



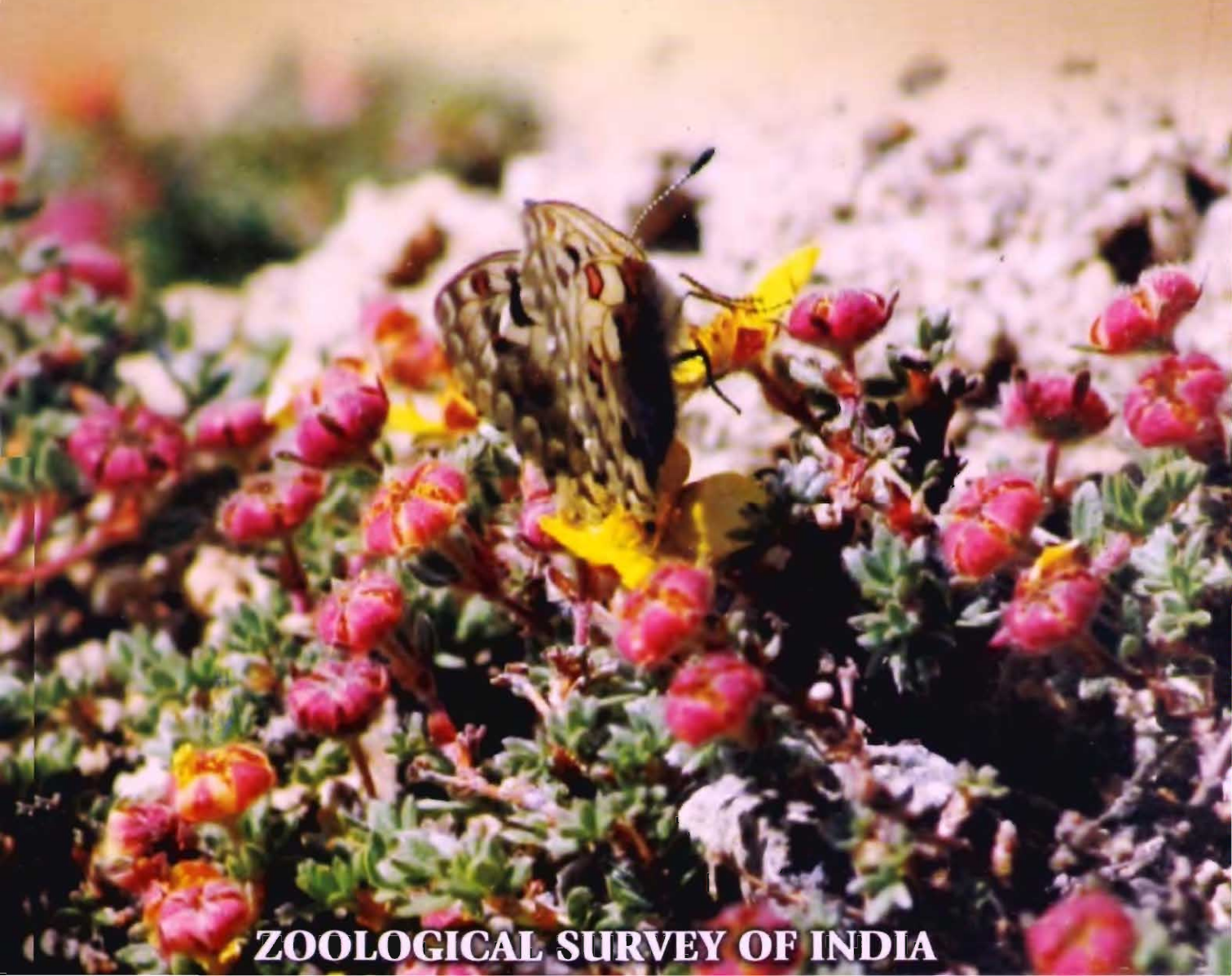
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**Status and Taxonomic Revision of
Butterflies of subfamily Parnassinae
from Indian Himalayas along with notes on its Phylogeny**

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ZOOLOGICAL SURVEY OF INDIA

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INTRODUCTION

Biodiversity is the concentration of life and its components, involving millions of species on planet earth. The growing concern over threat to the global biodiversity from habitat destruction and global warming has led a realization about the importance of conservation of biodiversity. Insects form an important component of our biodiversity. They out number all other animals in terms number of species. Amongst insects, butterflies especially Swallowtails have a unique role to play in conservation of biodiversity. Being delicate, butterflies are highly affected by any change in the environment and are thus effectively acting as bioindicators to know the real health of a habitat, followed by the conservation. Swallowtails belonging to family Papilionidae, have five hundred and seventy three species all over the world (Collins and Morris, 1985; New and Collins, 1991). Out of these, ninety four species belong to Indian subcontinent (Wynter-Blyth, 1957). They are highly spectacular and magnificent of all insects, even among the butterflies. The swallowtails though have a unique place in biodiversity yet there is as dubious distinction of their being highly exploited and illegally smuggled for trade purposes.

The swallowtails of the subfamily Parnassinae is a group of essentially Palaearctic butterflies. They are predominantly present in alpine and subalpine areas. In the world this subfamily is represented by three tribes, eight genera and 75 species (Plate-I, fig. 1) whereas in Indian region by two tribes, three genera and fifteen species and in India by two tribes, two genera and twelve species (Plate-I, fig. 2). In India this subfamily is represented only in high altitude areas of Himalayas. Most of the species are highly endemic in nature and inhabits in isolated pockets of Himalayas. Infact this group of butterflies is most affected by global warming, melting of glaciers and the change in habitat of fragile ecosystems in which they dwell. The Parnassinae butterflies are most sought of by the traders and are sold at very high prices. The subfamily Parnassinae of India has been studied by Evans (1932), Talbot (1939), Wynter-Blyth (1957) and Mani (1986) and it contains 12 species, of which nine (five in Schedule I part IV and four in Schedule II part II) are included in Indian Wildlife (Protection) Act, 1972 (amended up to 1991). But the present status of these butterflies needs to be assessed and the knowledge about the exact localities of the availability of various species present in tough areas of Himalayas needs to be known. Further most of the *Parnassius* Lattreille species commonly called as Snow Apollos show lot of variations in the wing maculation as well as wing venation. The taxonomic characters used in erecting keys to species of this genus by previous workers (Evans, 1932; Talbot, 1939; Mani, 1986) are based on wing maculation and wing venation, and are thus highly unreliable. During the course of present studies the status of nine species (out of twelve from India) has been assessed. The genitalic organs of these

species have been described and the diagnosis of various taxa has been updated incorporating these characters besides erecting the keys on the basis of adding these stable characters. The phylogeny of the species/species-groups/genera/tribes has been worked out. Some behavioural observations in certain species have also been incorporated.

TAXONOMIC BACKGROUND

Bryk (1923) did not recognize any tribe level taxon under the subfamily Parnassinae (Family : Parnassidae), which has, subsequently been split up into two tribes viz., Parnassini and Zerynthiini, as treated by Ford (1944) and (Talbot, 1939). Mani (1986) has however applied family names i.e., Parnassidae to include two genera viz., *Hypermnestra* Menetries and *Parnassius* Latreille, and Zerynthiidae to include a single Palaearctic genus *Bhutanitis* Atkinson. Munroe (1961) has, in fact, opined that the groups mentioned above, are sister tribes and the said arrangement has subsequently been followed under the subfamily Parnassinae by workers like Ackery (1975), Igarashi (1979,1984), Hiura (1980), Hancock (1982), Collins and Morris (1985), Miller (1987), Bridges (1988), and Varshney (1993). Besides *Parnassius*, the tribe Parnassini also contains two more existing genera viz., *Archon* Hubner, *Hypermenstra* and a fossil genus *Thaites* Scudder (Hancock, 1982). In world this subfamily is represented by three tribes and eight genera viz., Parnasini (including genera *Hypermnestra* Menetries, *Parnassius* Latreille), Zeruthiini (including genera *Sericinus* Westwood, *Bhutanitis* Atkinson, *Zerynthia* Ochsenheimer, *Allancastrina* Bryk) and Luehdorfiini (including genera *Luehdorfia* Cruger, *Archon* Hubner) (Stekolnikov and Kuznetsov, 2003; Omoto *et al.*, 2004; Katoh *et al.*, 2005; Nazari *et al.*, 2007) and the total number of species in this subfamily is 75, of which genus *Parnassius* is represented by maximum number of species i.e. 53 species, followed by *Bhutanitis* (06 species), *Luedirfia* (05 species), *Allancastrina* (04 species), *Archon* (03 species), *Zerythia* (02 ppecies), *Hypermnestra* (01 species) and *Sericinus* (01 species). In Indian region this subfamily is represented only in Himalayas. In this region Parnasinae is represented by two tribes i.e., Parnassini (containing genera *Parnassius* and *Hypermnestra*) and Zerynthiini (containing *Bhutanitis*) (Varshney, 1993). The genus *Parnassius* is represented by 13 species whereas the latter two genera contain one species each (Evans, 1932; Talbot, 1939; Mani, 1986). Whereas in India this subfamily is represented by only two genera *Parnassius* (11 species, of tribe Parnassiini) and *Bhutanitis* (01 species, of tribe Zerynthiini) (Talbot, 1939). The latter genus is restricted to eastern Himalayas and contains single subspecies *Bhutanitis lidderdalei lidderdalli* Atkinson. In the genus *Parnassius*, the eastern Himalayas represents seven species of which most are found in Sikkim and adjoining Tiger Hills of Darjeeling and the north-west Himalayas represents nine species of which all nine are represented in Jammu and Kashmir (eight in Ladakh and five in Tagalang La), five in Uttarakhand and five in Himachal Pradesh (Plate-II and Plate-III) (Talbot, 1939, Mani, 1986 and as per present studies).

OBSERVATIONS

Subfamily PARNASSINAE Duponchel

Common Name : The Apollos

Duponchel, 1835, In : *Godart. Hist. nat. Lepid.*, 380.

Type genus : *Parnassius* Latreille

Latreille, 1804, *Nouv. Dict. Hist. nat.*, **24**(Tab.) : 185, 199.

Diagnosis : Third segment of labial palpi elongated; antennae shorter; forewing with basal spur (Cu-v) absent or rudimentary; middle discocellular vein incurved; hindwing with precosta forked or simple; male genitalia with pseuduncus absent, tegument broader, aedeagus thin and narrower; female genitalia with 8th abdominal pleuron strongly sclerotized, fused with genital plate and 8th abdominal sternum to ring around bursa copulatrix; female with sphragis.

Remarks : Giving due weightage to male genitalic characters, the present study supports that the genera *Parnassius* and *Bhutanitis* should belong to distinct tribes i.e., *Parnassini* and *Zerynthiini* respectively. In addition to the key given above, the latter tribe can be distinguished due to the presence of a long and sleek aedeagus besides that the valve is also without any distinct harpe, whereas, in the former tribe, the aedeagus is relatively shorter and the valva is decorated with a stout harpe.

Key to the tribes of the subfamily PARNASSINAE Duponchel

1. Antennae and legs scaled; hindwing without tails or indentations; male genitalia with dorsal surface of valvae Smooth PARNASSINI Duponchel
- Antennae and legs unscaled; hindwing with tails or indentations; male genitalia with dorsal surface of valvae bulging outwards, uneven ... **Zerynthiini** Grote

Tribe : **Parnassini** Duponchel

Duponchel, 1835, In : *Godart. Hist. Nat., Lepid.*, : 380.

Type genus : *Parnassius* Latreille

Latreille, 1804, *Nouv. Dict. Hist. nat.*, **24**(Tab.) : 185, 199.

Diagnosis : Antennae and legs scaled, forewing with precostal cell vestigial, hindwing with out tails or indentations; male genitalia with dorsal surface of valvae smooth; female genitalia with size of bursa copulatrix reduced.

Genus *Parnassius* Latreille

Common Name : Snow Apollos

Latreille, 1804, *Nouv. Dict. Hist. nat.*, **24**(Tab.) : 185, 199; Bingham, 1907, *Fauna Brit. Ind. Butts.*, **2** : 166; Evans, 1932, *Ident. Ind. Butts.*, (2nd ed.) : 42; Talbot, 1939,

Fauna B. India (Butts.), (ed. 2) : 256; Wynter-Blyth, 1957, *Butts. Ind. Region* : 409; Munroe, 1961, *Can. Ent.* (17) : 10; Ackery, 1975, *Butt. Br. Mus. Nat. Hist.*, (Ent.) **31** (4) : 76; Hancock, 1982, *Smithersia*, **2** : 9; Igarashi, 1984, *Tyo to Ga.*, **34** (2) : 65; Miller, 1987, *Butt. Amer. Mus. Nat. Hist.*, **184**(4) : 380.

Doritis Fabricius, 1807, *Mag. f. Insektenk* (Illiger), **6** : 283.

Parnassis Hubner, 1819, *Verz. Bebannt. Schmett.*, (6) : 90.

Therius Billberg, 1820, *Enum. Ins. Mus. Billb.*, : 75.

Euboramius Bryk , 1935, *Parnassiana* : 630.

Kailasius Moore, 1902, *Lep. Ind.*, **5**(53) : 118.

Koramius Moore, 1902, *Lep. Ind.*, **5**(53) : 120.

Lingamius Bryk , 1935, *Das Thierreich*, **65** : 538.

Tadumia Moore, 1902, *Lep. Ind.*, **5**(53) : 116.

Type species : ***Papilio apollo*** Linnaeus

Linnaeus, 1758, *Syst. Nat.*, (ed. 10) **1** : 465.

Diagnosis : Antennae scaled, straightened; vein R₃ stalked with vein R₄₊₅; wings rounded, tailless, pattern reduced to extent; male genitalia with pseuduncus absent, uncus well developed, bifid, aedeagus narrow; female genitalia with ostial region heavily sclerotized; female with sphragis well developed; abdomen heavily sclerotized, 7th segment laterally produced into a pair of curved processes in male.

Remarks : The snow Apollo butterfly genus, *Parnassius* Latreille is distributed throughout the mountainous and northern areas of the Palaearctic and the Western Nearctic regions (Ackery, 1975). It is abundantly represented in the Himalaya at high elevations and almost all the species are available beyond timberline. Except for common blue Apollo, *P. hardwickii* Gray, all the remaining species fly exclusively in high altitude above 3000 m to 5,500 m ASL. The adults fly on high flower covered Himalayan meadows and over the rocky slopes of the mountains, especially during the summer season. This group is quite homogenous in ecology and general habitats. However, collection of the apollo is undoubtedly very difficult owing to inaccessibility of high altitude localities in the Trans or the Greater Himalaya. The adults can easily be recognized from their characteristically shaped wings, particularly the hindwing which is almost egg-shaped. The females of most of the apollo carry a horny pouch, called as sphragis. The latter is formed from quickly drying substance discharged by the male during fertilization at the end of the abdomen. Trade wise, the snow apollo are perhaps highly priced butterflies because of their rare status coupled with hardships in collection.

Workers such as Elwes (1886), Bingham (1907), Evans (1932), Herning (1932), Bryk (1935), Seok (1939), Talbot (1939), Fisher (1950), Munroe (1961), Wilson (1961), Dos Passos (1964), Eisner (1966), Yokohama and Wakabayashi (1968), Kurnetsov (1970), Muller (1973), Ackery (1975), Hancock (1982), Mani (1986), and Miller (1987), have expressed varied opinions about the composition of this genus. Bryk (loc. cit.) has

divided the snow apollo into five genera viz., *Koramius* Moore, *Tadumia* Moore, *Lingumius* Bryk, *Eukaramius* bryk and *Kailasius* Moore, on the basis of differences in the wing venation and relative length of the foretibial epiphyses. However, Munroe (loc.cit.) who has examined the male genitalia, wing maculation, venation and foretibial epiphyses disagree with the above division. In fact he has divided *Parnassius* into two subgenera i.e., *Parnassius* (sens. str.) and *Doritis* Fabricius. Somehow or the other, instead of Latreille, he has wrongly understood Fabricius as a discoverer of the genus *Parnassius*. While partially adopting the aforesaid worker. Ackery (1975) has however, declined to agree with the subdivisions of the genus into two subgenera, as *Doritis* being a junior objective synonym of *Parnassius* has been held as invalid (Hemming, 1967).

Genus *Parnassius* is represented by, as many as, fifty three species worldover (Bridges, 1988). Out of these, thirteen species have been enlisted from the British India but nothing concrete can be said about the number of their subspecies (Bingham, 1907; Evans, 1932; Piele, 1937; Talbot, 1939 and Wynter-Blyth, 1957). According to Mani (1986), there are about fifty subspecies referable to twelve Indian species.

During the course of present studies, a sample comprising eight species viz., *jacquemonti* Boisduval, *epaphus* Oberthur, *hardwickii* Gray, *maharaja* Avinoff, *acco* Gray, *stoliczkanus* Felder & Felder, *imperator* Oberthur and *charltonius* Gray has been studied. The examinations of their lock and key arrangement shows that there is lot of consistency in general plan structure of both the male (aedeagus weak and narrower, valvae with a stout arm-like harpe) and the female genitalia (bursa copulatrix quite reduced, 8th sternum and genital plate forms a ring like structure, undifferentiated). Munroe (1961), Ackery (1975) and Hancock (1982) have arranged different species belonging to this genus into ten species-groups on the basis of characters such as structure of the male genitalia, wing venation, sphragis and fore tibial epiphyses etc. Along with this, Ackery (loc. cit) has also mentioned that the apparent uniformity of structure within different species-groups together with multiplicity of variations in the wing pattern within most of the species, presents difficulty in preparing a key to the species of this genus. The presently studied species fall in seven species – groups i.e., Apollo group (*jacquemonti* Boisduval and *epaphus* Oberthur), *hardwickii* group (*hardwickii* Gray), *szechenyii* group (*maharaja* Avinoff), *acco* group (*acco* Gray), *delphi* group (*stoliczkanus* Felder & Felder), *imperator* group (*imperator* Oberthur) and *charltonius* group (*charltonius* Gray). The key for interspecific discrimination is given as below :

Key to the species of the genus *Parnassius* Latreille

1. Forewing with vein M1 arising from cell; male genitalia with aedeagus Very weakly developed; vinculum produced into well developed saccus 2
- Forewing with vein M1 stalked with vein R3+5; male genitalia with aedeagus strongly Developed, broader; vinculum produced into a rudimentary saccus ...
..... 6

2. Upperside of hindwing without red spot on discal area; male genitalia with apices of uncus lobes, squarish, dentate; valva very broad, large*maharaja* Avinoff
 - Upperside of hindwing without red spot on discal area; male genitalia with apices of uncus lobes narrow, not dentate; valva narrow, reduced 3
3. Forewings veins R1 and R2 not anastomosed, free or touching each other; female with sphragis cylindrical, with ventral side squashed; male genitalia with juxta shield-like 4
 - Forewings with veins R1 and R2 anastomosed; female with sphragis band-like pendulous bag, sides squashed; male genitalia with juxta U-shaped 5
4. Upperside of hindwing with discal spots not white centered, no red spot present in space Sc+R1; female with sphragis split divergently in two directions; male genitalia with distal margin of valva oblique, smaller in size
 *stoliczkanus* Felder & Felder
 - Upperside of hindwing with discal spots white centered, red spot present in space Sc+R1; female with sphragis bilobed, not divergent; male genitalia with distal margin of valva narrow, twisted downwards, relatively in size
 *imperator* Oberthur
5. Forewing with vein R2 arising from vein R5, veins M1 and M5 well separated at origin; male genitalia with uncus lobes not narrower, beak-like, apex of valva squarish *charltonius* Gray
 - Forewing with vein R2 not arising from vein R5, veins M1 and M5 approximate at origin; Male genitalia with uncus lobes not narrower, Finger-like, apex of valva rounded *acco* Gray
6. Antennae completely black, not white ringed; hindwing upperside generally with submarginal series of blue centered spots; uncus broad, stout, with minute spines, without median spatulate process, apex of valva squarish*hardwickii* Gray
 - Antennae ringed with black and white; hindwing upperside lacking submarginal series of blue centered spots; uncus narrow, weak, without spines, with median spatulate process, apex of valva rounded 7
7. Hindwing upperside with a basal red spot usually present; discal spot in space Cu1b on underside of forewing often heavily scaled, sometimes centered with red; female with sphragis strongly keeled; male genitalia with juxta U-shaped, stout*jacquemonti* Boisduval
 - Hindwing with upperside without a basal red spot, if present, then the discal spot in space Cu1b on underside of forewing lightly scaled, not entered with red; female with sphragis not keeled; male genitalia with juxta Y-shaped, weak
 *epaphus* Oberthur

***Parnassius maharaja* Avinoff**

Common name : Maharaja Apollo

Avinoff, (1916), *Trans. ent. Soc. Lond.*, **63**(3/4) : 353 (*Parnassius*).

Diagnosis : Antennae black ; forewing with veins R1 and R2 anastomosed, veins R2 and R5 separate at origin, vein M1 arise from cell, veins M1 and R5 approximated at base; forewing with fringe black, marginal band fuscous, with a series of very obscure submarginal lunules, without red spots, postdiscal band of separated small spots; hindwing with an elongated ocellar spot on costa, submarginal markings hardly visible.

Male genitalia : Pseuduncus wanting, eighth tergite not fused; uncus bifid from base, lobes well sclerotized, stout, strip-like with squarish dentate apices; tegument wide, curved; vinculum broader in apical half, narrowed distally; saccus moderate; rounded; dorsolateral sclerite broad, free. Valva oblong, large, broad, apex squarish; from middle of valva arise a stout apine like process of harpe, ending just below apex; valva pilose. Juxta y-shaped, basal arm long, rounded, lateral arms short pointed. Aedeagus short, narrow, straight, moderately sclerotized, base swollen, apex pointed, subzone smaller, vesica dorsad, bulbus ejaculatorius entering cephalad; eighth abdominal segment modified to a pair of processes.

Female genitalia : Genital plate bilobed, moderately sclerotized, fuses with well sclerotized pleuron, extends a little above ostium bursae with sclerotized flap, apices bifid, pointed, ostium bursae opens at its anterior end, posterior end of genital plate possess an oval, curved, well sclerotized inner flap. Corpus bursae very long, oblong, ductus bursae extremely reduced in size, ductus seminalis arise from middle of corpus bursae dorsally. Apophyses anterioris absent; apophyses posterioris narrow rods; papilla anales oval, well sclerotized, minutely pilose.

Forewing length : Male : 30.0 -31.0 mm

Female : 30.5 mm

Material examined : Jammu and Kashmir : 1 ♂, 20 vi. 1993, 1 ♂, 26. vi. 93, 1 ♀, 19. vii. 1994, Mimaling, Ladakh.

Altitude : 5,000 m ASL

Distribution : India (North-Western Region : Jammu and Kashmir: Ladakh)

Remarks : The material, being examined has been identified as *maharaja* Avinoff a full fledged species (Bryk, 1935, Talbot, 1939; Munroe, 1961; Collins and Morris, 1985; Mani, 1986; Smart, 1985; Varshney 1993). However, Eisner (1968), Ackery (1975), Hancock (1982) and Bridges (1988) have enlisted *maharaja* as a subspecies of *cephalus* Grum-Grashmailo. The indepth study of this literature supports the view that the former recognition is more correct and, accordingly, *maharaja* is described here as a full fledged species. Further, the examination of its male genitalia shows that it belongs to *szechenyii* group of species rather than the *acco* group, as has been considered by Munroe (loc. Cit.) who did not study the corresponding female genitalia.

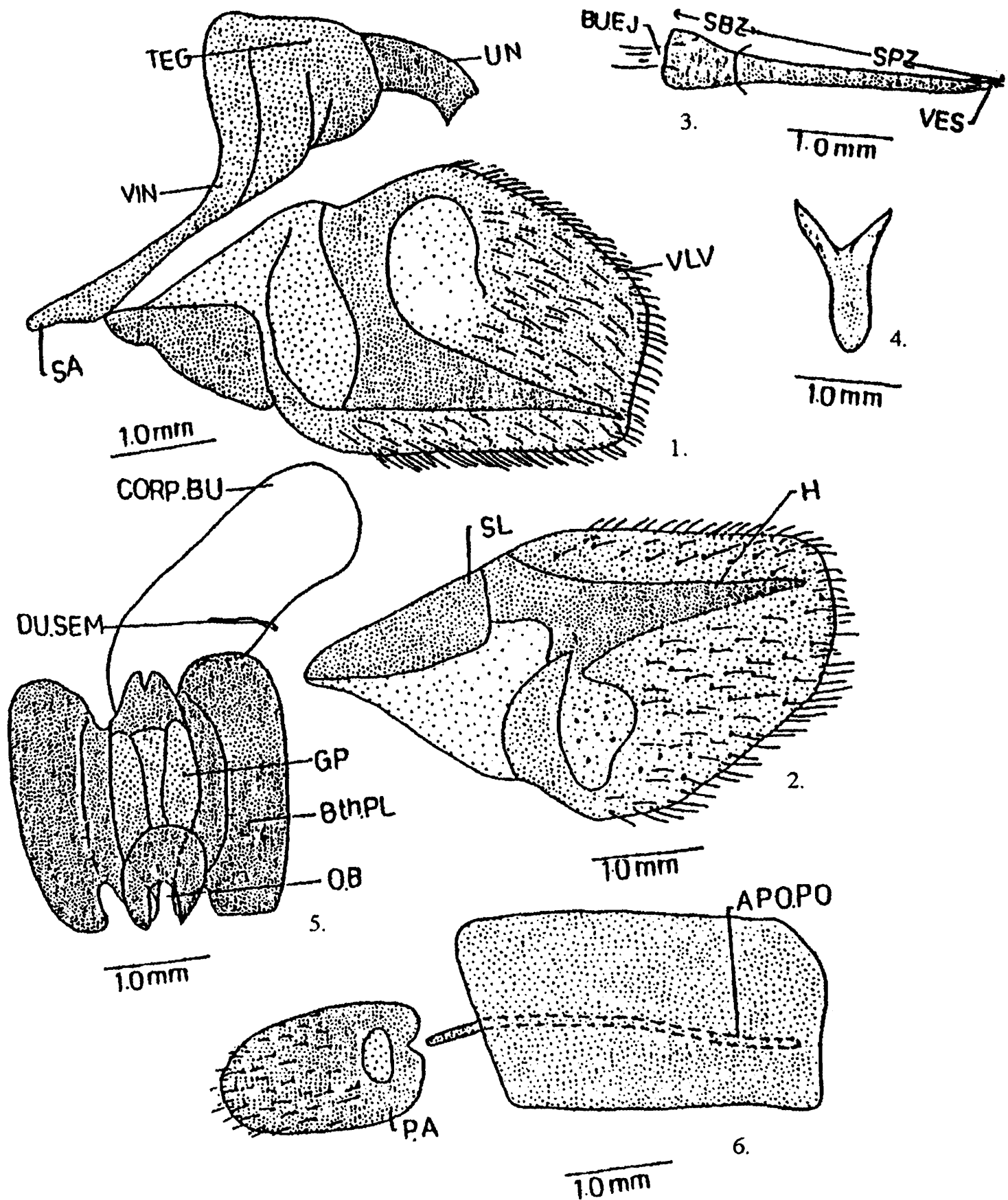


PLATE - 1 : *Parnassius maharaja* Avinoff

1. Male genitalia (lateral view); 2. Valva (inner view); 3. Aedeagus (lateral view);
4. Juxta (dorsal view); 5. Female genitalia (lateral view); 6. Papilla analis (lateral view).

The latter of *maharaja* also differs considerably from *acco* Gray. In the former species, the uncus lobes are flap-like, well sclerotized with apices dentate, juxta is y-shaped, non-hairy, valva is large and broad in male genitalia, and papilla anales are elongated, minutely pilose and genital plate with a well sclerotized posterior u-shaped flap in female genitalia, whereas, the uncus lobes are narrow, finger-like, weakly sclerotized, juxta is hairy and u-shaped, valva narrower in male genitalia and the papilla anales are triangular, densely pilose and genital plate without any posterior flap in female genitalia of the latter species.

Also, there happens to be some dispute about the range of species. According to Collins and Morris (1985), it is available only in Ladakh range of Jammu & Kashmir (appears to be endemic) but Mani (1986) has reported that its range extends from middle Asia through the Karakoram to North-West Himalaya. It flies at an elevation of 5,000 m ASL. The presently studied specimens from Ladakh have great commercial value in trade and generally fetch at high price. It is rare in Ladakh.

***Parnassius stoliczkaus* Felder & Felder**

Common Name : Ladakh Banded Apollo

Felder & Felder, [1865], *Reise Novara*, 2 : 138 (*Parnassius*).

***Parnassius stoliczkansus stoliczkanus* Felder and Felder.**

Diagnosis : Antennae black; forewing with veins R₁ and R₂ not anastomosed, veins R₅ and M₁ separated at base, vein M₁ arise from cell; forewing without sub-basal red spot on vein R₅, hindwing without red spot in space Sc+ R₁, discal ocellar spot neared to the cell than margin, with the a series of black submarginal spots, no marginal ocellar spot present; female with sphragis like a cylinder squashed, flat from below, ends splitted, divergent.

Male genitalia : Pseuduncus absent, eighth tergite separated by memberane; uncus bifid, each lobe with base broader, arms well sclerotized, pointed, divergent; tegument broader strap-like; vinculum wider in apical portion, narrow below; saccus elongated, knob-like, apex rounded. Valva rectangular; costa diagonal, narrow, sacculus straight with inner fold; harpe with inner fold at base, arise as a stout process, narrowing gradually, extending beyond apex, pointed; valva with elongated, finger-like process, latter with base broader, apex punctate ; valva densely pilose. Juxta shield-shaped, with folds on apical margins. Aedeagus extremely narrow, well sclerotized; subzonal portion broader, thicker, shorter; vesica ventral; bulbus ejaculatorius cephalad; last abdominal segment with clasper – like processes.

Female genitalia : Genital plate rectangular, bilobed, with base straight, upermargin wavy, with two lateral, pointed curved processes, one on each side; very heavily sclerotized eighth segmental pleuron, the latter well joined, well sclerotized with eighth tergite and genital plate. Corpus bursae globular, membranous; ductus bursae longer, narrow, weakly sclerotized; ductus seminalis attached near base of corpus bursae. Apophyses anteriores absent; apophyses posterioris long, narrow; papilla anales subovate, punctate, median memberanous area very small, pilose.

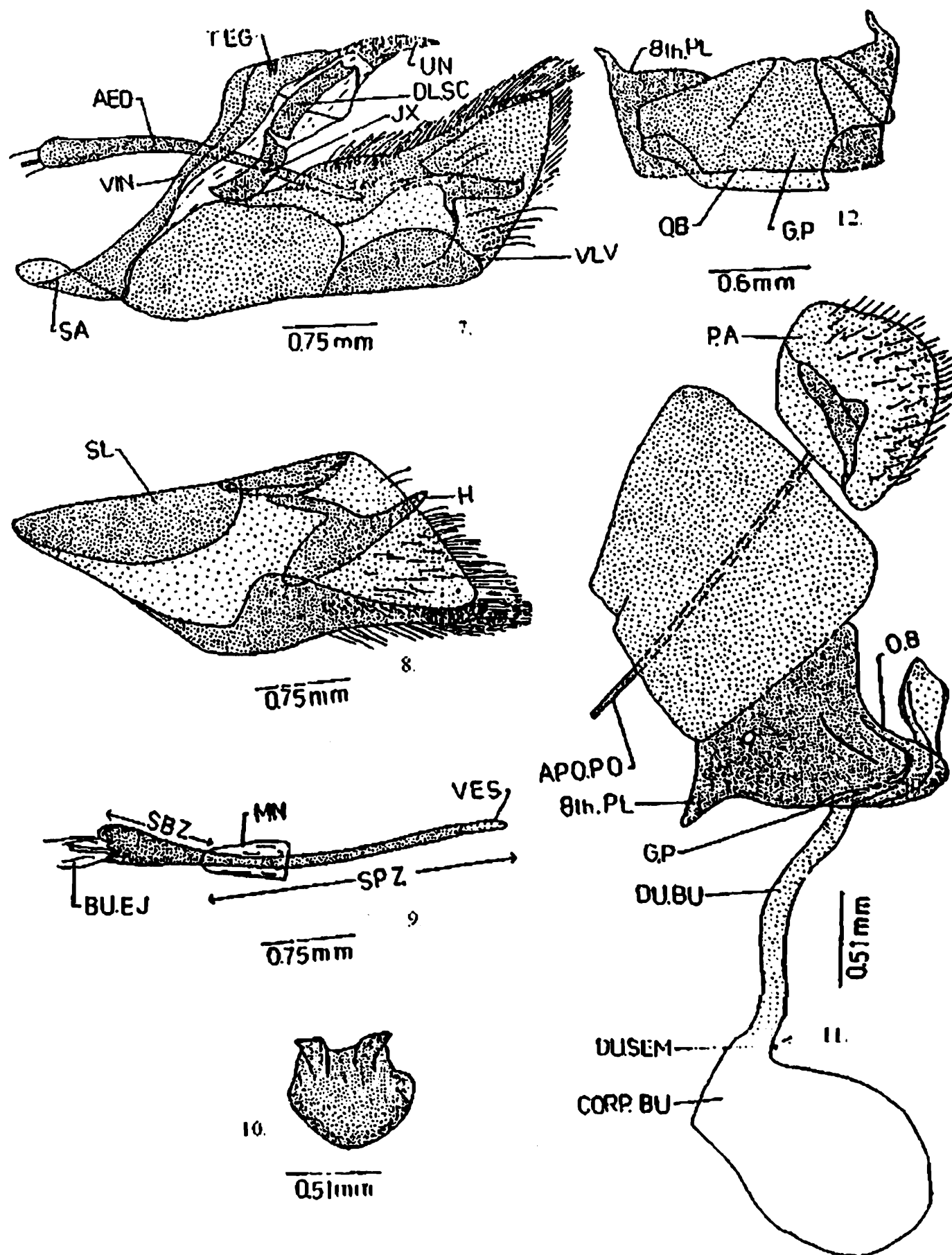


PLATE - 2 : *Parnassius stoliczkanus stoliczkanus* Felder & Felder

7. Male genitalia (lateral view); 8. Valva (inner view); 9. Aedeagus (lateral view); 10. Juxta (dorsal view); 11. Female genitalia (lateral view); 12. Genital plate (ventral view).

Forewing length : Male : 26.0 mm

Female : 27.0 mm

Material Examined : Himachal Pradesh : 1 ♂, 1 ♀, 3. viii. 1994, Baralacha La.

Altitude : 4,700 m ASL

Distribution : India, Afganistan, Pakistan, China and Tibet.

Remarks : According to Collins and Morris (1985), *stoliczkanus* Felder & Felder and *delphi*us Eversmann have an overlapping range and are available in the states of Jammu and Kashmir, Himachal Pradesh and Uttar Pradesh in India. The presently studied specimens, collected from Baralacha La have been identified as *Parnassius stoliczkanus* Felder & Felder. Bingham (1907) and Evans (1932), while mentioning the range of the subspecies from Ladakh to Kullu Valley have identified this population as *stoliczkanus*, which according to them is a subspecies of *delphi*us. Eisner (1968), Ackery (1975) and Bridges (1988) have also given it a subspecific status. However, both Talbot (1939) and Mani (1986) have recognized *stoliczkanus* as a full fledged species, having seven subspecies viz., *P.s. rileyi* Tytler (Rupal Valley, Astor, Farsat Pass, Chilas), *P.s. nicevillei* Avinoff (Kashmir : Burzil Pass), *P.s. atkinsoni* Moore (Kashmir : Pir Pingal, East Gilgit, Haramosh), *P.s. stoliczkanus* Felder & Felder (Ladakh to Kullu), *P.s. spitiensis* Bang-Hass (Spiti : Tum Tum Thang mountains) and *P.s. florenciae* ;tytler (Garhwal), whereas, Bryk (1935) and Turlin (1983) have reported nine and fifteen subspecies respectively Munroe (1961), New and Collins (1991), and Varshney (1993) have also recognized the taxon, under reference, as a full fledged species. The male external genitalia of *stoliczkanus*, an illustrated account of which is given herewith conforms to the *delphi*us group of species (Munroe, 1961). In the female genitalia, the ductus bursae are weakly sclerotized and the ductus seminalis originates from base of the corpus bursae. The genital plate is broader than long and the ostium bursae opens at the end of the genital plate. Both the specimens studied presently. show variations in colour of the spots which may be either red or orange.

The nominate subspecies *Parnassius stoliczkanus stoliczkanus* being rare (Evans 1932; Talbot; 1939) has also been included in Schedule-I, Part IV of the Indian Wildlife (Protection) Act, 1972. Even, New and Collins (1991) have remarked that this species in quite poorly known and need immediate monitoring. Regarding trade, it being sold at highest price and the cost of a single specimen has been estimated to be about \$ 20,000 (The Tribune, December 17, 1997).

***Parnassius imperator* Oberthur**

Common Name : Imperial Apollo

Oberthur, 1883, *Bull. Soc. Ent. Fr.*, : 79 (*Parnassius*); Bingham, 1907, *Fauna Brit. Ind. Butts.*, 2 : 127 (*Parnassius*); Evans, 1932, *Iden. Ind. Butts.*, (2nd ed.) : 61 (*Parnassius*); Talbot, 1939, *Fauna B. Ind.*, (Butt.), 2nd ed.) : 286 (*Parnassius*); Mani, 1986, *Butts. Himalaya* : 40 (*Parnassius*); Haribal, 1992, *Butts. Sikkim* : 60 (*Parnassius*); Varshney, 1993, *Oriental Insects* : 355 (*Parnassius*).

imperialis Eisner, 1897, *Orthogen. Schmett.*, : 385 (*Parnassius*).

***Parnassius imperator augustus* Fruhstorfer**

Fruhstorfer, 1903, *Soc. Ent.*, **18**(15) : 113 (*Parnassius*)

Diagnosis : Antennae black; forewing veins R1 and R2 not anastomosed, veins R5 and M1 separated at base, vein M1 arise from cell; large, creamish white with yellowish tinge, upperside of forewing with broad black bands complete; upperside of hindwing with discal spots in space M2 and R5 large, white centered, from spot in M1 to dorsum present a black band, a red spot at base of Rs, submarginal blue spots in space Cula and Culb large, underside of hindwing with basal red spots prominent.

Male genitalia : Uncus bilobed, base of each lobe broad, apex curved, pointed; tegument broader; vinculum broader in upper half, narrow in lower half; saccus lobes, well developed. Valva long, narrow, apex very narrow, strongly curved downward, lower margin of valva somewhat membranous; harpe long, stout, ending well below apex; valva pilose at apex and along sides, densely at membranous lower margin. Juxta shield-like, base broad, curved cup-like. Aedeagus very long; subzone shorter and broader; suprazone narrow, of even width; bulbus ejaculatorius entering cephalad; vesica ventral; eighth abdominal segment modified into a pair of processes.

Female genitalia : Genital plate bilobed, lobes well fused with heavily sclerotized eighth segmental pleuron, posteriorly inner angles bear foot-like projections : ostium bursae opening at anterior end. Corpus bursae globular; ductus bursae narrow, moderate in length, membranous. Apophyses anterioris absent; apophyses posterioris narrow, apices triangular; papilla anales trapezoidal, pilose.

Forewing length : Male : 37.0 mm

Female : 36.0 mm

Material examined : West Bengal : 1 ♂, 1 ♀, 28. vii. 95, Tiger hills, Darjeeling.

Altitude : 2,590 m ASL

Distribution : India, Western China, Tibet, Qinghai, Gansu, Sichuan, Szechwan and Yunnan.

Remarks : According to Bingham (1907) and Evan (1932), *augustus* Fruhstorfer is a subspecies of *imperator* Oberthur, available in the eastern Himalaya on the boundary between Sikkim and Tibet at an altitude between 2,500-5,200 m ASL. Talbot (1939) while following aforesaid workers has referred it to be very rare and, accordingly it has also been protected as Indian Wildlife (Protection) Act, 1972 (in part IV of Schedule-I). Though Collins and Morris (1985), and Haribal (1992) have recognized *augustus* as a valid subspecies yet the same has been considered as a synonym of *imperator* by Bridges (1988). Mani (1986) and Varshney (1993) have also not given any subspecies from India, though otherwise there are twenty subspecies of *imperator* (Bridges, 1988). In depth study reveals that the presently examined specimens from Darjeeling belong to *Parnassius imperator augustus*.

Like other species, *imperator* also shows some variations in maculation. In one of the specimens, the discal spot is white centered on upperside of the hindwing while

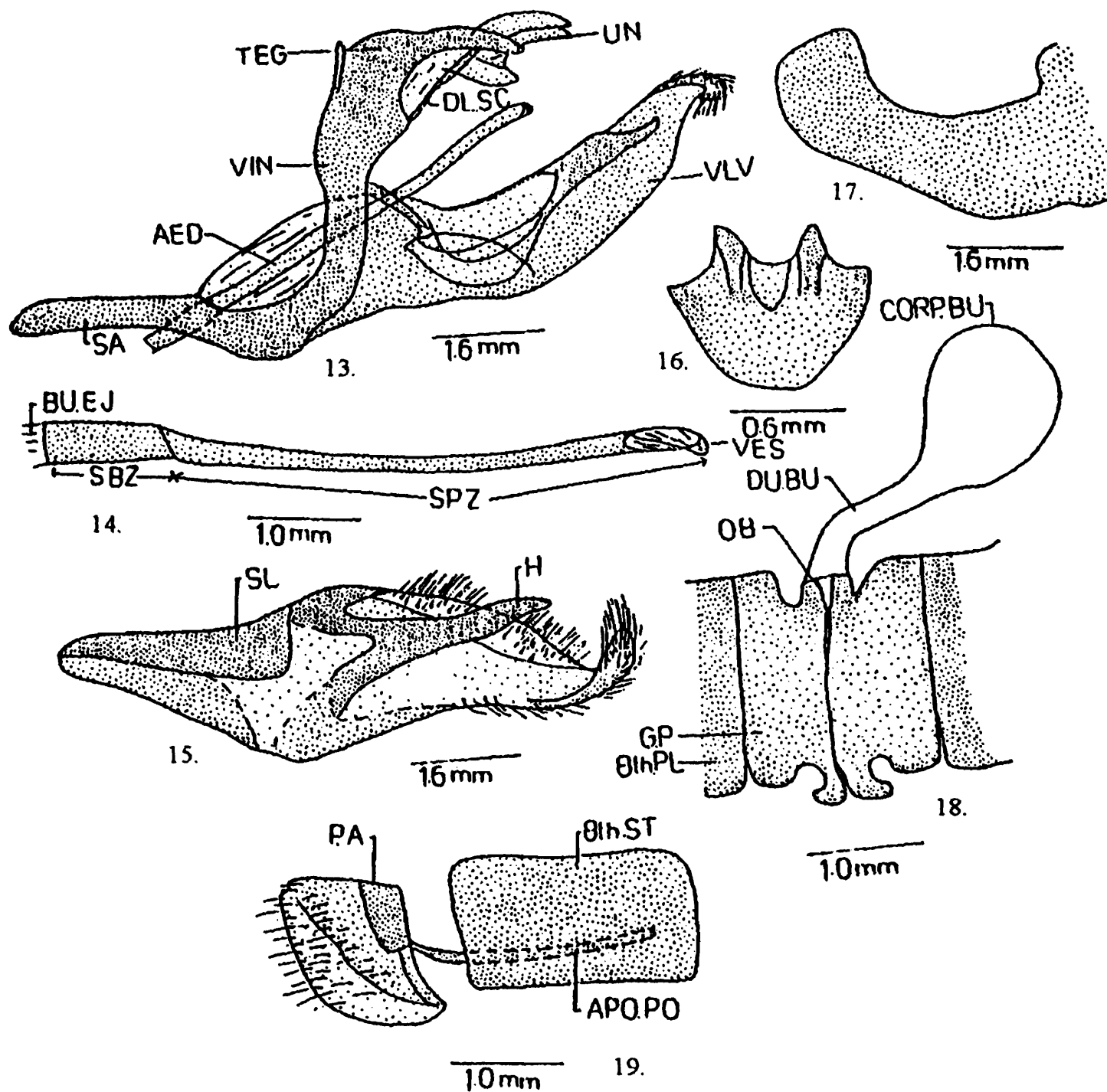


PLATE - 3 : *Parnassius imperator augustus* Fruhstorfer

13. Male genitalia (lateral view); 14. Aedeagus (lateral view); 15. Valva (inner view); 16. Juxta (dorsal view); 17. Eighth abdominal segment (lateral view); 18. Female genitalia (lateral view); 19. Papilla analis (lateral view).

in other specimen, it is not so. Similarly, the submarginal spots in Cula and Culb may be oval or rounded. Such variations appear to be population variations, as both the sexes have been reported to be alike in the previous literature (Bingham, 1907; Talbot, 1939; Mani, 1986). On the basis of this Palaearctic species, Munroe (1961), Ackery (1975) and Hancock (1982) have delimited *imperator* as a definite species-group which is also supported by the present studies in which due emphasis has been given to the structure of both the male and the female genitalia, which differ considerably from other such species-groups. The male genitalia is characterized by sharply curved apex of the valva, whereas, the lower margin of valva is some what membranous. The suprazone of the aedeagus is very long and of even width. Similarly, the female genitalia is conspicuous owing to somewhat spherically shaped corpus bursae, besides having a foot – shaped projections at end of each lobe of the genital plate. Ackery (1975) has report ¹ *Corydates* as larval food plant of this species.

***Parnassius charltonius* Gray**

Common Name : Regal Apollo

Gray, 1852, *Cat. Lep. Brit. Mus., Pap.*, : 77 (*Parnassius*); Moore, 1879, *Sci. Res. Sec. Yark.*

• *Miss. Lep.*, : 5 (*Parnassius*); Elwes, 1886, *Proc. Zool. Soc.*, : 43 (*Parnassius*); Moore, 1903, *Lep. Ind.*, : 118 (*Parnassius*); Wynter-Blyth, 1957, *Butts. Oriental Region* : 411 (*Parnassius*); Mani, 1986, *Butts. Himalaya* : 41 (*Parnassius*); Varshney, 1993, *Oriental Insects* : 355 (*Parnassius*).

Charlthionius Verity, 1911, *Rhop. Palae* : 81 (*Parnassius*)

Bryki Haude, 1912, *Soc. Ent.*, 27: 75 (*Parnassius*).

Deckerti Verity, 1911, *Rhop. Palae* : 85 (*Parnassius*).

Intermedialis Bryk and Eisner, 1937, *Parnassiana*, 4 : 30 (*Parnassius*).

Fermata Bryk, 1912, *Jb. Nass. Ver. Nat.* 65 : 9 (*Parnassius*).

***Parnassius charltonius charltonius* Gray**

Diagnosis : Antennae black, forewing with veins R1 and R2 anastomosed, vein R2 arising from vein R5, veins M1 and R5 well separated at origin, vein M1 arise from cell; wings above white, with a row of prominent blue centered black marginal spots; a prominent red spot in costa on spperside of hindwing.

Male genitalia : Pseudouncus lacking, eighth tergite separated; uncus bilobed, both the lobes adpressed with each other, base common, each lobe well sclerotized, stout, beak-like, down curved, just before apex, a small tooth present; tegument wider, heavily sclerotized, hump-shaped; vinculam moderate, sclerotization heavy; saccus elongated, tube-like, slightly wavy; dorsolateral sclerite free, modified into small lobes. Valva narrow, elongated, costa diagonal, apex squarish, from mid base of inner surface harpe arise as a broad flap with apical, stout, spine-like, long process, ending just before apex; margins of valva densely pilose. Juxta u-shaped, lateral sides from base stretched out to form boat-shaped structure. Aedeagus very sleek, narrow, wider at base, slightly curved; subzone shorter; vesica; ventral, bulbus ejaculatorius entering cephalad; eighth abdominal segment with a pair of processes.

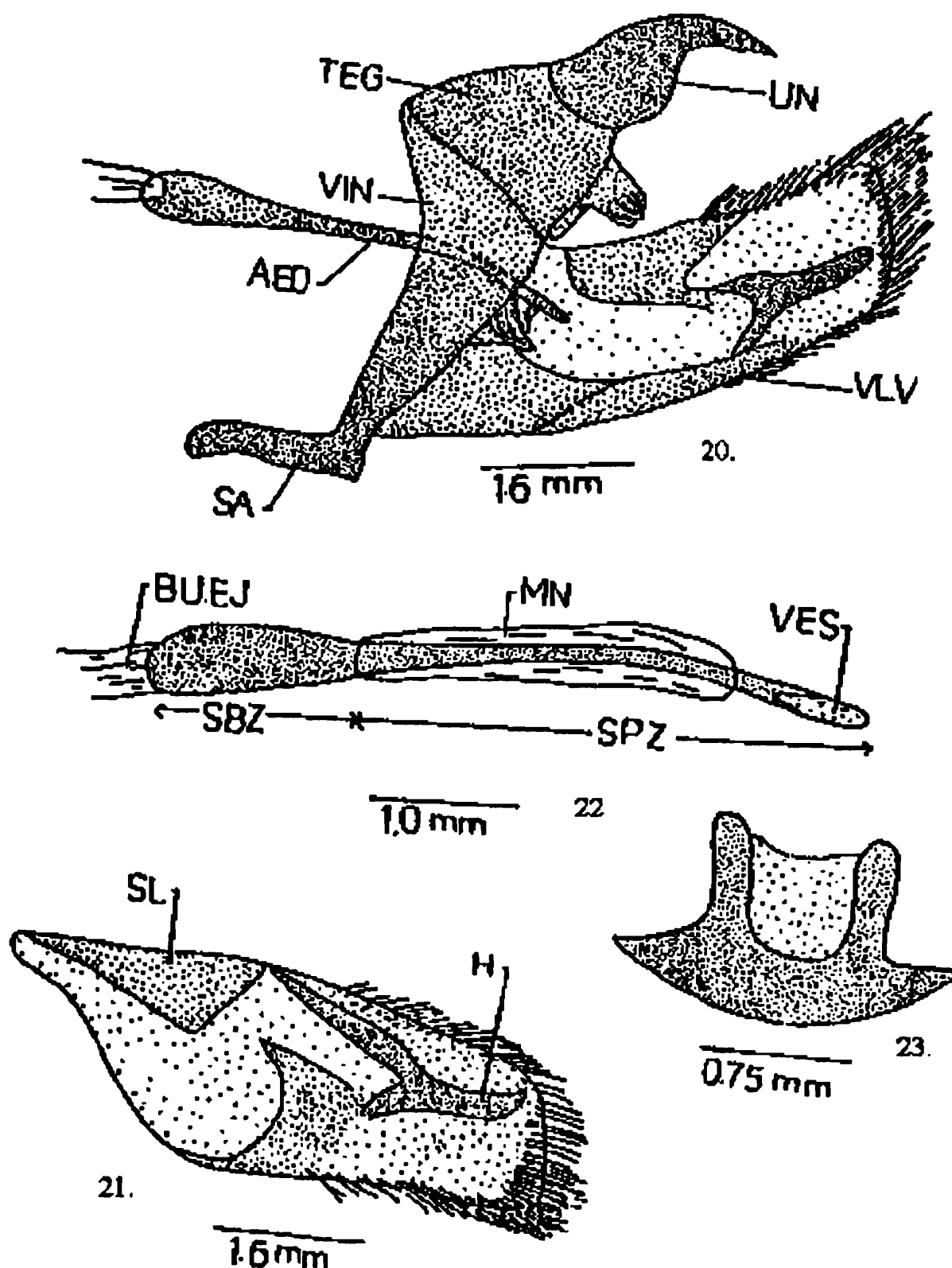


PLATE - 4 : *Parnassius charltonius charltonius* Gray

20. Male genitalia (lateral view); 21. Valva (inner view); 22. Aedeagus (lateral view);
23. Juxta (dorsal view).

Female genitalia : Not studied.

Forewing length; Male : 33.0–42.0 mm

Material examined : Himachal Pradesh : 8 ♂♂, 17.vi.1993, Manimahesh to Dhanshoo.

Altitude : 3,200 m ASL

Distribution : India, Afghanistan, old USSR, Pakistan, China and Tibet.

Remarks : *charltonius* Gray, a large sized apollo, is distributed in east Palaearctic region and possesses, as many as, twenty one subspecies (Bridges, 1988). According to Talbott (1939) and Mani (1986), the Indian Himalayan region contains four subspecies viz., *Parnassius charltonius charltonius* Gray, *P.c. ducalis* Boullet & Le Cref, *P.c. duckerti* Verity and *P.c. bryki* Haude. The present collected sample comprising eight males from Dhanshoo enroute to Manimahesh (Himachal Pradesh), belong to the nominate i.e., *P. c. charltonius* Gray. It has a specific habitat which is a rock prone area and all these individuals were collected from there within a sunshine period of 20-25 minutes. With the weather turning cloudy, many flying individuals were seen hiding themselves underneath big stones. Even otherwise, while collecting, they create a difficult situation by going in concealment under these stones. However, as per field observations, the species, under reference, appears to be locally abundant in that area. Therefore, it is being felt that the inclusion of the nominate subspecies in Schedule II, Part II of the Indian Wildlife (Protection) Act, 1972, need reassessment through extended field work.

All the eight male individuals, presently studied, show certain remarkable variations in the wing maculation. The spots and tornal band on upperside of the hindwing are red in seven individuals and the same being yellow in one male. Further, the tornal band may either be well separated from the red spot in space M2 and M3 or fused with it. The red colour may be entirely absent in a costal spot present in Sc+R1 or with a minute red patch or with an irregular red patch as seen in different individuals. The red spot in space M2 and M3 may be minutely white centered or broadly white centered. The marginal spots may have more or lesser blue scalings. As an acid test, the conspecificity of all these variable individuals has been established through examination of their male genitalia. Further, a species group named as *charltonius* group (Munroe, 1961; Ackery, 1975; Hancock, 1982) has characteristic uncus (beak-shaped uncus lobes) and juxta (boat-shaped) in the male genitalia. *Corydalis gortschakovi* is its larval food plant, according to Ackery (1975).

***Parnassius acco* Gray**

Common Name : Varnished Apollo

Gray, 1852, Cat. Lep. Brit. Mus., Pap.; 76 (*Parnassius*); Elwes, 1886, Proc. Zool. Soc., 25 (*Parnassius*); Moore, 1903, Lep. Ind., 5 : 116 (*Tadumia*); Bingham, 1907, Fauna Brit. Ind. Butts., 2:128 (*Parnassius*); Evans, 1932, Iden.Ind., Butts., (2nd ed.) : 61 (*Parnassius*); Talbot, 1939, Fauna B.Ind. (Butts.), (2nd ed.) : 294 (*Parnassius*); Mani, 1986, Butts., Himalaya : 41 (*Parnassius*); Haribal, 1991 Butts. Sikkim: 60 (*Parnassius*); Varshney, 1993, Oriental Insects : 835 (*Parnassius*).

***Parnassius acco tagalangi* Bang–Haas**

Bang–Haas, 1927, *Horae Macrolep.*, 1 : 23 (*Parnassius*).

Diagnosis : Antennae black; forewing with veins R1 and R2 anastomosed, vein R2 separated from vein R5 at base, veins M1 and R5 approximated at origin, vein M1 arise from cell; forewing above with fringe yellowish white; hindwing above with basal red spot.

Male genitalia : Uncus bilobed, less sclerotized, each lobe short, narrow, laterally bear well developed lobes of dorsolateral sclerite; tegument broad; vinculum narrow; saccus elongated with rounded apex. Valva broad; costa narrow; sacculus blade-like; apex of valva rounded; harpe stout, slightly oblique, apex blunt; valva pilose. Juxta u-shaped, curved, pilose. Aedeagus, short, narrow; subzone shorter than superazone; ductus ejaculatorius entering cephalad; vesica ventral; eighth segment of abdomen modified into a pair of processes.

Female genitalia : Genital plate well sclerotized, highly curved, well fused with well sclerotized eighth segmental pleuron, not well demarcated into lobes, at base bear a cup like depression; ostium bursae opening a little beyond seventh and eighth intersegmental region. Bursa copulatrix very short, undemarcated into corpus bursae and ductus bursae, sac-like. Apophyses anterioris absent, apophyses posterioris long, narrow, weak rods, with apices squarish; papilla anales triangular, weakly sclerotized, minutely pilose; the end of eighth segmental sternum narrowed posteriorly, with outer margins dentate.

Forewing length : Male : 22.0-26.0 mm

Female: 28.0 mm

Material examined : Jammua and Kashmir: 2 ♂♂, 1 ♀, 26.vi.1993, Tagalang La, Ladakh, 1 ♂, 9.vii.1994, Tagalang La, Ladakh.

Altitude : 5,200-5,360 m ASL

Distribution : India, Pakistan, Nepal, China, Tibet and Bhutan.

Remarks : According to Bridges (1988), There are, as many as, fifteen subspecies of *acco* Gray and the species is distributed in the east Palaearctic region. In India, it is represented by six subspecies viz., *Parnassius acco acco* Gray, *P.a. tagalangi* Bang–Haas, *P.a. hampsoni* Avinoff, *P.a. baltorana* Bang–Haas, *P. a. pundjakensis* Bang–Hass and *P. a. gemmifer* Fruhstorfer. The latter subspecies available from Sikkim is protected by law in India. However, the presently described specimens from Tangalangi and Tagalang La (5,200-5,360m ASL) belong to another subspecies, *tagalangi*. The correct spellings of the subspecies named after its locality is *tagalangi* (Talbot, 1939; Mani, 1986) and not *tagalagi*, as have erroneously been considered by Bridges (1988). According to Collins and Morris (1985), and New and Collins (1991), the status of the species, under reference, is not exactly known, particularly in Indian highlands. Further, this species is very rarely captured as it flies at high altitudes (5,000-6,200 m ASL). The presently borrowed sample collected earlier, has been examined and it

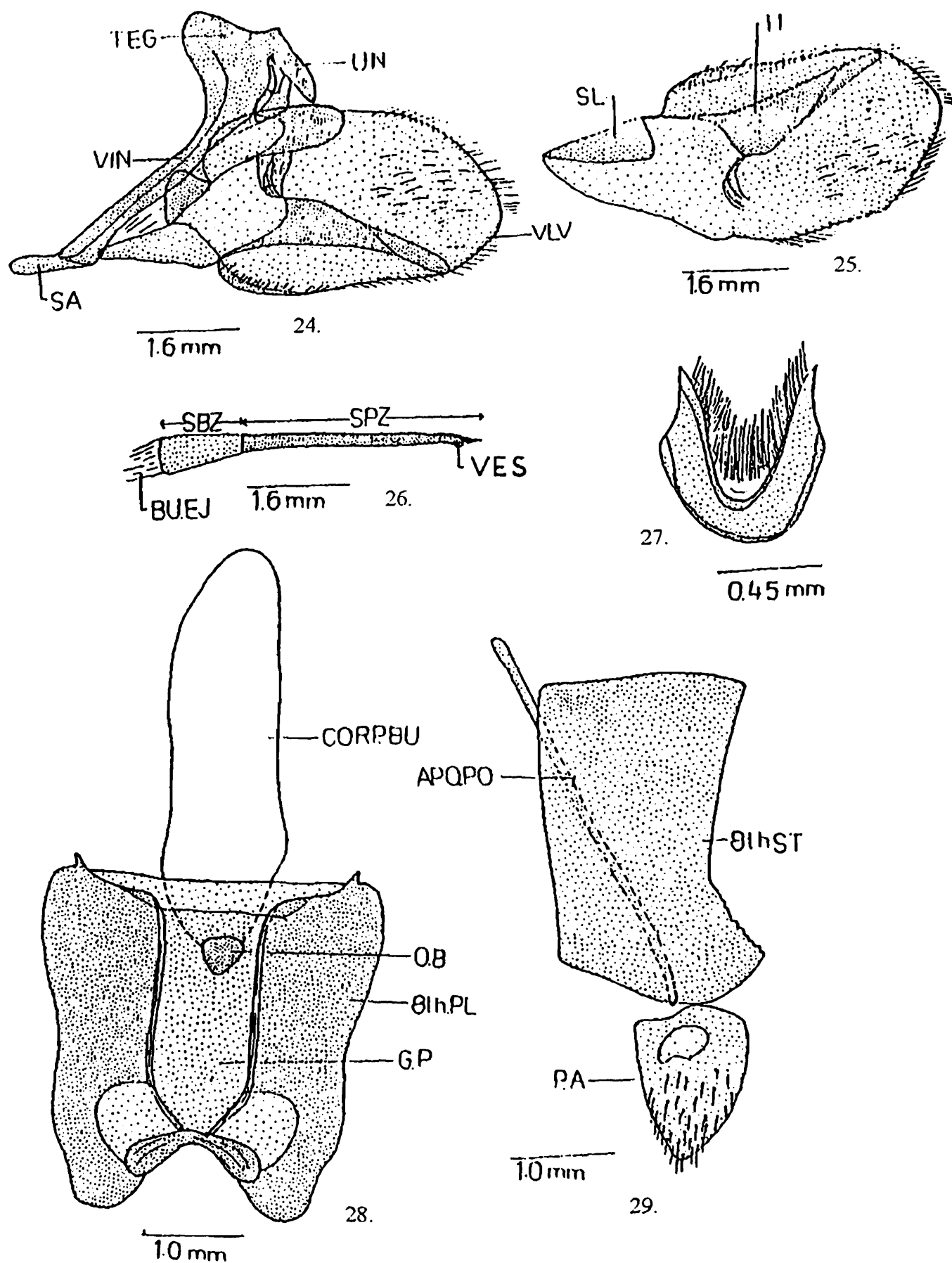


PLATE - 5 : *Parnassius acco tagalangi* Bang-Haas

24. Male genitalia (lateral view); 25. Valva (inner view). 26. Aedeagus (lateral view); 27. Juxta (dorsal view); 28. Female genitalia (ventral view); 29. Papilla analis (lateral view).

shows certain variations in the wing maculation. In one of the males, it has been observed that there are present red spots on upperside of both the wings, whereas, in the remaining specimens these spots are orange coloured. Similarly, on upperside of the forewing, the red discal spots in spaces M1, R5 and R2 are present in one male but missing in the remaining specimens. However, on the basis of their male genitalia, they are completely conspecific.

***Parnassius hardwickii* Gray**

Common Name : Common Blue Apollo

Gray, 1832, *Zool. Misc.*, 1 : 32 (*Parnassius*); Gay, 1846, *Lep. Ins. Nepal* : pl. 4 (*Parnassius*); Elwes, 1886, *Proc. Zool. Soc.*, : 38 (*Parnassius*); Moore, 1903, *Lep. Ind.*, 5 : 111 (*Parnassius*); Bingham, 1907, *Fauna Brit. India Butts.*, 2 : 121 (*Parnassius*); Evans, 1932, *Ident. Ind. Butts.*, (2nd ed.): 59 (*Parnassius*); Talbot, 1939, *Fauna B. Ind. (Butts.)*, (2nd ed.) : 269 (*Parnassius*); Wynter-Blyth, 1957, *Butts. Ind. Region* : 410 (*Parnassius*); Mani, 1986, *Butts. Himalaya* : 39 (*Parnassius*); Haribal, 1992, *Butts. Sikkim* : 60 (*Parnassius*); Varshney, 1993, *Oriental Insects* : 355 (*Parnassius*).

parva Verity, 1907, *Rhop. Palae* : 90 (*Parnassius*).

siegeli Eisner, 1941, *Zool. Meded.*, 23 : 46 (*Lingamius*).

***Parnassius hardwickii hardwickii* Gray**

Diagnosis : Antennae black; forewing with veins R1 and R2 not anastomosed, veins R3+5 and M1 stalked at origin, far away from origin of vein R2; upperside of wings creamy white, dusted with black scales, upperside of forewing with a black bar across the middle of the cell, one at apex, one beyond apex with two red spots, spots at end cell not connected by dark band to middle anal vein; upperside of hindwing with row of bluish, white centered submarginal series of black spots, two discal red spots and one red spot at base.

Male genitalia : Pseuduncus wanting, eighth tergite separated; uncus two lobed, each lobe stout with base wider, arms hook-shaped, down curved, minutely spinose and pilose, apex pointed, a pair of ventral processes present; tegument moderate; vinculum well sclerotized, straight, goes into very short saccus. Valva oblong; costa oblique; sacculus with margins wavy; apex of valva squarish, slightly arched, lower margin folded, lower apical area deeply arched, a stout pillar like process of harpe arise from middle of inner surface, extends beyond apex, pointed, valva pilose. Juxta V-shaped, well sclerotized. Aedeagus shorter, broader, well sclerotized, straight; apex pointed, bears teeth on upper surface; subzonal portion slightly shorter, wider, vesica ventral; ductus ejaculatorius entering dorsally.

Female genitalia : Genital plate well sclerotized, lobes completely fused with eighth abdominal heavily sclerotized pleuron, ostium bursae open at end of genital plate, opening sclerotized, a membranous pouch extends beyond it. Corpus bursae long, elongated in shape; ductus bursae extremely reduced; the size of bursa copulatrix much shortened. Apophyses anterioris absent, apophyses posterioris narrow rods; papilla anales somewhat triangular, pilose;

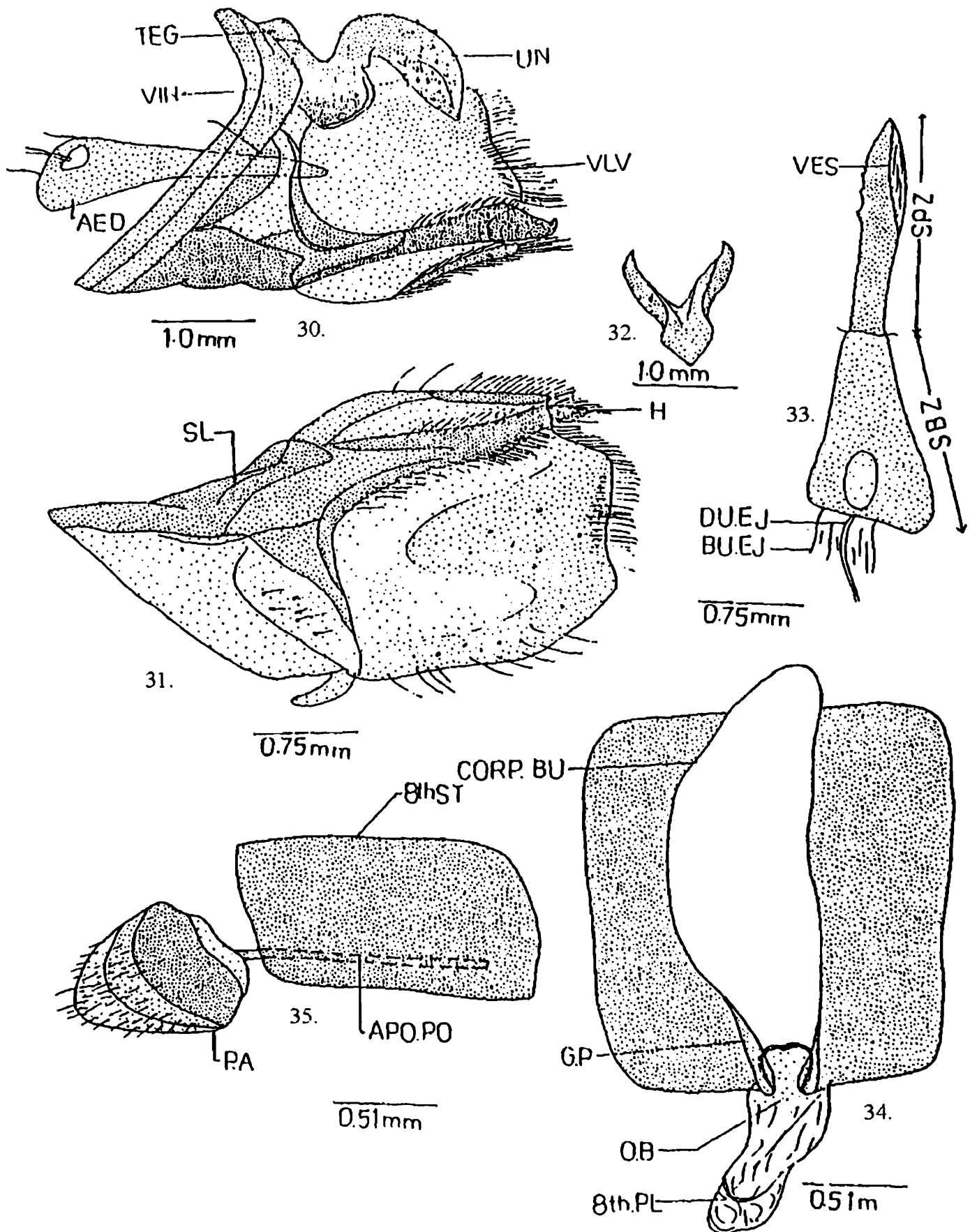


PLATE - 6 : *Parnassius hardwickii hardwickii* Gray

30. Male genitalia (lateral view); 31. Valva (inner view); 32. Juxta (dorsal view);
33. Aedeagus (lateral view); 34. Female genitalia (ventral view); 35. Papilla analis
(lateral view);

Forewing length : Male : 29.0 mm

Material examined : Female : 29.0-29.5 mm Himachal Pradesh: 1 ♂, 29. iv. 1944, Sanjauli, Shimla; 1 ♀, 7.vi.1991, Rohtang Pass, Kullu.

Altitude : 2,200-3,980 m ASL.

Distribution : India, Pakistan, Nepal, Bhutan, China and Tibet.

Remarks : The species, under reference, is restricted in the Himalaya and has been reported at varying altitudes between 2,000-5,000 m ASL (Bingham, 1907; Talbot, 1939). On global basis, it has eleven subspecies (Bridges, 1988), whereas, in the Indian Himalayan region, it is represented by three subspecies i.e., *Parnassius hardwickii hardwickii* Gray (Chitral to Kumaon), *P.h. albicanus* Fruhstorfer (East Himalaya) and *P.h. virdicanus* Fruhstorfer (Sikkim). In fact, there is some confusion as to the exact number of valid subspecies. Evans (1932) has synonymised the subspecific name *albicanus* under *hardwickii* but Talbot (1939) synonymised *virdicanus* under *albicanus*. However, according to Bridges (1988), all the three names represent valid subspecies. As per distribution, the presently collected specimens definitely represent the monotype. Both the specimens differ from each other, as the red spots are prominently marked in the female and obscure in the male. The sphragis is cylinder – like, with sides squashed and lower portion dentate. The female genitalia is highly reduced as far as size of the bursa copulatrix is concerned. The male genitalia is characterized by stout, spinose uncus lobes and the apical area of the aedeagus being dentate. Though Ackery (1975) has given an outline of the male genitalia yet it lacks details and is without any description. The needful is, accordingly, done in the present studies. The female genitalia is studied for the first time. The *hardwickii* group, to which this species belongs, differs considerably from other species – differs considerably from other species – groups in the above mentioned characters of the male and the female genitalia. This subspecies is redescribed from only two individuals. However, according to Wynter-Blyth (1957) it is quite uncommon below 8,000 ft. ASL but abundant in the meadows above that height where it flies close to the ground in sunshine and frequently settles on flowers to suck the nectar. According to Talbot (1939) its larva feeds on *Sexifraga*, which is available in Kashmir and Shimla all round the year.

***Parnassius jacquemonti* Boisduval**

Common Name : Keeled Apollo

Boisduval, 1836, *Spec. Gen. Lep.*, **1** : 400 (*Parnassius*); Oberthur, 1879, *Etud. Ent.*, **4** : 23 (*Parnassius*); Mackinnon & deNiceville, 1898, *Jour. Bomb. Nat. Hist. Soc.*, **11** : 596 (*Parnassius*); Moore, 1903, *Lep. Ind.*, **5** : 105 (*Parnassius*); Bingham, 1907, *Fauna Brit. India Butts.*, **2** : 118 (*Parnassius*); Evans, 1932, *Ident. Ind. Butts.*, (2nd ed.) : 59 (*Parnassius*); Talbot, 1939, *Fauna B. Ind. (Butts.)*, (2nd ed.) : 263 (*Parnassius*); Wynter-Blyth, 1957, *Butts. Ind. Region* : 411 (*Parnassius*); Mani, 1986, *Butts. Himalaya* : 38 (*Parnassius*); Varshney, 1993, *Oriental Insects* : 355 (*Parnassius*).

in picta Eisner, 1936, *Parnassius*, **4** : 14 (*Parnassius*).

jacquemontii Kirby, 1871, *Syn. Cat. Diurn. Lep.*, : 512 (*Parnassius*)

unipicta Bryk, 1935, *Tierreich*, 65; 301 (*Parnassius*).

***Parnassius jacquemonti jacquemonti* Boisduval**

Diagnosis : Antennae white ringed; forewing vein M1 stalked with vein R₃₊₅; forewing fringe not chequered; forewing with discal spot in space Culb heavily scaled, sometimes centred with red, prominent post discal band, red spots very small; hindwing underside with a basal red spot, broad submarginal lunules, ocellar spot with white pupil.

Male genitalia : Pseuduncus absent, eighth tergite not fused; uncus bilobed, each lobe with base broader, arms very narrow, sharp, curved; tegument broad, a flap-like median structure with rounded apex extends from its anterior wall, fits between the lobes, laterally tegument with horns; goes into very short triangular saccus. Valva elongated, narrow; costa long, arched; sacculus straight with small, triangular fold at its anterior end, apex of valva somewhat rounded from the apex of anellifer arise a broad flap-like harpe, narrowed apically into curved spine, margins of valva densely pilose. Juxta U-shaped, arms wavy, bear two well sclerotized parallel spines. Aedeagus slender, broader, straight, apex narrow, subzone shorter, vesica ventral, bulbus dorsally entering into the aedeagua, base broader.

Female genitalia : Genital plate well sclerotized, forming cup-like structure to enclose base of ductus bursae, consists of two lateral well sclerotized lobes, jointed by membrane; eighth abdominal pleuron well sclerotized, fuses with lobes of genital plate. Corpus bursae elongated, apex rounded, membranous, imperceptibly goes into ducts bursae; the latter membranous for short distance, had a projection on lateral side to which ductus seminalis enters, base sclerotized, swollen, ostium bursae narrower, opening a little beyond genital plate. Apophyses anterioris absent; apophyses posterioris shorter, apices squarish, long; papilla anales triangular, Base and margin sclerotized, middle portion membranous, pilose.

Forewing length : Male : 31.0 mm-32.0 mm

Female : 31.5-33.0 mm

Material examined : Himachal Pradesh: 1 ♂, 29.vii.1994, Teling, 1 ♀, 30.vii.1994, Chhola Dara, 1 ♂, 31.vii.1994, Losar, 1 ♀, 7.viii.1994, Kunzum La., Lahaul and Spiti.

Altitude : 3,600-4,560 m ASL

Distribution : India, Afghanistan, Pakistan, Old USSR, China and Tibet.

Remarks : *jacquemonti* Boisduval – a widely distributed species is represented by twenty nine subspecies worldover (Bridges, 1988). According to Mani (1986), in addition to its nominotype (Kashmir to Kumaon; Evans, 1932), another subspecies *shandura* Tytler also occur in North-West Himalaya. The presently examined sample from Lahaul and Spiti in the Western Himalaya, accordingly, represents nominate subspecies, *Parnassius jacqueonti jacquemonti* Boisduval. It seems to be highly

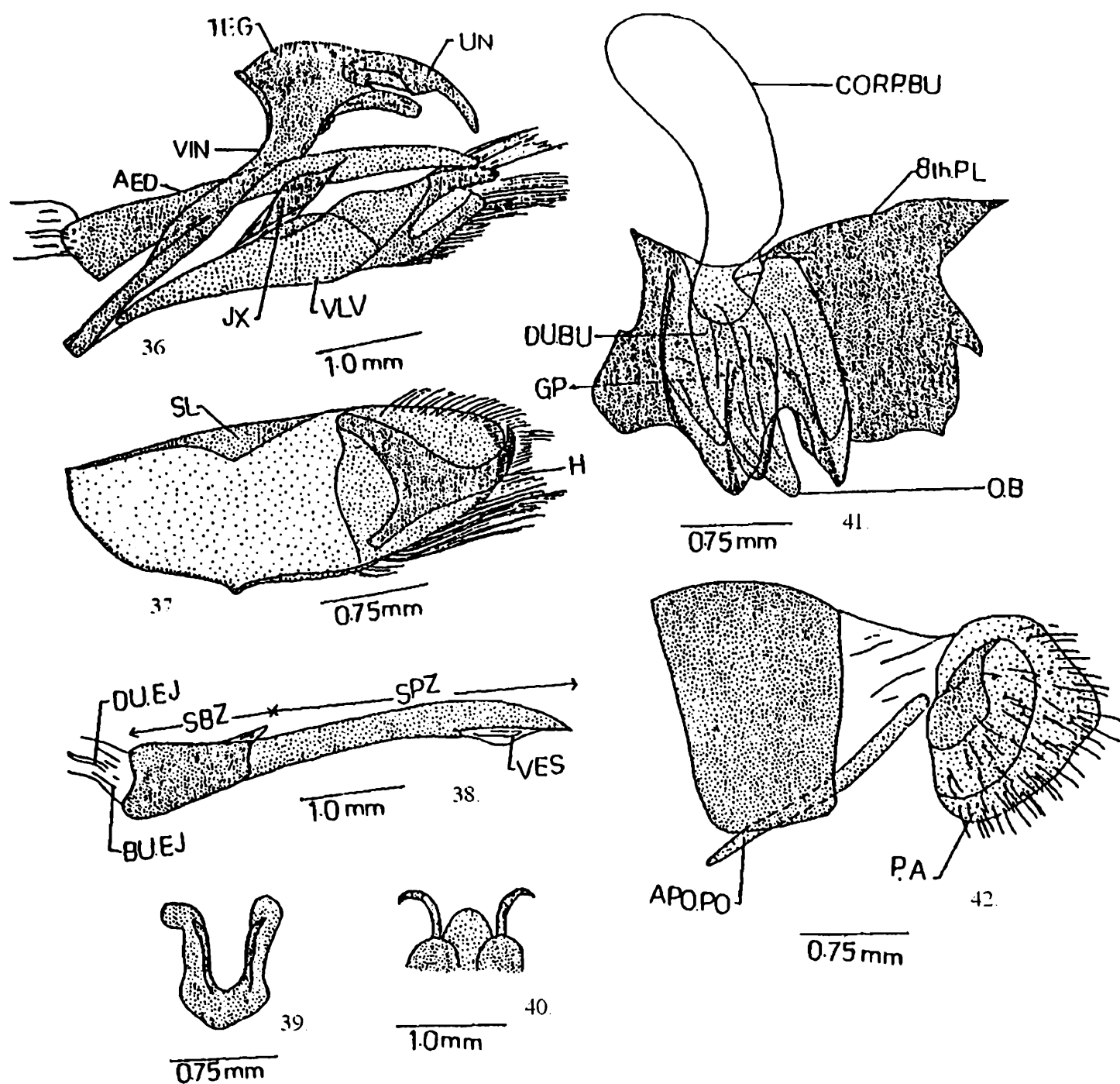


PLATE - 7 : *Parnassius jacquemonti jacquemonti* Boisduval

36. Male genitalia (lateral view); 37. Valva (inner view); 38. Aedeagus (lateral view);
 39. Juxta (dorsal view); 40. Uncus (dorsal view); 41. Female genitalia (ventral view);
 42. Papilla analis (lateral view).

variable both in respect of wing colouration and maculation. The red spots are present on upperside of the forewing in spaces Cula M1 and R_3 in a female specimen (from Kunzum La) and are wanting in other three specimens two males from Teling and Lossar respectively, and one female from Chhola Dara. Similarly, on upperside of the hindwing, the red streak in space Cula and Culb is absent in the female from Kunzum La and is present in the remaining specimens. Further, the red spots are either not centrally white (on male from Lossar) or minutely centrally white (one female from Chhola Dara and one female from Kunzum La) or broadly centrally white (one male from Teling). Bingham (1907) though made a mention of such variations, yet did not describe them precisely in either sex. In fact, he found different females being identical on the basis of sphragis, which is characteristically keel-shaped (hence the common name keeled Apollo). Owing to variations, all the four specimens (two males and two females) were dissected and the conspecificity of either sex determined through genitalic studies. Further, the placement of this species in Apollo-group is also estabolished on the basis of structure of the valva of the male genitalia (Munroe, 1961; Ackery, 1975; Hancock, 1982). An illustrated account of the male and the female genitalia of *P. Jacquemonti jacquemonti* is given for the first time.

The nominate subspecies, *P.j. jacquemonti* is protected by law in India and is enlisted in Schedule-II, Part-II of the Wildlife (Protection) Act, 1972. Bingham (1907) reported this subspecies at elevations from 3,650 to 5,600m ASL and Evans (1932) has stated it to be rare.

***Parnassius epaphus* Oberthur**

Common Name : Common Red Apollo

Oberthur, 1879, *Etud. Ent.*, **4** : 23 (*Parnassius*); Elwes, 1882, *Proc. Zool. Soc.*, : 399 (*Parnassius*); Moore, 1903, *Lep. Ind.*, **5** : 109 (*Parnassius*); Bingham, 1907, *Fauna Brit. India Butts.*, **2** : 120 (*Parnassius*); Evans, 1932, *Iden. Ind. Butts.*, (2nd ed.) : 59 (*Parnassius*); Talbot, 1939, *Fauna B. Ind. (Butts.)* (2nd ed.) : 266 (*Parnassius*); Wynter-Blyth, 1957, *Butts. Ind. Region* : 411 (*Parnassius*); Mani, 1986, *Butts. Himalaya* : 37 (*Parnassius*); Haribal, 1992, *Butts. Sikkim* : 60 (*Parnassius*); Varshney, 1993, *Oriental Insects* : 355 (*Parnassius*).

ocellodivisa Bryk & Eisner, 1936, *Parnassiana*, **4** : 13 (*Parnassius*).

sabaudus Turati, 1933, *Atti. Soc. Ital. Sci. nat.*, **72** : 193 (*Parnassius*).

epaphactius Bang-Hass, 1915, *Deut. Ent. Zeit.*, [Iris] **29** : 92 (*Parnassius*).

Nuda Peschke, 1938, *Ent. Rundsch.*, **55** : 155 (*parnassius*).

***Parnassius epaphus hillensis* Bang-Hass**

Type locality : Bashahr (Spiti).

Diagnosis : Antennae white ringed; forewing vein M1 stalked with vein R_{3+5} ; upperside with both wings transparent white, having black and prominent red spots, sometimes on forewing underside, the discal spot in space Cu1b lightly scaled and hindwing upperside without basal red spot; margin prominently chequered; hindwing base heavily black.

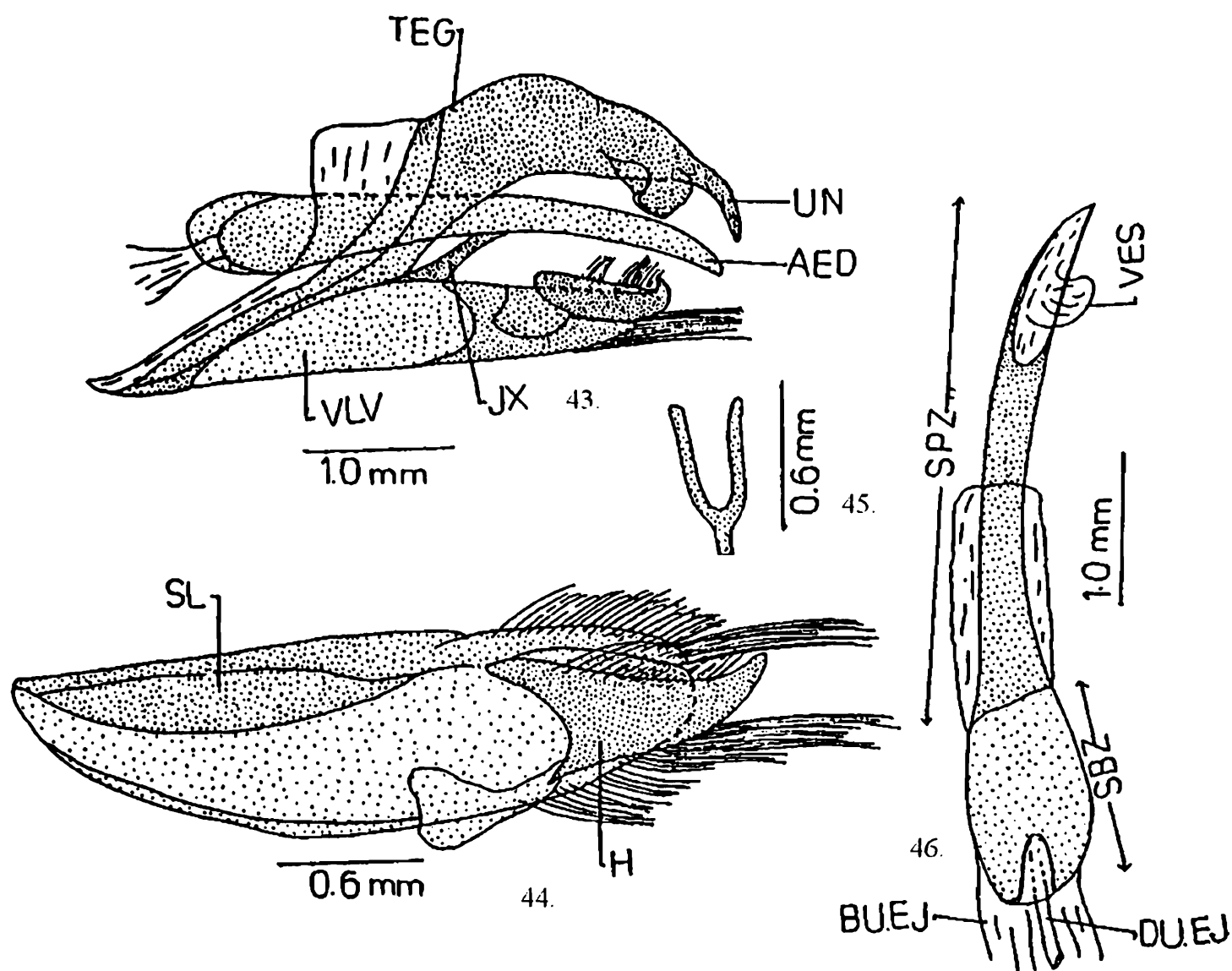


PLATE - 8 : *Parnassius epaphus hillensis* Bang-Haas

43. Male genitalia (lateral view); 44. Valva (inner view); 45. Juxta (dorsal view);
46. Aedeagus (lateral view).

Male genitalia : Pseuduncus absent, eighth tergite well separated; uncus divided into two each lobes with basal half broader, apical half in the form of long, narrow, slender, downcurved, pointed processes, uncus sparsely pilose; tegument very broad, hump like, a flap-like median structure extends from its anterior wall; vinculum narrow, diagonal, making the overall shape of male genitalia broader than long; saccus extremely short, triangular, apex narrower but blunt. Valva elongated, narrow, apex rounded, nearly from middle of valva arise a broad process of harpe, gradually narrowed towards apex, beyond apex turned upwards, pointed at tip. Juxta y-shaped, narrow, weakly sclerotized. Aedeagus straight, slender, subzone shorter, apex pointed, vesica dorsal, base swollen, bifid; bulbus cephalad.

Female genitalia : Not studied.

Forewing length : Male : 27.0-32.0 mm
Female : 28.0 mm

Material examined : Jammu and Kashmir : 1 ♂, 25.vi.1995, Khardung La, Ladakh, 1 ♂, 8.viii.95, Ladakh, 1 ♂, 9.viii.1994, Taglang La, Ladakh; 3 ♂, 27.07.2009, Khardungla, Ladakh.

Altitude : 5,000-5,300 m ALS

Distribution : India, Afghanistan, Pakistan, Nepal, Bhutan, China, Zingjiang, Sichuan and old U.S.S.R.

Remarks : *Parnassius epaphus* Oberthur is widely distributed in east Palaearctic region (Ackery, 1975) and has thirty seven valid subspecies (Bridges, 1988). According to Mani (1986), it ranges from Turkmenian area to South-East China and is differentiated into four subspecies viz., *cachemirensis* Oberthur, *hinducucia* Bang – Haas, *sikkimensis* Elwes and *hillensis* Bang-Hass in the Himalaya. On the basis of distributional record, the presently examined specimens (two males from Ladakh and North Sida) from the North – West Himalaya represent the latter subspecies *Evans*. Evans (1932) has, however, synonymised *hillensis* under *niritus* Moore, whereas, Mani (1986) and Bridges (1988) have considered it as a valid subspecies and accordingly, followed in the present studies. Talbot (1939) has reported this subspecies as rare and the same is also listed in Schedule-II, Part-II of the Indian Wildlife (Protection) Act, 1972. As per recent surveys in Ladakh, a rich zone of this species is present near Khardungla where lot of specimens of this species were seen either mudpuddling or sunbasking (plate XI to XV). Mating behavior in this species was also observed. Some specimens were taking nectar from flowers of *Potentilla arbuscula* (Rosaceae).

Further, critical examination of three male specimens of *Parnassius epaphus hillensis* Bang-Hass shows certain variations in the wing coloration (more whitish in a male from Ladakh and more transparent black in other two males) and wing maculation (upperside of the hindwing with a spot in space Sc+R1 present in Ladakh specimen and missing in other two, the spots are red in Ladakh specimen and red scales are absent in other). These variable individuals upon dissection were found to be conspecific.

Tribe **Zerynthiini** Grote

Grote, 1899, *Proc. Amer. Phil. Soc.*, : 17

Type genus : **Zerynthia** Ochenheimer

Ochsenheimer, 1816, *Schmett. Europe*, 4 : 29

Diagnosis : Antennae and legs unscaled; forewing with vein M1 from cell, five radial veins present; palpi long; hindwing with tails or indentation; males with asymmetrical tarsal claws; male genitalia with dorsal surface of vanae bulging outwards, uneven.

Remarks : Bryk (1923) has included the species of the tribe, under reference in the subfamily Parnassiinae, whereas, Ford (1944) and Talbot (1939) have upheld *Zerynthiini* as a tribe level taxon. However, Mani (1986) has used it as a family level taxon i.e., Zerynthiidae. The scrutiny of relevant literature published by Munroe (1961), Hiura (1980), Hancock (1982), Saigusa and Lee (1982), Collins and Morris (1985), Miller (1987), Bridges (1988) and Varshney (1993) reveals that there are five living and one fossil genus known under this tribe, which is represented by fifteen species in the globe. In India, this tribe is represented only by the presently reported species i.e., *Bhutanitis lidderdalii* Atkinson.

Genus **Bhutanitis** Atkinson

Atkinson, 1873, *Proc. Zool. Soc. Lond.*, 1872 : 570; Ackery, 1975, *Bull. Br. Mus. Nat. hist.*, (Ent.) 31 (4) : 92; Hancock, 1983, *Smithersia*, 2 : 11; Miller, 1987, *Bull. amer. Mus. Nat. Hist.*, 186 (4) : 380.

Armandia Blanchard, 1871, *C.R. Acad. Sci. Paris*, 72 : 809.

Type species : **Bhutanitis lidderdalii** Atkinson

Atkinson, 1873, *Proc. Zool. Soc. Lond.*, 1873 : 570.

Diagnosis : Antennae, tibiae and tarsi unscaled; forewing vein R3 stalked with vein R4+5; trace of basal spur present; hindwing precosta simple, precostal cell large lobes or tails at veins M 3, Cula, Culb of hindwing; male genitalia with pseuduncus absent, uncus lobes long, bifid, saccus elongated, very long, valve broad, harpe absent, aedeagus long, sleek, narrow.

Bhutanitis lidderdalii Atkinson

Common Name : Bhutan Glory

Atkinson, 1873, *Proc. Zool. Soc. Lond.*, 1873 : 570; Bingham, 1907, *Fauna Brit. Ind. Butts.*, 2 : 3 (*Armandia*); Evans, 1932, *Ident. Ind. Butts.*, (2nd ed.) : 58 (*Armandia*); Talbot, 1939, *Fauna B. India (Butts.)*, (ed. 2) : 250 (*Armandia*); Wynter-Blyth, 1957, *Butts. Ind. Region*, : 408 (*Armandia*); Ackery, 1975, *Bull. Br. Mus. Nat. Hist. (Ent.)*, 31 (4) : 94 (*Bhutanitis*); D' Abrera, 1982, *Butts. Orient. Region* : 488 (*Bhutanitis*); Hancock, 1982, *Smithersia*, 2 : 11 (*Bhutanitis*); Miller, 1987, *Bull. amer. Mus. Nat. Hist.*, 186 (4) : 380 (*Bhutanitis*); Haribal, 1992, *Butts. Sikkim*: 61 (*Bhutanitis*).

lidderdahlii Bryk, 1912, *J.B. Nass. Ver. Nat.*, **65** : 5 (*Bhutanitis*).

lidderdalei Fruhstorfer, 1909. In : *Seitz. Grossschmett. Erbe*, **9** : 109 (*Armandia*).

***Bhutanitis lidderdalli lidderdalli* Atkinson**

Diagnosis : Upperside of both wings black with pale white narrow vertical lines; upperside of hindwing with very large orange red tornal patch with blue grey spots, inwardly white edged, wings elongated, narrow, hindwing tailed at veins M₃, Cula and Culb, the tail long at vein M₃, toothed at veins M₂ and M₁; sexes similar.

Male genitalia : Pseuduncus lacking, eighth tergite separated; uncus bilobed, well sclerotized, stout, each lobe swollen at base, pilose, with arms very long, narrow, straight, with sharp apices; tegument broad, hump-like with lateral horns; vinculum broader in upper half, mingles with very elongated, tube-like saccus with apex rounded. Valva joined to tegument with dorsalateral sclerite, valva with dorsal surface uneven, bulges outwards, costa narrow, anellifer extending upto middle, apex sharp, harpe lacking, lower and upper apical margins of the valva pilose. Juxta curved, V – shaped. Aedeagus very sleek, narrow, slender, elongated, suprazone larger, apex squarish, vesica ventral, ductus ejaculatorius entering cephalad.

Female genitalia : Not studied.

Forewing length: Male : 50.0-57.0 mm

Material examined : West Bengal : 1 ♂, 12.vii.1992, 1 ♂, 15.vii.1994, Tiger hills, Darjeeling

Altitude : 2,590 m ASL

Distribution : India, Burma, Thailand, China.

Remarks : Out of the five species i.e., *dongchuanensis* Lee, *ludlowi* Gabriel, *thiadina* Blanchard, *mansfieldi* Riley and *lidderdalli* Atkinson (Bridges, 1988), the latter is represented in the Oriental region (D' Abrera, 1982). Further, it has four subspecies viz., *l. lidderdalli*, *l. ocellatamaculata* Igarashi, *l. ochracea* Tytler and *l. spinose* Stichel, and the nominate subspecies represents the Indian population. During the course of present field work at Darjeeling, it has been observed that it has a unique hill topping behaviour amongst tree tops and rarely descends to the grounds. The adults can be readily recognized from their oblong narrow wings besides slow Danaid-like flight. Tytler (1912) has reported that this butterfly is quite common in the Naga Hills during the months of August, September and October. Its larvae feed upon *Aristolochia griffithii*. Subsequent workers like Evans (1932), Talbot (1939), Wynter-Blyth (1957), and Collins and Morris (1985) have recorded this subspecies to be quite rare and it has also been included in Schedule-II (Part-II) of the Wildlife (Protection) Act, 1972. Owing to all this, New and Collins (1991) have stressed the need to monitor the species regularly besides preventing its decline in natural habitat which is under threat and is being destroyed. Further, *B. lidderdalli* is a highly priced butterfly and hundreds of its individuals are imported annually from Thailand (Collins and Morris, 1985). It is also being exported from India to the European countries (The Tribune,

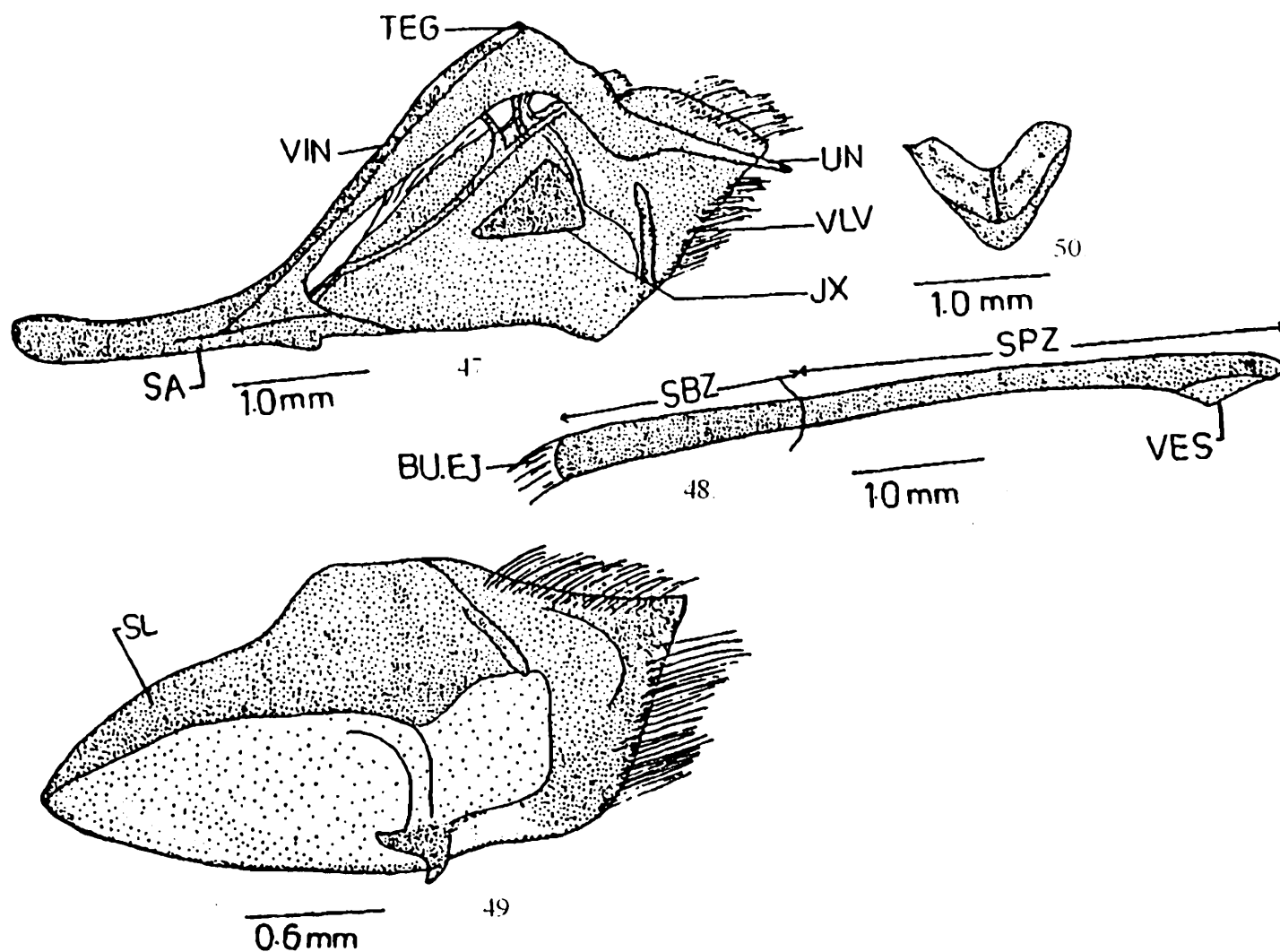


PLATE - 9 : *Butanitis lidderdalii lidderdalii* Atkinson

47. Male genitalia (lateral view); 48. Aedeagus (lateral view); 49. Valva (inner view);
50. Juxta (dorsal view).

17th December, 1997). The illegal trade of this rare butterfly needs to be checked effectively besides taking care of its habitats. Its ranching will go a long way to benefit survival of this species. Its farming and conservation through scientific means could prove to be highly productive.

PHYLOGENY OF SUBFAMILY PARNASSIINAE

In the subfamily Parnassiinae, two genera i.e. *Parnassius* Latreille (eight species) and *Bhutanitis* Atkinson (one species) referable to the tribes Parnassiini and Zerynthiini have respectively been studied, presently (Fig. XVI). The male genitalia shows that in the tribe Parnassiini, the harpe is stout and well developed, outer surface of each of the valva is smooth, the aedeagus is relatively shorter and broader at base, and gradually narrowing distally, the saccus is either moderately developed or indistinct and the uncus is rather shorter in size. In Zerynthiini, the harpe is absent, outer surface of each of the valva is uneven and bulges outwards, the aedeagus being very sleek, long and of even width and the saccus is comparatively quite longer and tubular (though occurs parallel in genera *Teinopalpus* Hope and *Pachliopta* Reakirt of subfamily Papilioniae and the uncus is relatively longer in size. On the basis of structure such as thin and weakly sclerotized aedeagus and presence of stout harpe, which are wanting in Zerynthiini. Parnassiini is, accordingly, more primitive than the Zerynthiini. Munroe (1961) has also considered Zerynthiini to be more specialized than Parnassiini due to loss of scaling on the antennae, the tibiae and the tarsi. Hancock (1982) has suggested their linear descent relationship, whereas, Miller (1987) has supported Munroe's opinion and accordingly, the male genitalia of *Bhutanitis* is more specialized than that of *Parnassius*.

Further, as evident from key to the genus *Parnassius*, an attempt has been made to precisely utilize various genitalic parts like the valva, juxta, harpe and aedeagus for their separation, wherever possible (Fig. XVII). Except *P. maharaja* Avinoff, in which the valva is large and broad with margin entire, the same is relatively narrower in all the remaining seven species i.e. *P. stoliczkanus* Felder and Felder, *P. imperator* Oberthur, *P. charltonius* Gray, *P. acco* Gray, *P. hardwickii* Gray, *P. jacquemontii* Boisduval and *P. epaphus* Oberthur. In addition to this, the uncus lobes are spatulate and lie closer to each other with their apices being squarish and minutely dentate. Munroe (1961) and Hancock (1982) have enlisted *maharaja* in primitive group viz., *szechenyii* group of species owing to larger size of the valvae in the male genitalia. It may also be added here that *maharaja*, besides the remaining species viz., *stoliczkanus*, *imperator*, *charltonius* and *acco* referable to different groups, broadly depict a natural grouping, as all of them have a weak and narrow aedeagus, besides that the vinculum is produced anteriorly to from a moderately sized saccus. Though belonging to two different groups, yet the species *hardwickii* (*hardwickii* group) and *jacquemonti* Boisduval and *epaphus* Oberthur (*apollo* group) have their aedeagus being broader and stout, and the vinculum which is more inclined, is not produced into a distinct saccus in all of them. Even their female genitalia (not studied in *epaphus*) shows that the latter two species – groups are more closer to each other in having base of the bursa copulatrix extending well beyond the genital plate and

opening into a pouch. The *apollo* group containing *epaphus* and *jacquemontii*, which are more closer to each other (uncus lobes narrow, median spatulate lobe between uncus lobes well developed, valvae very narrow) can easily be sorted out from allied group *hardwickii* (uncus broad, stouter, spinose and without median process, valvae broader) on the basis of characters, mentioned in the parenthesis. In the female genitalia, the corpus bursae is bag-like and the ductus bursae is extremely reduced in the species *hardwickii*, whereas in *jacquemonti*, the ductus bursae though not very slender but runs parallel to the genital plate. Munroe (1961), Ackery (1975) and Hancock (1982) have placed *epaphus* and *jacquemonti* in *Apollo* and *hardwickii* under *hardwickii* species-groups respectively. Hancock (loc. cit.) has considered *apollo* group to be most advanced in having foretibial epiphysis reduced. The interpretation of both the male and the female genitalia shows that these three species, representing above mentioned two groups are more advanced than former five species i.e., *maharaja*, *stoliczkanus*, *imperator*, *charltonius* and *acco* referable to *szechenyii*-group, *delphius* group, *imperator* group, *charltonius* group and *acco* group respectively, in having broader and stouter aedeagus in the male genitalia, besides that the ostium bursae opens into a membranous pouch in the female genitalia. It has also been observed that the species *stoliczkanus* and *imperator* of *delphius* and *imperator* species-groups respectively, are quite closer to each other in having very long but very weakly sclerotized aedeagus, the juxta is typically shield – like, upper margin of the valva is punctate and the dorsolateral sclerite of the uncus is strip – like in the male genitalia. Similarly, in the female genitalia, the ductus bursae is long, narrow, slender, and the corpus bursae is comparatively smaller and globular in shape. However, these two species can be separated from each other on the basis of apex of the valva, which is very oblique in *stoliczkanus*, and narrow and twisted in *imperator*. The structure of the genital plate is also different, being shorter and wider in former, and elongated and bilobed in latter species. It may also be mentioned here that opening of the ostium bursae is not consistent in the tribe Parnassiini. It may open at the posterior or anterior end of the eighth sternum, as witnessed in *stoliczkanus* and *imperator* respectively. Further, the species *charltonius* and *acco* representing nominate species – groups are though closer to each other in having u-shaped juxta and dorsolateral sclerite of the uncus being elongated and lobe-like, yet can be separated from each other on the basis of dorsolateral sclerites, which are very well developed and well sclerotized in *acco* as compared to less developed in *charltonius*. Similarly, apex of the valva is entire in the former species and squarish in the latter. In the species *acco*, the juxta is found to be hairy along inner margins (autapomorphic in subfamily).

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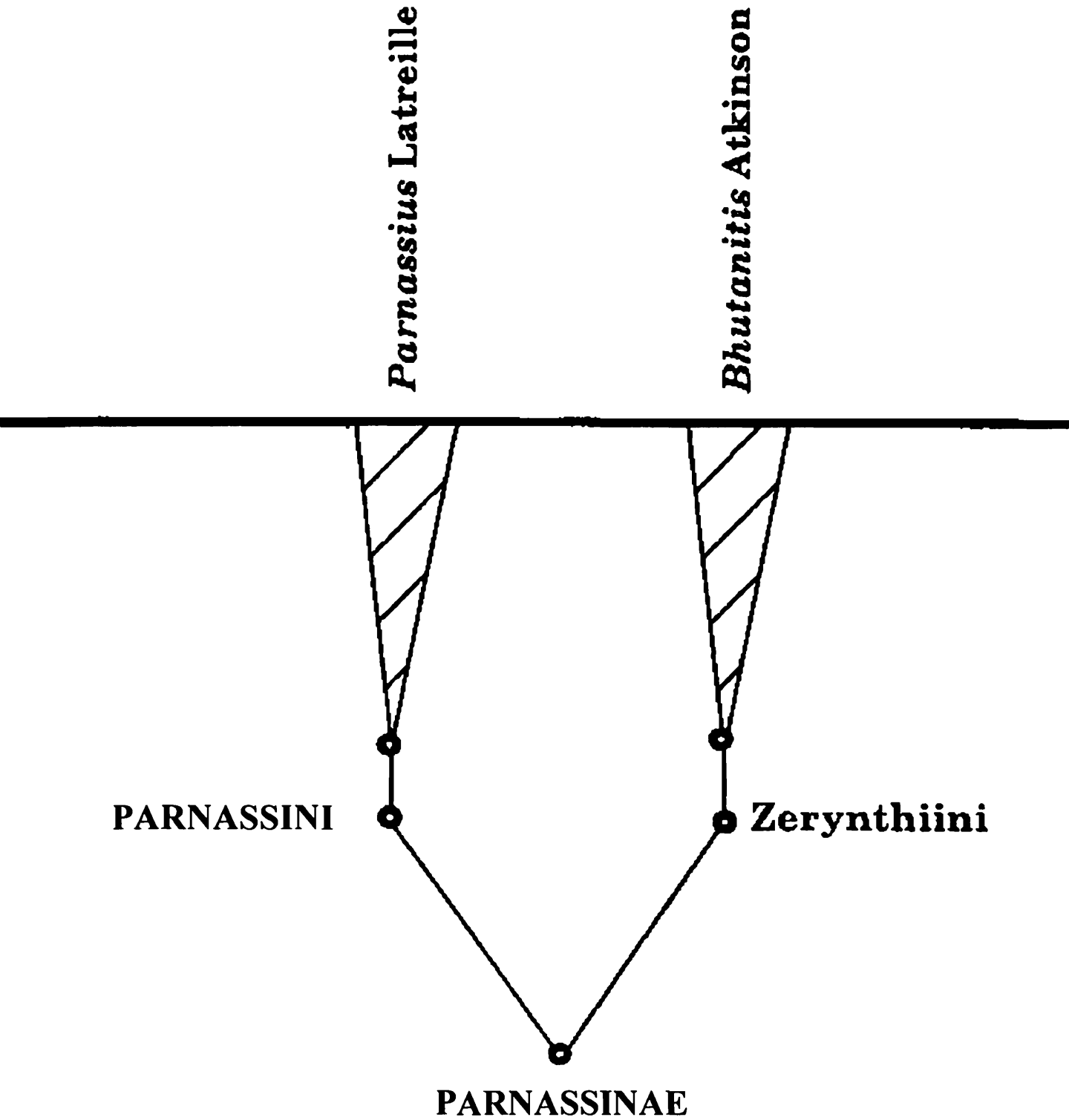


PLATE-XVI : Phylogenetic relationships of different Tribes and Indian Genera of the subfamily PARNASSINAE Duponchel

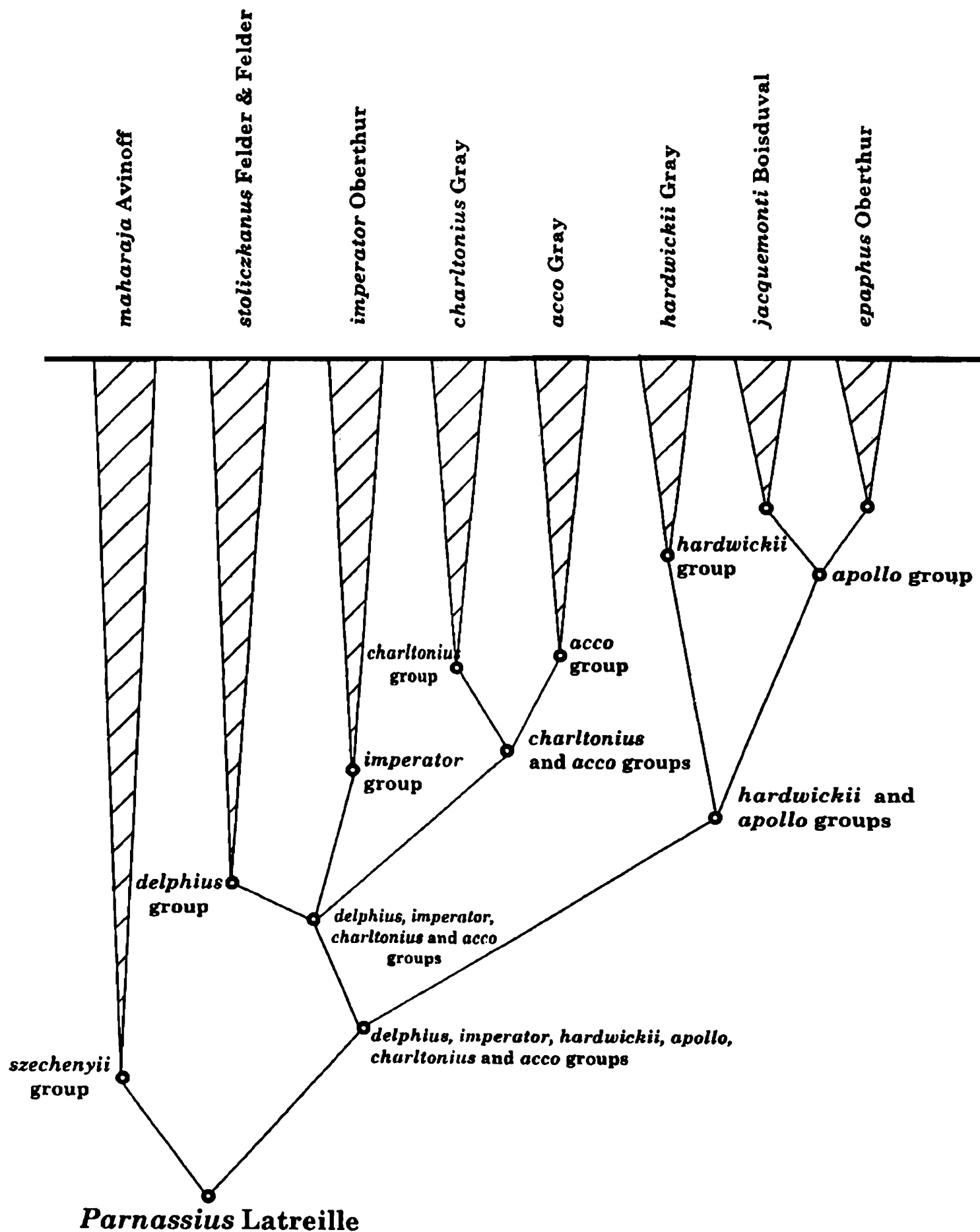


PLATE-XVII : Phylogenetic relationships of different Indian Species of the Genus *Parnassius* Latreille

PLATE - I

Fig. 1. Species diversity of Parnassiinae in the world

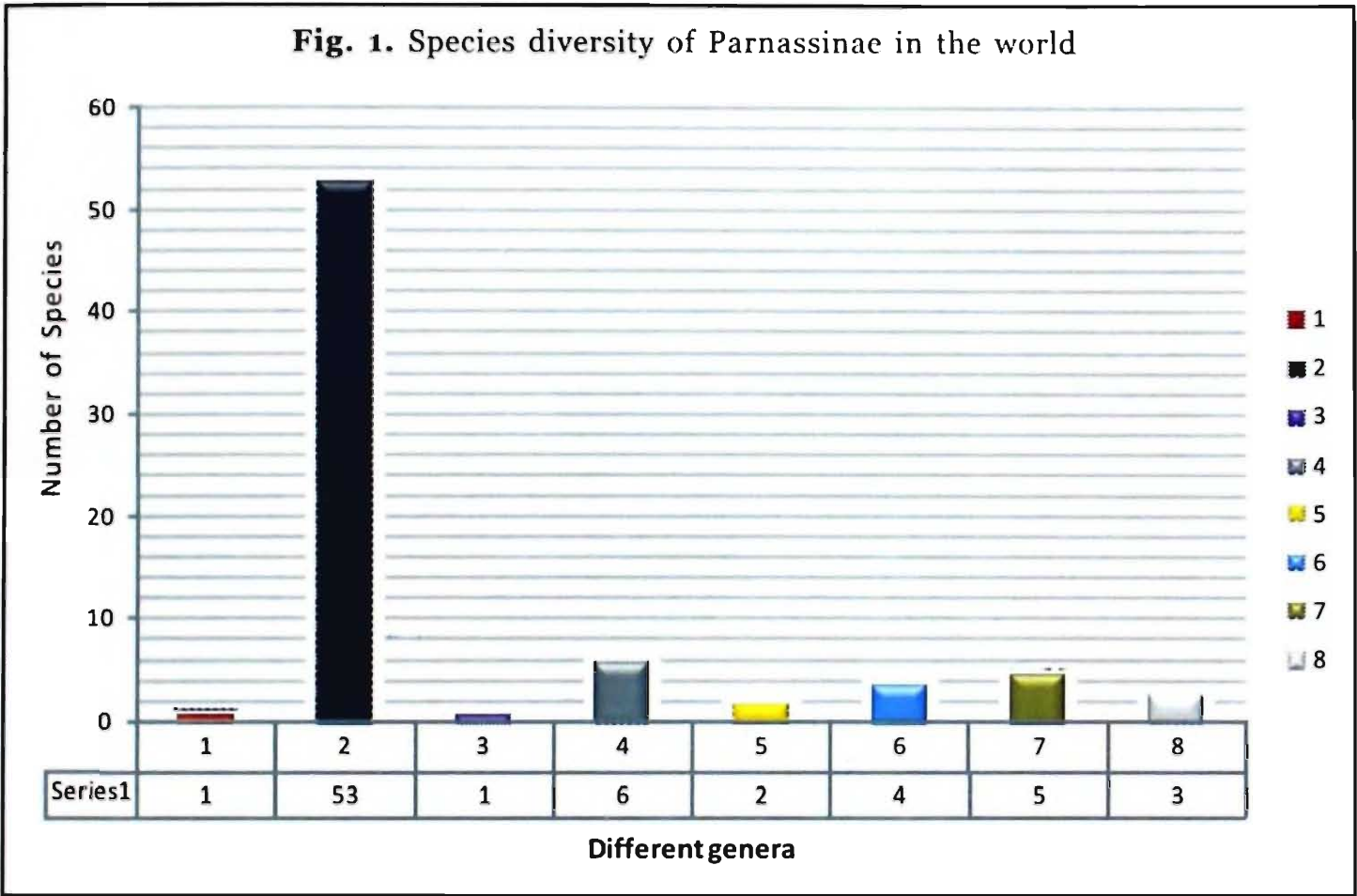


Fig. 2. Comparative chart of Parnassiinae diversity

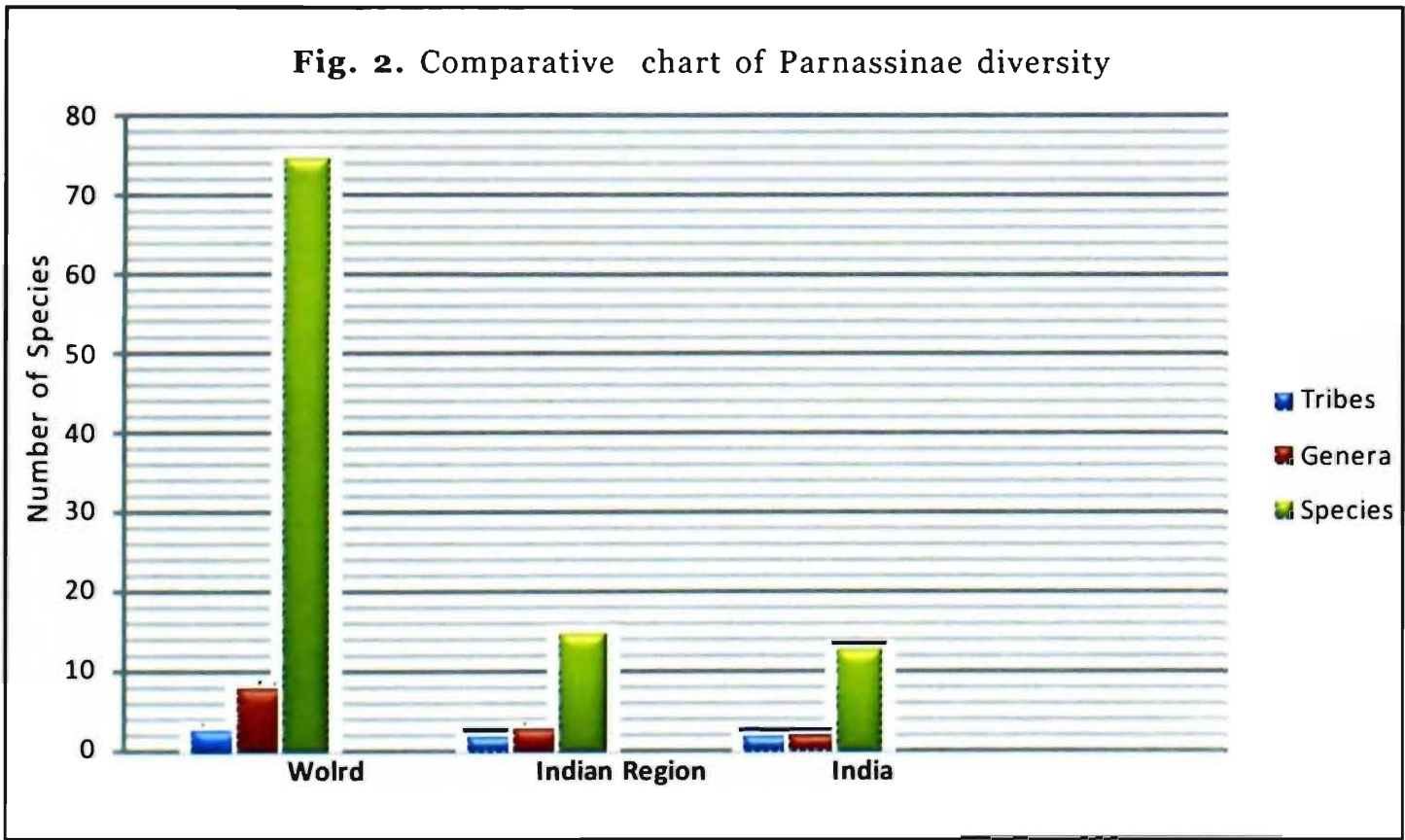


PLATE - II

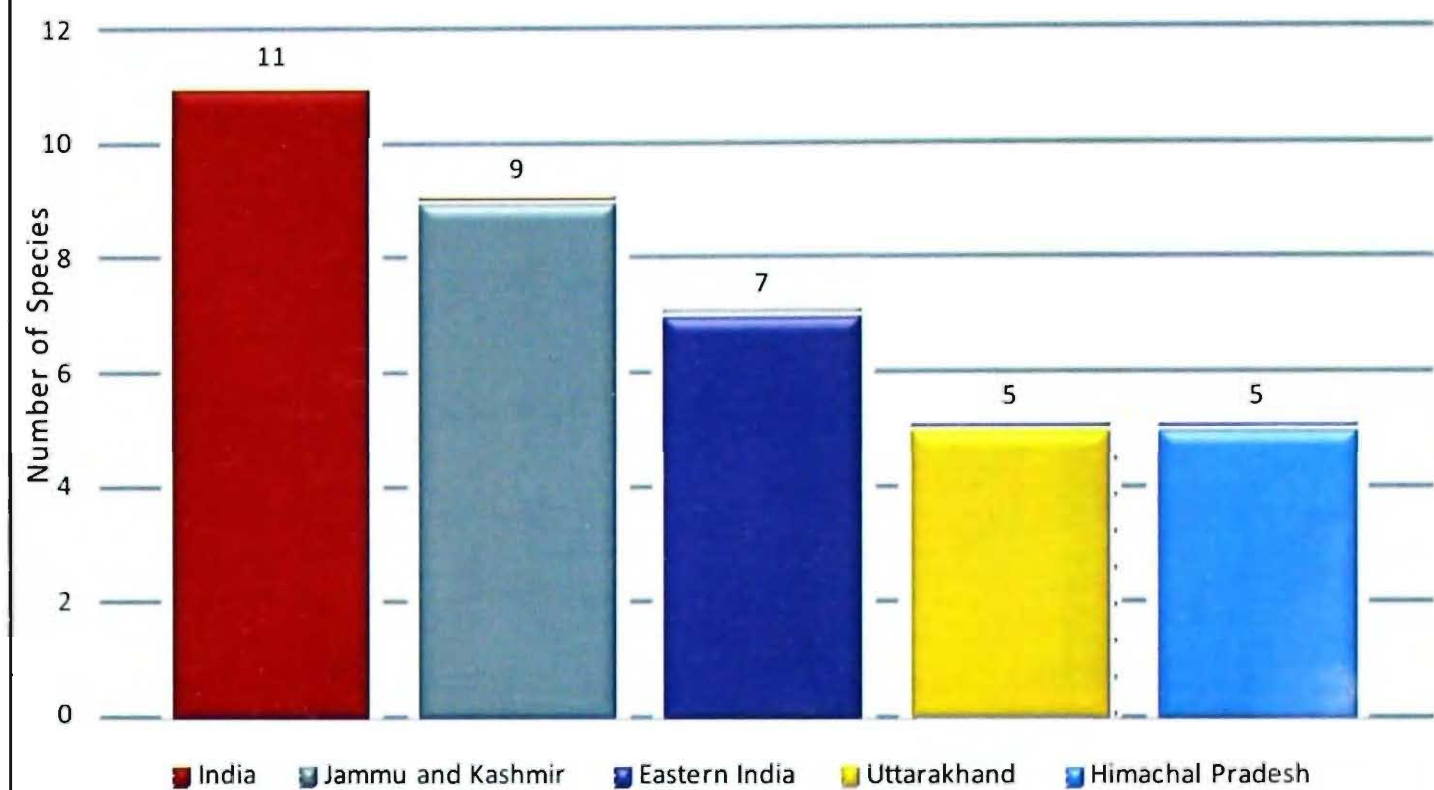
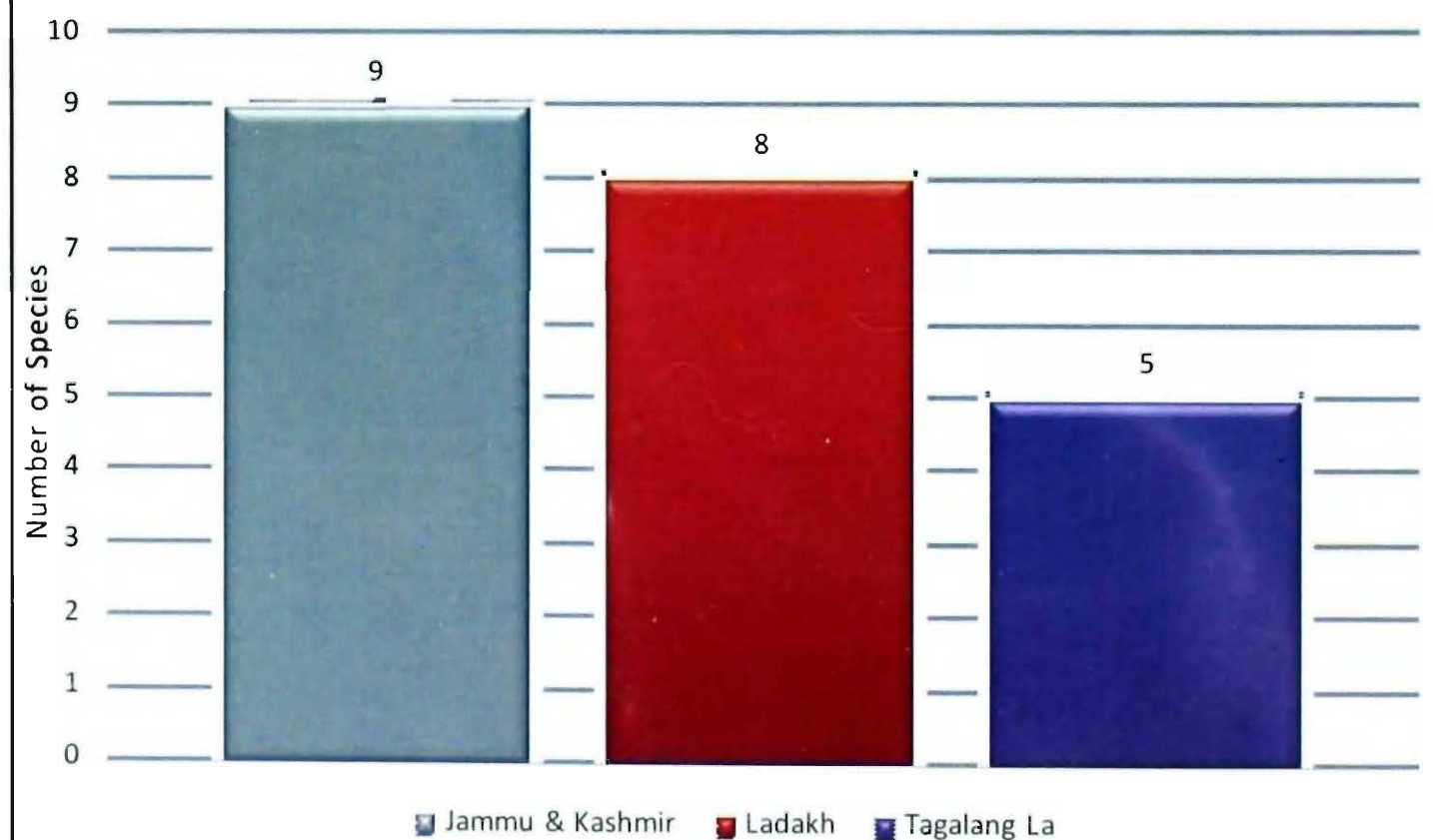
Fig. 3. Diversity of Snow Apollos in Himalayas of India**Fig. 4.** Diversity of Snow Apollos in Jammu and Kashmir

PLATE - III

Fig. : 5 Species diversity of Snow Apollo Butterflies

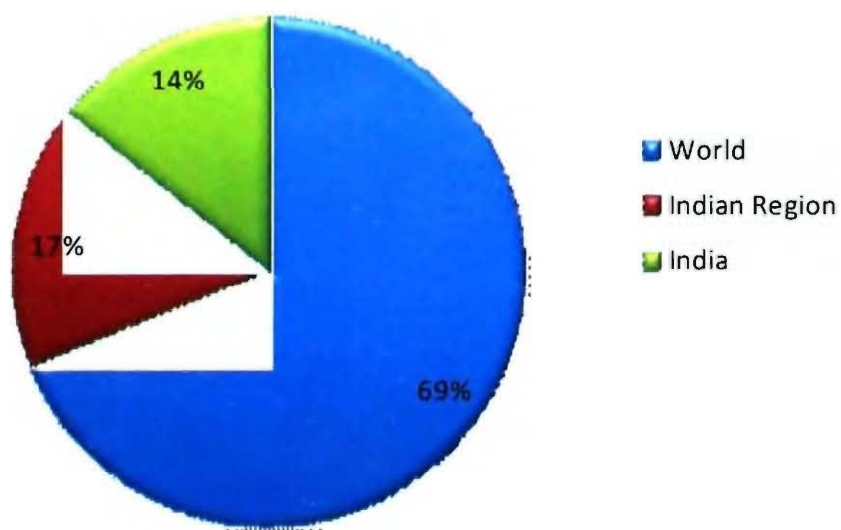


Fig. : 6 Diversity of Parnassiinae studied presently

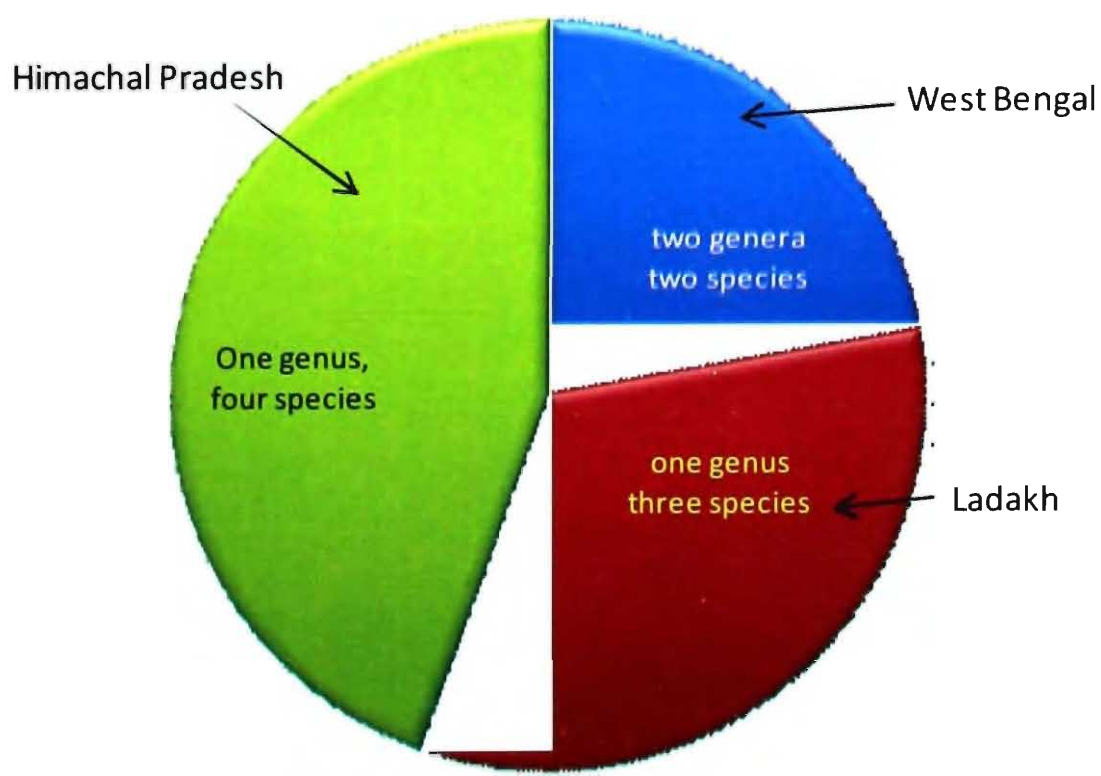


PLATE - IV (Genus *Parnassius* Latreille, Snow Apollos)

Fig. 7. (male, upperside)

P. maharaja

Fig. 8. (male, underside)



Fig. 9. (female, upperside)

P. maharaja

Fig. 10. (female, underside)

Fig. 11. (male, upperside) *P. stoliczkanus stoliczkanus*

Fig. 12. (male, underside)

PLATE- V (Genus *Parnassius* Latreille, Snow Apollos)



Fig. 13. (female, upperside) *P. stoliczkanus stoliczkanus* Fig. 14. (female, underside)



Fig. 15. (male, upperside) *P. imperator augustus* Fig. 16. (male, underside)



Fig. 17. (female, upperside) *P. imperator augustus* Fig. 18. (female, underside)

PLATE- VI (Genus *Parnassius* Latreille, Snow Apollos)

Fig. 19. (male, upperside) *P. charltonius charltonius* Fig. 20. (male, underside)

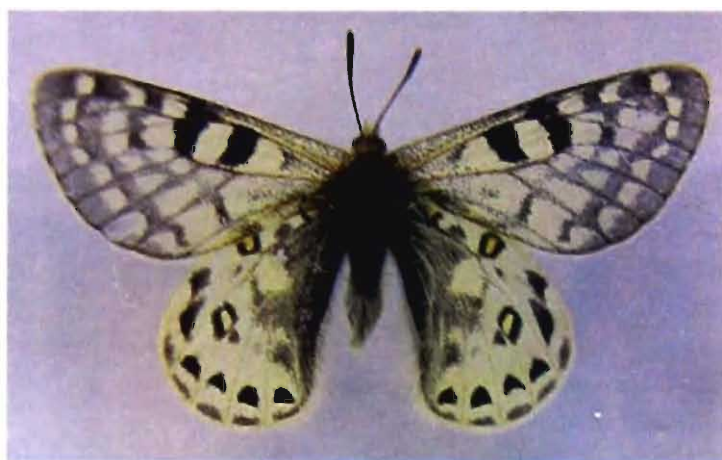


Fig. 21. (male, upperside) *P. acco tagalangi* Fig. 22. (male, underside)



Fig. 23. (female, upperside) *P. acco tagalangi* Fig. 24. (female, underside)

PLATE- VII (Genus *Parnassius* Latreille, Snow Apollos)



Fig. 25. (male, upperside) *P. hardwickii hardwickii* Fig. 26. (male, underside)



Fig. 27. (female, upperside) *P. hardwickii hardwickii* Fig. 28. (female, underside)



Fig. 29. (male, upperside) *P. jacquemonti jacquemonti* Fig. 30. (male, underside)

PLATE-VIII (Genus *Parnassius* Latreille, Snow Apollos)

Fig. 31. (male, upperside) *P. jacquemonti jacquemonti* Fig. 32. (male, underside)



Fig. 33. (male, upperside) *P. jacquemonti jacquemonti* Fig. 34. (male, underside)



Fig. 35. (female, upperside) *P. jacquemonti jacquemonti* Fig. 36. (female, underside)

PLATE-IX



Fig. 37. (male, upperside) *Parnassius epaphus hillensis* Fig. 38. (male, underside)



Fig. 39. (male, upperside) *Bhutanitis lidderdalii lidderdalii* Fig. 40. (male, underside)

PLATE-X



Fig. 41 : Alpine habitat of Common Red Apollo near Khardung La (Ladakh) (4950 m ASL).



Fig. 42 : Tagalang La (Ladakh), a rich habitat of Snow Apollo Diversity.

PLATE-XI



Fig. 43 : Khardung La, Ladakh (5100 m ASL).



Fig. 44 : Common Red Apollo busy in mudpuddling near Khardungla.

PLATE-XII

Figs. 45 & 46 : In strong wind, while puddling the common red Apollo folds its wings and tilts its body to one side in the direction of wind.

PLATE-XIII



Fig. 47 : Common Red Apollo sucking nectar from flowers of *Potentilla arbuscula* (Rosaceae) near Khardungla.



Fig. 48 : Common Red Apollo drinking water flowing in between stones.

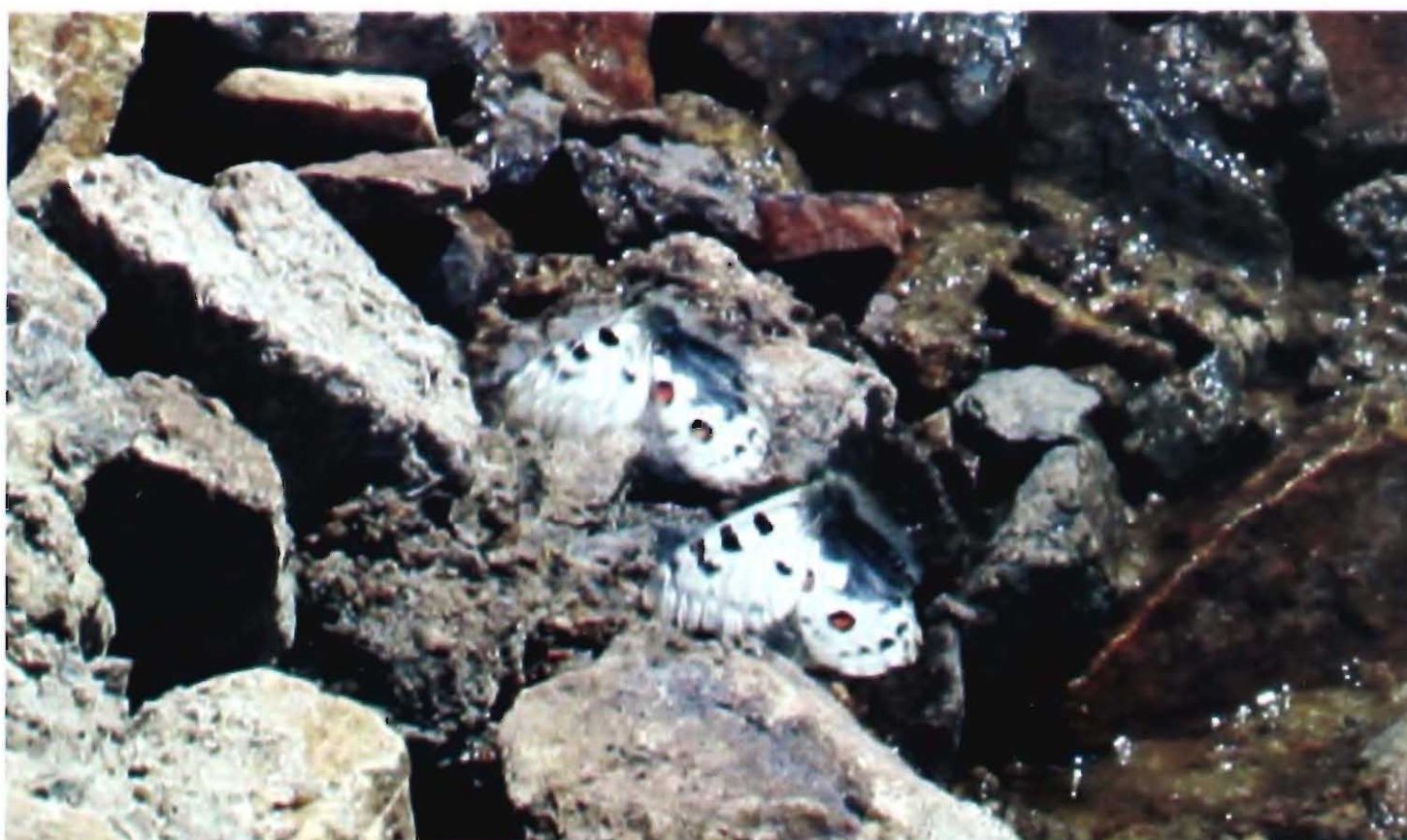
PLATE-XIV

Fig. 49 : Premating behavior of Common Red Apollo.



Fig. 50 : Appressed Basking, Behavioural Thermoregulation in common Red Apollo.

PLATE-XV



Fig. 51 : Dead specimen of Common Red Apollo near Khardug La – a consequence of tourist influx.