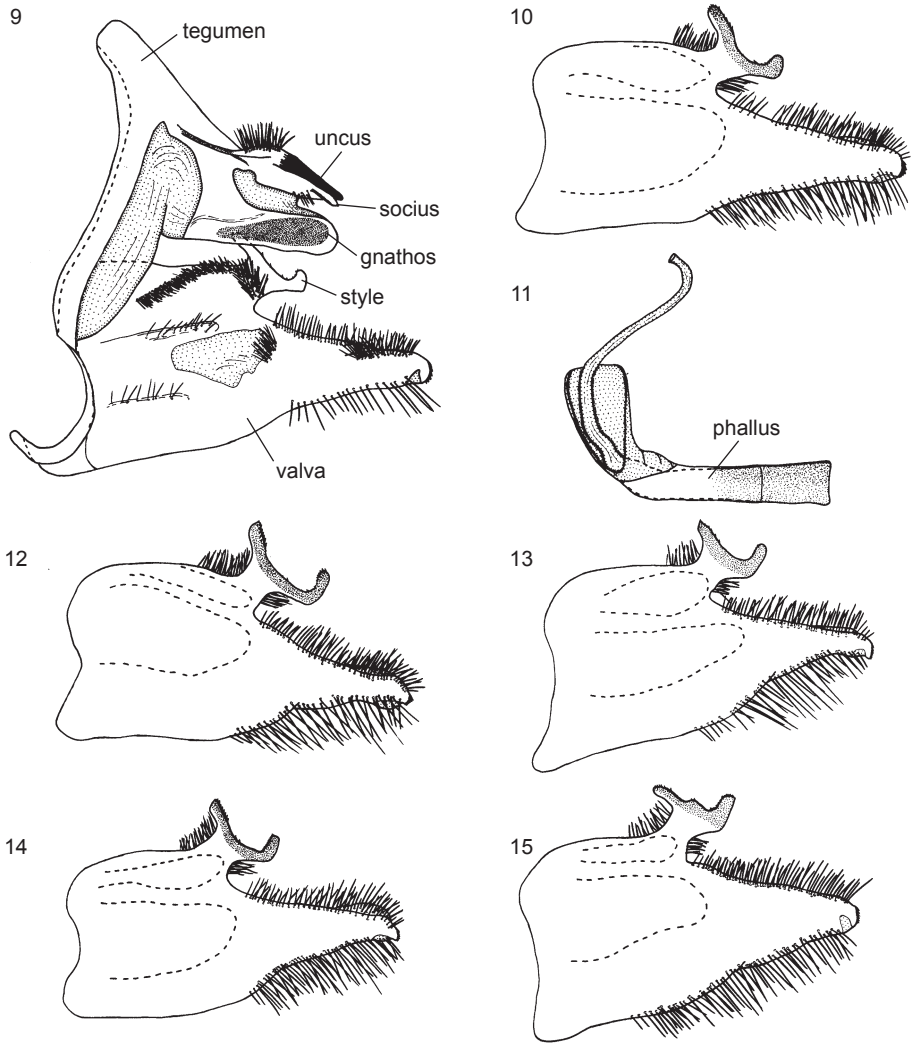
from sternite IX. Ductus bursae elongate, slender, with ductus seminalis near posterior end. Corpus bursae bullet-shape. Signum forming a narrow, elongate band ventrally.

Immatures (Figs. 18-21). *Ovum* (Figs. 18, 19). Approximately 0.65 ± 0.01 mm in diameter, 0.36 ± 0.03 mm in height (*n* = 13). Dome-shaped; surface with 15-18 longitudinal ribs (*n* = 13). Creamy-white when first laid, turning gray upon hatching. *Larva* (Fig. 20). First instar: Body cylindrical, attenuate toward caudal end, bearing transparent or pale brown primary setae; T1 shield a transverse band, somewhat pentagonal in shape, with dark brown glossy surface; anal



Figs. 1-8. Subspecies of *Hasora mixta*. **1.** *Hasora mixta limata*, subsp. nov., holotype ♂, upperside. **2.** *Hasora mixta limata*, subsp. nov., paratype ♀, upperside. **3.** Nominotypical subspecies, ♂ (Marinduque, the Philippines), upperside. **4.** Nominotypical subspecies, ♀ (Mindoro, the Philippines), upperside. **5.** *Hasora mixta limata*, subsp. nov., holotype ♂, underside. **6.** *Hasora mixta limata*, subsp. nov., paratype ♀, underside. **7.** Nominotypical subspecies, ♂ (Marinduque, the Philippines), underside. **8.** Nominotypical subspecies, ♀ (Mindoro, the Philippines), underside. Scale bar = 1 cm.

lobe weakly sclerotized, semicircular, with a dark-brown longitudinal median band. Head rounded with slightly depressed, dark brown glossy vertex. Body brown in T1, remaining segments creamy-white, with obscure dark longitudinal lines dorsally and narrow rings in each segment. A series of faint brown spots visible along lateral sides from A1 through A8 by 1st molt. Legs dark brown, glossy. Primary setae as follows: on T1: XD2 slightly longer than XD1, both much longer than D1 and D2. D1 equal to D2 in length, with D1 anterior to D2. L1, L2, and L3 on a vertical line, with L1 at top, L2 at bottom, L3 in between; L3 immediately in front of spiracle. SV unisetose. On T2 and T3, D1 and D2 in a transverse line, D2 longer than D1. SD1 and SD2 in a longitudinal line, on a pinaculum, SD1 longer than SD2. L group unisetose. SV unisetose. On A1 to A8, D1 in front of D2, with D2 longer than D1. SD unisetose. L group bisetose, with L1 posterior to and L2 in front of spiracle; L2 slightly dorsal to L1, L2 nearly equal in length to L1. SV bisetose, with SV1 longer than SV2. On anal plate, D1 and D2 in a longitudinal line, with D2 longer than D1. SD1 and SD2 both located near posterior margin of anal plate, with SD2 in front of SD1; SD1 nearly equal in length to SD2. Body length approximate 3.73 ± 0.19 mm at 1st molt (*n* = 9). Second instar: Body length

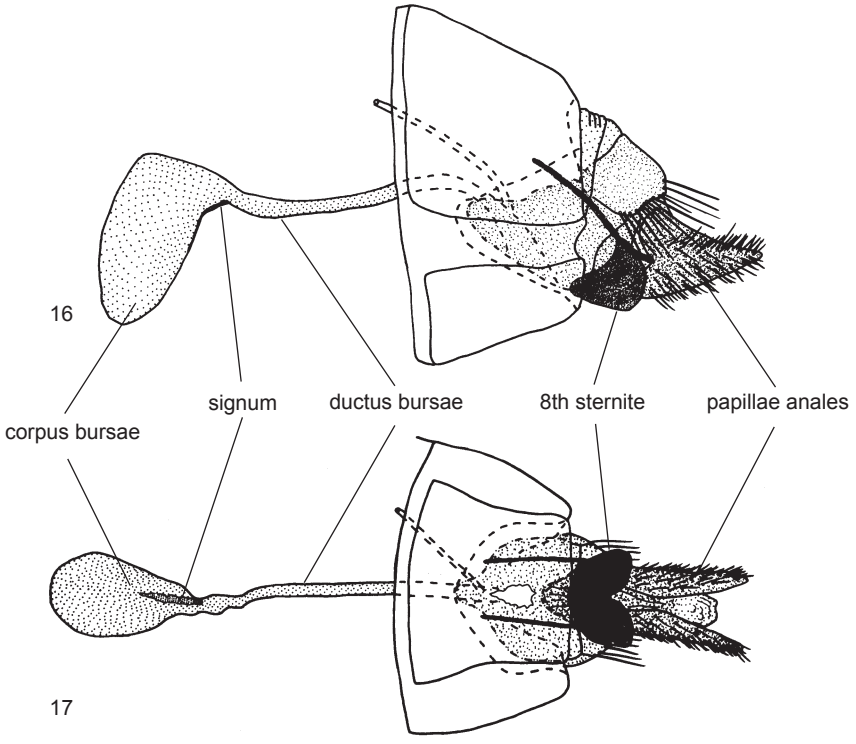


Figs. 9-15. Male genitalia of *Hasora mixta* subspecies. **9.** *Hasora mixta limata*, subsp. nov., lateral view of 9th + 10th sclerites, with left valva removed. **10.** The same, lateral view of left valva. **11.** The same, lateral view of phallus. **12.** Subsp. *mixta* (Babuyan Is., the Philippines), lateral view of left valva. **13.** Subsp. *mixta* (Mindoro, the Philippines), lateral view of left valva. **14.** Subsp. *mixta* (Marinduque, the Philippines), lateral view of left valva. **15.** Subsp. *prabha* (Palawan, the Philippines), lateral view of left valva. Scale bar = 1 mm.

approximately 6.51 ± 0.29 mm upon 2nd molt (*n* = 11). Body covered with short secondary setae. Head, T1 shield similar to those of 1st instar; dark brown band on anal lobe vestigial. Body ground color pale brown except brown at T1; 4 prominent, pale creamy-yellow longitudinal lines present dorsally, several lateral lines of same color present on each side. Prominent dark brown patches present laterally on T3, A2, A4, A6, and A8. Spiracles brown. T1 leg dark brown, T2 leg brown, T3 leg pale brown. Third instar: Generally similar to 2nd instar, but secondary setae becoming long, soft, white hairs, and spiracles becoming white. Body length approximately 11.41 ± 0.78 mm at 3rd molt (*n* = 12). Fourth instar: Head becoming pale brown, slightly tinged with orange. A prominent dark brown spot present on each side of head capsule, with an additional dark brown spot on frons. Stemmata in a patch of dark brown. Body with pale-brown T1 ground color, T2 through A7 white tinged with gray, caudal part white. Creamy-yellow lines as in 3rd instar. Prominent, somewhat rectangular, dark-brown lateral patches present on T2, T3, A2, A4, A6, and A8, with dark-brown thoracic patches and brown abdominal patches tinged with red. Legs white tinged with gray. Spiracles white. Body length approximately 20.30 ± 0.88 mm upon 4th molt (*n* = 28). Fifth instar: Head color becoming brick red, with dark-brown spots as in 4th instar but considerably smaller. Body similar to 4th instar in coloration and markings but T1 ground color becoming red and abdominal spots becoming brown tinged with red. Crochets biserial, uniordinal, circle on ventral prolegs but biserial, uniserial, caudal penellipse on caudal prolegs. Body length reaching 39.0 mm upon maturation. Pupa (Fig. 21): Pupal length 25.93 ± 1.07 mm (*n* = 30). Body of regular hesperiid form, stout, with flat cephalic end but bearing a prominent digitate process and attenuate toward caudal end. Brown setae present dorsally and on head. A small bump-like process present immediately behind thoracic spiracle. Proboscis reaching A5. Body ground color pale green, with dark-brown marking around thoracic spiracle. A small dark brown dot present along inner margin of eye-piece ventrad. Cephalic process dark brown anteriorly. Spiracles brown.

Type material: *Holotype*: ♂, TAIWAN: TAIDONG Co., Lanyu, Sidougou, 18-20 Mar. 2006, Coll. Y.F. Hsu and H.C. Huang, reared from *Paraderris* ?*piscatoria*, emgd. 12 Apr. 2006, HSU 06C16 (BMNH).

Paratypes. 1 ♂, 1 ♀, same locality and



Figs. 16-17. Female genitalia of *Hasora mixta limata*, subsp. nov. **16.** Lateral view. **17.** Ventral view. Scale bar = 1 mm.

same date as holotype; 3 ♂♂, 7 ♀♀, 18-20 Mar. 2006, same locality and date as for holotype, Coll. Y.F. Hsu and H.C. Huang, reared from *Paraderris* ?*piscatoria*, emgd. 8-15 Apr. 2006, HSU 06C16; 7 ♂♂, 14 ♀♀, same locality as for holotype, 3-4 Mar. 2007, Coll. Y.F. Hsu and H.C. Huang, reared from *Paraderris* ?*piscatoria*, emgd. 1-11 Apr. 2007, HSU 07C3; 8 ♂♂, 5 ♀♀, same locality as for holotype, 17-18 Mar. 2007, Coll. Y.F. Hsu, reared from *Paraderris* ?*piscatoria*, emgd. 14-26 Apr. 2007, HSU 07C14; 1 ♀, same locality as for holotype, Coll. Y.F. Hsu, reared from *Paraderris* ?*piscatoria*, emgd. 18 May 2007, HSU 07D9.

Host association: *Paraderris* ?*piscatoria* (Blanco) Adema (Fabaceae) (see discussion of taxonomic problem with regard to this plant).

Etymology: From *limatus* (Latin adjective) = polished, refined, elegant, fine, referring to the impressive purple and pale green scalings on wing undersides.

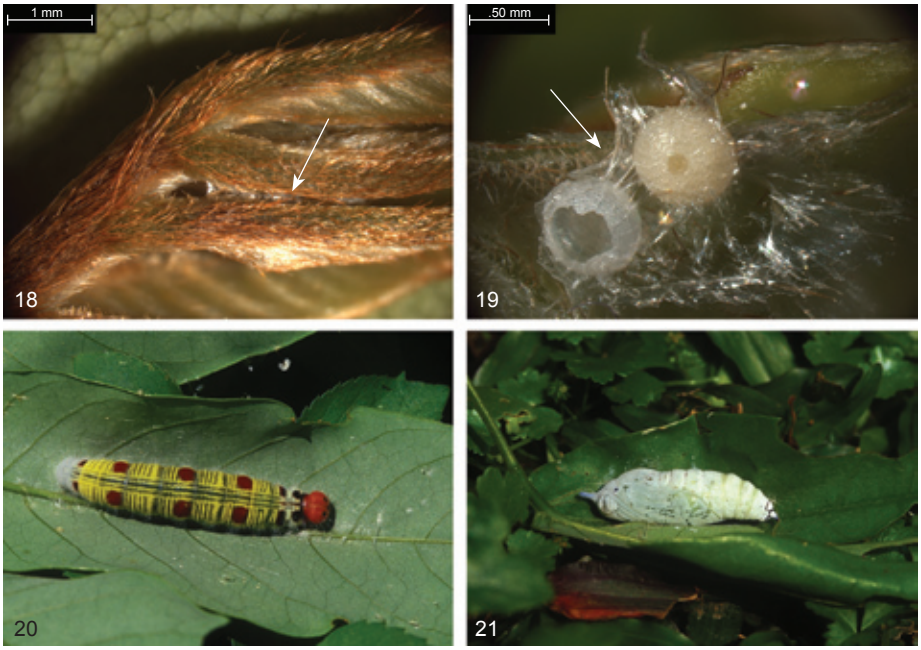
Distribution: Known only from Lanyu, Taiwan. Other subspecies are found in Sundaland, the Philippines, Sulawesi and the Moluccas (Evans 1949, Tsukiyama 1981, de Jong and Treadaway 1993).

Biology: In total , 8 ♂♂ and 9 ♀♀ were observed in the wild during the study. For each observation, adults showed up only at dusk or under cloudy conditions. Both sexes visited flowers of *Bidens pilosa* Linnaeus (Asteraceae) for nectar, starting at 16:00 and ending by 17:30. The female oviposited upon young buds in the afternoon (*n* = 5), and inserted its ova into tightly attached leaflets. Ova were mostly laid in a cluster of 2 (*n* = 8) (Fig. 19), but occasionally single eggs (*n* = 1) or a cluster of 3 (*n* = 2) was found. Spumaline (froth) was secreted by the female and applied to 2 leaflets, which were glued together by the substance to form a pouch containing the ova (Fig. 18). The larva devours the soft leaves.

Voltinism: Evidently multivoltine as adults and various stages of immatures were observed at the same time (HSU 06C16, 07C3, 07C14).

Host plant acceptance by *Hasora mixta limata*

In total, 15 first instar larvae were tested with leaves of *D*. *laxiflora* from northern Taiwan (HSU 06C16, *n* = 5; 07C3, *n* = 4; 07C14, *n* = 6), and 13 first instar larvae with *Milletia pachycarpa* (HSU 07C14, *n* = 13). *Derris laxiflora* was rejected by all larvae tested. Two larvae exhibited some feeding when tested with *M*. *pachycarpa*, but growth was retarded and they subsequently died; the plant was



Figs. 18-21. Immatures of *Hasora mixta limata*, subsp. nov. **18.** Ova concealed within 2 leaflets on a bud of *Paraderris* ?*piscatoria* (indicated by an arrow). **19.** Ova revealed after a leaflet was removed. Notice the transparent spumaline surrounding the ova (indicated by an arrow). **20.** Last instar larva. **21.** Pupa, lateral view.

rejected by the other 11 larvae tested.

DISCUSSION

Although *Hasora mixta* has a relatively large size among skippers, it is unclear why it was overlooked by previous butterfly surveys carried out on Lanyu. It is well known that most species of *Hasora* are crepuscular (Eliot 1992), and the adults of *H. mixta limata* we observed were all on the wing in the late afternoon or during cloudy weather, making its observation comparatively difficult (n = 17). Recognition of Coeliadinae species from an area may lag behind other species due to this crepuscular activity. A good example may be provided by the discovery of *Choaspes xanthopogon* (Kollar, [1844]) from the main island of Taiwan. Although *C. xanthopogon* is a relatively large and conspicuous species, it was found on the island as late as 1986 (Hsu 1988), right at a time when Shirôzu, a prominent butterfly researcher usually considered an authority on Taiwan butterflies, claimed that the inventory of butterfly and skipper fauna of Taiwan was nearly complete (Shirôzu 1986). Alternatively, *H. mixta* may have been confused with other *Hasora* species that were known to occur on the main island of Taiwan. Chen (1986) stated that *H. taminatus* (Hübner, [1818]) was an abundant species on Lanyu. Nevertheless, specimens of *H. taminatus* from Lanyu were not found in major butterfly collections in Taiwan, such as those of the NMNS and TARI. It is possible that individuals of "*H. taminatus*" observed by Chen (1986) were actually *H. mixta*.

No account of the biology or morphology of *H. mixta* has previously been documented in the literature, except for a brief host plant record in Zhang (1994) and Robinson et al. (2001). The most interesting observation of the account of immatures given in the present study is on the oviposition behavior of this skipper. The ovum is inserted among budding leaflets (Fig. 18) by the female and is then concealed with spumaline (Fig. 19). The papillae anales of *H. mixta* appear to be shovel-like (Fig. 16), a modification corresponding to endophytic oviposition (Powell 1984, Davis et al. 1992, Kristensen 2003, Yen et al. 2005, Hsu and Yen 2006). Among butterflies, such an oviposition behavior has been found in the lycaenid genera, *Jamides* (Bascombe et al. 1999) and *Prosotas* (Hsu and Yen 2006), but rarely found in skippers. To the present, only *H. taminatus* is known to demonstrate oviposition behavior similar to that of *H. mixta*, as reported in the present study and by Hsu (2002). It is noteworthy that *H. mixta* and *H. taminatus* belong to different species groups of *Hasora* (Evans 1949, Tsukiyama 1981, Parsons 1999), suggesting that this behavior may be more widespread than previously believed within *Hasora*, which contains 28 species (Tsukiyama et al. 1997) and is one of the most speciose genera of skippers in Southeast Asia (Tsukiyama 1981, Chiba 1995, Hsu et al. 2005).

The larval host of *H. mixta* found in the present study is a woody legume, a plant native to Lanyu and used as a poison for fishing or an item of talisman against rats by the local aboriginal Dao people (Cheng and Lu 2000). The taxonomic identity of this plant, however, is problematic. It is usually identified as "*Derris oblonga* Benth." (with type localities in India and Sri Lanka; syntypes listed by Adema 2003a) (e.g., Huang and Ohashi 1993, Cheng and Lu 2000), a name synonymized with *Paraderris canarensis* (Dalzell) Adema by Adema (2003a b). *Paraderris canarensis* (with a type locality in India; neotype designated by Thothathri 1982), however, is a plant with a distribution known to be restricted to India and Sri Lanka (Adema 2003a, ILDIS 2005); thus, it is unlikely to occur on Lanyu considering the enormous geographical gap between the Indian subcontinent and this volcanic island belonging to the Luzon volcanic arc (Ho 1988). According to Jer-Ming Hu (pers. comm.), the legume species that most conforms to the host plant of *H. mixta limata* on Lanyu in diagnostic characters of foliage, inflorescences, and fruit type may be *Paraderris piscatoria* (Blanco) Adema, which was described from Luzon of the northern Philippines (Adema 2003a). We tentatively accepted this name for the host plant of *H. mixta limata* on Lanyu, but have added a question mark in front of the specific name in this text to indicate that this identification is provisional, and its confirmation should await a formal treatment by botanists.

Although Lanyu is geographically not very far away from the islands of Taiwan and Luzon, it is well known that some of its inhabitants show a considerable degree of diversification, forming well-recognized races or subspecies endemic to the island. The swallowtail *Papilio bianor kotoensis* Sonan, 1927, is a well-known example; it possesses wing markings much brighter than those of *P. b. thrasymedes* Fruhstorfer, 1909, which inhabits the neighboring main island of Taiwan (Shirôzu 1960). Yen et al. (2003) provided an even more-impressive example by describing a

new subspecies of hawkmoth endemic to Lanyu, as this group of moths is known to be among the fastest insects, with some members being well-known migrants (Lemaire and Minet 1999). *Hasora mixta limbata* represents an additional such case. The style on the valva of *m*. *limbata* bears a short, clavate posterior arm (Fig. 11), whereas samples of *m*. *mixta* of Babuyan Is., Marinduque, and Mindoro of the Philippines all share similarly shaped styles (Figs. 12-14), with their posterior arms elongate and digitate. The style of *m*. *prabha* from Palawan is similar to that of *m*. *mixta* but possesses an additional dorsal bump (Fig. 15). Moreover, the metallic pale-green scales on the ventral wing surfaces are extensive in *m*. *limata* (Figs. 5, 6) but poorly recognizable or vestigial in *m*. *mixta* (Figs. 7, 8) or on other subspecies (BMNH specimens). Richard et al. (1986) stated that most rocks on Lanyu are less than 5 million yr old, and Pelletier and Stephan (1986) postulated that the volcanism that gave rise to Lanyu is of Miocene-Pliocene age. Although the birth of Lanyu might not be ancient, it seems likely that it is relatively difficult for organisms from nearby Taiwan or Luzon to reach the island. The wind currents that dominant Lanyu are mostly southerly and northeasterly in direction (Kano 1941), thus less likely to carry flying insects from the main island of Taiwan that lies some 60 km west of Lanyu. The island of Luzon is approximately 380 km to the south, and such a sea gap may be far enough to act as an effective barrier, as many butterflies and skippers commonly found on Luzon are not present on Lanyu, notably the species-rich lycaenid genus *Arhopala*. Patterns of wind currents, the distance from Luzon, and the age of the island may have provided sufficient isolation and time for founding populations of organisms on Lanyu to have differentiated. Several small islands are present between Lanyu and Luzon, including the Batan Is., Babuyan groups, and Camiguin de Luzon. Among these small islands, de Jong and Treadaway (1993) listed only Camiguin de Luzon in the distributional range of *H*. *m*. *mixta*, but we examined confirmed specimens of this taxon from the Babuyan groups (n = 10), and found their diagnostic characters agreeable with those of *H*. *m*. *mixta* from other islands of the Philippines (n = 17). There is no confirmed record of *H*. *mixta* from the Batan Is., which is situated between Lanyu and the Babuyans. It will be intriguing to determine whether *H*. *mixta* occurs on this island group.

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