

ON AN ACCOUNT OF INDIAN SPECIES OF GENUS *BAETIS*
LEACH (BAETIDAE : EPHEMEROPTERA) WITH KEY TO
THEIR IDENTIFICATION

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INTRODUCTION

The genus *Baetis* (Leach, 1815) is represented , within our limits , by 18 species. This well established, widely distributed genus belongs to Baetidae which is represented in India by 35 species under 6 genera. *Baetis* is widely distributed among all the Zoo -Geographical regions inhabiting lotic aquatic ecosystem at higher elevations. *Baetis* is single largest genus and constitutes a little more than half of Baetidae (18 :35) and one fifth of (18 :90) of all Indian mayflies species taken together - Srivastava (1984). All *Baetis* species are endemic to India and 7/9 of them (14 : 18) are high altitude inhabitants ranging between 2438-3618 meters above mean sea level. Of the 18 species male of 15, female of 11 and larvae of only three known. A key has been formulated to distinguish all Indian species of genus *Baetis*.

SYSTEMATICS

Baetis Leach(1815) was established under the subfamily Baetinae. This was given family status subsequently. Its type species -genotype was subsequently designated as *Ephemerafuscatus* Linnaeus. Part of *Cloe* (Pictet, 1843). *Brachyphlebia* Westwood (1840) and part of *Acentralla* Bengtsson (1912) was also placed under *Baetis*. Our knowledge of Indian species of *Baetis* is due to Dubey (1971), Gillies(1949), Kapur and Kripalani (1963), Kaul & Dubey (1970), Srivastava (1979, 1983) has discussed the high altitude components among Indian mayflies and also our endemic components. It has been pointed out that all Indian *Baetis* species are endemic within our limits and out of these 7/9 of them (14 :18) are high altitude inhabitants ranging between 2438-3618 meters above mean sea level. This represent bulk of our high altitude mayflies (14 : 37). Accompanying table (Table I, page 356) indicates qualitative composition of Indian *Baetis*, their male, female and larval status known, endemic distribution and altitudinal records. Hubbard and Peters (1978) pointed that in the Indian subregion (i.e. India, Sri Lanka, Pakistan, Nepal, Sikkim, Bhutan, Bangladesh, Burma) a total of 23 species of *Baetis* are recorded, 18 among these are endemic to India, 3 species viz. *B. consuetus* (Hagen), *B. feminalis* Eaton and *B. solidus* (Hagen) are restricted to Sri Lanka, while another two species viz. *B. macamis* Ali and *B. meeheanis* Ali are known only from Pakistan. These have not been recorded from other countries of subregion. There are strong possibilities of genus being represented in more wider zone by more species on further detailed investigation of our water bodies, specially lotic ones of high altitude.

Salient Features of *Baetis* with special reference to Indian species

Imago : Size and colour :

Members of this genus are small to medium in size. A few ranging between 3-5 mm. like *B. palmyree*, *B. solitorius* and *B. fluitans*, while certain others like *B. chandra*, *B. longistylis*, *B. lahulensis*, *B. serragruiis* range between 10-12 mm. Others are mainly medium ranging species between 6-7 mm. like *B. acuticostalis*, *B. solangensis*, *B. septemmenes*, *B. simplex*, *B. thurbonis*, *B. tigroides*, *B. punjabensis*, *B. himalayana*, *B. bifurcatus*, *B. dipsicus*, *B. festivus*, female of these species are mostly a shade bigger are equal to male imagos.

Male are almost always more colorful than female, being always dull reddish or some shade of brown pigmented. Immature stage larvae of only three Indian species are known. Of these larvae of *B. simplex* is 6mm. while larvae of other two viz., *B. chandra* and *B. lahulensis* are almost double in body length measuring respectively 10 and 11 mm.

Eyes in male are turbinate mounted on stalk of variable size and two eyes meeting or closely approximated on middorsal zone of head. In contrast eyes in female are simple, unstalked and relatively well separated dorsally.

Wings : All members possess paired wings. Forewings of each side almost as long as body and little more than double of it in across wings of both sides. Hindwings are relatively very small almost 1/4 to 1/5 of former. This may be even to the extent of 1/8 in *B. septemmenes*, *B. himalayana* and *B. simplex*. Wings are generally hyaline, membranous with brownish or yellowish on veins.

Forewing : area around wing base and outer one third of costal and subcostal space in *B. punjabensis* slightly darker than rest which is hyaline. In *B. tigroides* above area is sooty brown but it is only one fourth rather than one third of costal and subcostal space. In *B. fluitans* wings are translucent instead of hyaline. There are variable number of simple, slanting slightly anastomosed cross veins. These widely ranges between 3-15 in different Indian species of genus *Baetis*. In *B. longistylis*, 3-6 in *B. thurbonis*, 4-7 in *B. palmyrae*, 5 in *B. acuticostalis*, 5-6 in *B. fluitans*, 6 in *B. solangensis*, 6-7 in *B. solitarii* 6-10 in *B. dipsicus*, 7-9 in *B. tigroides*, 8 in *B. simplex*, 8-9 in *B. chandra*, 9 in *B. himalayana*, 8 complete 1 incomplete in *B. septemmenes*, 10 in *B. lahulensis*, 10-12 in *B. bifurcatus*, 8 complete 6- incomplete in *B. serragruiis* and 15 in *B. festivus*. Space corresponding to the stigmatic area in subcostal space generally devoid of any cross vein but in *B. festivus* there are 5 and 7 in *B. bifurcatus*.

There are paired intercalaries all along hind margin in between branches of longitudinal vein. Intercalary is not present in costal and sometimes subcostal space also. In *B. simplex* there is no intercalary in first space also, only one in the second space, but short paired intercalaries in the rest. Hinder margin of wing invariably fringed, in some these fringes are relatively more conspicuous.

Hindwing : These are always present but are relatively smaller. These may be even 1/8 of forewing. It shows more variations and as such presents characters of taxonomic

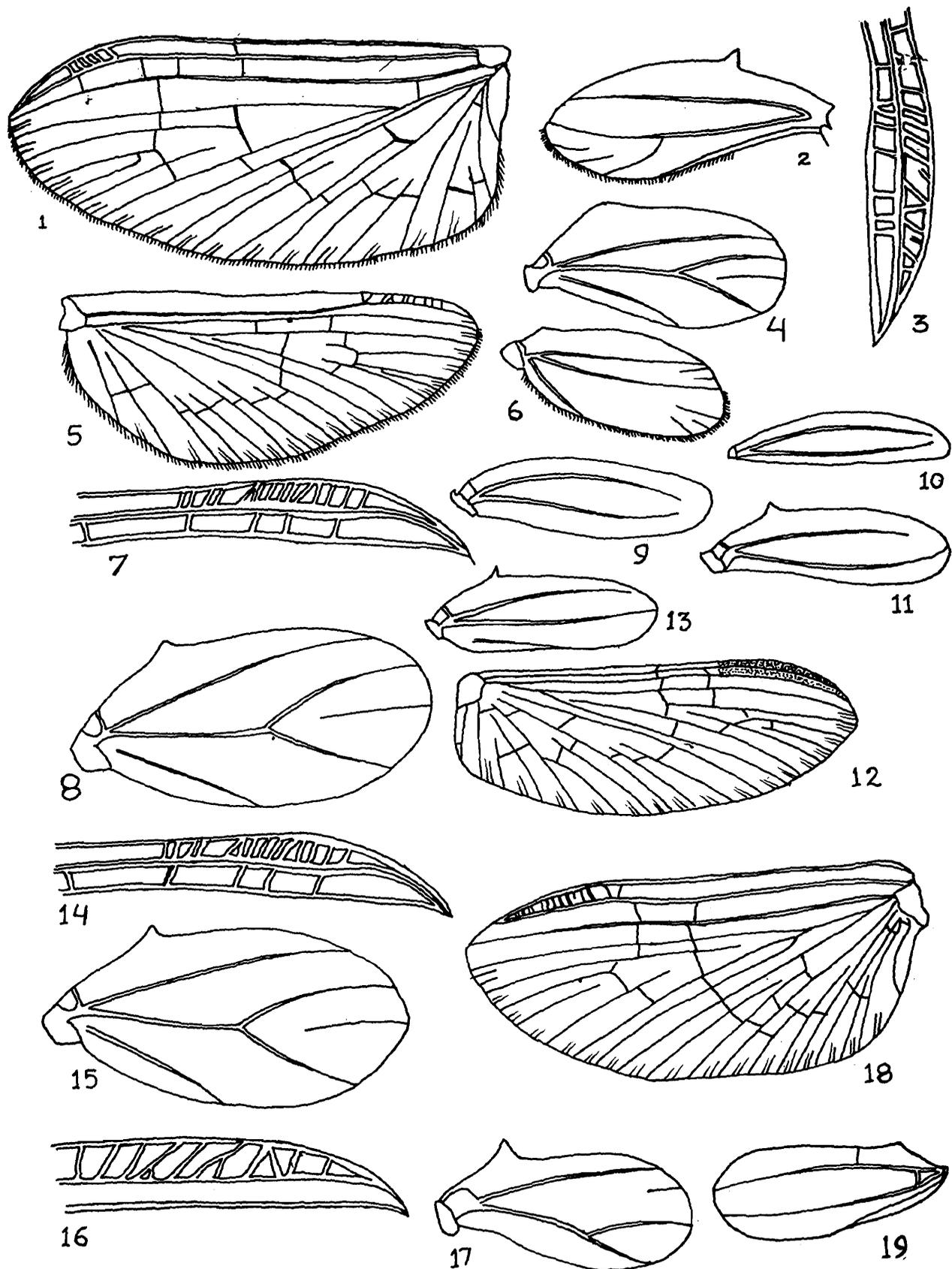
importance, specially at specific level. Among Indian representatives *B. palmyrae* have the smallest hindwing measuring 0.1mm, while that of *B. chandra* having largest measuring 3.5 mm. In between these ranges rest of our species *B. solitarius* (0.5mm), *B. fluitans* (0.6mm), *B. tigroides* (0.7mm), *B. dipsicus* (0.8mm.), *B. acuticostalis* (0.9mm.), *B. septemmenes*, *B. solangensis* and *B. thurbonis* (1mm.), *B. festivus* (1.2mm.), and *B. punjabensis* (1.1mm.), *B. himalayana*, *B. simplex*, *B. lahulensis* and *B. longistylis* (3mm.). These are hyaline or translucent, may be colourless or brownish on veins. In *B. chandra* these are translucent grey with violet tinge. Costa has in most cases a costal spur but lacks in *B. dipsicus* and *B. palmyrae*. This is in contrast to all other 16 species of genus which possess ill developed to well developed costal spur. In respect of presence of 2 longitudinal veins instead of 3 above two species are unique, however *B. solitarius* also has only 2 longitudinal veins. Two species mentioned above were previously placed in *Acentrella* group but were subsequently placed under *Baetis* by Gillies (1949). This points deserves further examination in greater detail, based on more material to justify their inclusion in genus, though at present these are treated as parts of genus. Costal spur is small and subacute in *B. longistylis* and *B. punjabensis*; that of *B. lahulensis* is also small but acute. It may be well developed, acute, pointed backwards in *B. acuticostalis* and *B. fluitans* or may be well developed but not pointed as in *B. festivus* or it may be only as obtuse projection as in *B. chandra* and *B. septemmenes*. Rest of the species have well developed costal process of moderate length.

Third longitudinal vein is always relatively smaller which is present in all species except three species mentioned earlier. Second longitudinal vein is either forked as only in 5 species viz., *B. acuticostalis*, *B. furcatus*, *B. festivus*, *B. himalayana* and *B. solangensis* but remains unforked in rest of species. There are no intercalaries between longitudinal veins and cross veins are absent in most of Indian representatives except 1 between fork of second longitudinal vein in *B. festivus*, 2 between fork of second longitudinal vein of *B. acuticostalis* but 4-5 same position in *B. chandra* and *B. himalayana*.

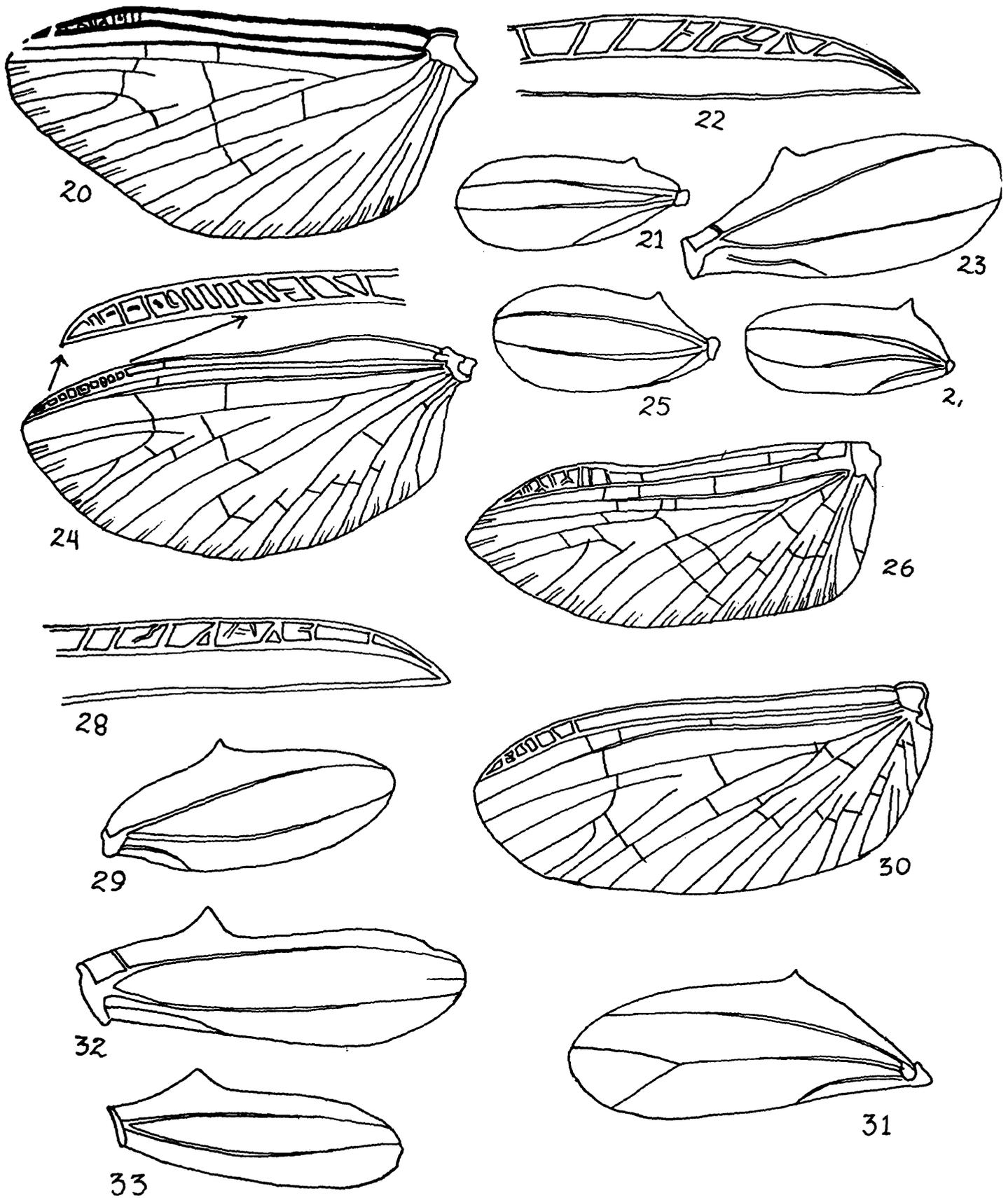
Abdomen : It is long, 0.5 to 0.7 times that of whole body length excluding cerci which are two in number. Cerci are long, slender, filamentous. These are 1.4 times body length in *B. acuticostalis*, double the body as in *B. dipsicus*. 2.5 times in *B. serragrui* and a little less than or thrice the body length as in *B. solitarius*, *B. thurbonis* and *B. tigroides*. Pigmentation on abdomen and or cerci are either white, yellow or some shade of brown.

Genital forcep : The genital forcep is invariably 4 segmented, of which 2 and 3 are more or less completely fused in all the Indian species of genus, though male of 3 species viz., *B. festivus*, *B. serragrui* and *B. simplex* are not recorded and described so far. Small basal tubercle to second segment in *B. dipsicus*; distinct but obtuse tubercle on inner basal side of second in *B. himalayana*; distinct tubercle on inner of basal segment of *B. fluitans* and basal, obtuse tubercle to the basal inner side of third segment in *B. longistylis*. Rest of the species have no tubercles on the genital forcep. Most of the species have more or less straight arms of forcep but a few, however, show departure from it. Third segment of *B. palmyrae* and *B. tigroides* show a sharp bent at basal one third.

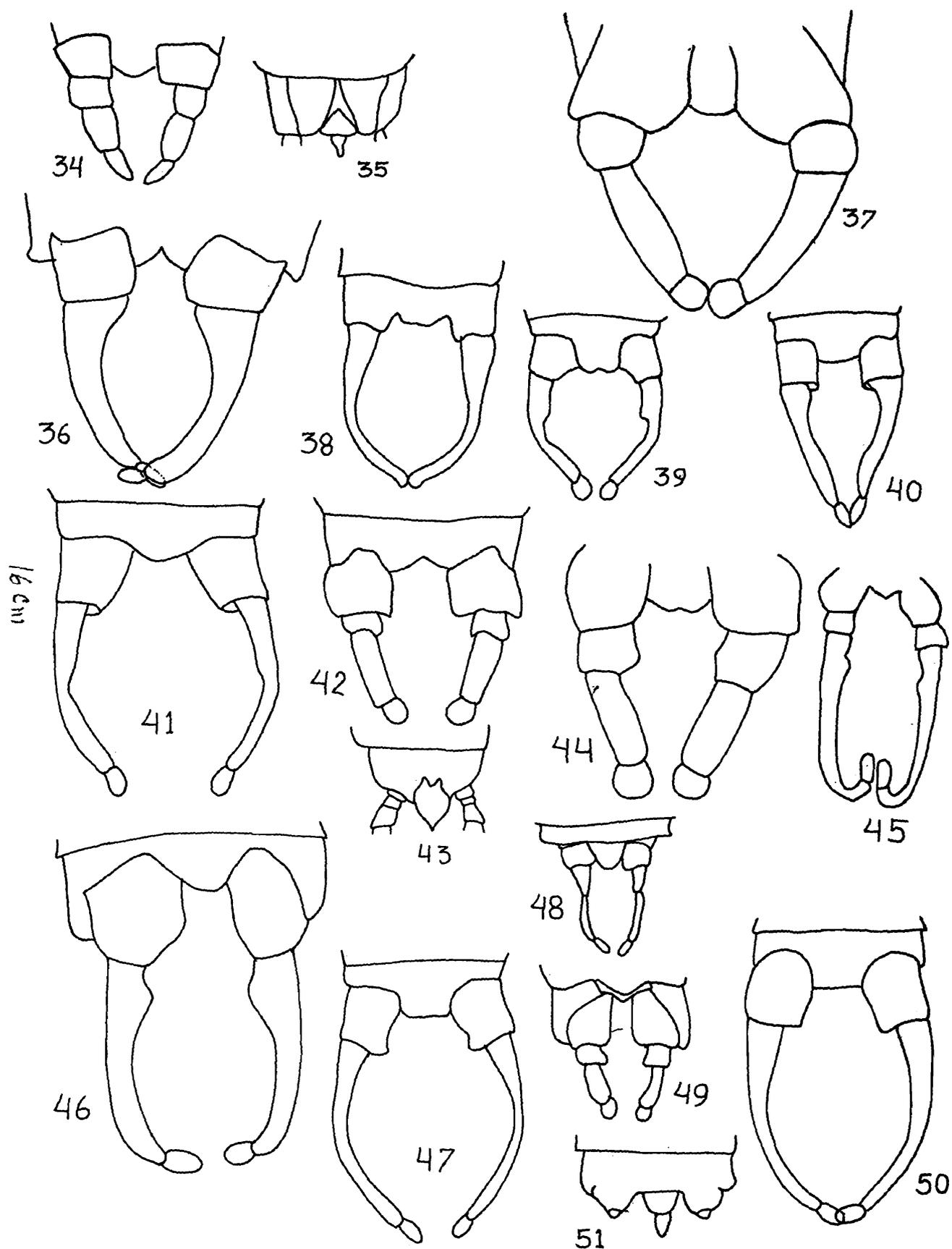
There are two main type of genitalia in this genus separated on the basis of genital



Text figures: 1-19 (Wing): 1, 2 Fore Wing (F.W.) and Hind Wing (H.W.) of *B. acuticostalis*; 3, 4 stigmatic are of forewing (S.F.W.) and whole of H. W. of *B. bifircatus*; 5, 6 F.W. and H.W. of *B. Chandra*; 7, 8 S.F.W and whole of H.W. of *B. festivus*; 9, 10, 11 H.W. of *B. dipsicus*, *B. palmyrae* and *B. fluitans* respectively; 12, 13 F.W. and H.W. of *B. tigroides*; 14, 15 S.F.W. and whole of H. Wing of *B. himalayana*; 18, 19 F. W. and H. W. of *B. lahulensis*.



Text figures : 20-23 (Wing-contd.) : 20, 21 F.W. and H.W. of *B. longistylis*; 22, 23 S.F.W. and whole of H.W. of *B. punjabensis* ; 24, 25, 26, 27 F.W. and H.W. of *B. seragrui* and *B. septemmenes* respectively; 28, 29 S.F.W. and whole of H.W. of *B. simplex* ; 30, 31 F.W. and H.W. of *B. solangensis* and 32, 33 H.W. of *B. thurbonis* and *B. solita* : ius respectively.



Text figures : 34-51 (External genitalia) : 34, 35 Male (genital forcep) (G.F.) and female ovipositor (O.) *B. acuticostalis*; 36, 37, 38, 39, 40, 41 G.F. of *B. bifucatus*, *B. chandra*, *B. dipsicus*, *B. palmyrae*, *B. fiuitans* and *B. tigroides* respectively ; 42, 43 G.F. and O. of *B. lahulensis*, 44, 45, 46, 47, 48, 49, 50 G.F. of *B. himalayana*, *B. logistyles*, *B. punjabensis*, *B. thurbonis*, *B. solangenis*, *B. septemmenes* and *B. solitarius* and 51 O. of *B. seragruis*.

forcep. In the *Intercalaries type* basal forcep joint is beset with tubercle or projection on its inner apical margin which are not present in *Moffati type*. Second joint relatively long, slender, conical, tapering apically. Further it differs in third joint quite long, slender getting narrower at base in former type but in latter type this joint is rather less slender and not appreciably getting narrower at base.

Ovipositor : Female genitalia consists of ovipositor which is invariably 2 segmented in all the 4 species whose female is known and ovipositor described viz., *B. acuticostalis*, *B. lahulensis*, *B. longistylis* and *B. serraguris* and are yellowish to pale brown. In others either female is not yet recorded and described or ovipositor have not been studied.

Nymph : Larvae of only 3 Indian species are known in respect of genus, these are *B. chandra*, *B. lahulensis* and *B. simplex*, whereas larvae of other 15 species yet to be described. Perusal of literature reveals that there had been mention of occurrence etc, of larvae of genus *Baetis* within our limits. Hora (1930) has recorded nymphs of *Baetis* sp. inhabiting fast flowing lotic water body even at the point of fall, clinging to rocky substratum by help of claws. Traver (1939) also reported occurrence of nymphs of *Baetis* from Kashmir and Nepal. Kapur and Kriplani (1963) described *B. chandra* and *B. simplex*, including imago and larvae, from Lahul and Spiti valleys based on direct field and camp laboratory observations. Certain other specimens were recorded referable to this genus from the same area; but they were not linked to particular species. Kaul and Dubey (1970) described nymphs of *B. lahulensis* from Gramphu, Northern Slope of Pir Panjal Range, North West Himalaya inhabiting fast riverine ecosystem.

Larvae of *Baetis* are stream lined, slender forms, well adapted to negotiate as free swimming forms between inter-space of vegetation and rocks in the littoral zone of mostly lotic type of water body, streams, rivers etc. Head is smaller in width and length than thorax and directed downwards. This body form of larvae are also known as 'torpedoshaped' Body size of larvae are more or less that of their respective imagos. This proportion varies in larvae of different species. In *B. simplex* it is 6 mm; 7mm., in *B. chandra* 10mm.: 10mm. Male, 11mm. Female and *B. lahulensis* 10mm.: 10mm. Male, 11mm. Female. *Cerci* are 2 in the larvae of *B. simplex* and length wise ratio of these and body is 3 : 2 or 9 and 6mm. There is in addition to paired cerci a terminal caudal filament in larvae of *B. chandra* and *B. lahulensis* In former body length, cerci and caudal filament are in ration of 5 : 3 : 2 (or 10, 6 and 4mm.) while in latter ratio is 5:4:2.5 (or 10, 8 and 5mm.), *Cerci* are fringed on inner side and median caudal filament on both sides . These together help movement and provide rader effect to the larvae. Only two cerci are also present in larvae of *B. caudatus* and *B. propeisguis* group, both not occuring within our limits.

Corresponding to abdominal segments 1-7 there are 7 paris of simple, slightly ovoid, plate like gill lamellae. Of these first smallest, increasingly bigger posteriorly, last again relatively small. In some members gill lamellae may be pinnately branched but not is any Indian representatives.

Endemism and High Altitude Representation

An overview of the faunal component of Indian mayflies reveal that the genus *Baetis*

Leach is represented by 1/5 of all species taken together (18 : 90). Genus itself is single largest represented within our limits and constitutes a little more than half of Baetidae (18 : 35) to which it belongs. Srivastava (1979, 1983) has dealt with the analysis of the faunal component of Indian Ephemeroptera including endemism, relative preponderance and high altitude representation. It is shown that a large proportion of 74 species or 5 : 1 is endemic within our limits. Among these Baetidae with 29 endemic component, all 18 species of genus are endemic to India, though genus has its species distributed amongst wider Zoo-geographical range even beyond oriental into Holarctic, Palearctic, Nearctic, Ethiopan.

Of 18 *Baetis* species 15 have been found to inhabit riverine (= lotic) ecosystems of Himalayan Mountain range ranging between 2438-3618 meters above mean sea level. Remaining 3 species are recorded, not within consideration of high altitude dwellers, at altitude of 569 m. Species of this genus alongwith other genera viz., *Baetiella* Ueno, *Cloeon* Leach and *Pseudocloeon* Klapalek having 1, 2 and 1 high altitude forms respectively constitutes almost half of our high altitude forms (19 : 37) of our 15 high altitude *Baetis* a little more than half (8 : 7) range above 3000 meters. Incidentally there is a single record of *Ororotsia hutchinsoni* Traver above 4000 at an altitude of 5927 meters while most of high altitude Indian mayflies have been reported occurring between 3000-4000 meters.

Key to the Indian species of genus *Baetis* Leach

1. Hind wing with 2 longitudinal veins.....2
Hind wing with 3 longitudinal veins, third may be smaller and weakly developed ...5
2. Costal spur of hind wing absent.....3
Costal spur of hind wing present.....4
3. Body length 6-6.5mm abdominal tergites 2-6 white semi-opaque 7-10 opaque brownish cream, gonostyle with small vasa tubercle to second segment, 6-10 cross vein to stigmatic area.....*dipsicus* Gillies
Body length 3 1/2 - 4 1/2 mm. Abdominal tergite 2-6 translucent white, 7-10 opaque
Gonostyle with no tubercle third segment with sharp bent 4-7 cross vein to stigmatic area.....*palmyrae* Gillies
4. Body length 3 - 3.5 mm costal and subcostal area not milky. Abdominal tergite 2-6 white, 7-10 opaque sandy brown. Distinct tubercle in inner side basal segment of gonostyle.....*fluitans* Gillies
Body length 4.5 mm. Costal and subcostal area of fore wing milky, abdominal tergite 2-6, white 7-10 yellowish cream. Tubercle to gonostyle absent, 6-7 branched, horizontal veins to stigmatic area.....*solitarius* Gillies
5. Second longitudinal vein of hindwing not forked6
Second longitudinal vein of hindwing forked14
6. Fore wing 10-12mm. long.....7
Fore wing 6-8.5 mm. long.....10

7. 4-5 intercalaries present in the hindwing , 8-9 simple slanting, sometimes forked cross vein to stigmatic area.....*Chandra* Kapur & Kripalani
Intercalary in the hind wing absent8
8. Cross vein 2 or none in hind wing. Forewing 11mm., 10 complete and 2 incomplete cross veins to stigmatic area*lahulensis* Kaul & Dubey
Cross vein in hind wing absent9
9. Costal process small , subacute in hindwing, forewing 10 mm., 3 complete, 9 more or less complete anastomosed veins in stigmatic area*longitotylus* Kaul & Dubey
Costal process small , acute in hindwing, forewing 12 mm., 8 complete, 6 incomplete simple , slanting veins in stigmatic area *seragrui*s Dubey
10. 3-6 irregular slanting cross veins to stigmatic area of forewing. Forewing 6mm., Translucent colourless except dark brown at the wing base and faintly milky stigmatic area.....*thurbonis* Gillies
7-9 cross veins to stigmatic area of forewing11
11. Costal margin of forewing marked inwards, forewing 8 mm. Cross vein 8 complete, 1 incomplete in stigmatic area*septemmenus* Dubey
Costal margin of forewing not marked inwards.....12
12. Abdominal tergites red and yellow, bimaculate pigment in wings, second segment of Genostyle with few distinct hairs at its inner side*tigroides* Gillies
Abdominal tergites and pigment in wings not as above.....13
13. 8 complete veins in stigmatic area, costal process of hind wing acute, veins 1 and 2 in hindwing converging apically abdominal tergite 2-8 Brown or pale brown, 10 dark brown.....*simplex* Kapur & Kripalani
7 complete veins in stigmatic area, costal of hind wing not acute, veins 1 and 2 in hindwing converging abdominal tergite 2-6 dull brown , 8- 10 dark brown.....
.....*punjabensis* Kapur & Kripalani
14. Forewing 8 mm., stigmatic area with 9 veins, area below this in subcostal space without cross veins.....*himalayana* Kapur & Kripalani
Forewing 6-6.5 mm., stigmatic area with 10-15 cross veins.....15
Forewing 7 mm., stigmatic area with 5-6 cross veins.....16
15. Stigmatic area with 10-12 slanting , anastomosed cross veins, space below has 7 cross veins, 2 intercalaries between fork of second longitudinal vein in hind wing, abdominal dull brown*bifurcatus* Kapur & Kripalani
Stigmatic area with 15 slanting , anastomosed cross vein, space below has 5 cross veins, 1 intercalary between fork of second longitudinal vein in hind wing , abdominal golden brown*festivus* Kapur & Kripalani
16. 5 complete cross vein to stigmatic area, 2 intercalaries between fork of second vein of hindwing, wings hyaline - grey, hind margin fringed*acuticostalis* Dubey
6 complete cross vein to stigmatic area, intercalary absent, wings hyaline - veins pale brown, hind wing margin not fringed.....*solangensis* Dubey

SUMMARY

A detailed taxonomic status of the genus *Baetis* Leach (Baetidae) and its salient features have been presented with reference to 18 Indian species of the genus. A key to species has also been provided. Members of the genus represents half of Indian Baetidae and one-fifth of all our mayflies. All our *Baetis* species are endemic within our limits and 7/9 of them are high altitude inhabitants ranging between 2438-3618 meters.

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Table I. Qualitative composition on Indian *Baetis* Leach

	Species	M	F	L	Endemic	Distribution	Remarks
1.	<i>B. acuticostalis</i> Dubey	+	+	-	Himachal Pradesh	(P. Solong)	2800 M.
2.	<i>B. bifurcautus</i> Kapur & Kripalani	+	-	-	-do-	(Ralha, Kulu)	3048 - 3358 M.
3.	<i>B. chandra</i> Kapur & Kripalani	+	+	+	-do-	(Chhatoru, Lahul Sipti Valley)	2743 - 3618 M.
4.	<i>B. dipsicus</i> Gillies	+	+	-	Maharastra	(R. Mutha, Poona)	569 M.
5.	<i>B. festivus</i> Kapur and Kripalani-	+	-		Himachal Pradesh	(Ralha - Kulu Valley)	3048 - 3358 M.
6.	<i>B. fluitans</i> Gillies	+	+	-	Maharastra	(R. Mutha, Poona)	569 M.
7.	<i>B. himalayana</i> Kapur & Kripalani	+	+	-	H. P.	(Sissu, Lahul Valley)	3200 M.
8.	<i>B. lahulensis</i> Kaul & Dubey	+	+	+	H. P.	(Gramphu)	3507 M.
9.	<i>B. longistylus</i> Kaul & Dubey	+	+	-	-do-	-do-	569 M.
10.	<i>B. palmyrae</i> Gillies	+	-	-	Maharastra	(R. Mutha, Poona)	3048 - 3358 M.
11.	<i>B. punjabensis</i> Kapur & Kripalani	+	-	-	H. P.	(Ralha - Kulu Valley)	2800 M.
12.	<i>B. septemmenes</i> Dubey	+	-	-	H. P.	(R. Solong)	3600 M.
13.	<i>B. seragrüis</i> Dubey	-	+	-	H. P.	(Seragru Icefall, Kuninal)	2438 M.
14.	<i>B. simplex</i> Kapur & Kripalani	-	+	+	H. P.	(Kothi, Kulu Valley)	2800 M.
15.	<i>B. alauyensis</i> Dubey	+	-	-	H. P.	(E. Solong)	2615 M.
16.	<i>B. solitarius</i> Gillies	+	-	-	West Bengal	(Mirik)	2615 M.
17.	<i>B. thurbonis</i> Gillies	+	-	-	West Bengal	(Mirik)	2615 M.
18.	<i>B. tigroides</i> Gillies	+	-	-	West Bengal	(Mirik)	2615 M.
	18 species	15	11	3	Himachal Pradesh, Maharastra, West Bengal		2438 - 3618 M.