



## Taxonomic survey of four species of subfamily Apaturinae (Lepidoptera: Papilionoidea: Nymphalidae) from western Himalaya, India with illustration of external genitalia

Deepika Mehra\*, Jagbir Singh Kirti, and Avtar Kaur Sidhu#

Department of Zoology and Environmental Sciences, Punjabi University, Patiala, India;

Email: deepika.mehra.nymphalidae@gmail.com; Email: prjagbir2005@gmail.com;

#Zoological Survey of India, High Altitude Regional Centre, Saproon, Solan, Himachal Pradesh, India. Email: avtarkaur2000@gmail.com

**ABSTRACT:** Four butterfly species viz., *Dilipa morigana* (Westwood), *Hestina persimilis* Butler, *Hestinalis nama* (Doubleday) and *Sephisa dichroa* (Kollar) under the subfamily Apaturinae from western Himalaya with external genitalic attributes were described and illustrated in detail. Pictorial identification keys for the taxa have been formulated. © 2018 Association for Advancement of Entomology

**KEYWORDS:** Taxonomy, Apaturinae, external genitalia, western Himalaya

### INTRODUCTION

Subfamily Apaturinae is one amongst the 12 subfamilies (Nymphalinae, Biblidinae, Calinaginae, Charaxinae, Cyrestinae, Danainae, Heliconiinae, Libytheinae, Limentidinae, Pseudergolinae, and Satyrinae) (Wahlberg *et al.*, 2009) of the cosmopolitan butterfly family Nymphalidae (Lepidoptera) which includes about 7200 species occurring in all habitats and continents except Antarctica (DeVries, 1987; Shields, 1989; Harvey, 1991). The species of this subfamily are mostly dispersed in Eurasia, South-East Asia and Africa (Old World) while a very few species are distributed mainly in New world, indicating a disjunctive distributional pattern. The species under the subfamily Apaturinae are classified under 20 genera (Harvey 1991). Although the Apaturinae larvae mainly feed on the Cannabaceae, those of the genus *Apatura* are associated with *Salix* and

*Populus* (Salicaceae), which are distantly related to the Cannabaceae (Ohshima *et al.*, 2010).

In India, a total of 15 species referable to nine genera are found, whereas in western Himalaya, eight species referable to seven genera are found. The Apaturinae species are very fast and high fliers, fond of mud peddling, preferably sip from garbage exude and even from putrefying carcasses of animals etc. Hence, some species can often be spotted near the garbage bins during the morning hours. The females of few species (e.g. *S. chandra* Moore) also exhibit polymorphism. Mimicry is also prominently advertised by both male and females of different species.

As compared to other subfamilies under Nymphalidae, the Apaturinae is relatively small and only scanty taxonomic information is available about the species distributed in India. The taxonomic

\* Author for correspondence

characters help in constructing the higher classification of a group. So, in the present work, four species referable to four genera (*Dilipa morigana* (Westwood), *Hestina persimilis* Butler, *Hestinalis nama* (Doubleday), and *Sephisia dichroa* (Kollar)) under the subfamily Apaturinae have been taxonomically dealt with, and their external genitalic attributes have been illustrated in detail. Moreover, *Dilipa morigana* (Westwood) and *Sephisia dichroa* (Kollar) are the type species of their respective genera, and the former species is a Schedule-I species protected under Wild life (Protection) Act (1972).

## MATERIALS AND METHODS

Collection-cum-survey tours were conducted to various localities in western Himalaya (Shivalik range and middle Himalaya) during the pre-monsoon and post monsoon season. Different ecosystems surveyed included: open grasslands, human inhabitations, subtropical evergreen forest above 1200m, tropical deciduous forest between 400 and 1400 m, cultivated lands, water shed areas and scrubland. The adult representatives of the family Apaturinae were actively collected by using the sweeping net. The collected butterfly specimens were killed with ethyl acetate vapours in the killing bottle. The specimens, while soft, were pinned and stretched on adjustable wooden stretching boxes, and were dried for 2-3 days. The dried specimens were preserved in air tight wooden boxes, containing naphthalene balls as fumigants. The specimens were photographed from the dorsal and ventral side, using a digital camera Nikon DSLR 3300 fitted with an 80 mm lens. To study the wing venation permanent slides of fore and hind wings were made by following the methodology provided by Common (1970) and advocated by Zimmerman (1978). For dissection and preparation of the external genitalia, the method proposed by Robinson (1976) was adopted. The terminology for the male genitalia has been adopted from Sibatani *et al.*, (1954), Shirozu and Yamamoto (1956), Klots (1970), and Sibatani (1972).

The photography of the male and female external genitalia was accomplished by using Leica™

microscope equipped with a photographic unit. For the male genitalia, the right valve was removed with the help of the forceps and genitalia were photographed in a lateral and dorsal view (to highlight structure of uncus from dorsal side). The inner and outer view of the right valva was also photographed. For the female genitalia, generally lateral view was taken in consideration. The enlarged view of the signum (wherever present) has also been photographed. The reference material has been preserved in vial containing clove oil. Identification keys have been formulated for four taxa under consideration in this paper (Figure 1).

## RESULTS AND DISCUSSION

### Genus *Dilipa* Moore

Moore, 1857; in Horsfield & Moore, Cat. lep. Ins. Mus. East India Coy 1: 201.

Type species: *Apatura morgiana* Westwood

Westwood, [1850]; Gen. diurn. Lep. (2): 305 nota.

Body robust; head dressed with long hair; eyes prominent and glabrous; antennae equals to half costa, club well defined, compressed and long but gradual; labial palpi porrect, not extended beyond head; male genitalia with a very long saccus and aedeagus, valvae simple.

### *Dilipa morgiana* (Westwood)

Common name: The Golden Emperor (Figure 2)

Westwood, [1850]; Gen. diurn. Lep. (2): 305 nota (*Apatura*).

**Adult:** Fore wing upper side with ground colour dark brown, an oblique light orange coloured band extends from costal margin to termen, another oblique orange coloured post discal band extends from costa to termen, one small and another minute white spot near apex, underside maculation similar as above but quite faded; hind wing basal half of wing dark brown, discal area orange, marginal area very broad and dissected by a zigzag orange coloured streak, under side colour light yellow, no dark markings.

**Venation:** Fore wing with discal cell shorter than half length of wing, vein Sc slightly stout at base, long and terminates at half costa,  $R_1$  from slightly before end cell, vein  $R_2$  just from upper apex of end cell, stalk of vein  $R_3+R_4+R_5$  present,  $R_3$  ending at apex,  $M_1$  from just below upper apex of end cell,  $M_2$  closer to  $M_1$  than  $M_3$ ,  $M_3$  just from lower apex of end cell, origin of  $Cu_1$  well before end cell, discal cell closed; hind wing with a bifurcated humeral vein,  $Sc+R_1$  run parallel to costa terminating at wing apex,  $Sc+R_1$  run parallel to costa and ending just below apex, stalk of  $R_3+M_1+M_2$  present, vein  $M_3$ ,  $Cu_1$  and  $Cu_2$  also stalked, discal cell open.

**Male genitalia:** Tegumen broad, slightly extended backwards, U-shaped from dorsal view; uncus shorter than tegumen, slender, beak like, tip pointed and curved downward; saccus extremely long, curved upwards at base, tubular, slender, tip swollen, blunt; vinculum narrow, u-shaped from ventral view, longer than latero-ventral projections of tegumen; appendices angulares broad but not curved; valvae simple, well sclerotized, densely setose with long and fine setae; costa flat, saccus narrow; ampulla and harpe indistinguishable; apex of valve curved into a pointed hook like tip; aedeagus very long, sinous, well sclerotized, vesica dorsal and membranous; ductus ejaculatorius enters dorsad.

Female genitalia: Not examined.

Material examined: 1♂, 29.iii.2015, Totu village, Shimla (H.P.)

Distribution: India (Jammu and Kashmir to Arunachal Pradesh, Northeast), Nepal, Bhutan, Myanmar.

**Remarks:** Genus *Dilipa* Moore was erected on the basis of the type species *Apatura morgiana* Westwood. This genus has only two species, namely, *D. fenestra* (Leech) and *D. morgiana* Westwood. Only the latter species is found in Western Himalaya in India. The nominate species is very rare and has a patchy distribution. It is also included in the Schedule –I of Wildlife (Protection) Act (1972). There are three broods of this species in Western Himalaya and are fond of ripe fruits.

The external male genitalia of the nominate species is described and illustrated in detail in the present work.

### Genus *Hestina* Westwood

Westwood, [1850]; Gen. diurn. Lep. (2): 281 (35).

*Diagora* Snellen, 1894; Tijdschr. Ent. 37: 67.

*Parhestina* Moore, [1896]; Lepidoptera Indica 3 (26): 34.

*Hestinalis* Bryk, 1938; in Stichel, Lep. Cat. 86: 291.

Type species: *Papilio assimilis* Linnaeus

Linnaeus, 1758; Syst. Nat. (Edn 10) 1: 479.

Body robust; head hairy; eyes glabrous; labial palpi divergent, porrect; antennae equals to half costa, club well defined, long but gradual; thorax robust; discal cell of both wings open.

**Remarks:** The nominate genus was erected on the basis of type-species *Papilio assimilis* Linnaeus. Only two species, namely *persimilis* (Westwood) and *nicevillei* Moore are found in India. Within India, the former species is distributed from western to eastern Himalaya, whereas the latter is only restricted in western Himalaya. Both the species are rare to find.

### *Hestina persimilis* Butler

Common name: The Siren (Figure 3)

Westwood, [1850]; Gen. diurn. Lep. (2): 281.

**Adult:** Fore wing upper side ground colour blackish, discal cell with a small white streak and a sinuate spot, end cell covered with three white spots, discal area with broad but scattered white spots, sub-marginal area with a series of white spots, underside maculation as above but upper half of wing lightly coloured than lower half; hind wing upper side from basal area to discal area covered with white maculation, a sub-marginal series of white spots present.

**Venation:** Forewing with discal cell shorter than half length of wing, vein Sc short and

terminates before half costa,  $R_1$  parallel to Sc and originates well before upper apex of end cell, vein  $R_2+R_3+R_4+R_5$  stalked,  $R_3$  from well before half of vein  $R_5$  and terminates at apex,  $M_1$  just from upper apex of end cell,  $M_2$  closer to  $M_1$  than  $M_3$ ,  $M_3$  and  $Cu_1$  just from lower apex of end cell, discal cell open, hind wing with a forwardly curved humeral vein,  $Sc+R_1$  parallel to costa margin and terminates at apex,  $Rs+M_1+M_2$  stalked, discal cell open, vein  $M_3+Cu_1+Cu_2$  stalked.

Male genitalia: not examined.

**Female genitalia:** Ductus seminalis enters dorsally directly into corpus bursae; ductus bursae long, narrow, slender and heavily sclerotized, broad at base, gradually narrow towards corpus bursae, inception at corpus bursae well-marked; corpus bursae round, signum boomerang shaped, well-marked with short spines; apophyses anteriores absent; apophyses posteriores not long, thin, slender, straight with pointed arrow-like apices; papilla analis oval, with proximal margin more sclerotized in middle, pilose.

Material examined: 1♀, 18.v.1971, Shimla (H.P.); 1♀, 26.ix.2015, Andretta, Kangra (H.P.)

Distribution: India (Himachal Pradesh to Arunachal Pradesh, Northeast), Nepal, Bhutan.

Larval host plants: Ulmaceae (Smetacek, 2012).

**Remarks:** The nominate species is rare and localized in western Himalaya. In India, there are two subspecies *i.e.* *Hestina persimilis zella* Butler and *Hestina persimilis persimilis* Westwood, found in western Himalaya and eastern Himalaya, respectively. This species can be found frequenting around over ripe fruits. The altitudinal range of this species lies between 1200 m – 2100 m asl. D’Abrera (1985) mentioned its distribution from Nepal and Sikkim which is erroneous, as this species can be recorded from Shimla to Kumaon. The species under reference wonderfully mimics the danaid species *Tirumala limniace* (Cramer) in looks; however, its flight is quite weak as compared to that of the latter.

The external female genitalia of the nominate species has been described and illustrated for the first time in the present manuscript.

### Genus *Hestinalis* Bryk

Bryk, 1938; in Stichel, *Lep. Cat.* 86: 291.

*Hestina* Westwood, [1850]; Gen. diurn. Lep. (2): 281 (35).

Type species: *Hestina mimetica* Butler

Butler, 1874; Trans. ent. Soc. Lond. 1874 (4): 426.

**Remarks:** This genus is mainly centred in south-east Asia. However, only a single species namely *Hestina nama* (Doubleday) is distributed throughout western and eastern Himalaya, India. The species under this genus are admirable mimics of butterflies under genera *Parantica* Moore and *Papilio* Linnaeus.

### *Hestinalis nama* (Doubleday)

Common name: The Circe (Figure 4)

*nama* Doubleday, 1844; List. lepid. Ins. Brit. Mus. 1: 97 (*Diadema*).

**Adult:** Fore wing with ground colour deep brown with violet tint, maculation light blue in colour, discal cell with a narrow streak and a rectangular spot, long extended bands in between spaces of veins, two parallel series of irregularly shaped light blue spots in sub-marginal area and marginal area, under side similar as above; hind wing upper side basal colour dark brown, maculation light blue interrupted by dark coloured veins, sub-marginal area very broad with a series of round spots and faded lunular patches in marginal area, underside similar as above, but ground colour bright brown and maculation more prominent.

**Venation:** Fore wing discal cell shorter than half length of wing, vein Sc long, stout at base and terminates slightly before half costa,  $R_1$  parallel to Sc and from well before upper apex of end cell, stalk of  $R_2+R_3+R_4+R_5$  just from upper apex of end cell,  $R_2$  just from base of stalk and parallel to

Pictorial keys for the identification of various taxa under consideration

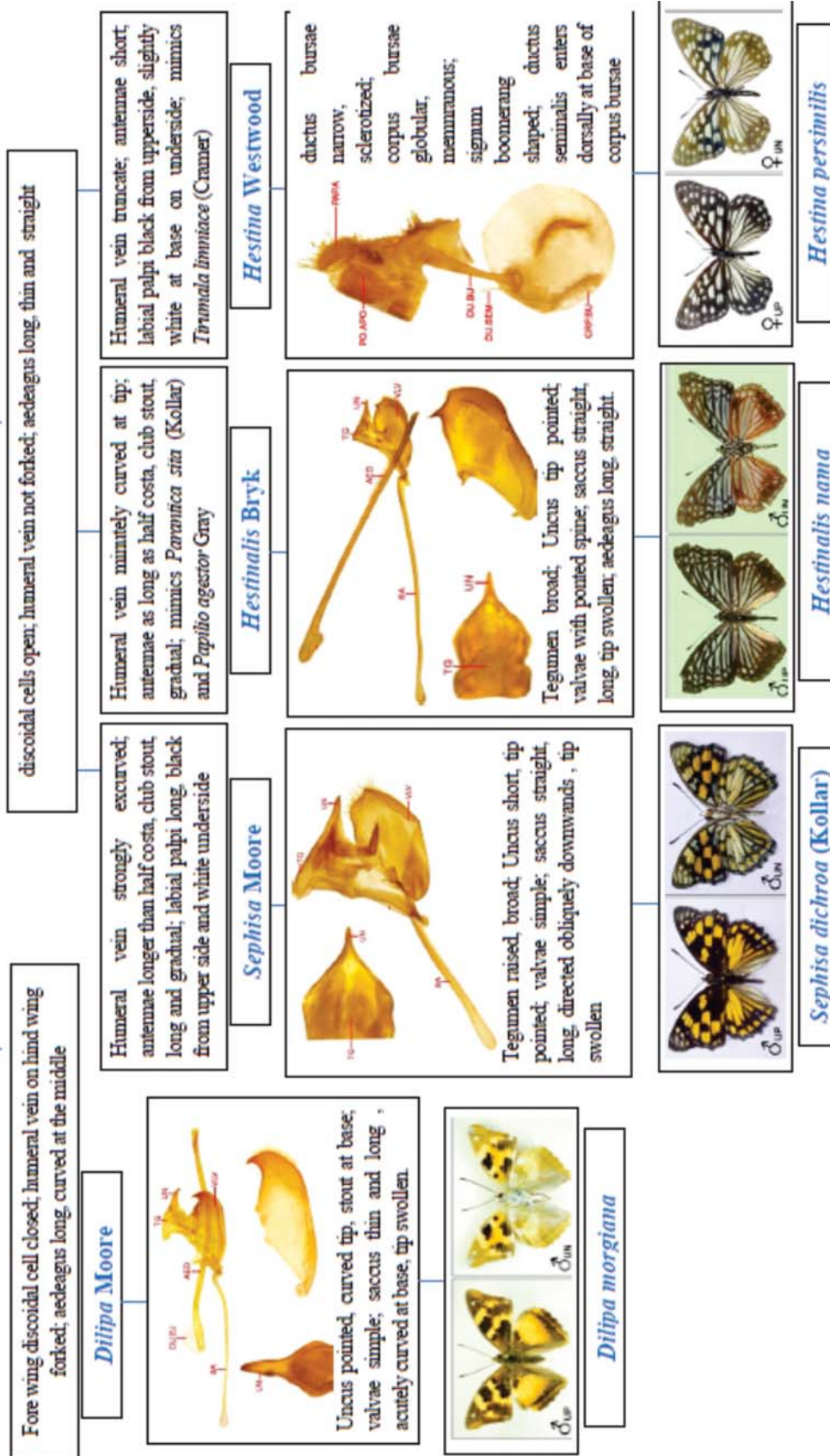


Figure 1: Pictorial keys for the identification of various taxa under consideration.

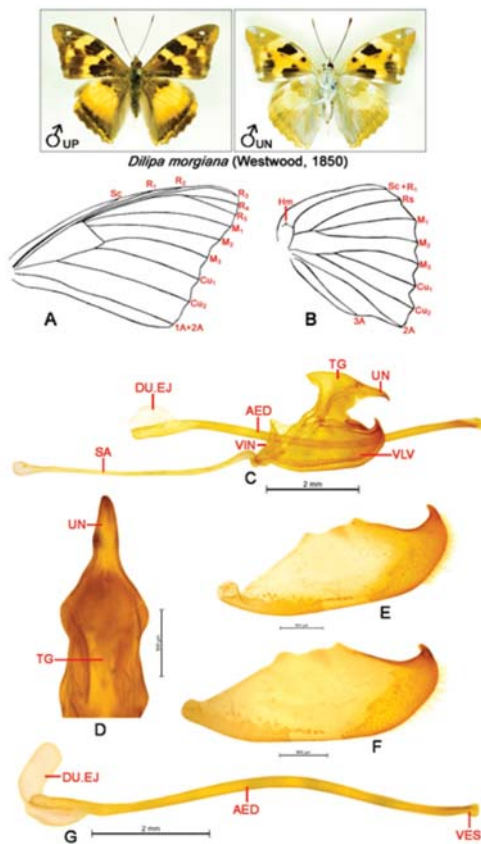


Figure 2: *Dilipa morgiana* (Westwood, 1850); A. Forewing, B. Hindwing, C. Male genitalia, D. Uncus (Dorsal View), E. Valva (Inner View), F. Valva (Outer View), G. Aedeagus.

R<sub>1</sub>, R<sub>2</sub> and R<sub>3</sub> end on costal margin, R<sub>4</sub> terminates at slightly below apex of wing, M<sub>1</sub> from slightly below upper apex of end cell, M<sub>2</sub> closer to M<sub>1</sub> at origin than to M<sub>3</sub>, M<sub>3</sub> deeply, discal cell open, udc and mdc present, ldc absent, hind wing with forwardly curved humeral vein, Sc+R<sub>1</sub> run parallel to costa and terminates just at wing apex, stalk of Rs+M<sub>1</sub>+M<sub>2</sub> and stalk of M<sub>3</sub>+Cu<sub>1</sub>+Cu<sub>2</sub> present, discal cell open, ldc absent.

Adult (Female): not examined.

**Male genitalia:** Tegumen broad, U-shaped from dorsal view; uncus quite short in length than tegumen, well sclerotized, straight, slender, tip pointed and acutely curved downwards; gnathos narrow but sclerotized, C-shaped from lateral view; saccus very long, slightly curved upwards at base, tip swollen, blunt, slightly sinuous; vinculum quite

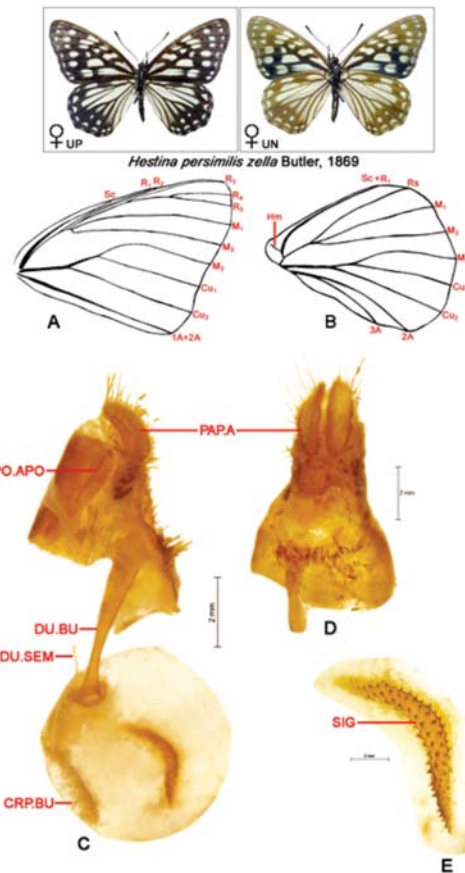


Figure 3: *Hestina persimilis zella* Butler, 1869; A. Forewing, B. Hindwing, C. Female genitalia, D. Papilla analis, E. Signum

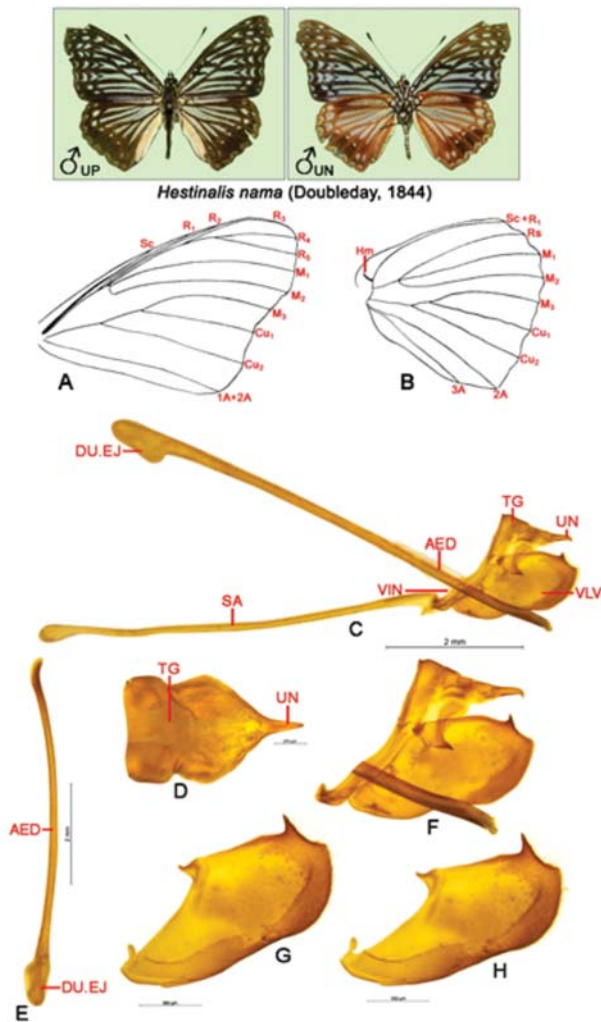
narrow, U-shaped from ventral view; appendix angular area indistinct; valvae simple, well sclerotized, quite broad and somewhat oval in shape, densely setosed with fine and long setae, a sharp spine like extension on dorsal margin of valvae; aedeagus very long, slightly curved, slender, well sclerotized; vesica membranous.

Female genitalia: not examined.

Material examined: 1♂, 5.v. 2015, Andretta, Kangra (H.P.); 1♂, 14.v.2015, Mussoorie, Dheradun (Uttarakhand).

Distribution: India (Himachal Pradesh to Arunachal Pradesh, Northeast), Nepal, Bhutan, Myanmar.

Larval host plants: Urticaceae (Smetacek, 2012).



**Figure 4:** *Hestinalis nama* (Doubleday, 1844); A. Forewing, B. Hindwing, C. Male genitalia, D. Uncus (Dorsal View), E. Aedeagus, F. Male genitalia (Enlarged), G. Valva (Inner View), H. Valva (Outer View).

**Remarks:** The taxonomic placement of this species had been problematic in the past. Originally it was described as *Diadema nama* Doubleday. Various other workers designated it as a type species of genus *Hestina* Westwood. However, its recent placement under the genus *Hestinalis* Bryk has been accepted by most workers. The species under reference preferably inhabits the subtropical evergreen forest above 1200m and tropical deciduous forest between 400 and 1400 m asl in Western Himalaya. It is rather a rare species and is known to mimic a danaid species *Parantica sita* (Kollar) and papilionid species *Papilio agestor* Gray, both in looks as well as behaviour. The

external male genitalia of the nominate species is described and illustrated in detail in the present work.

### Genus *Sephisa* Moore

Common name: The Courtiers

Moore, 1882; Proc. zool. Soc. Lond. 1882 (1): 240.

*Castalia* Westwood, [1850]; Gen. diurn. Lep. (2): 303.

*Castalia* Moore, 1857; in Horsfield & Moore, Cat. lep. Ins. Mus. East India Coy 1: 199.

Type species: *Limenitis dichroa* Kollar

Kollar, [1844]; in Hügel, Kaschmir und das Reich der Siek 4: 429.

Body moderately stout; head hairy; eyes reddish and glabrous; antennae longer than half costa, club well defined, gradual and long; labial palpi porrect, oriented obliquely; male genitalia with a very long saccus; female genitalia with sclerotized ductus bursae.

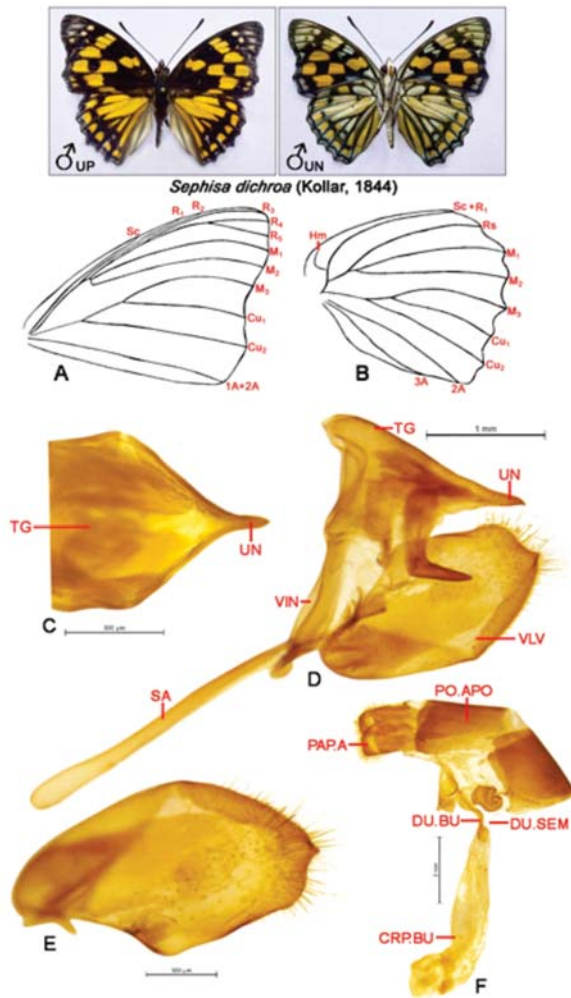
### *Sephisa dichroa* (Kollar)

Common name: The Western Courtier (Figure 5)

*S. dichroa* Kollar, [1844]; in Hügel, Kaschmir und das Reich der Siek 4: 429 (*Limenitis*).

**Adult:** Fore wing upper side ground colour blackish brown, discal cell with a dark yellow spot, discal area with prominent dark yellow spots, two light coloured spot near apex, under side maculation similar as above but a white patch at base of wing, three white spots at end cell and apical area with broad but lightly coloured patch; hind wing upper side with ground colour similar as that of fore wing, discal area occupied with dark yellow maculation, a prominent dark yellow colour spots in sub-marginal area.

**Venation:** Forewing with discal cell shorter than half length of wing, vein Sc moderately long and terminates on half costa,  $R_1$  parallel to Sc, originate well before upper apex of end cell, stalk of  $R_2+R_3+R_4+R_5$  just from upper apex of end cell, vein  $R_3$  well before mid of vein  $R_5$ ,  $R_3$  terminates



**Figure 5:** *Sephisa dichroa* (Kollar, 1844); A. Forewing, B. Hindwing, C. Uncus (Dorsal View), D. Male genitalia, E. Valva, F. Female genitalia.

just at apex of wing,  $M_1$  arises from just below upper apex of end cell,  $M_2$  closer to  $M_1$  at origin than to  $M_3$ ,  $M_3$  curved,  $Cu_2$  arises just opposite to  $R_1$ , hind wing with forwardly curved humeral vein,  $Sc+R_1$  parallel to costa and terminates just at apex of wing, stalk of  $Rs+M_1+M_2$  and stalk of  $M_3+Cu_1+Cu_2$  present, discal cell open, ldc absent.

**Male genitalia:** Tegumen broad and square in lateral view, slanting towards uncus, well sclerotized, U-shaped from dorsal view; uncus shorter than tegumen, quite broad at base from dorsal view and gradually tapers into a short tubular portion, tip pointed; gnathos well sclerotized, L-

shaped from lateral view; saccus quite long, obliquely directed downwards, slender, tip slightly swollen and blunt; vinculum narrow along entire length, approximately as long as latero-ventral projections of tegumen; appendices angulares small, curved and well sclerotized; juxta short, u-shaped, slit like; valvae simple, broad, slightly protruding beyond tip of uncus, densely setose with ling setae.

**Female genitalia:** Sterigma poorly well developed, lamella antevaginalis reduced to form emarginated sclerotization around ostium bursae, lamella postvaginalis reduced and lightly sclerotized; ductus bursae moderate in length, well sclerotized, slightly twisted; ductus seminalis enters on dorsal side at distal end of ductus bursae; corpus bursae long, elongated balloon like, membranous, tip blunt and swollen, signum absent; apophyses anteriores broad at base, inconspicuous; apophyses posteriores moderate, broad at base, tapers to narrow apices; papilla analis rectangular, well sclerotized, distal portion heavily sclerotized, pilose.

Material examined: 1♂, 29.v.2013, Shimla (H.P.); 1♀, 26.ix.2015, Andretta, Kangra (H.P.); 1♂, 27.ix.2015, Barot, Kangra (H.P.).

Distribution: India (Jammu and Kashmir to Uttarakhand), Pakistan, Nepal.

Larval host plants: Fagaceae (Smetacek, 2012).

**Remarks:** The nominate genus was erected on the basis of the type- species *Limenitis dichroa* Kollar. Only two species are found in India, namely, *Sephisa chandra* (Moore) and *Sephisa dichroa* Kollar. The former is distributed in the eastern parts of India, whereas, the latter in western Himalaya. It is a common species and is fond of sucking sap from ripe fruits, and can be occasionally found around human inhabited places. The external male and female genitalia of the nominate species has been described and illustrated for the first time in the present work and these characters have been used for upgrading of genus diagnosis.

**Discussion:** Four species referable to four genera under the subfamily Apaturinae were taxonomically



studied under the present work. The morphological characters of external male and female genitalia for the species under reference have been studied for the first time. However, the number of specimens studied was limited to only seven because of the rarity of the species. The species *Dilipa morigana* (Westwood) is protected under Schedule-I of Wildlife (Protection) Act (1972); *Hestina persimilis* Butler is rare; *Hestinalis nama* (Doubleday) and *Sephisa dichroa* (Kollar) are uncommon in the western Himalaya. One of the shortcomings of the present study is that intra-population variations could not be studied due to small sample size. Moreover the male of the *H. persimilis* Butler and female of the *D. morigana* (Westwood) and *Hestinalis nama* (Doubleday)

could not be collected. The future studies on this group should be aimed at filling these gaps. Moreover, regular surveys should be conducted to update the population status of these species.

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### ABBREVIATIONS used

♀UN	Female Under side	M <sub>3</sub>	Third median vein
♀UP	Female Upper side	mdc	Middle disco-cellular vein
♂UN	Male Under side	PAPA	Papilla analis
♂UP	Male Upper side	PO.APO	Posterior apophyses
1A	First anal vein	R <sub>1</sub>	First radial vein
2A	Second anal vein	R <sub>2</sub>	Second radial vein
AED	Aedeagus	R <sub>3</sub>	Third radial vein
AMP	Ampulla	R <sub>4</sub>	Fourth radial vein
ANT.APO	Anterior apophyses	R <sub>5</sub>	Fifth radial vein
CO	Costa	Rs	Radial sector
CRN	Cornuti	SA	Saccus
CRP.BU	Corpus bursae	Sc + R <sub>1</sub>	Stalk of SC and R1
Cu <sub>1</sub>	First cubital vein	Sc	Subcosta
Cu <sub>2</sub>	Second cubital vein	SIG	Signum
DU.BU	Ductus bursae	SL	Sacculus
DU.EJ	Ductus ejaculatorius	TG	Tegumen
HRP +AMP	Harpe and Ampulla (fused)	udc	Upper disco-cellular vein
JX	Juxta	UN	Uncus
ldc	Lower disco-cellular vein	VES	Vesica
M <sub>1</sub>	First median vein	VIN	Vinculum
M <sub>2</sub>	Second median vein	VLV	Valva

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