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Description of a new subspecies of *Talicada nyseus* (Guérin-Méneville, 1843) from Hainan, China (Lepidoptera: Lycaenidae), with notes on the genus *Talicada* Moore, 1881

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Abstract

An insular population of *Talicada nyseus* was discovered from Hainan Island, representing a butterfly species unrecorded in China. Materials of this species from Hainan were compared with the races from other regions, revealing that the wing pattern is distinct from that of other subspecies, and is hereinto described as *T. nyseus lami* ssp. nov.. Information on immature stage and host association of the new subspecies, and notes on the genus is also provided.

Key words: South China, Indochina, butterflies, Crassulaceae, leaf miner, host association

Introduction

Talicada Moore, 1881 (Type species: *Polyommatus nyseus* Guérin-Méneville) is a monotypic Oriental genus, and the sole species of the genus, *T. nyseus* (Guérin-Méneville, 1843) distributes from Sri Lanka, Indian subcontinent to Indochina region. Eight subspecies were recognized prior to 2016, *viz*. *T. n. nyseus* from S. India and Sri Lanka, *T. n. khasiana* Swinhoe, 1893 from Khasia Hills, NE. India, *T. n. metana* Riley & Godfrey, 1921 from N. Thailand, *T. n. assamica* Seitz, 1924 from Assam, NE India, *T. n. annamitica* Seitz, 1924 from Indochina, *T. n. burmana* Evans, 1925 from Shan State, Myanmar to W. Thailand, *T. n. macbethi* Riley, 1932 from E. Thailand, and *T. n. delhiensis* R. Kumar, 2009 from N. India (Seitz, 1924; Evans, 1925; Pinratana, 1981; D'Abrera, 1986; Kumar *et al*., 2009).

An insular population of *T. nyseus* was found from Hainan Island, China during a series of joint biodiversity surveys conducted by Kadoorie Conservation China and Hainan Wildlife Conservation Bureau. That population represents the easternmost distribution of *T. nyseus* and is hereinto described as a new subspecies based on distinctive morphological differences between it and other known subspecies. The immature biology of the new subspecies was also investigated, and an account on life history and host associations is given herein. The possible origin of the new subspecies is briefly discussed.

Materials and methods

Rearing observation. Hostplant association of *Talicada nyseus* was documented as early as Moore (1881) and Nicéville (1890). The known hostplants of *T. nyseus* are all succulent plants of the family Crassulaceae, including *Bryophyllum pinnatum* (sometimes as *Bryophyllum calycinum* or *Kalanchoe pinnata*), *Kalanchoe integra* (also as *Kalanchoe spathulata*) and *Kalanchoe laciniata* (Nicéville, 1890; Seitz, 1924; D'Abrera, 1998; Kumar *et al*., 2009; Smetacek, 2011; Saito, 2014).

In this study, the immatures of *Talicada nyseus* were collected from *Bryophyllum pinnatum* and *Kalanchoe integra* in Yinggelling National Nature Reserve (Yinggeling NNR) of Hainan. Larvae were kept in plastic container with leaves of hostplant provided until pupation. Duration of immature stage was also recorded.

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Taxonomic methods. Dissection of male genitalia follows the protocol of Hsu (2015). Terminology for genitalia follows Klots (1970), wing patterns follows Nijhout (1991) and venation follows Scoble (1992). Vouchers are or will be deposited in the following institutes or collections: Institute of Zoology, Chinese Academy of Sciences, Beijing (IOZ); The Museum of Biology, School of Life Sciences, Sun Yat-sen University, Guangzhou (SYSU); The Natural History Museum, London (BMNH); Insect Collection, Kadoorie Conservation China, Kadoorie Farm and Botanic Garden, Hong Kong (KFBG); Department of Biology, National Taiwan Normal University, Taipei (NTNU); Private collection of the senior author, Hong Kong (YFLC). Samples of *Talicada nyseus* from Hainan were compared with photos of the collections in BMNH and Indian Agricultural Research Institute, New Delhi (IARI), or actual specimens of conspecific taxa from other regions including: *T. n. nyseus* (2♂2♀, South India, BMNH; 1♂2♀, India, YFLC, ♂ dissected, genitalia YFL ly0023), *T. n. khasiana* (1♂ holotype 1♀ allotype, Khasia Hill, BMNH), *T. n. metana* (1♀ holotype, N. Siam, BMNH), *T. n. assamica* (1 gender undetermined specimen, Khasia Hills, BMNH), *T. n. annamitica* (1♀, S. Vietnam, YFLC), *T. n. burmana* (1 gender undetermined specimen, Upper Burma, BMNH), *T. n. machethi* (1♀, East Siam, BMNH), *T. n. delhiensis* (1♂ holotype 1♀ paratype, New Delhi, IARI). Illustrations from original description of above taxa also served as supplementary reference.

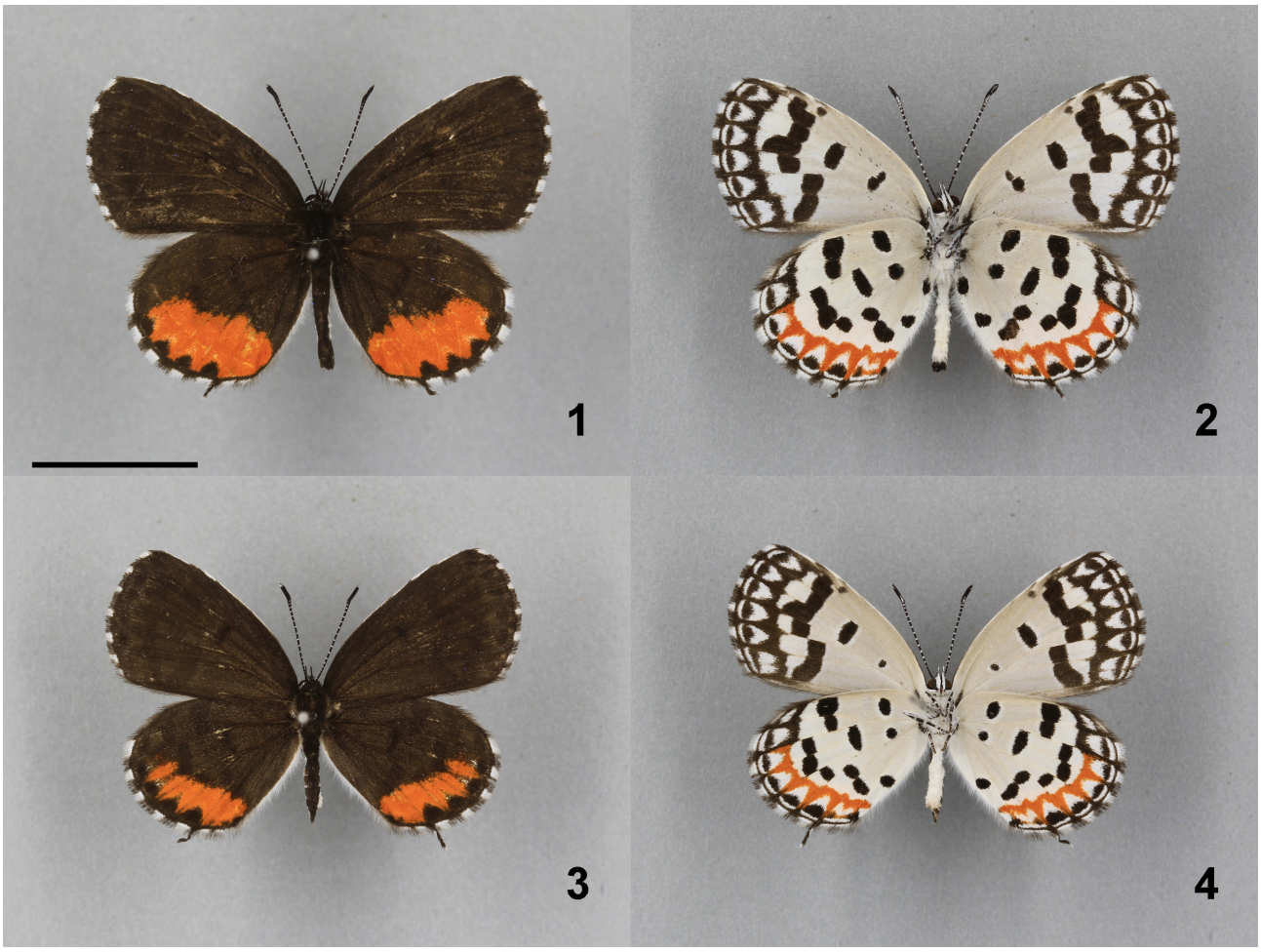
Systematic accounts

Talicada nyseus lami Lo, Li & Ding subsp. nov.

Type material. HOLOTYPE: ♂, China: Hainan Island, Baisha County, Yinggeling NNR, Gaofeng River, 15–16.XII.2007, Coll. Y. F. Lo, pupa on *Bryophyllum pinnatum*, emgd. 18.XII.2007 (IOZ). PARATYPES: 2♂1♀, locality and date as holotype, Coll. Y. F. Lo (IOZ, YFLC) (1♂ dissected, genitalia YFL ly0015). 4♂3♀, locality and date as holotype, Coll. Y. F. Lo, reared from *Kalanchoe integra*, emgd. 09–15.I.2008 (YFLC, KFBG). 2♂1♀, locality and date as holotype, Coll. Y. F. Lo, reared from *Bryophyllum pinnatum*, emgd. 16.II.2008 (YFLC, BMNH). 3♂, locality as holotype, 14–16.V.2008, Coll. Y. F. Lo (YFLC, NTNU). 1♂, locality as holotype, 11.I.2009, Coll. Y. F. Lo (YFLC). 1♂, China: Hainan Island, Changjiang County, Nanyao River, Huangdi Cave, 26.IV.2009, Coll. Y. F. Lo (YFLC). 2♂, China: Hainan Island, Changjiang County, Nanyao River, Huangdi Cave, 06.VI.2009, Coll. Y. F. Lo (YFLC). 1♂1♀, locality as holotype, 03.IX.2010, Coll. F. Li, reared from *Kalanchoe integra*, emgd. XI.2010 (YFLC). 1♂, China: Hainan Island, Dongfeng County, Exianling, 14.I.2012, Coll. Y. F. Lo (YFLC). 3♂, China: Hainan Island, Changjiang County, Bawangling NNR, Donger, 25.XI.2013, Coll. Y. F. Lo & F. Li (YFLC, SYSU).

Male (Figs. 1–2): Length of antenna 6.7–7.7mm (7.2mm ± 0.3mm, n=17). Wingspan 23.9–27.7mm (25.8mm ± 1.2mm, n=13). Forewing: Upperside ground color dark brown. Underside ground color white. Central symmetry system with distal band forming a series of dark bars. The bar in cell M_2 twice as width as others while the bars completely dislocated inward in cell CuA_1 and bent outwards in cell CuA_2. Proximal band represented by 1 to 2 dark dots in discoidal cell. Discal spot represented by a dark bar. Element "g" prominent forming a continuous dark band with dark scales extending to marginal band along each vein. Marginal ocelli present in each cell as a series of barely connected dark oval spots. Parafocal element forming a continuous dark line along the margin. Hindwing: Upperside ground color dark brown. Bright orange band with wavy outer margin present at outer half of postdiscal and marginal area from cell M_1 to A. "Tail-like" projection of CuA_2 short, dark with white tip. Underside ground color white. Central symmetry system with distal band forming a series of dark bars, completely dislocated outward in cells M_1 to M_3, displaced inward in cells CuA_1 and CuA_2, becoming a stand alone dark spot in cell 2A and also in 3A in some individuals. Proximal band forming two dark spots in $Sc+R_1$ cell and discoidal cell. Discal spot represented by a dark bar. Element "g" prominent represented by a continuous band with color scales extending to marginal band along each vein, dark in cells $Sc+R_1$ and R_2 while bright orange from cells M_1 to 2A. Marginal ocelli present in each cell as a series of dark oval spots. Parafocal element forming a continuous narrow dark line along the margin. Fringes of both wings distinctly chequered with dark and white cilia.

Female (Figs. 3–4): Length of antenna 6.2–7.7mm (6.9mm ± 0.5mm, n=6). Wingspan 25.2–28.7mm (26.6mm ± 1.2mm, n=6). Wing pattern resembles to that of the male.



FIGURES 1–4. *Talicada nyseus lami* subsp. n.. 1, holotype ♂, upperside; 2, ditto, underside; 3, paratype ♀, upperside; 4, ditto, underside. (scale bar = 10 mm)

Distribution and habitat. This subspecies is known only from well preserved natural forests in mountainous area of Baisha, Changjiang and Dongfang counties on Hainan Island, China. It prefers shrubs adjacent to bare rock in karst landscape or along stream, where its hostplants present.

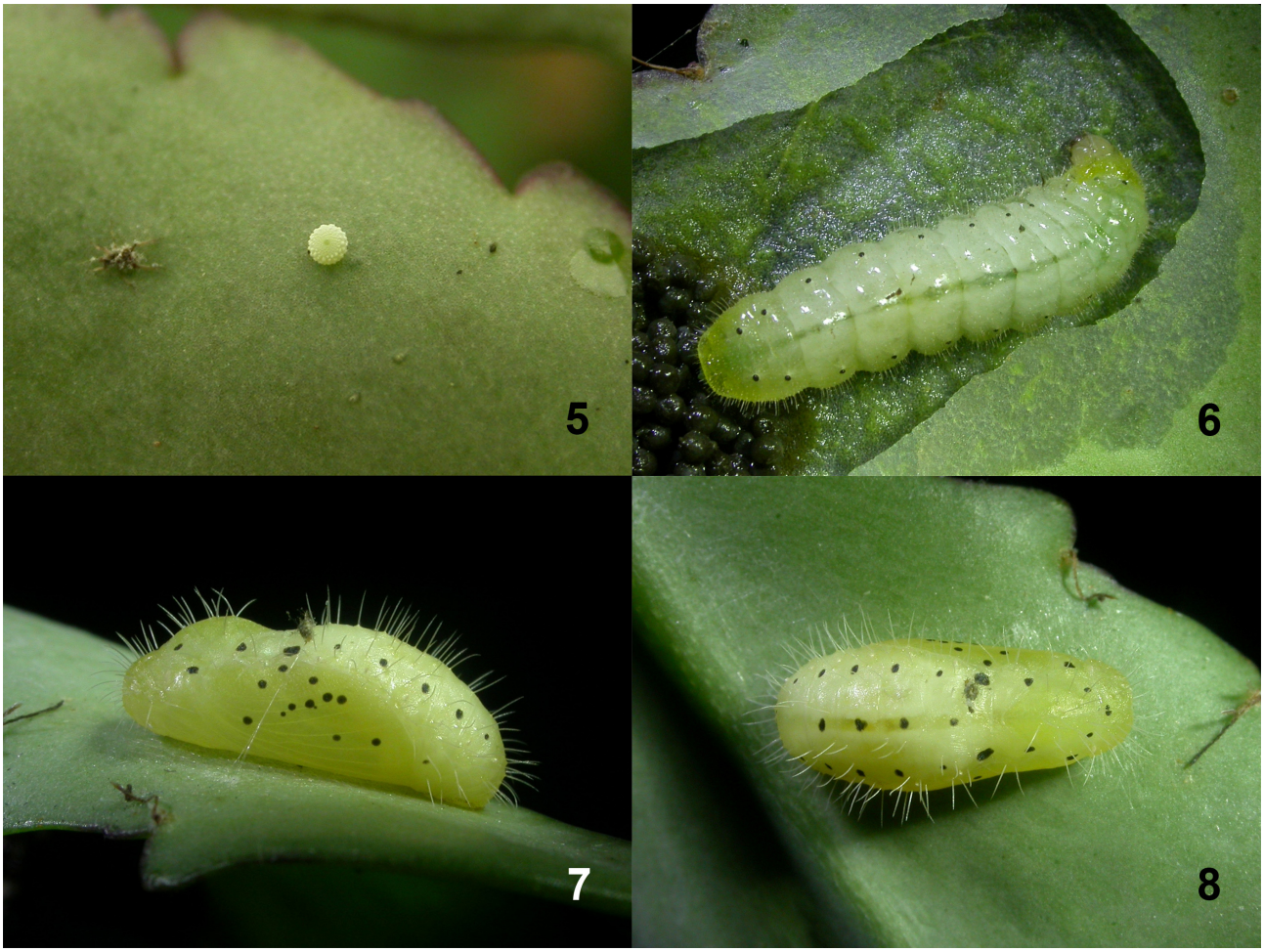
Host plant. The immature of this subspecies is apparently associated with the family Crassulaceae. *Kalanchoe integra* and *Bryophyllum pinnatum*, a naturalised plant with African origin, were utilized by larvae in the wild.

Immature bionomics. ovum (Fig. 5) is laid singly on the underside of leaf blade. Once hatched, larva bores into leaf of hostplant as leaf miner and feeds on tissue in mesophyll layer (Fig. 6). Larva does not emerge unless the original leaf is completely consumed. Mature larva pupates on the underside of leaf of hostplant (Figs. 7–8). The entire immature stage, from egg to emergence of adult, takes 61–62 days (n=3) under indoor uncontrolled condition.

Voltinism. Multivoltine, adult occurs all year round.

Etymology. The name of the subspecies is dedicated to Alexander Lam's family in Boston, USA, for their love and care to the senior author during his undergraduate study in Boston.

Diagnosis. The male genitalia (Figs. 9–12) of *T. n. lami* resembles that of nominate subspecies and *T. n. delhiensis* in general, with long and tapering uncus, prominent brachium, broad valvae with harpe modified to long spine-shaped projection. The size of *T. nyseus lami* is similar to *T. n. annamitica* and both are the smallest among all subspecies. Interestingly, the wing pattern of *T. nyseus lami* seems like a combination of several other subspecies. First of all, the wavy outer margin of the orange band on upper hindwing and dark marginal ocelli from cell M_1 to 2A on underside hindwing are features only found in three eastern subspecies, *T. n. metana*, *T. n. annamitica* and *T. n. lami*. However, dark spots in the middle of discoidal cell is a trait only shared by *T. n. macbethi* and *T. n. lami*. Furthermore, *T. n. lami* is similar to *T. n. burmana* the most in that the arrangement of distal band of central symmetry system, but all the spots are detached from the band of element "g" as defined by Nijhout (1991).

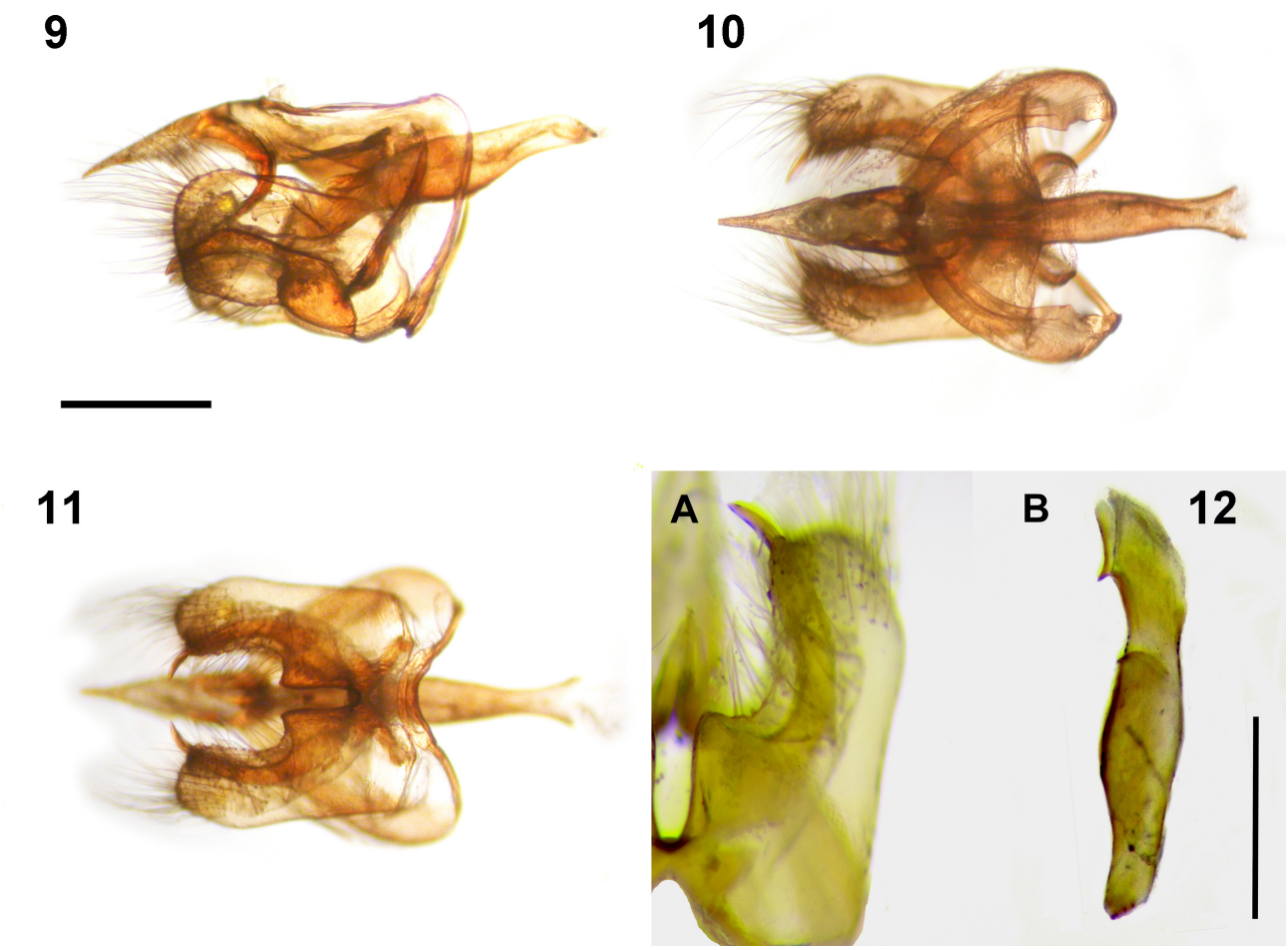


FIGURES 5–8. Immature stages of *Talicada nyseus lami* subsp. n.. 5, ovum on underside surface of *Bryophyllum pinnatum*; 6, last-instar larva (epidermis of the hostplant removed); 7, pupa on underside surface of *Kalanchoe integra*, lateral view; 8, ditto, dorsal view.

Six distinctive underside patterns, assigned as A to F hereinto, can be identified among the nine subspecies: three subspecies, *macbethi* (A), *burmana* (B) and *lami* (C), have unique pattern and the rest three patterns are shared by three subspecies pairs, *nyseus* & *delhiensis* (D); *khasiana* & *assamica* (E); *metana* & *annamitica* (F), respectively.

Tentative key to subspecies of *Talicada nyseus*

1 Marginal ocelli on underside hindwing from cell M_1 to 2A orange 2
- Marginal ocelli on underside hindwing from cell M_1 to 2A dark 5
2 Proximal band of central symmetry system absent on forewing underside 3
- Proximal band of central symmetry system present on forewing underside. . . . . *macbethi* (pattern A)
3 Distal band of central symmetry system on underside of forewing very broad but that of hindwing poorly developed as dot shape . . . . . *nyseus, delhiensis* (pattern D)
- Distal band of central symmetry system on underside of forewing and hindwing equally developed as bar shape 4
4 Distal band of central symmetry system on underside of forewing barely in touch with the band of element “g” . . . . . *burmana* (pattern B)
- Distal band of central symmetry system on underside of forewing detached from the band of element “g”. . . . . *khasiana, assamica* (pattern E)
5 Distal band of central symmetry system on underside of forewing and hindwing fully in touch with the band of element “g” . . . . . 6 (pattern F)
- Distal band of central symmetry system on underside of forewing and hindwing detached from the band of element “g” . . . . . *lami* (pattern C)
6 Orange band on upper hindwing reaching cell Rs . . . . . *metana*
- Orange band on upper hindwing never extend into cell Rs . . . . . *annamitica*



FIGURES 9–11. Male genitalia of *Talicada nyseus lami* subsp. n.. 9, lateral view; 10, dorsal view; 11, ventral view. (scale bar = 0.5 mm)

FIGURE 12. Enlarged view of male genitalia of *Talicada nyseus lami* subsp. n.. A, right valva; B, aedeagus. (scale bar = 0.5 mm)

Discussion

In this study, we consider *Talicada* as a monotypic genus mainly based on morphological similarity and distribution pattern of different subspecies of *T. nyseus*. According to literature records, museum collections and present study, the six underside patterns A to F have allopatric distribution (Fig. 13), which forms an almost continuous belt from west to east without obvious overlapping. Different pattern and size among subspecies probably only reflects evolution and adaptation of different populations. Differentiation is likely in process but these subspecies are not distinctive enough for specific status because there is no significant differentiation in male genitalia morphology between *T. n. nyseus* from Western Ghats, the westernmost population, and *T. n. lami* from Hainan, the easternmost population. Meanwhile, although the status between the counterparts of the three subspecies pairs (*nyseus* & *delhiensis*; *khasiana* & *assamica*; *metana* & *annamitica*) needs further verification, and it is very likely to involve synonyms, no taxonomic action is taken in this study since the authors were unable to examine all the necessary type materials.

Additional population of *T. nyseus* occurs in central and southern Vietnam (Monastyrskii and Devyatkin 2015) but absent in the continental China. Such distribution pattern suggests that the ancestor of *T. nyseus lami* was probably a race of Indochinese population that inhabited on dry land of present submerged continental shelf during last glaciation. When dry-land connection disappeared after glaciation, the Hainan race became isolated and evolved to a distinct subspecies consequently. In that sense, *metana* and *annamitica* from Indochina could be the

closest sister subspecies of *lami*, and they indeed share some characteristics that do not exist in other subspecies, such as the dark marginal ocelli on the underside hindwing. In addition, similar distribution pattern is not rare in butterflies of Hainan. For example, *Losaria coon insperata* and *Graphium aristeus hainanensis*, from the family Papilionidae, are Hainan endemic subspecies with their closest conspecific taxa present in central and southern Indochina but absent in adjacent continental provinces of China and northern Vietnam and Laos (Gu and Chen 1997, Osada *et al*, 1999, Monastyrskii and Devyatkin 2015, Wu and Hsu, 2017). The present ranges of these taxa demonstrate certain connection between insect fauna in Hainan and the southern half of Indochina.

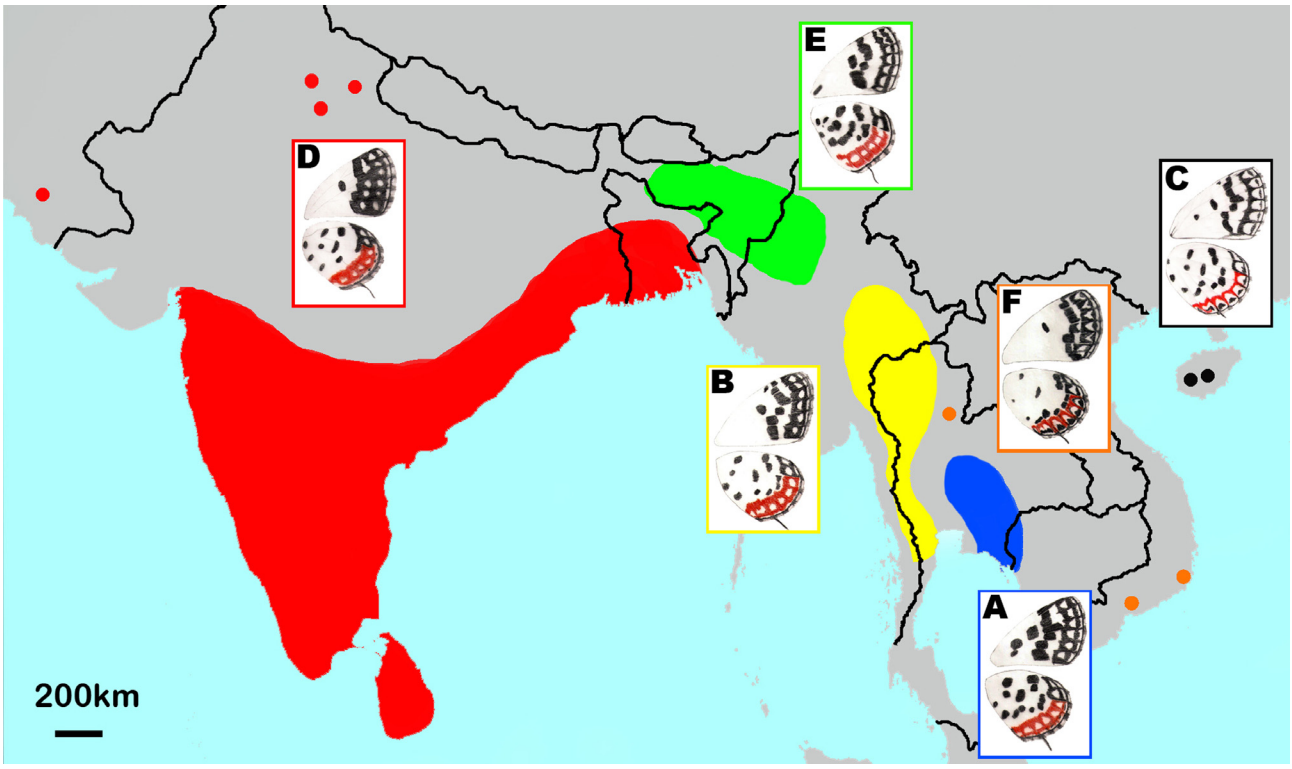


FIGURE 13. A map showing approximate distribution of *Talicada nyseus* underside pattern A to F (refer to the key of main text) and corresponding subspecies: red, *T. n. nyseus* & *T. n. delhiensis*; green, *T. n. khasiana* & *T. n. assamica*; yellow, *T. n. burmana*; blue, *T. n. macbethi*; orange, *T. n. metana* & *T. n. annamitica*; dark circle, *T. n. lami*. (data sources: Amnuay 2006; Evans 1925; Kumar *et al.* 2009; Monastyrskii and Devyatkin 2015; Pinratana 1981; Riley 1932; Riley & Godfrey 1921; Singh 2005; Smetacek 2011; collections of BMNH and YFLC)

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