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Research Article

Taxonomic status of Genus *Brahmaea* Walker (Lepidoptera: Bombycoidea: Brahmaeidae) from India

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Abstract

Background and Objective: The genus *Brahmaea* Walker is represented by eight species out of which two species i.e., *wallichii* Gray and *hearseyi* White are known from India. These species are closely allied and it is not easy to differentiate these species on the basis of external morphological characters. Hence, to differentiate these species, external genitalic structures have been examined and illustrated in detail. A key has also been formulated. In the present study, the external morphological features such as wing maculation, venation along with external male genitalic attributes have been studied in detail. **Materials and Methods:** During collection cum survey tours conducted in different areas of Himachal Pradesh, the adult specimens of these species were collected by using light traps. The external morphological features were studied from the dried specimens. The permanent slides of wings were prepared and dissections were done to explore genitalic features. **Results:** The wing venation and the genitalic features of these two species proved to be significant in differentiation. **Conclusion:** On the basis of these studies, these two species are significantly distinct from each other.

Key words: Lepidoptera, *Brahmaea*, *wallichii*, *hearseyi*, external genitalia

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The family Brahmaeidae referable to superfamily Bombycoidea is found in African, Oriental and Palaearctic regions. The genus name *Brahmaea* Walker was established by Walker¹ with *Bombyx certhia* Fabricius as its type species. Later on Butler² described that type species *Brahmaea certhia* Fabricius has been misidentified as *Bombyx certhia* Fabricius by Walker. Hampson³ designated *Bombyx certhia* Fabricius from China as true type species of genus *Brahmaea* Walker which was virtually accepted by all the authors. Mell⁴ established *Brahmophthalma* with type species *Bombyx wallichii* Gray as subgenus of *Brahmaea*. Bryk⁵ gave *Brahmophthalma* Mell as full generic status with two subgenera namely *Brahmaeops* and *Brahmidia*. This concept was accepted by Sauter⁶ and Barlow⁷, but Inoue *et al.*⁸ synonymised Bryk's genus *Brahmophthalma* and subgenera with *Brahmaea* Walker. Nassig and Nye⁹ reviewed this genus and proposed confirmation of its type species. Presently this family is represented by four genera namely Oriental and Palaearctic genus *Brahmaea* Walker with eight species, a monotypic European genus *Acanthobrahmaea* Sauter, a monotypic Chinese genus *Calliprogonos* Mell and an Afrotropical genus *Dactyloceras* Mell with eight species¹⁰. Sauter⁶ placed two genera i.e., *Calliprogonos* Mell and *Dactyloceras* Mell in a separate subfamily Dactyloceratinae, but this division was not accepted by latter workers. Presently the genus *Brahmaea* Walker is represented by eight species. However, six species of this genus are endemic to Palearctic region namely *Brahmaea tancrei* Austaut (Russian Far East, Korea), *Brahmaea certhia* Fabricius (Sino-Korean), *Brahmaea litserra* Hao, Zhang and Yang (Northern China), *Brahmaea japonica* (Butler) (from Japan), *Brahmaea (Acanthobrahmaea) europaea* Hartig (from Italy), *Brahmaea ledereri* Rogenhofer (Turkey and adjacent small area of Syria). The genus *Brahmaea* Walker is represented by two species namely *Brahmaea wallichii* Gray and *Brahmaea hearseyi* White from India. The species *Brahmaea wallichii* Gray was named after the botanist Nathaniel Wallich whereas, the species *Brahmaea hearseyi* White was named after the General Sir John Hearsey who collected this species for the first time from India. The adult representatives of these species are characterised by medium to large sized moths having wing expanse ranging from 115-170 mm and the species occurring in tropical-subtropical regions are with circular "eye" markings on their wings (Owl moths). These species feed on *Ligustrum vulgare* Linnaeus (Oleaceae) and *Syringa vulgaris* Linnaeus (Oleaceae) and these are able to neutralize plant toxins produced by

Ligustrum. Both these species are reported for the first time from Himachal Pradesh. The taxonomic status of genus *Brahmaea* Walker has been updated along with an inclusions of important characters such as wing venation, maculation particularly the genitalic features.

MATERIALS AND METHODS

During collection surveys (2013-2014) for the collection of bombycoid moths, the adult representatives of species namely *wallichii* Gray and *hearseyi* White of genus *Brahmaea* Walker of family Brahmaeidae were collected from different localities of Himachal Pradesh (North-West India). The collected moths were killed in the jars containing ethyl acetate and were properly stretched on stretching boards and finally preserved in air tight wooden boxes. The procedure given by Robinson¹¹ to explore the external genitalic attributes has been followed and to study wing venation, the procedure given by Zimmerman¹² has been adopted. The terminology for naming different genitalic features is after Klots¹³.

RESULTS AND DISCUSSION

Genus *Brahmaea* walker: Walker, 1855, *Cat. Lepid.*, 6: 1315, Hampson, 1892, *Moths India* 1: 29-30, Holloway, 1987, *Moths Borneo*, 3: 94, Nassig and Treadway, 1998, *The Brahmaeidae (Lepidoptera)* of the Philippines, 17: 427.

- **Type species:** *Certhia* Fabricius
- **Distribution:** Africa, Oriental and Palaearctic regions

Diagnosis: Labial palpus large, rounded, upturned, reaching upper level of frons. Antennae bipectinate, branches short. Forewing broader, discal cell closed, nearly one-third length of wing, 3A and 2A fused with basal fork, 1A absent, Cu₂ emerging from beyond middle of discal cell, Cu₁ from well before lower angle of discal cell, M₃ from lower angle of cell, M₁ from upper angle of cell, R₅-R₁ from upper angle, Sc originating from base of wing, not reaching up to apex. Hindwing with discal cell one-fourth length of wing, 3A and 2A fused, without basal fork, 1A absent, Cu₂ emerging from beyond middle of discal cell, M₃ arising from lower angle of cell, M₁ from upper angle of discal cell; Rs from before upper angle of cell, Sc+R₁ emerging from base of wing forming a bar just beyond discal cell. Legs with mid-tibia having one pair and hind-tibia with two pairs of tibial spurs (0-2-4), forelegs with epiphysis.

***Brahmaea wallichii* Gray:**

- *Brahmaea wallichii*, Gray, 1831, Zool. Mus., 1831: 39, Hampson, 1892, Moths India, 1: 30-31
- *Bombya spectabilis*, Hope, 1841, Trans. Linn. Soc., 18: 443
- *Brahmaea conchifera*, Butler, 1880, American Mus. Nat. His., 5 (5): 188
- *Brahmaea rufescens*, Butler, 1880, American Mus. Nat. His. 6 (5): 62 (Fig. 1)

Diagnosis: Head black. thorax brown with three pairs of black lines, collar and tegula black edged with brown scales, underside black. Abdomen black edged with brown scales, laterally brown with two zig-zag black markings, underside brown with broad black band narrowing towards anal end, lateral black lines on both sides, last segment black.

Wing maculation: Forewing broader, basal area black intermingled with brown scales, nine black lunulate lines on outer area between vein M_2 and inner margin, some in the form of brackets, two black medial lines, outer one concave enclosing an irregular space below costa at vein Cu_2 and enclosing round space above inner margin, sub apical patch black decorated with yellow and white scales, yellow band above vein Cu_2 , brown submarginal broken line, marginal area brown, cilia brown, underside black. Hindwing with basal area black having prominent brown streaks towards inner margin, nine wavy lunulate lines on outer area, eight black wavy lines running from costa to inner margin, underside black.

Wing venation: Forewing with vein M_2 from above middle of discocellulars, M_1 from upper angle of cell, R_5-R_1 all stalked from upper angle of cell. Hindwing with vein M_2 from middle of discocellulars.

Male genitalia: Uncus well developed, moderately sclerotized, setosed, broad, hood-like, gradually narrowing towards blunt apex; gnathos well sclerotized, fused forming a shield like flap, armed with minute denticles; tegumen semi-sclerotized, broad, 'U' shaped, gradually narrowing towards vinculum, vinculum narrow almost half length of tegumen, saccus absent, juxta broad, shield-like, proximal half narrow, distal half slightly sclerotized. Valva broad, slightly sclerotized, costa semi-sclerotized, setosed, broad, having flap like structure representing costula extending beyond middle of valva, saccus well sclerotized having a ridge like curved, highly sclerotized saccular projection, distally with dentate margins,

distal end of valva rounded, setosed. Aedeagus short, moderately sclerotized, gradually broad towards distal end, proximal one-third portion flap-like, ductus ejaculatorius entering under this flap, vesica armed with numerous, minute denticles.

- **Wing expanse:** Male: 138 mm
- **Abdomen:** Male: 31 mm
- **Material examined:** Himachal Pradesh: Chitkul, 23.vi.2014, 2♂♂
- **Distribution:** India: Assam, Khasi Hills; Himachal Pradesh; Jammu and Kashmir, Sikkim. Elsewhere: Nepal, Philippines, Sundaland, Myanmar and West China

***Brahmaea hearseyi* White:** *Brahmaea hearseyi* White, 1862 Proc. Ent. Soc. London, 1 (3): 26, Hampson, 1892, Moths India, 1: 31; Holloway, 1987, Moths Borneo, 3: 93, Nassig and Treadway, 1998, The Brahmaeidae (*Lepidoptera*) of the Philippines, 17: 427.

Brahmaea whitei Butler, 1866, Proc. Zool. Soc. London, 1866: 119 (Fig. 2).

Diagnosis: Head black. thorax brown with three pairs of black lines, collar and tegula black intermingled with brown scales, underside black. Abdomen brown with paired black bands on upper side, laterally brown with two zig-zag black markings, underside brown with single medial black line, with lateral black lines on both sides, last segment black.

Wing maculation: Forewing with basal area black intermingled with some brown scales, eight black lunulate lines on outer area between vein M_2 and inner margin, some in form of brackets, two black medial lines, outer one concave enclosing an irregular space below costa at vein Cu_2 and enclosing round space above inner margin, sub apical patch black decorated with yellow and white scales, yellow band above vein Cu_2 , brown submarginal broken line, marginal area brown, cilia brown, underside black. Hindwing with basal area black with prominent brown streaks towards inner margin, nine wavy lunulate lines on outer area, eight black wavy lines running from costa to inner margin, underside black.

Wing venation: Forewing with vein M_2 emerging from well above middle of discocellulars, R_5-R_2 stalked, R_1 from upper angle of cell. Hindwing with vein M_2 from above middle of discocellulars.

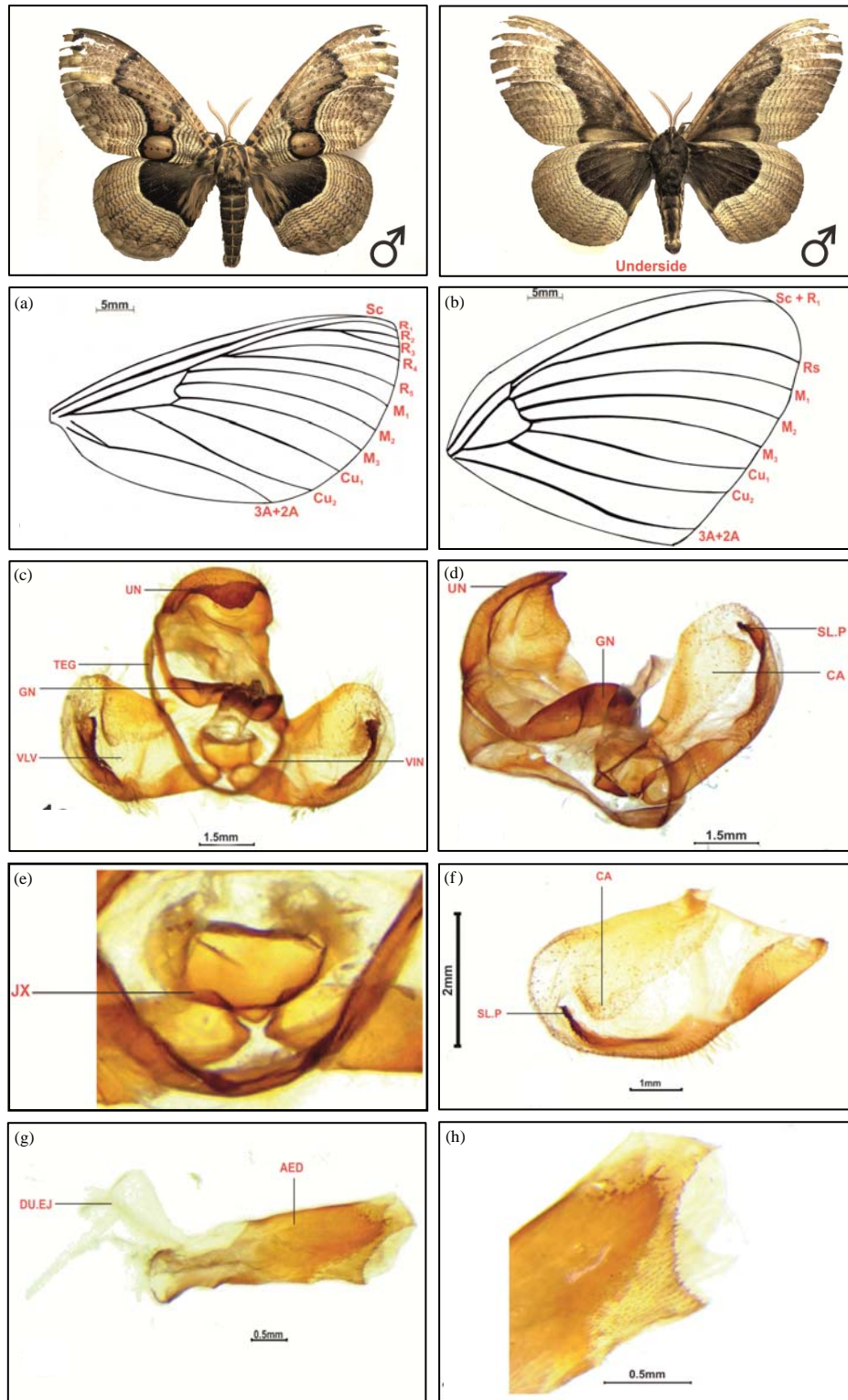


Fig. 1(a-h): *Brahmaea wallichii* Gray (a) Forewing, (b) Hindwing, (c) Male genitalia-ventral view, (d) Lateral view, (e) Juxta (enlarged), (f) Valva, (g) Aedeagus and (h) Aedeagus-distal end

3A: Third anal vein, 2A: Second Anal vein, Cu₂: Second cubital vein, Cu₁: First cubital vein, M₃: Third medial vein, M₂: Second medial vein, M₁: First medial vein, R₅: Fifth radial vein, R₄: Fourth radial vein, R₃: Third radial vein, R₂: Second radial vein, R₁: First radial vein, Rs: Radial sector, Sc: Subcosta, Sc+R1: Subcosta+radial vein, UN: Uncus, TEG: Tegumen, GN: Gnathos, VIN: Vinculum and VLV: Valva, CA: Costula, SL.P: Saccular projection, JX: Juxta, AED: Aedeagus, DU.EJ: Ductus ejaculatorius

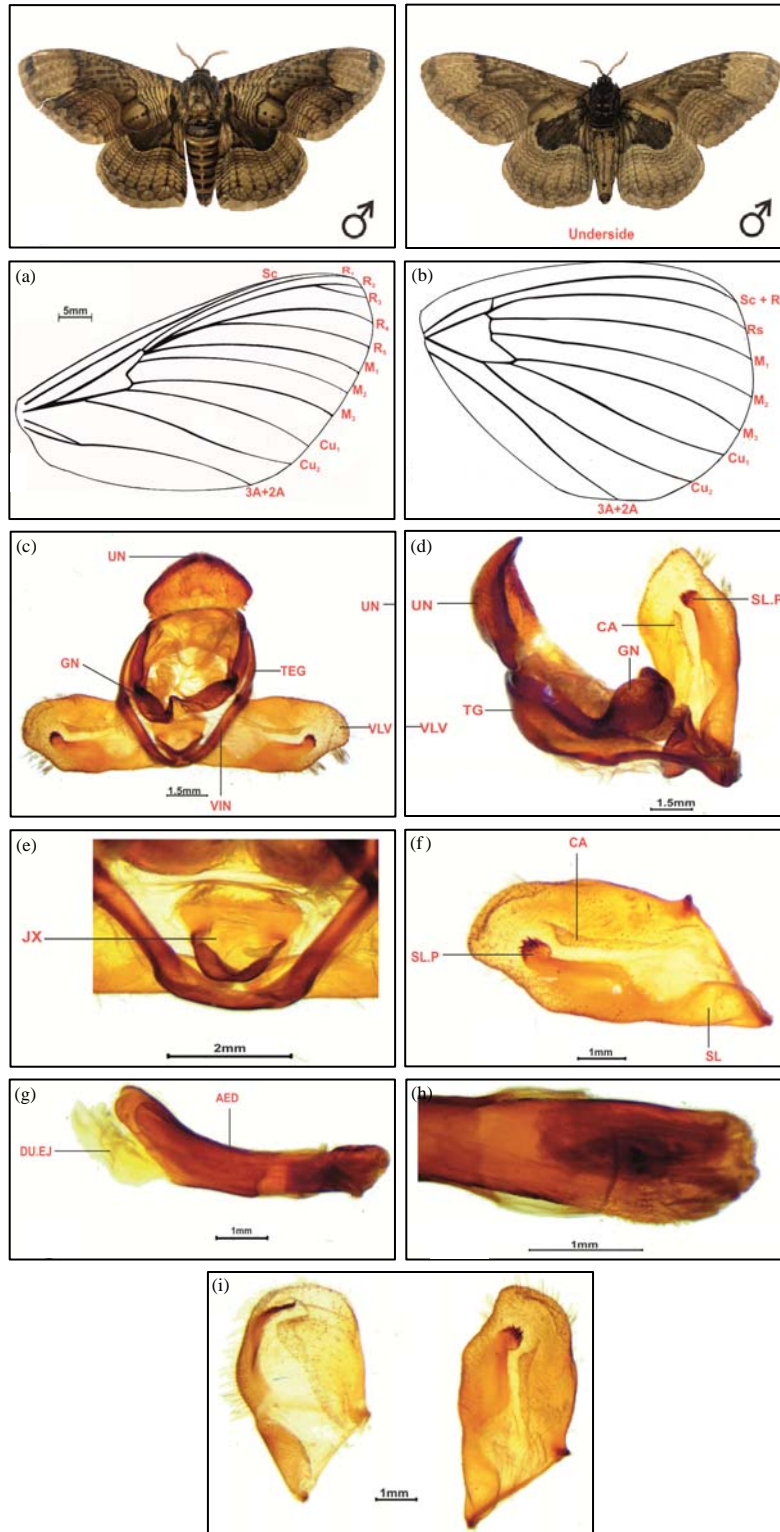


Fig. 2: (a-i) *Brahmaea hearseyi* White (a) Forewing, (b) Hindwing, (c) Male genitalia-ventral view, (d) Lateral view, (e) Juxta (enlarged), (f) Valva, (g) Aedeagus, (h) Aedeagus-distal end and (i) Valve of *B. wallichii* and *B. hearseyi*

3A: Third anal vein, 2A: Second Anal vein, Cu₂: Second cubital vein, Cu₁: First cubital vein, M₃: Third medial vein, M₂: Second medial vein, M₁: First medial vein, R₅: Fifth radial vein, R₄: Fourth radial vein, R₃: Third radial vein, R₂: Second radial vein, R₁: First radial vein, Rs: Radial sector, Sc: Subcosta, Sc+R1: Subcosta+radial vein, UN: Uncus, TEG: Tegumen, GN: Gnathos, VIN: Vinculum, VLV: Valva, CA: Costula, SL: Sacculus, SL.P: Saccular projection, JX: Juxta, AED: Aedeagus, DU.EJ: Ductus ejaculatorius

Male genitalia: Uncus well developed, well sclerotized, setosed, broad, triangular hood-like, apex rounded, distally with bulbous ending, gnathos well sclerotized with minute denticles, fused medially forming shield-like structure, tegumen well sclerotized, broad, 'U' shaped, narrowing towards distal end; vinculum narrow, shorter than tegumen, saccus reduced, juxta 'V' shaped, more sclerotized. Valva slightly sclerotized, costa setosed with narrow well setosed flap-like structure representing costula, sacculus broad, well sclerotized with broad saccular projection having globular ending with prominent dentations, distal end of valva setosed, slightly narrower towards distal end. Aedeagus of moderate size, highly sclerotized, proximal one-third portion flap-like, ductus ejaculatorius entering directly under this flap, vesica with distal end more sclerotized and its lower half having minute denticles.

- **Wing expanse:** Male: 126 mm
- **Abdomen:** Male: 31 mm
- **Material examined:** Himachal Pradesh: Mandi, 26.vii. 2014, 1♂; 206.v.2015, 2♂♂
- **Distribution:** India: Himachal Pradesh, Sikkim, Uttarakhand, elsewhere: Myanmar, Philippines, Sundaland and West China

The morphological features and particularly the genitalic features of these two species completely confirms with type species i.e., *Certhia* Fabricius and forms a natural group.

Key to the Indian species of genus *Brahmaea* Walker:

Forewing with medial line concave, nine black lunulate lines on outer area between vein M_2 and inner margin, R_5 - R_1 all stalked from upper angle of cell, hindwing with vein M_2 from middle of discocellulars, abdomen black with median black lines edged with brown, underside brown with broad black band narrowing towards anal end, male genitalia with uncus having blunt apex, saccus absent, costula covering almost half portion of valva, aedeagus moderately sclerotized and vesica armed with prominent denticles...*B. wallichii* Gray....Forewing with medial line convex, eight black lunulate lines on outer area between vein M_2 and inner margin, R_5 -to R_2 stalked from upper angle of discal cell, R_1 emerging from upper angle of cell, hindwing with vein M_2 from above middle of discocellulars, abdomen brown with paired narrow black bands, underside brown with single black line in middle, male genitalia with uncus having rounded apex, saccus reduced,

costula is represented by flap-like structure, aedeagus highly sclerotized and vesica armed with minute denticles...*B. hearseyi* White.

CONCLUSION

The external morphology features such as general ornamentation, wing maculation, venation and particularly the male genitalic features proved to be the significant features for differentiation of these two closely allied species namely *Brahmaea wallichii* Gray and *Brahmaea hearseyi* White.

SIGNIFICANT STATEMENT

This study determined the importance of male external genitalic structures in order to segregate the closely allied species i.e., *wallichii* Gray and *hearseyi* White and hence, these finding helps in the field of taxonomy in order to provide the current status of these species. Besides this, these two species have been examined and illustrated in detail from North-West India for the first time.

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