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Authors: Sharma, Narender, and Rose, H.S.

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ADDITIONAL NOTES ON THE HIMALAYAN GENUS *AULOCERA* BUTLER (NYMPHALIDAE : SATYRINAE)

NARENDER SHARMA

AND

H.S.Rose

Zoological Survey of India, Northern Regional Centre, 218 Kaulagarh Road, Dehradun-248 195, e-mail : narender@scientist.com

ABSTRACT. All the four species i.e., *brahminus* Blanchard, *saraswati* Kollar, *padma* Kollar and *swaha* Kollar referable to the Himalayan genus *Aulocera* Butler have been re-examined. The structures of the male and female genitalia have been interpreted along with previously known characters. In spite of minor variation in the valva of the male genitalia of *saraswati* Kollar, all the four species are broadly congeneric and form a natural group in the Himalayan region.

Additional key words: Genitalia, brachia, angular appendices, signa, genital plate.

During the course of surveys undertaken in an ICAR (Indian Council of Agricultural Research) project, four species i.e., *Aulocera brahminus* (Blanchard), *A. saraswati* (Kollar), *A. padma* (Kollar) and *A. swaha* (Kollar) were collected from certain localities in Dhaula Dhar Range, Pir Panjal range, Greater Himalaya, and Shiwalik foot Hills. These localities fall within an altitudinal range varying from 1363 m to 2929 m. Based upon examination of various morphological characters, particularly the genitalia, it has been established that *Aulocera* Butler is a natural group, having its distribution only in the Himalayan region. Evans (1932), Talbot (1947) and Mani (1986) have given interspecific keys, but none has used the genitalic characters, which are otherwise quite consistent in different biological species. Accordingly, besides an updated key, an illustrated account of the genitalia and new distributional localities are presented here.

Key to species
Aulocera Butler
Common name: The Banded Satyrs

Aulocera Butler, 1867, Ent. mon. Mag. I 4 :121. Type –species by selection by Butler (Feb. 1868, Ent. mon. Mag. 4: 194) : *Satyrus brahminus* Blanchard [1844], in Jacquemont, Voy. Inde 4 (Zool) : 22.
Type-species : *Satyrus brahminus* Blanchard

1. Forewing upperside with brand distinct.....2

1a.Forewing upperside with brand indistinct.....3

2. Upperside dark brown, forewing upperside with white spot on inner side of subapical black spot present in male, band on forewing either bright yellow or white, hindwing upperside band enters cell; male genitalia with brachia arm like; female genitalia with central process of lamella antevaginalis bilobed.....*swaha* Kollar

2a. Upperside blackish, white spot on inner side of subapical black spot on forewing upperside missing in male, band pure white, hindwing upperside band does not enter cell; male genitalia with brachia small, thumb-like; female genitalia with central process of lamella antevaginalis oval, posteriorly notched.....*padma* Kollar

3. Forewing upperside with white spots well separated and small, hindwing upperside band narrow, underside bronzy-brown with white striations; male genitalia with uncus long, slightly curved at distal end; female genitalia with central process of lamella antevaginalis long with trilobed distal end, signa smaller.....*brahminus* Blanchard

3a. Forewing upperside with white spots larger and narrowly spaced, hindwing upperside band broad, below very pale with numerous greyish-white striae; male genitalia with uncus very long, curved ventrally; female genitalia with central process of lamella antevaginalis reduced, deeply notched posteriorly, signa longer..... *saraswati* Kollar

Genitalic Descriptions
Aulocera swaha (Kollar)
Common name: The Common Satyr

Kollar, 1844, in Hugel's Kashmir 4(2): 444 (*Satyrus*)

Male genitalia (Figs. 1–5). Uncus long, smaller than tegumen, more or less straight, distal end blunt, studded with small setae dorsally at proximal end; brachia arm-like, strongly sclerotized, twisted upwards, distal end dentate; tegumen broad dorsally, narrower ventrally, uniformly sclerotized; appendices angulares tooth-like with blunt distal end; vinculum almost equal in length to tegumen, slightly curved inwards, uniform in breadth except near saccus; saccus short, broad proximally, narrow distally; valva long, much broader in the middle than at both the ends, pilose, costa produced into a spine-like costal process, sacculus with ridge distally, sparsely setosed proximally and densely setosed distally, ampulla digitate distally and with wavy margin proximally, harpe cone-like with pointed distal end; juxta v-shaped; aedeagus long, tubular, suprazone

longer than subzone, coecum rounded in dorsal view, ductus ejaculatorius entering dorsally near proximal end.

Female genitalia (Fig. 6). Corpus bursae oblong, membranous; signa crescent-shaped, quite apart, lying longitudinally, moderately long, scobinate patches; ductus bursae less than corpus bursae, moderately sclerotized; ductus seminalis originate from ductus bursae near anterior end; central process of lamella antevaginalis bilobed, lateral lobes elongated, somewhat triangular plate present below central process; lamella postvaginalis with two ellipsoidal plates; apophysis anterioris wanting; apophysis posterioris moderately long , narrow, membranous; papilla analis oblong, pilose.

Length of forewing: Male: 28.0–34.0 mm (n = 30); Female: 30.0–36.0 mm (n = 26).

Material examined. Himachal Pradesh: 8♂, 9♀, 7.ix.1992, Narkanda, Shimla; 1♂, 18.ix.1991, Shimla; 9♂, 4♀, 17.ix.1992, Sangla, Kinnaur; 2♂, 3♀, 19.ix.1992, Kalpa, Kinnaur; 2♂, 5♀, 16.ix.1992, Nichar, Kinnaur; 2♂, 19.ix.1992, Bhabhanagar, Kinnaur; 2♂, 1♀, 13.ix.1992, Chowai, Kullu; 1♂, 25.ix.1994, Kalatop, Dalhousie. Jammu & Kashmir: 2♂, 4♀, 28.vii.1994, Patni Top; 1♂, 29.vii.1994, Kud, Patni Top.

Remarks: *Aulocera swaha* (Kollar), "as represented by its nominotype," is quite common and extends throughout the length of the Himalaya and ascends almost to 3000 m (Marshall and de Niceville, 1883; Mani, 1986; Smith, 1993). As will be evident "from the above," during the course of present studies a large, representative sample comprising fifty-six individuals (30♂, 26♀) was examined. Specimens were collected from localities falling within an altitudinal range varying between 1624 m and 2708 m. All specimens possess a conspicuous white discal band on both fore and hindwings except the forewing in 4–5 individuals among eight collected from Patnitop (2060 m) in the North Himalaya. According to Marshall and de Niceville (1883) 'typical specimens of this variety are very distinct but gradations in tone of yellow tint are so gradual in intermediate localities that it is impossible to draw actual line of separation'. Fruhstorfer (1911) has referred to specimens with forewing bright yellow as garuna (different from the nominotype). This practice has also been followed by Evans (1932) and Talbot (1947), with a note that the habitat of this subspecies lies in the inner ranges from Kashmir to Kullu. However, in present surveys both types (white banded and yellow banded) have been collected from the same locality (Patni Top) in the northwestern Himalaya. Therefore, the naming of these two populations as different subspecies "appears to be unjustified." In fact, this is simply a population variation because conspecificity of different individuals has been confirmed through the examination of their male and female genitalia which form a precise lock and key arrangement (consistent character). With regard to sexual dimorphism, the brand is always present in the male of this species (not usually very obscure, Marshall and de Nicevile, 1883), and is devoid of androconia. The androconia are always present in the remaining three species: *A. brahminus* Blanchard, *A. saraswati* Kollar and *A. padma* Kollar, presently studied. Evans (1932) and Talbot (1947) have separated this species on the basis of maculation of upper hindwing surfaces, in which the band narrows distinctly toward the inner margin and does not reach it except rarely in the females. It may be mentioned that this exception is also seen in two males where this band reaches the inner margin. The present study thus shows that this variable character should not be used as a key character, as it was applied by the above two workers.

Aulocera padma (Kollar)

Common name: The Great Satyr

Kollar, 1844, in Hugel's Kashmir 4(2): 445 (*Satyrus*)

Male genitalia (Figs. 7–11). Uncus beak-like, shorter than tegumen, beset with small setae on dorsal surface; brachia short, thumb-like, strongly sclerotized with dentate distal margin; tegumen broad dorsally, laterally compressed, narrow ventrally; appendices angulares reduced with distal margin straight; vinculum tapers from distal end to proximal end, longer than tegumen; uniformly sclerotized; saccus short, broad proximally, narrow and rounded apically; valva moderately long, pilose, broad in middle, costa produced into a straight, thin, strongly sclerotized, finger-like process, sacculus long, slightly curved dorsally, sparsely setosed, harpe digitate; juxta a rectangular plate, weakly sclerotized; aedeagus long, broader at distal end, subzone smaller, five pairs of small spines in the suprazone, coecum rounded, ductus entering dorsad.

Female genitalia (Fig. 12).Corpus bursae divided by a constriction into anterior small rounded structure and posterior large globular; signa quite apart, moderately long, lying in the posterior globular part, scobinate patches present; ductus bursae moderately long, curved in the middle, tapers towards posterior end; ductus seminalis enters into ductus bursae near corpus bursae; lamella antevaginalis with oval, posteriorly notched central process, lateral lobes leaf-like, below central process lies triangular plate; lamella postvaginalis wanting; apophysis anterioris missing; apophysis posterioris moderately long, narrow; papilla analis elliptical, fringed with setae.

Length of forewing: Male: 38.0–40.0 mm (n = 22); Female: 42.0 mm (n = 2).

Material examined. Himachal Pradesh: 8♂, 15.vi1992, Chail, Shimla; 5♂, 13.vi.1996, Narkanda, Shimla; 2♂, 26.vi.1996, Dikadhar, Narkanda, Shimla; 2♂, 13.vi.1996, Kandyali, Narkanda, Shimla; 3♂, 1♀, 11.vi.1996, Phalgu, Narkanda, Shimla; 1♂, 14.vi.1996, Taklech, Rampur, Shimla; 1♀, 3.x.1993, Larji, Kullu; 1♂, 25.vii.1992, Rajgarh, Sirmaur.

Remarks: Out of all the four species, *A. padma* Kollar is the largest in the genus *Aulocera* Butler. The nominotype *A. padma padma* Kollar has been collected at an elevation ranging from 1408 m to 2708 m. The male population is much more abundant as compared to the female population (22♂, 2♀), and this record goes in accordance to Marshall and de Niceville (1883). The two females, one collected from Larji (Kullu) and the other from Phalgu (Shimla) show variations in the white-discal band on the upperside of the hindwings. The band is broad and scattered in the specimen collected from Larji and narrower in the other. However, the individuals were found conspecific on genitalic basis. The species *A. padma*, according to Evans (1932) and Talbot (1947) have eight subspecies i.e., *A. p. padma* Kollar, *A. p.* burnetti Evans, *A. p. grandis* Tytler, *A. p. loha* Dohery, *A. p. chumbica* Moore, *A. p. fulva* Evans, *A. p. japora* Tytler and *A. p. thawgawa* Tytler, of these *A. p. loha* has been upgraded to the level of full-fledged species by Smith (1993), who collected it from Nepal.

Aulocera brahminus (Blanchard)
Common name: The Narrow-Banded Satyr

Blanchard, 1844, In Jacquemont, Voy. Inde 4(Zool) : 22 (*Satyrus*).

Male genitalia (Figs. 13–17). Uncus long, almost straight except slightly curved at distal end, sparsely setosed dorsally at base, shorter than tegumen; brachia small, less than half the length of uncus, slightly curved dorsally, narrow at base, broad distally; tegumen laterally compressed, dorsally narrow, strongly sclerotized; appendices angulares with conical distal end, broad at base; vinculum more than double the length of tegumen, strap-like, broader near saccus; saccus foot-like with rounded and narrow distal end; valva elongated, pilose, costa with elongated costal process, broad at base, sacculus with distal end rounded and fringed with short setae, ampulla and harpe well separated by deep groove, ampulla thumb-like with serrated distal end, harpe knife-like, studded with setae of equal size; juxta U-shaped; aedeagus longer, tubular, subzone smaller, distal end twisted upwards in lateral view, suprazone with six pairs of small spines, coecum rounded, ductus entering dorsad.

Female genitalia (Fig. 18). Corpus bursae elongated; signa comprising two, moderately long, parallel patches, situated in the middle, approximated, studded with minute teeth; ductus bursae smaller than corpus bursae, broader posteriorly, narrow towards corpus bursae; ductus seminalis entering ductus bursae near corpus bursae; lamella antevaginalis with central process well developed, posterior end with three lobes, lateral lobe with large, triangular plates, a rectangular, strongly sclerotized plate lies below central process; lamella postvaginalis wanting; apophysis anterioris missing; apophysis posterioris moderately long, spine-like, membranous, papilla analis oblong, fringed with setae.

Length of forewing: Male: 30.0–32.0 mm (n = 4); Female: 30.0 mm (n = 1).

Material examined. Himachal Pradesh: 4♂, 1♀, Dracha, Keylong, Lahoul and Spiti.

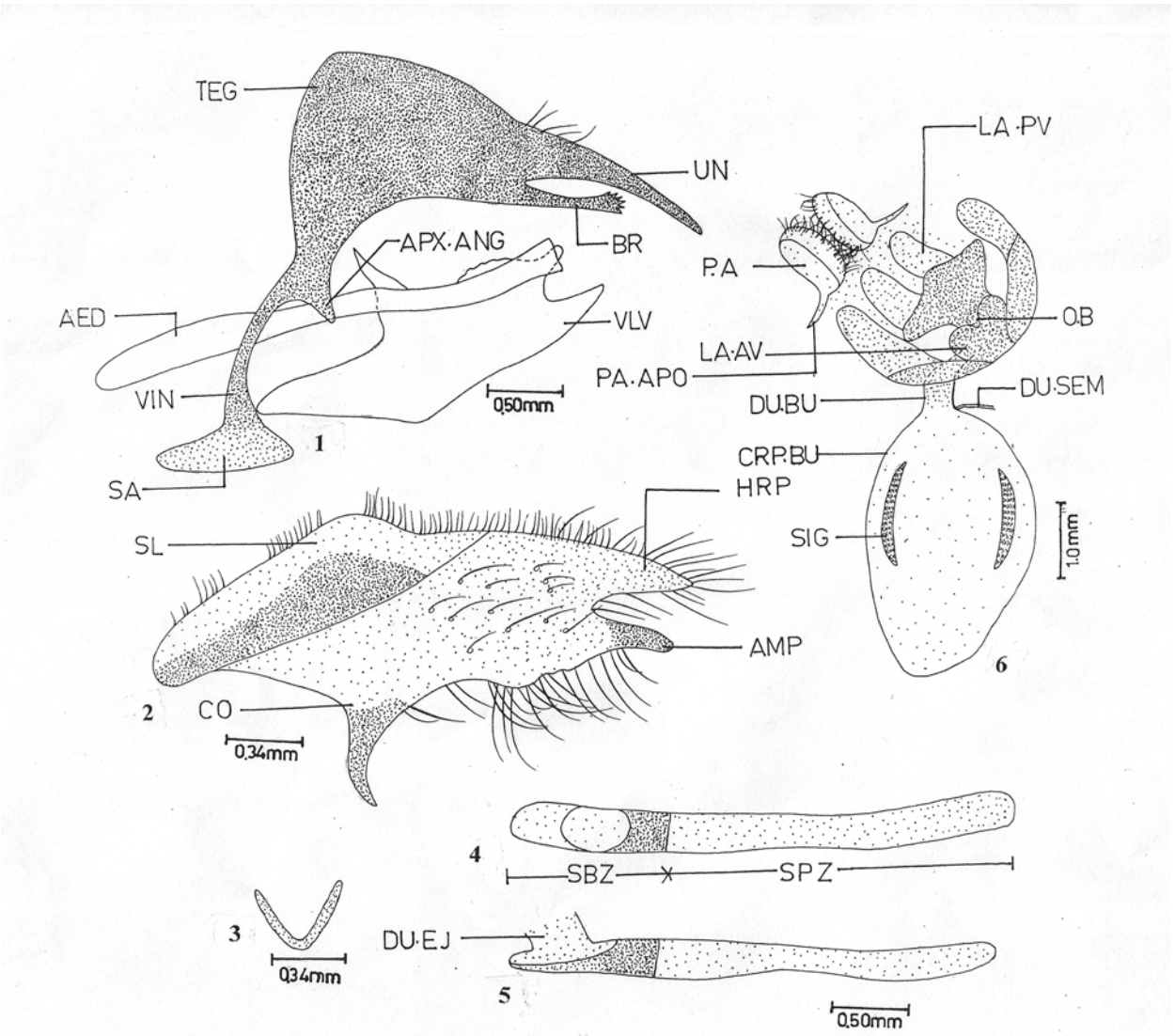
Remarks: Besides the nominotype, *Aulocera brahminus* (Blanchard) is represented by two subspecies: *A. b. dokwana* Evans extending from the Garhwal to Nepal Himalaya and *A. b. brahminoides* Moore in the East Himalaya. The range of the nominotype extends from Kashmir to Mossoorie/North-West to the Garhwal Himalaya (Evans, 1932; Talbot, 1947; Mani, 1986). Specifically speaking *Aulocera brahminus brahminus* (Blanchard) (= *scylla* Butler : *werang* Lang) has been reported from Kashmir (Goolmurg, now spelled as Gulmarg), Kullu, Koksar (Chandra Bhaga river), Keylong, Mandi and Pangi (Sach Pass) in the North-West Himalaya from 2121 m to 3939 m (Marshall and de Niceville, 1883). The species could not be collected from its old localities. The species has been collected from a new locality, Darcha (3400 m) which is about 32 Kms. ahead of Keylong in Lahoul. The inclusion of this species in Schedule II (Part II) of the Wildlife (Protection) Act, 1972 is supported on the basis of surveys. The steps need to be taken for its conservation, especially in Dracha and surrounding areas.

Two subspecific names i.e., *A. b. werang* Lang (Collected at Werang Pass, 3636 m, Lahoul; Patseo, 3333 m, Lahoul; Sach Pass 3939 m, Pangi; Goolmurg, 2727 m, Kashmir) and *A. b.*scylla Butler from Sylhet have already been considered as synonyms by Evans (1932).

Aulocera saraswati (Kollar)
Common name: The Striated Satyr

Kollar, 1844, in Hugel's Kashmir 4(2): 445 (*Satyrus*)

Male genitalia (Figs. 19–24). Uncus long, proximal half broader, distal half narrower, curved ventrally, setae

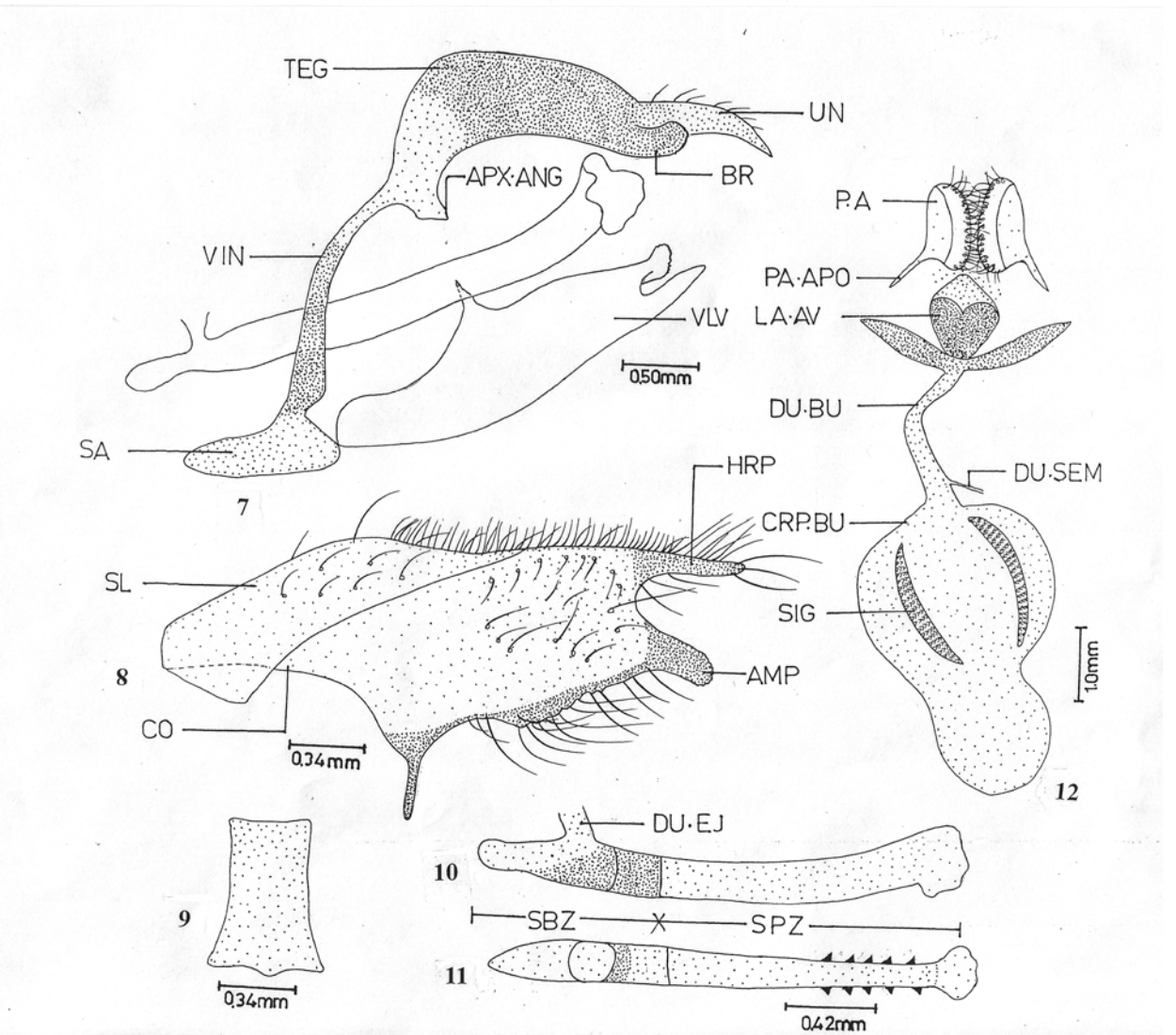


FIGS. 1–6. *Aulocera swaha* (Kollar): **1.** Male genitalia (lateral view), **2.** Valva (inner view), **3.** Juxta, **4.** Aedeagus (dorsal view), **5.** Aedeagus (lateral view), **6.** Female genitalia (Ventral view).

Abbreviations used in figures are: AED: Aedeagus, AMP: Ampulla, APX.ANG: Appendix angularis, BR: Brachium, CO: Costa, CRP.BU: Corpus bursae, DU.BU: Ductus bursae, DU.EJ.: Ductus ejaculatorius, DU.SEM: Ductus seminalis, HRP: Harpe, LA.AV: Lamella antevaginalis, LA.PV.: Lamella postvaginalis O.B.: Ostium Bursae, P.A.: Papilla analis, PO.APO: Apophysis posterioris, SA: Saccus, SBZ: Subzonal portion of aedeagus, SIG: Signum, SL: Sacculus, SPZ: Suprazonal portion of aedeagus, TEG: Tegumen, UN: Uncus, VIN: Vinculum, VLV: Valva.

absent; brachia slender, half the length of uncus, strongly sclerotized, distal end dentate; tegumen shorter than uncus, broad, hump-shaped, moderately sclerotized; appendices angulares small, spine-like, uniformly sclerotized; vinculum shorter than tegumen, uniform in breadth; saccus short, thumb-like, moderately sclerotized; valva moderately long, broad, pilose, costal process well developed, spine-like, sacculus slightly curved dorsally, setosed distally, ampulla and harpe (Sibatani et.al, 1954) not properly developed, ampulla with distal end knob-like, well-sclerotized, harpe-stumpy, densely setosed; juxta oblong; aedeagus with distal half broader, subzone smaller, tubular, coecum with almost conical margin, ductus ejaculatorius entering dorsad.

Female genitalia (Fig. 25). Corpus bursae globular, membranous; signa moderately long, broader at middle than at ends, parallel, longitudinal patches beset with



FIGS. 7–12. *Aulocera padma* (Kollar): **7.** Male genitalia (lateral view), **8.** Valva (inner view), **9.** Juxta, **10.** Aedeagus (lateral view), **11.** Aedeagus (dorsal view), **12.** Female genitalia (Ventral view).

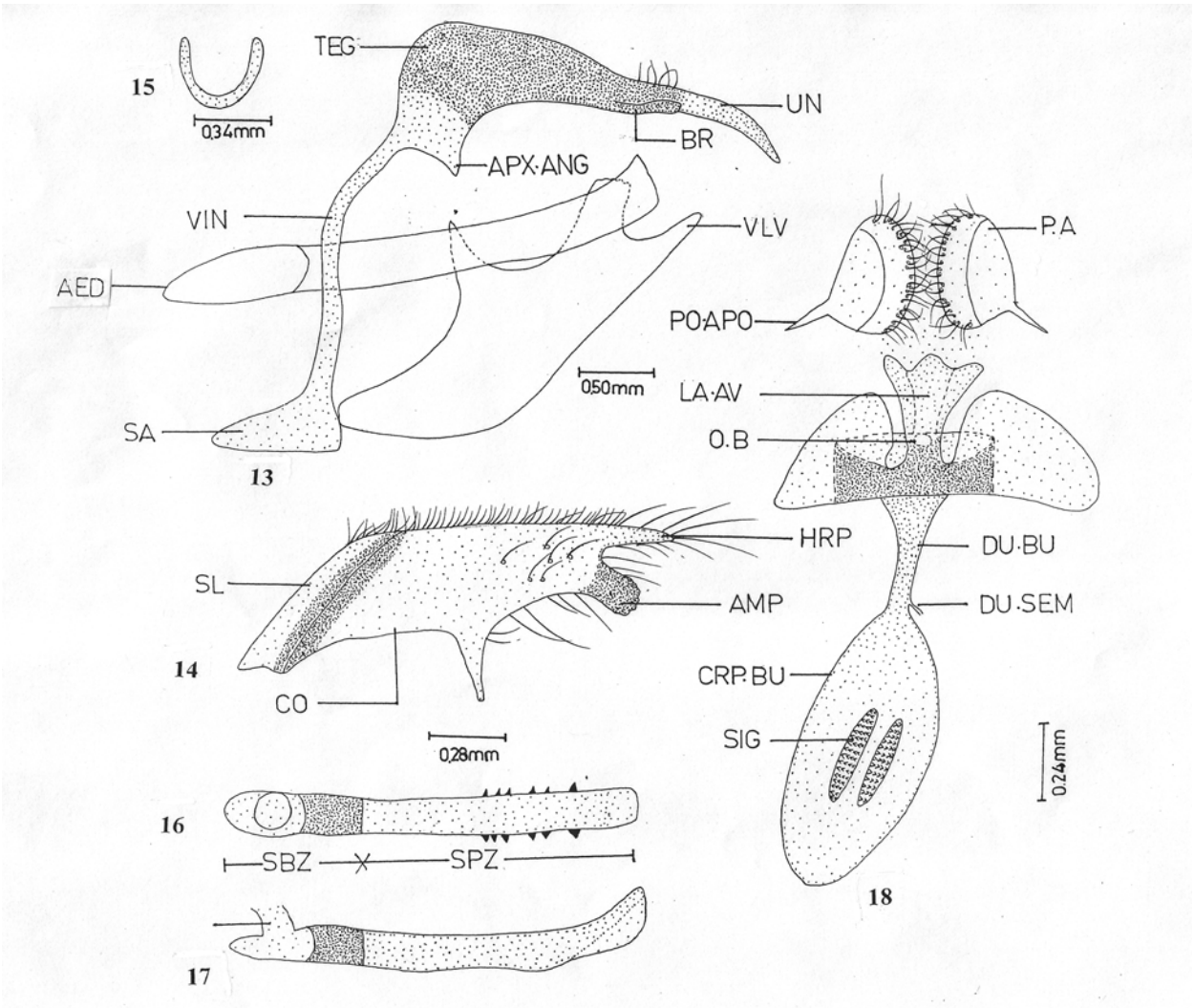
Abbreviations used in figures are: AED: Aedeagus, AMP: Ampulla, APX.ANG: Appendix angularis, BR: Brachium, CO: Costa, CRP.BU: Corpus bursae, DU.BU: Ductus bursae, DU.EJ.: Ductus ejaculatorius, DU.SEM: Ductus seminalis, HRP: Harpe, LA.AV: Lamella antevaginalis, LA.PV.: Lamella postvaginalis O.B.: Ostium Bursae, P.A.: Papilla analis, PO.APO: Apophysis posterioris, SA: Saccus, SBZ: Subzonal portion of aedeagus, SIG: Signum, SL: Sacculus, SPZ: Suprazonal portion of aedeagus, TEG: Tegumen, UN: Uncus, VIN: Vinculum, VLV: Valva.

minute teeth; ductus bursae short, membranous, broader anteriorly, narrow posteriorly; ductus seminalis entering ductus bursae near corpus bursae; central process of lamella antevaginalis deeply notched posteriorly into two small, slightly notched lobes distally, surrounded by a elliptical plate, below central process lies a finger-like projection; lamella-postvaginalis with two, parallel, elongated plates; apophysis anterioris missing; apophysis posterioris moderately long, membranous, slightly curved; papilla analis oval, pilose.

Length of forewing: Male: 30.0–33.0 mm (n = 4); Female: 32.0–40.0 mm (n = 9).

Material examined. Himachal Pradesh: 1♀, 19.ix.1991, Shimla; 3♂, 5♀, 8.ix.1992, Kumarsain, Shimla; 1♀, 11.ix.1992, Duttnagar, Rampur, Shimla; 1♀, 12.ix.1992, Taklech, Rampur, Shimla; 1♂, 17.ix.1992, Sangla, Kinnaur; 1♀, 13.ix.1992, Chowai, Kullu.

Remarks: *Aulocera saraswati* (Kollar), a Himalayan species (Marshall and de Niceville, 1883; Wynter-Blyth, 1957) has been recorded from certain localities from

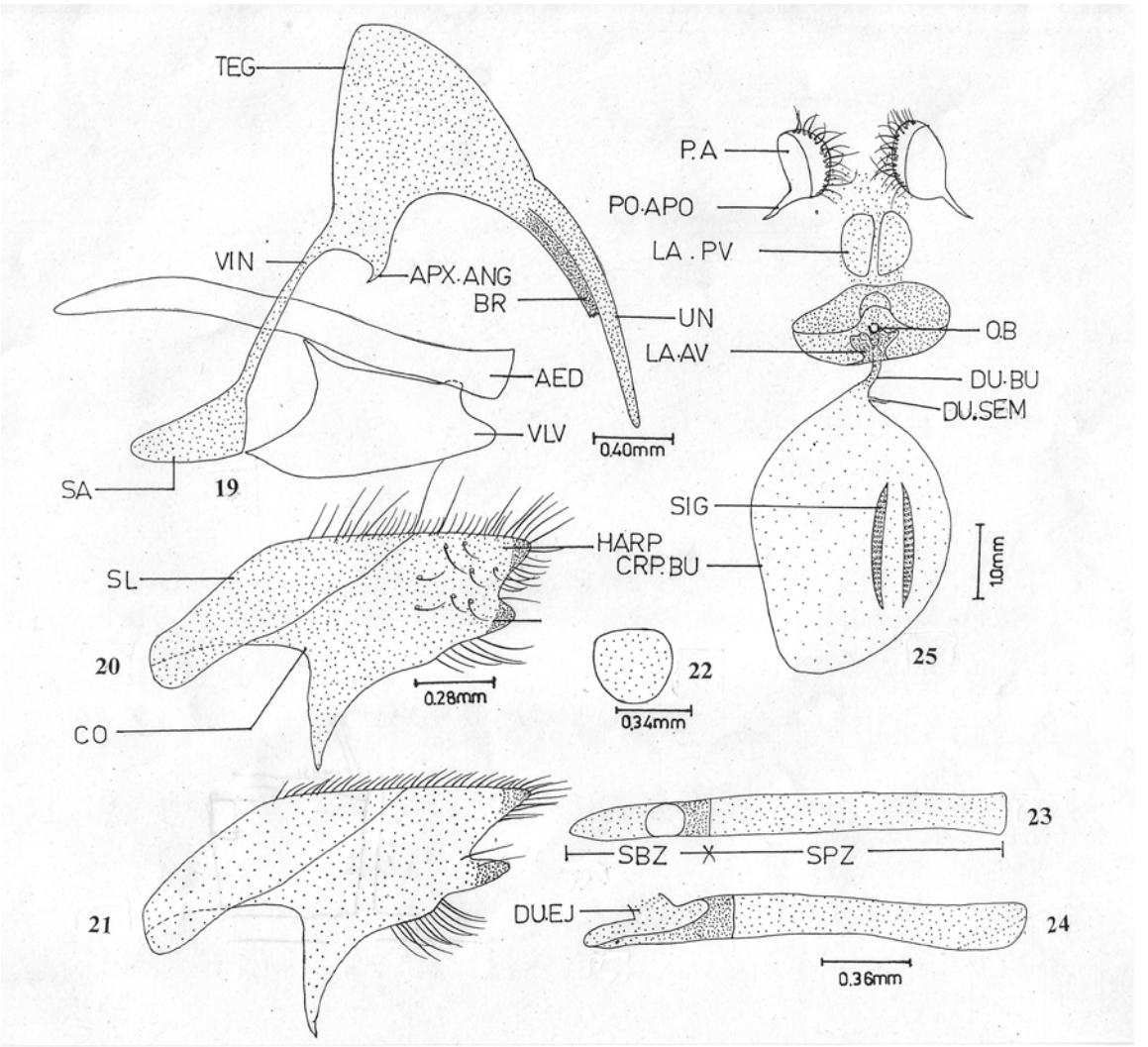


FIGS. 13-18. *Aulocera brahminus* (Blanchard): **13.** Male genitalia (lateral view), **14.** Valva (inner view), **15.** Juxta, **16.** Aedeagus (dorsal view), **17.** Aedeagus (lateral view), **18.** Female genitalia (Ventral view).

Abbreviations used in figures are: AED: Aedeagus, AMP: Ampulla, APX.ANG: Appendix angularis, BR: Brachium, CO: Costa, CRP.BU: Corpus bursae, DU.BU: Ductus bursae, DU.EJ.: Ductus ejaculatorius, DU.SEM: Ductus seminalis, HRP: Harpe, LA.AV: Lamella antevaginalis, LA.PV.: Lamella postvaginalis O.B.: Ostium Bursae, P.A.: Papilla analis, PO.APO: Apophysis posterioris, SA: Saccus, SBZ: Subzonal portion of aedeagus, SIG: Signum, SL: Sacculus, SPZ: Suprazonal portion of aedeagus, TEG: Tegumen, UN: Uncus, VIN: Vinculum, VLV: Valva.

Kashmir to Nepal (Bingham, 1905), Chitral to Sikkim (Evans, 1932; Talbot, 1947) and Nepal (Smith, 1993) by the respective workers. Inspite of repeated intensive and extensive surveys, no topotype could be collected from Mussoorie in the month of June between 1992 to 1996, although it had been described as being quite common there by Mackinnon and de Niceville (1897). However, the species has been collected from some new localities such as Sangla (2680 m), Taklech (1600 m), Kumarsain (1485 m), Chowai (1800 m) and Rampur (924 m) although it could not be collected from its old localities such as Shimla, Pangi, Kullu, Mussoorie or Kumaon. The collection data point out the shifting of the species to new breeding grounds, perhaps due to varied changes in the old localities.

Moreover, four males (three from Kumarsain and one from Sangla) vary from each other in respect of a white subapical speck on the innerside of black subapical ocellus on the upperside of the forewing (present in two males , absent in one male, developed in one male from Kumarsain). In view of these variations, all these males were dissected and found conspecific, excepting the one



FIGS. 19-25. *Aulocera saraswati* (Kollar): **19.** Male genitalia (lateral view), **20-21.** Valvae (inner view), **22.** Juxta, **23.** Aedeagus (dorsal view), **24.** Aedeagus (lateral view), **25.** Female genitalia (Ventral view).

Abbreviations used in figures are: AED: Aedeagus, AMP: Ampulla, APX.ANG: Appendix angularis, BR: Brachium, CO: Costa, CRP.BU: Corpus bursae, DU.BU: Ductus bursae, DU.EJ.: Ductus ejaculatorius, DU.SEM: Ductus seminalis, HRP: Harpe, LA.AV: Lamella antevaginalis, LA.PV.: Lamella postvaginalis O.B.: Ostium Bursae, P.A.: Papilla analis, PO.APO: Apophysis posterioris, SA: Saccus, SBZ: Subzonal portion of aedeagus, SIG: Signum, SL: Sacculus, SPZ: Suprazonal portion of aedeagus, TEG: Tegumen, UN: Uncus, VIN: Vinculum, VLV: Valva.

collected from Kumarsain, which shows some variation in the structure of the distal porion of the valva (Fig. 21). Goulson (1993), who studied such variations in the male genitalia of *Maniola jurtina* Linnaeus, has stated that they have no function to perform during copulation, and therefore appear to be a non-functional part of the valva. This characteristic has also been pointed out in another satyrid taxa (*Erebia* Dalman) by Lorkovic (1957). Rose and Sidhu (1996) have also discussed variations in the male genitalia of the type-species *Aricia agestis* (Denis and Schiffermuller). In order to further confirm conspecificity of the variable males, their androconia have been examined. These are moderately long, with bottle-shaped bases, and their apical portion is very slender. Four females out of seven showing variations in the band on both the sides of the hindwing (three females with upperside band not in line, two females with band interrupted near the lower angle of cell on the underside) have been dissected and found to be conspecific. The ostial region in the female genitalia is also highly modified in this species.

Discussion: The present study re-establishes that the

genus *Aulocera* is represented by the above-mentioned four species and not by seven species as indicated by Marshall and de Niceville (1883) and Bingham (1905). Besides other morphological characters, Talbot (1947) specifically made an attempt to characterize this genus on the basis of the uncus in the male genitalia but failed to fully appreciate various genitalic characters, for example characterizing the brachia as "hooks" by him. Hemming (1967) has affirmed that *A. brahminus* Blanchard is the type-species of the genus, not *circe* (Fabricius). In view of the above, the present authors have examined both the external male and female genitalia of all four species. Evaluation of taxonomic characters shows that structures such as a slightly curved uncus and brachia are always present with variable length. There is a well pronounced gap between the tegumen and the uncus. The valvae are not only consistent in *A. saraswati* Kollar, *A. padma* Kollar, *A. swaha* Kollar but also conform to these structures in *A. brahminus brahminus* Blanchard, the type-species of the genus. The congeneric status of these species is also supported by the female genitalia because of the structures such as paired signa, small ductus bursae, complex genital plate and papillae anales. Maculation, wing-venation and genitalic structures all support the contention that *Aulocera* is a natural group having its distribution only in Himalayan localities. It also seems appropriate to mention here that Smith (1993) has considered *loha* Doherty as a full-fledged species rather than a subspecies of *padma* (Evans, 1932; Talbot, 1947).

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LITERATURE CITED

BINGHAM, C.T. 1905. The Fauna of British India including Ceylon and Burma, Butterflies, 1. London: Taylor & Francis: 1–511, Pls. 1–10.

EVANS, W.H. 1932. The Identification of Indian Butterflies, 2nd ed. Bombay Natural History Society, Bombay : x+ 454 pp., 32 pls., 9 figs.

FRUHSTORFER, H. 1911. Satyridae: *In* 'Die Gross-Schmetterlinge der Erde' (Ed. A. Seitz). Stuttgart: 285–401.

GOULSON, D. 1993. Variation in the genitalia of the butterfly *Maniola jurtina* (Lepidoptera: Satyrinae). Zool. Journ. Linn. Soc. 107: 65–71, 3 figs.

HEMMING, A.F. 1967. The Generic names of the Butterflies and their type-species (Lepidoptera: Rhopalocera). Bull. Br.Mus. nat. Hist.(Ent.) Suppl. 9: 509pp.

LORKOVIC, Z. 1957. Die. Speciationsstuffen in der *Erebia tyndarus*-Gruppe. Biolosk glasnik 10: 61–110.

MACKINNON, P.W. and DE NICEVILLE L.. 1897. A list of butterflies of Mussoorie in the Western Himalayas and neighboring region. J. Bombay Nat. Hist. Soc. 11: 205–221; 368–389; 585–605.

MANI, M.S. 1986. Butterflies of the Himalaya. Oxford & IBH Publ. Co. New Delhi: x+181, 25 pls., 34 figs.

MARSHALL, G. F. L. and DE NICEVILLE, L. 1883. The butterflies of India, Burmah and Ceylon, Vol. 1. Reprinted by A.J. Reprints Agency, New Delhi: 327 pp.

ROSE, H.S. AND SIDHU, A.K. 1996. Wing maculation and genitalic variations in the type-species *Aricia agestis* (Dennis and Schiffermuller) (Lepidoptera : Lycaenidae). Uttar Pradesh J. Zool. 16: 159–163.

SIBATANI, A., OGATA, M., OKADA, Y. AND OKAGAHI, H. 1954. Male genitalia of Lepidoptera: morphology and nomenclature I. Divisions of the valvae in Rhopalocera, Phalaenidae (Noctoidae) and Geometridae. Ann. Ent. Soc. Amer. 47: 93–106.

SMITH, C. 1993. Illustrated checklist of Nepal's butterflies. Craftsman Press, Bangkok: 127pp.

TALBOT, G. 1947. The Fauna of British India including Ceylon and Burma. Butterflies volume 2. Taylor and Francis, London: 506pp.

WYNTER-BLYTH, M.A. 1957. Butterflies of the Indian region. Bombay Nat. Hist. Soc., 1957: xx + 523 pp,72pls.

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