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# Taxonomic Studies of the Species *Belenois aurota* (Lepidoptera: Pieridae) from India

***Manpreet Kaur[1*], Jagbir Singh Kirti[1] and Avtar Kaur Sidhu[2]***
*[1]Department of Zoology and Environmental Sciences, Punjabi University, Patiala (Punjab), India.*
*[2]High Altitude Regional Centre, Zoological Survey of India, Saproon, Solan (Punjab), India.*

*(Corresponding author: Manpreet Kaur*)*
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**ABSTRACT: In the present research work, the morphological features including genitalia and distribution of *Belenois aurota* (Fabricius) have been studied in detail. Klots (1931) studied the genitalia of *Prioneris* Wallace and mentioned its strong resemblance with the genitalia of *Belenois* Drury but there is no illustration and description of the male and female genitalia Belenois Drury. In this manuscript, the male genitalia of both the forms i.e. DSF and WSF and female genitalia of WSF of *Belenois aurota* (Fabricius) have been studied, illustrated and compared for the first time.**

**Keywords:** *Belenois aurota*, dry season form, wet season form, genitalia.

**Abbreviations: Wing Venation:** Sc = Subcosta vein; R1 = Radius vein 1; R2 = Radius vein 2; R3 = Radius vein 3; R4+5 = Radius vein 4+5; Rs = Radial sector; M1 = Median vein 1; M2 = Median vein 2; M3 = Median vein 3; Cu1 = Cubitus vein1; Cu2 = Cubitus vein 2; 1A+2A = Anal vein 1+2; 3A = Anal vein 3.
**Male Genitalia:** AED = Aedeagus; TG = Tegumen; UN = Uncus; VLV = Valva; VIN = Vinculum; SA = Saccus; DU.EJ = Ductus ejaculatorious; HRP = Harpe; VES = Vesica.
**Female Genitalia:** PAP.A=Papilla analis, PO.APO=Posterior apophysis, ANT.APO= Anterior apophysis, DU.BU=Ductus bursae, SIG=Signum, CRP.BU=Corpus bursae, APP.BU= Appendix bursae.

## INTRODUCTION

Drury (1773) reported the genus *Belenois* with the type species *Papilio calypso* (Drury). There are total 30 species under genus *Belenois* which are widely distributed in Indian subcontinent, south-east Asia, Australia and Afrotropical region (Chandra, 1985; Kunte, 2006; Ghosh and Saha 2016). *Belenois aurota* (Fabricius) has a wide distributional range extending across Arabia to the Indian subcontinent, sub-Saharan Africa and north of the Himalayas in Turkmenia and Tajikistan (Haldhar *et al*., 2016). Whereas, in India only one species i.e. *Belenois aurota* (Fabricius) has been reported so far. Out of three subspecies i.e. *Belenois aurota taprobana* (Moore), *Belenois aurota aurota* (Fabricius) and *Belenois aurota turanica* (Sheljuzhko) only *Belenois aurota aurota* (Fabricius) has been reported so far from India (Talbot, 1939). This genus is studied by various eminent workers like Moore (1881); Bingham (1907); Klots (1931); Evans (1932); Talbot (1939); Vane Wright (2003). Bingham (1907) described it as *Anaphaeis mesentina* and studied its external morphological descriptions and distribution of its DSF and WSF. Bingham (1907) reported a DSF specimen of this species collected by Mr. G. Rogers, Deputy Conservator of Forests from Great Nicobar Islands. Klots (1931) described it as *Belenois aurota* (Fabricius) and studied the genitalia of *Prioneris* Wallace and mentioned its strong resemblance with the genitalia of *Belenois*, Drury but there is no illustration and description of the genitalia of *Belenois* Drury. Evans (1932) devised its key including DSF and WSF. Talbot (1939) described its DSF, WSF and external morphological attributes in detail. Gasse (2013) recorded it as a straggler from Great Nicobar Islands. During the past few years, the research on this genus is related to the species diversity, richness, and abundance. Noor *et al.* (2018) conducted field survey to update the latest diversity of butterfly fauna in the Quetta region of Pakistan from April to October, 2012 and found *Belenois aurota* as the most abundant species in that region. Paria *et al.* (2018) studied the distribution of various butterflies in and surrounding areas of the protected forests of Kuldiha Wildlife Sanctuary, Odisha, India and the *Belenois aurota* was reported as the exclusive visitor to interspersed water bodies in that Sanctuary. Gehlot *et al.* (2021) explored the diversity of moths and butterflies from the urban localities of Jodhpur and found *B. aurota* as very rare species in those particular areas. Ge *et al.* (2021) reported *Belenois aurota* for the first time and the highest altitude record of this species from the Chinese-Indian border area in Tibet Autonomous Region. Bhatnagar *et al.* (2022) studied the diversity of insect visitors on blossom of *Acacia senegal* at Kaylana Kumathiya enclosure located in Jodhpur, Rajasthan and recorded *B. aurota* as one of the visitor on *Acacia senegal* flowers during forenoon. Kumari and Thakur (2022) investigated the biodiversity of butterflies from Kanke, Ranchi, Jharkhand, India during 2019 to 2021. The

main objective of this research was to study the current status of species richness and diversity, particularly during the COVID-19 pandemic. The results indicated abundance of *Belenois aurota* in 2019 and 2021 only. Kumar *et al.* (2023) prepared the preliminary checklist of the diversity of butterflies from the Himachal Pradesh Agricultural University, Palampur, India and found rare record of *Belenois aurota*.

In this research work, the male genitalia of both the forms i.e. DSF and WSF and female genitalia of WSF of *Belenois aurota* (Fabricius) have been studied, illustrated and compared for the first time.

## MATERIAL AND METHODS

During present studies, the adults were collected by using sweeping net from different localities of India. The specimens were killed, stretched and preserved as per standard techniques in Lepidopterology. Each specimen was tagged with the labels of locality, date of collection, altitude, etc. The representatives were identified on the basis of their morphological characters by consulting literature such as Antram (1924); Bingham (1907); Evans (1932); Talbot (1939). The collections lying in the National Museum, Zoological Survey of India, Kolkata were also examined and identified by consulting the fauna, keys and catalogues (Evans, 1932; Talbot, 1939; Kehimkar, 2008; Varshney and Smetacek 2015). The adult images both from the dorsal and ventral sides were obtained with a digital camera (Nikon digital camera 18-105mm). The genitalia dissections were performed by adopting the method proposed by Robinson (1976). The terminology for the male genitalia has been adopted from Klot (1970). The photography of the male external genitalia has been accomplished by using Leica microscope equipped with a photographic unit.

## RESULTS AND DISCUSSION

**Genus *Belenois* Hübner, 1819**

Common name: Caper Whites

*Belenois*Hübner, 1819; *Verz. bek.Schmett.* (6): 92.

*Anaphaeis*Hübner, 1819; *Verz. bek. Schmett.* (6): 93.

*Glycestha* Billberg, 1820; *Enum. Ins. Mus. Bill.*: 76.

*Pseudohuphina* Stoneham, 1940; *Bull. Stoneham Mus.* (40): 4.

*Pseudanaphaeis* Bernardi, 1953; *Rev. franc. Ent.***20** (1): 50.

*Belenois* Moore, 1881; *Lepid. Ceylon* **1** (4): 137.

*Belenois* Winhard, 2000; *Butterflies of the World* **10**: 27.

**Type species: *Papilio calypso* (Drury, 1773)**

*Papilio calypso* Drury, 1773; *Illust. Nat. Hist. Exot. Insects* **2**: 17.

**Distribution:** India, Ethiopia, Sudan, Kenya, Tanzania, Rhodesia, Uganda, Africa, Palestine (Israel-Jordan), Indonesia, Australia, Java, Sulawesi, Britain, Ireland, Liberia, Pakistan, Afghanistan, Baluchistan, Arabia, Sri Lanka, Rhodesia.

***Belenois aurota* (Fabricius, 1793)**

Common name: Brown-veined White

*Papilio aurota* Fabricius, 1793; *Ent. Syst.* **3** (1): 197.

*Papilio mesentina* Cramer, 1780; *Uitl. Kapellen* **3**: 140.

*Anaphaeis aurota* Korb & Bolshakov, 2011; *Eversmannia Suppl.* **2**: 26.

**Distribution India:** Maharashtra, Karnataka, Uttarakhand, Telangana, Andhra Pradesh, Rajasthan, Tamil Nadu, Himachal Pradesh, Madhya Pradesh, Kerala, Delhi, Gujarat, Uttar Pradesh, Punjab, Jammu & Kashmir, Chandigarh, Sikkim.

**Global distribution:** Sri Lanka, Cambodia, Palestine (Israel-Jordan), Pakistan, Australia, Afghanistan, Baluchistan, Vietnam, Arabia, Tropical Africa, Madagascar, Turkmenia, Tajikistan.

***Belenois aurota aurota* (Fabricius)**

*Papilio aurota* Fabricius, 1793; *Ent. Syst.***3** (1): 197.

*Anapheis aurota* Hemming, 1932, p. 283.

*Pieris mesentina* Moore, 1857a, p. 72

*Belenois mesentina* Davidson, Bell and Aitken, 1897a, p. 575.

**Adult (Male WSF):** Forewing dorsal surface whitish with black costa upto vein 11; black curved bar at the end cell; apex widely black with six white spots, anterior spots are large. Ventral side similar to ventral side, maculation is more sharpened and white spots at the apex enlarged. Hindwing dorsal surface white with black marginal dentate border forming four white circular spots. Ventral side chrome-yellow; dark black prominent veins; black marginal dentate border forming circular spots.

**Adult (Male DSF *lordaca*):** Wing maculation same as in WSF, but markings on the dorsal side are thin with wide and large white spots at the apex. Dorsal and ventral surface white. Hindwing dorsal surface white with border white marginal spots. Ventral surface white with little yellow base.

**Adult (Female WSF):** Similar to male but the wing maculation is more darker, white spots at the apex of forewing are smaller.

**Adult (Female DSF):** Similar to wet season form but the dorsal side with narrower black markings, forewing with broader and longer white markings, hindwing with larger white submarginal spots. Forewing ventral side ground colour pure white but hindwing slightly yellowish (Talbot, 1939).

**Wing expanse:** 50-55 mm.

**Male Genitalia (Male WSF)(Plate 1):** Uncus narrow arched, finger-like with apex rounded; tegumen longer, not broader, posses long articulatory process; vinculum concave; saccus thin, smaller than tegumen and flat, distal end rounded; valve leaf-like, apex produced to form a sharp slightly upcurved tip; juxta V-shaped, moderately longer, little curved; aedeagus long, thin, straight, subzone slightly swollen and much smaller than suprazone, ductus ejaculatorious entering caudo-dorsad.

**Male Genitalia (Male DSF *lordaca*) (Plate 2):** Uncus slightly much narrower, longer and less arched, finger-like with apex rounded; tegumen longer and narrower, posses long articulatory process; vinculum concave; saccus thin and narrow, smaller than tegumen and flat, distal end rounded; valve leaf-like, apex elongates to form a sharp slightly upcurved pointed tip; juxta V-shaped, moderately longer, little curved; aedeagus long, thin, straight, subzone slightly swollen and much smaller than suprazone, ductus ejaculatorious entering caudo-dorsad.

**Female Genitalia (Plate 3):** Posterior apophysis long and thin, anterior apophysis very small; ductus bursae

long, narrow, membranous; corpus bursae almost spherical, spindle-shaped signum, present below middle of corpus bursae, with sharp pointed ends and dentate margins; appendix bursae large, globular, well separated from corpus bursae.

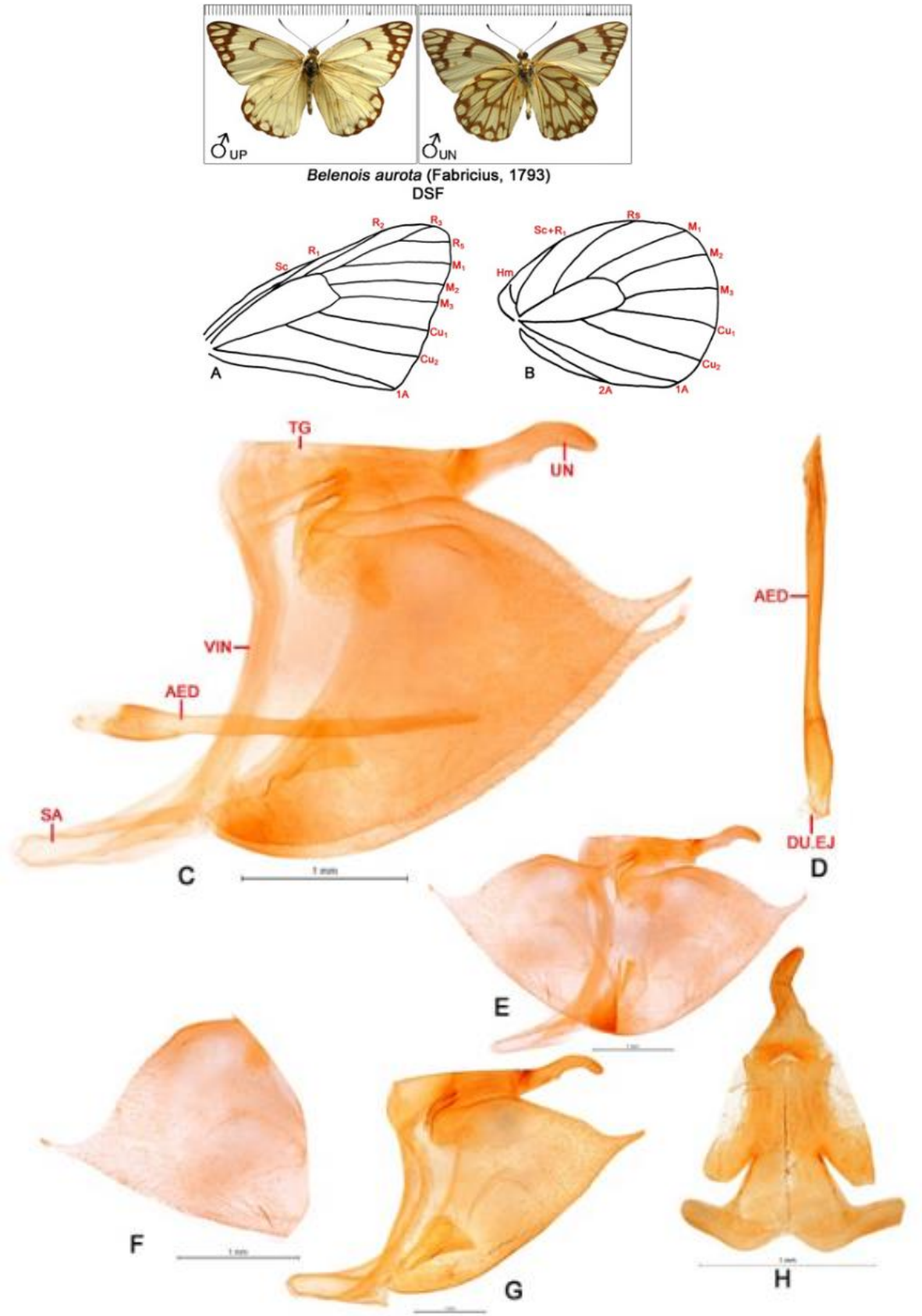


**Plate 1. A.** Forewing, **B.** Hindwing, **C.** Male genitalia, **D.** Aedeagus, **E.** Male Genitalia (Dorsal view), **F.** Valva, **G.** Male genitalia (Lateral view), **H.** Uncus (Dorsal view).

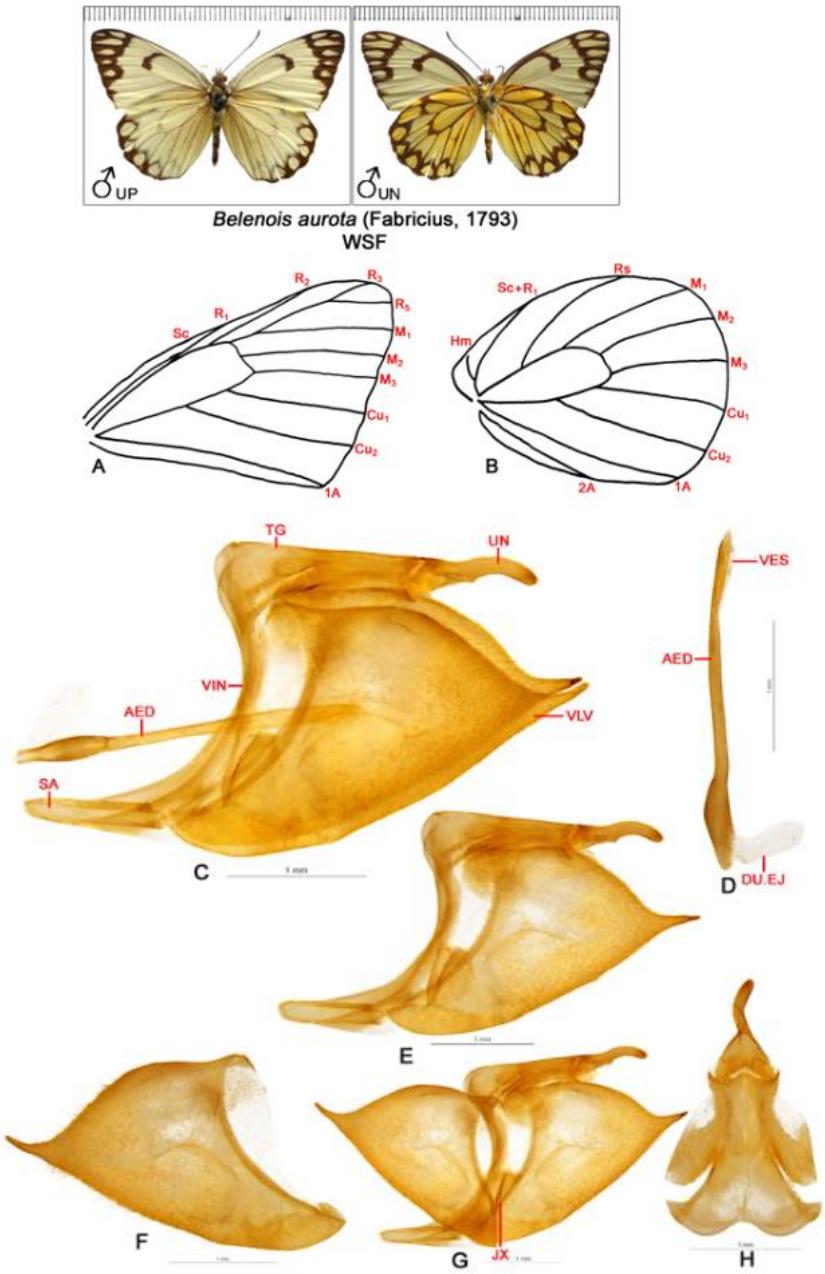


**Plate 2. A.** Forewing, **B.** Hindwing, **C.** Male genitalia, **D.** Aedeagus, **E.** Male Genitalia (Lateral view), **F.** Valva, **G.** Male genitalia (Dorsal view), **H.** Uncus (Dorsal view).

**Material examined:** ZSI, Kolkata, National Museum Collections.

1♂ (WSF), 1. xii.1956, Pali, Rajasthan; 1♂(DSF), 25. iv.1958, Jaipur, Rajasthan, (Coll. T.G. Vazirani); 1♂,(DSF), 26.iv.1958, Gudha, Rajasthan; 2♂(WSF), 1♀(WSF), 24.i.1971, Coimbatore, (Coll. Pradhan); 1♂ (WSF), 9.xii.1973, Baranagar, Gujarat, (Coll. P.T. Chenan); 1♂(WSF), 27.xi.1974, Bank of Saraswati River, Gujarat, (Coll. B. Datta); 1♂ (WSF), 2.vii.1999, Pora Chalana Forest, Guntur, Andhra Pradesh, (Coll. Roy); 1♂ (WSF), 1♀, 4.vii.1999, Konar Veedu Reserve Forest, Guntur, Andhra Pradesh, (Coll. Roy); 2♂, (WSF), 7.xii.2000, Yusufpur, Ghazipur, Uttar Pradesh, (M Prashad); 1♂(WSF), 1♂(WSF), 25.xi.2000, Jaunpur, Uttar Pradesh, (Coll. M Prashad); 2♂(WSF), 17.i.2004, 1♂(WSF), Rangreddy, Andhra Pradesh, (Coll. Maulik); 2♂(WSF), 3♀, 10.iii.2006, Rambagh, Agra, Uttar Pradesh, (B. Biswas); 9♂(WSF), 1♀, 11.iii.2006, Samsabad, Agra, Uttar Pradesh, (Coll. B. Biswas); 1♂(WSF), 14.iii.2006, Pathouli, Agra, Uttar Pradesh, (Coll. B.G. Kundu); 1♂(WSF), 26. x. 2006, Varanasi, Uttar Pradesh, (Coll. A. Bal); 3♂(DSF), 1♀, 20. iii. 2008, Bharatpur, Rajasthan, (Coll. J. Kumar); 4♂(DSF), 23. iii.2008, Band Baretha, Rajasthan; 2♂(DSF), 5. ix. 2009, Dauri Bazar, Kullu, Himachal Pradesh, (Coll. N. Sharma); 4♂, 2♀, 2.v.2016, Taradevi, Himachal Pradesh, (Coll. Manpreet Kaur); 6♂, 2♀, 17.v.2018, Shanghar, Himachal Pradesh, (Coll. Manpreet Kaur).

**Distribution India:** Maharashtra, Karnataka, Uttarakhand, Telangana, Andhra Pradesh, Rajasthan, Tamil Nadu, Himachal Pradesh, Madhya Pradesh, Kerala, Delhi, Gujarat, Uttar Pradesh, Punjab, Jammu & Kashmir, Chandigarh, Sikkim.

**Global distribution:** India, Tropical Africa, Madagascar.

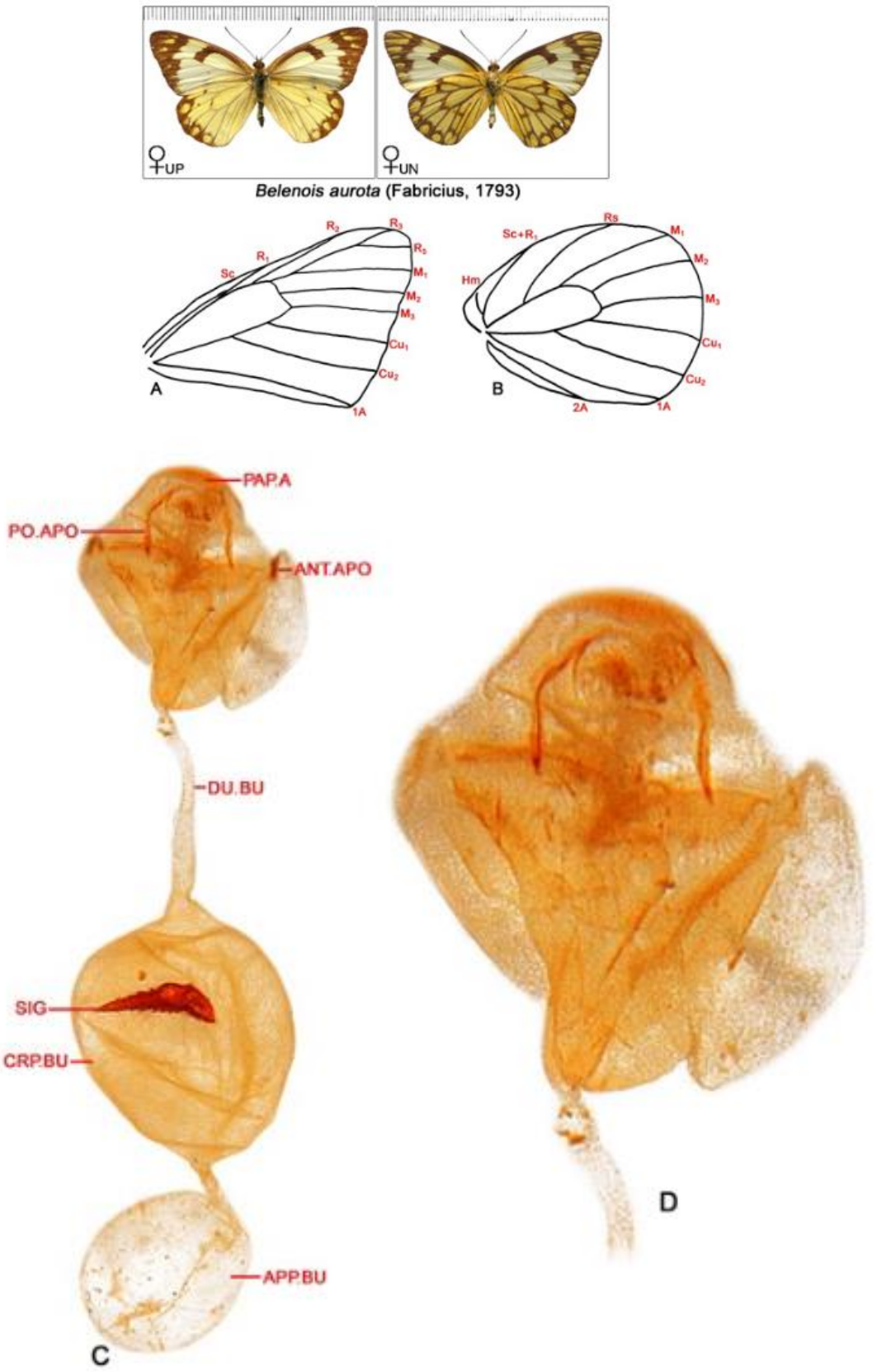


**Plate 3. A.** Forewing, **B.** Hindwing, **C.** Female genitalia, **D.** Papilla analis.

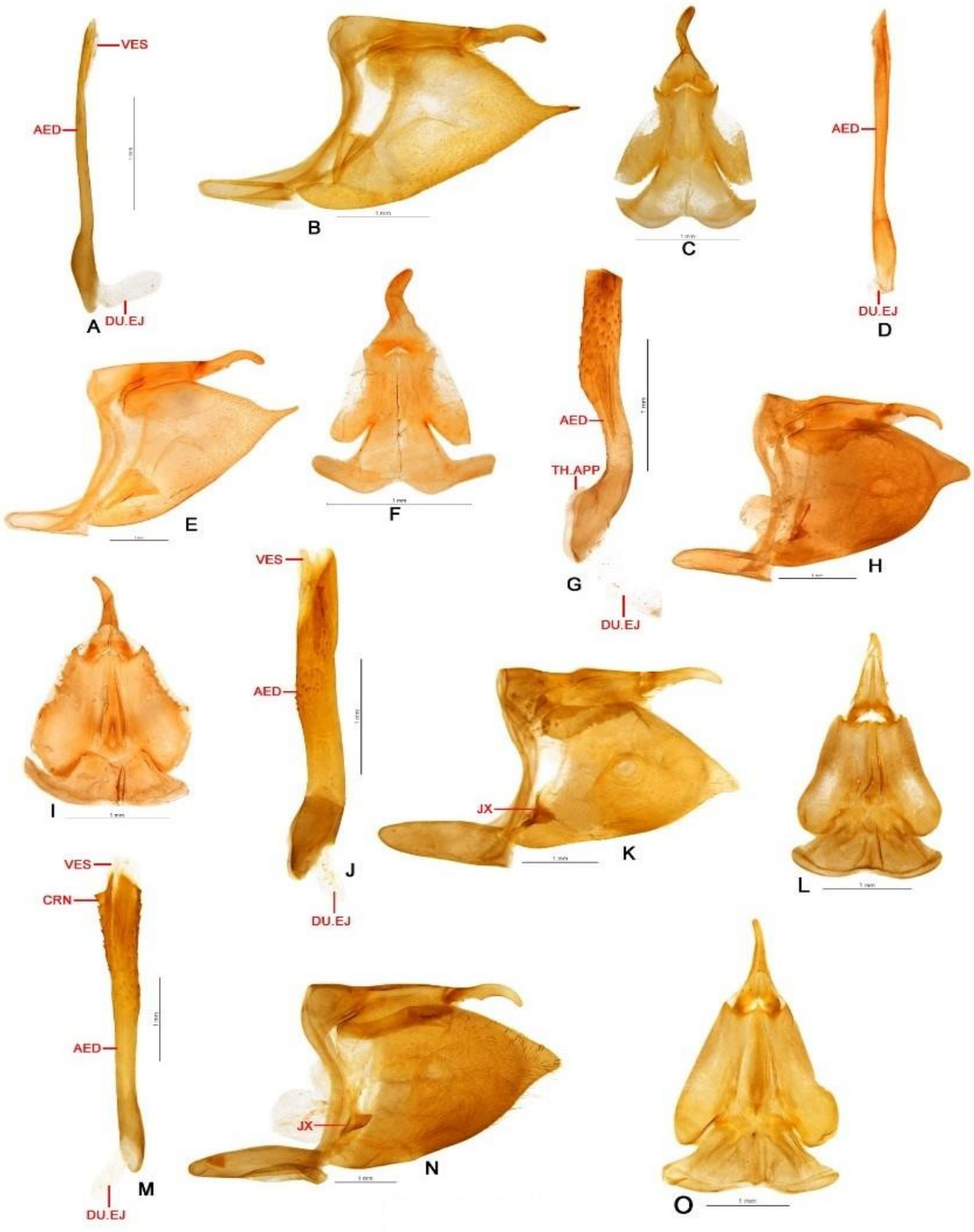


**Plate 4.** ***Belenois aurota*** **(Fabricius, 1793) WSF.** A. Aedeagus, B. Male genitalia (Lateral view), C. Uncus (Dorsal view); ***Belenois aurota*** **(Fabricius, 1793) DSF.** D. Aedeagus, E. Male genitalia (Lateral view), F. Uncus (Dorsal view); ***Prioneris sita*** **(Felder, 1865).** G. Aedeagus, H. Male genitalia (Lateral view), I. Uncus (Dorsal view); ***Prioneris thestylis*** **(Doubleday, 1842) DSF.** J. Aedeagus, K. Male genitalia (Lateral view), L. Uncus (Dorsal view); ***Prioneris thestylis*** **(Doubleday, 1842) WSF.** M. Aedeagus, N. Male genitalia (Lateral view), O. Uncus (Dorsal view).

**Remarks:** *Belenois aurota* (Fabricius) is a common species in the above mentioned localities. The genitalic attributes of DSF and WSF are similar, but in DSF the base of the uncus is not wider as compared to WSF (Plate 1 & 2). The genitalia of both the seasonal forms have slight variation which cannot be considered as independent species. The genitalia of *B. aurota* (Fabricius) is also compared with the genitalia of the members of the genus *Prioneris* Wallace (Plate 4). In case of *Belenois* Drury, from lateral perspective the distal part of the uncus is dorsally humped, tegumen narrow, valve leaf-like with pointed distal tip and aedeagus is thin and linear whereas in *Prioneris* Wallace, from lateral perspective the distal part of the uncus is arched but not humped [slightly humped in *Prioneris thestylis* (Doubleday) DSF and WSF], tegumen broad, valve broad with blunt distal tip and aedeagus is broad with proximal part of suprazone arched [except in *Prioneris thestylis* (Doubleday) WSF] and distal part linear and serrated.

**Host Plants:** Generally bred on Capers such as *Capparis aphylla, C. sepiaria* and *C. heyneana*. Haldhar *etal.*, 2016 first report the *B. aurota* as a pest of *Capparis decidua.* Also bred on *Cadaba indica* and *Maerua arenaria* (Wynter-Blyth, 1957; Ghosh and Saha 2016). Other host plants are *Cadaba farinosa, Capparis spinosa, Capparis zeylanica, Jasminum multiflorum and Maerua cylindrocarpa.* (Gupta and Majumdar 2012).

## CONCLUSIONS

Genus *Belenois* is one of the important group of butterflies under subfamily Pierinae. The species *Belenois aurota* has different seasonal forms which have been sorted on the basis of genitalic studies in the present work. The male genitalia of both the forms i.e. DSF and WSF and female genitalia of WSF of *Belenois aurota* (Fabricius) have been studied, illustrated and compared for the first time.

## FUTURE SCOPE

These studies can further be strengthened through molecular studies for sorting population variations in species complexes, and can further be taken up in other genera of subfamily Pierinae. Additionally, it can also be followed by phylogenetic studies. The representatives of family Pieridae are bio-indicators also so the relation between various climatic factors in an area and the presence of the *Belenois* butterflies can also be taken for future studies.

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**Conflict of Interest.** None.

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