THE MAYFLIES (EPHEMEROPTERA) FROM THE NORTH-WESTERN HIMALAYA*

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(With 1 Plate and 16 Text-figures)

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I—INTRODUCTION

The Mayflies (Ephemeroptera) of the north-western Himalayas are very inadequately known. Eaton (1883-1888), in a monograph on the order, recorded *Cloeon dipterum* Linnaeus from Europe to north-western India and *Epeorus psi* Eaton from Kulu in the Punjab. Ulmer (1935) reported *Cloeon inscriptum* Bengtsson, from the vicinity of Srinagar in Kashmir. Traver (1939) in her paper on the Himalayan Mayflies described five new species, namely *Caenis srinagari* Traver from Srinagar, *Cloeon kashmiri* Traver from Kashmir, *Baetiella ladakae* Traver, *Ameletus primitivus* Traver and *Ororotsia hutchinsoni* Traver from Ladak, thereby bringing the total number of species to eight. As a result of the present study eight more species are added to this number

The material was chiefly collected by one of us (A.P.K.) from the Kulu and the Lahaul-Spiti Valleys in the Punjab, India, in May and June, 1955, during the course of an insect survey of the area. It contained 130 examples of imagos and subimagos and some 500 nymphs belonging to various species. In addition, about 30 examples of imagos and subimagos of two species, very kindly lent by Dr. M. S. Mani, were also studied.

* For a general account of the insects collected in the same area see Kapur, A. P., 1958, *Proc. 10th intern. Congr. Ent.*, Vol. I, 1956 (1958), pp. 775—784 (1 map).

The eight new species described from the imago and subimago material belong to the genera *Ephemerella* Walsh, *Baetis* Leach and *Epeorus* Eaton. Hitherto *Ephemerella* was known from the nymphs only in the N. W Himalayas and Nepal. The nymphal material referred to above belongs to the genera *Paraleptophlebia* Lestage, *Ephemerella*, *Baetis*, *Ecdyonurus* Eaton, *Iron* Eaton, and *Ironopsis* Traver. Of these the first and the last are being recorded for the first time from India.

The main object of the insect survey referred to above was a study of the high altitude insects in these parts of the Himalayas and the collections under report came from the following localities with altitudes between 6,000 ft. and 13,000 ft. above sea-level. Brief notes on the general habitats of the material collected are given below.

Manali (*Ca.* 6,000 ft.=1,829 m.). In the Kulu Valley. Fast flowing to torrential Beas river, and moderately fast streams passing through pine forests, etc. ; 23rd May, 1955 and 23rd and 25th June, 1955.

Nymphs : *Paraleptophlebia* sp. 1, *Ephemerella* sp., *Baetis* sp., *Ecdyonurus* sp. and *Iron* sp.

Manali to Kothi (*Ca.* 6,500 ft.=1,981 m.). Moderately fast stream passing through forest and paddy fields ; 24th May, 1955.

Nymphs : *Ephemerella* sp.

Kothi (*Ca.* 8,000 ft.=2,438 m.). A moderately large stream of varying habitat on the right and back of the Rest House, passing through mixed but mainly *deodar* (*Cedrus deodara*) forest and with dense scrub growth near banks at lower elevations ; torrential at places, specially at higher altitudes but generally fast-flowing elsewhere ; 20th June, 1955.

Nymphs : *Paraleptophlebia* sp. 2, *Baetis simplex*, sp. n., *Baetis* sp., *Ecdyonurus* sp., *Iron* sp. and *Ironopsis* sp. 2.

Adults : *Baetis simplex*, sp. n.

Ralha base camp (*Ca.* 9,000 ft.=2,743 m.). Beas river, a few miles down its source ; torrential to fast flowing and generally with very cold and clear water except in the after-noon when the water gets slightly dirty owing to the melting of snow ; with little vegetation on the banks ; forest and meadows in the vicinity ; 26th May, 1956.

Nymphs : *Paraleptophlebia* sp. 2, *Baetis* sp., *Ecdyonurus* sp.

Adults : *Ephemerella indica*, sp. n., *Baetis chandra*, sp. n.

Two miles north-east of Ralha (*Ca.* 11,000 ft.=3,353 m.). Beas river, mostly torrential and fast flowing, as stated above ; 27th May, 1955.

Nymphs : *Baetis* sp., *Iron* sp.

Two miles south of Ralha (*Ca.* 10,000—11,000 ft.=3,048 m.—3,353 m.). At the edge of *deodar* forest and from very fast to moderately fast streams near or passing through the forest. Adults caught from shaded boulders and rocks ; 28th and 29th May, 1955.

Nymphs : *Baetis* sp., *Ecdyonurus* sp., *Iron* sp.

Adults : *Baetis bifurcatus*, sp. n., *Baetis festivus*, sp. n., and *Baetis punjabensis*, sp. n.

Near source of the Beas river (*Ca.* 11,000—12,000 ft.=3,353—3,658 m.). From the fast running Beas river, nearly 1 mile south of the Rohtang Pass ; 2nd June, 1955.

Nymphs : *Baetis* sp., *Iron* sp.

Ganddapu (*Ca.* 11,000 ft.=3,353 m.). In the Lahaul-Spiti Valley, from the river Chandra (10,500 ft.=3,200 m.) with enormous quantity of very fast-flowing water and with large boulders to smaller stones on its banks. Also from fast-running but smaller streams falling into the river ; 7th—9th June, 1955.

Nymphs : *Baetis chandra*, sp. n., *Baetis* sp., *Ecdyonurus* sp., *Iron sp.*, *Ironopsis* sp. 1.

Adults : *Baetis chandra*, sp. n.

Sissu (*Ca.* 10,500 ft.=3,200 m.). Lahaul Valley, torrential to fast-running streams near the Rest House ; with vegetation on the banks ; 10th June, 1955.

Nymphs : *Baetis* sp., *Iron* sp.

Adults : *Baetis himalayana*, sp. n., and *Epeorus lahaulensis*, sp. n.

Khoksar (*Ca.* 10,800 ft.=3,292 m.). Lahaul Valley ; torrential to fast-running streams falling into Chandra river ; little vegetation on the banks ; 11th June, 1955.

Nymphs : *Iron* sp.

Adults : *Baetis chandra*, sp. n.

Dorni Thach (*Ca.* 11,800—12,000 ft.=3,292—3,658 m.). Lahaul-Spiti Valley. Fast running streams falling into Chandra river ; 12th June, 1955.

Nymphs : *Baetis chandra*, sp. n.

Chhatoru (*Ca.* 11,000 ft.=3,353 m.). Lahaul-Spiti Valley. Fast running Chandra river with large to small boulders on the bank and little vegetation. Also torrential streams flowing into the river ; 15th and 16th June, 1955.

Nymphs : *Baetis chandra*, sp. n., *Ironopsis* sp. 1.

Adults : *Baetis chandra*, sp. n.

Purana Khoksar Nal (*Ca.* 13,000 ft.=3,962 m.). From fast flowing to torrential streams of small to moderate size. 17th June, 1955.

Nymphs : Baetis sp., *Iron* sp.

II—METHOD OF STUDY

The material, which was mostly preserved in alcohol, was at first carefully examined under a stereoscopic binocular and the body-form, size, colouration and other similar characters noted.

For the study of imagos, wings of one side were removed and mounted with a drop of alcohol on a slide and covered with a cover-glass which was fixed to the slide by strips of sticky paper. As the alcohol evaporated, the wing became dry and fit for study. The disadvantage of mounting wings in Canada balsam is that the weaker veins become

invisible. Permanent mounts in Canada balsam were, however, made of the male genitalia, legs of one side and of similar other structures when necessary. For permanent mounts in Canada balsam, usually dissected parts were treated with 10 per cent KOH (cold) for varying length of time, from a few hours to a day, depending on the size of the specimen, and after the usual process of neutralisation and dehydration, cleared in clove oil in which medium these were studied in greater detail. Finally, these were mounted in Canada balsam for study of minute structures and for making final sketches which were made with the help of camera lucida.

In the case of nymphs the gills and legs of one side and the mouth-parts were mounted in balsam on the slides.

III—Description of imagos and subimagos

Family Ephemerellidae

Genus **Ephemerella** Walsh

This holarctic genus was hitherto known from Nepal (Ueno, 1955) and India from nymphs only. In India Hora (1932) recorded nymphs of Ephemerellidae from the Krelnu Giri Nallah at Dalhousie, and Ravi River at Chamba. He did not assign these definitely to a genus, but stated that they looked like *Ephemerella*. We also consider from his description that he was dealing with *Ehpemerllea* only. Nymphs of the genus have been further recorded from Ladakh (Kashmir State) (Traver, 1939).

Ephemerella indica, sp. n. is being described from an adult caught at Ralha (*Ca.* 9,000 ft.=2,743 m.) in the Kulu Valley, Punjab. A few nymphs, apparently of another species, were also obtained from Manali (*Ca.* 6,000 ft.=1,829 m.) in the same valley.

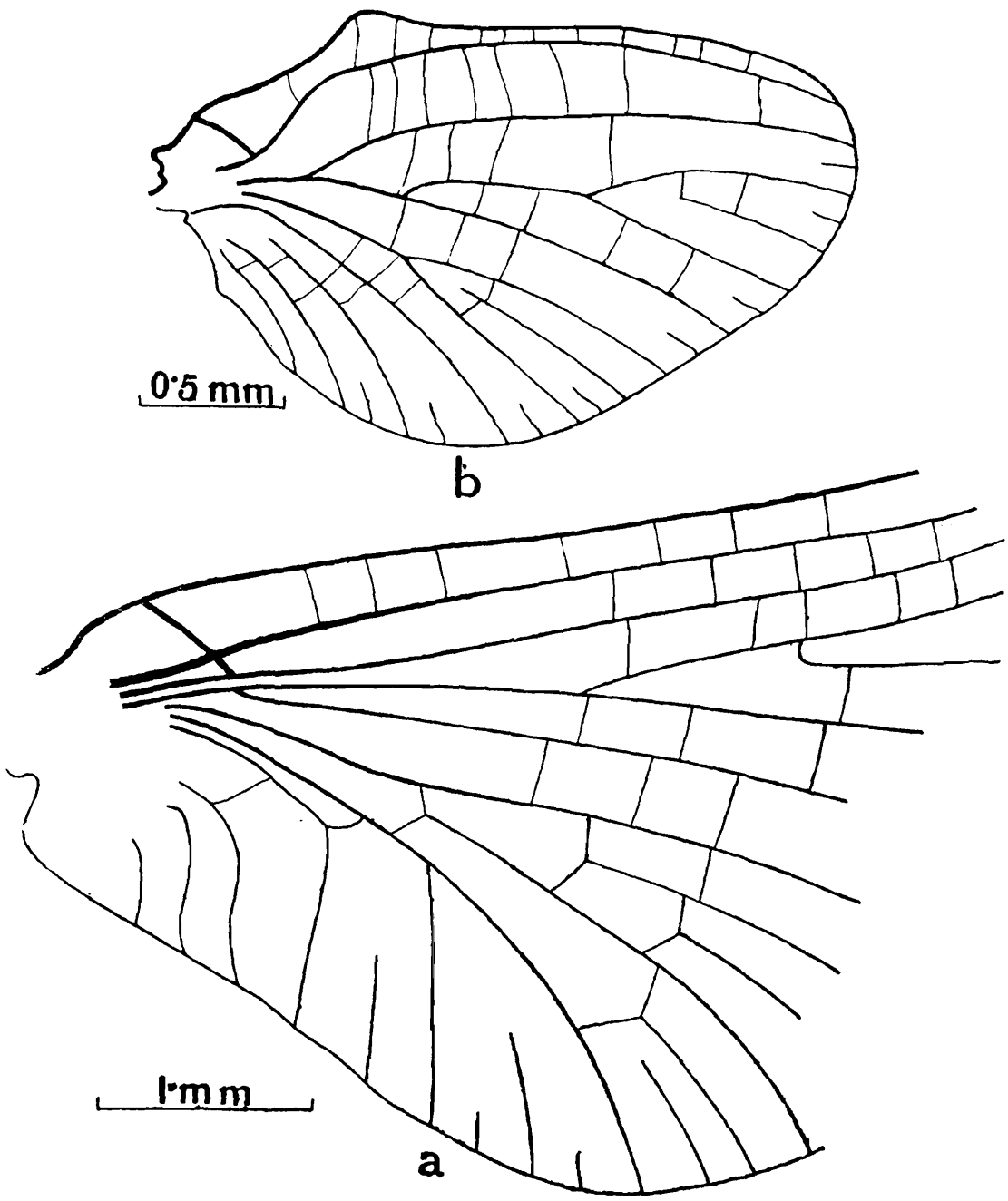
Ephemerella indica, sp. nov.

(Text-fig. 1)

Female imago Length of body 6 mm.; forewing 10 mm. Head mostly dull brown, eyes small and blackish, teeth whitish, antenna with the basal segment dark brown, the rest lighter. Thorax slightly darker than head, 3 white spots on the mesonotum, pleurae shaded with brown ganglionic area of mesosternum blackish. Coxae of legs light brown., Wings slightly opaque, the longitudinal veins brown, deepest on the costal margin of the forewings. In the forewing, stigmatic area opaque, whitish, the cross veins anastomosed ; 2 short intercalaries between median intercalary and posterior branch of M, also between the latter vein and Cu_1 (Text-fig. 1*a*). Hind wing (Text-fig. 1*b*) 2×1.2 mm., with Sc arched, ' Of ' of hind wing absent. Abdominal tergites brownish, much lighter in colour than thorax, anterior portions darker, giving the abdomen a ringed appearance ; sternites paler, ganglionic area on 7th sternite distinct, round and blackish. Terminal filaments (Tails) three

Holotype.—♀ imago, INDIA : Ralha (*Ca.* 9,000 ft.=2,743 m.), Kulu Valley, N. W Himalaya ; 26. v. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2456/H8).

Remarks.—As already stated, no adult of *Ephemerella* has been recorded from India before, although the nymphs of the genus have been collected from various localities in the Himalayas. In the adjoining area of Central Asia, the species of *Ephemerella submontana* Brodsky is



TEXT-FIG. 1.—*Ephemerella indica*, sp. nov.

(*a*). Basal part of forewing. (*b*). Hind wing.

known from Issyksee mountain and the Issyk river. *E. indica*, is easily distinguished from *submontana* by its smaller size, the presence of the whitish opaque stigmatic area and by the absence of the pattern (consisting of white spots) on the adbominal segments, which is characteristic of *submontana*.

Family BAETIDAE

Genus **Baetis** Leach

This large genus is widely distributed in the holarctic, neotropical and Indo-Australian regions. It is known from various localities in India, Ceylon and Nepal (Nymphs). In India a total of six species are recorded from Ladakh and Kashmir (both in Kashmir State), Darjeeling (N. Bengal), Hoshangabad (Madhya Pradesh) and Poona(Bombay State). Regarding the material from Ladakh and Kashmir Traver (1939) stated that it was inadequate in every case for specific determination. Gillies (1949) described six species from other localities mentioned above. Six more species are now being recorded from various habitats in the Kulu and Lahaul-Spiti Valleys in the Punjab.

The following key is given for determining the known Indian species of the genus.

Key to the Indian species of the genus Baetis *Leach*

1.	Hind wing with two longitudinal veins .	2
	Hind wing with three longitudinal veins, the third may be very weak .	5
2.	Costal spur of hind wing wanting .	3
	Costal spur of hind wing present .	4
3.	Body length 6—6.5 mm., abdominal tergites 2—6 yellow green, stigmatic veins 6—10, (♂+♀) (Poona)	*dipsicus* Gillies
	Body length 4—4.5 mm., abdominal tergites 2—6 white, stigmatic veins 4—7, (♂+♀) (Poona and Hoshangabad) .	*palmayrae* Gillies
4.	Body length 3.5-4 mm., abdominal tergites 2—6 white, stigmatic veins 5-6, (♂+♀) (Poona)	*fluitans* Gillies
	Body length 4.5—5 mm., abdominal tergites 2—6 lemon, stigmatic veins 6-7, (♂) (Darjeeling district, N. Bengal)	*solitarius* Gillies
5.	Second longitudinal vein of hind wing not forked	6
	Second longitudinal vein of hind wing forked	10
6.	Fore wing 11—11.5 mm., long, intercalaries between veins 1 and 2, 2 and 3 of hind wing present, (♂+♀) (Lahaul-Spiti and Kulu Valleys)	*chandra*, sp. nov.
	Fore wing 6—8.5 mm., long, intercalaries between veins 1 and 2, 2 and 3 of hind wing absent	7
7.	Fore wing with 3—6 stigmatic veins, dark mesosternal ring of thorax present, (♂) (Darjeeling district, N. Bengal)	*thurbonis* Gillies
	Fore wing with 7—9 stigmatic veins, dark mesosternal ring of thorax absent	8

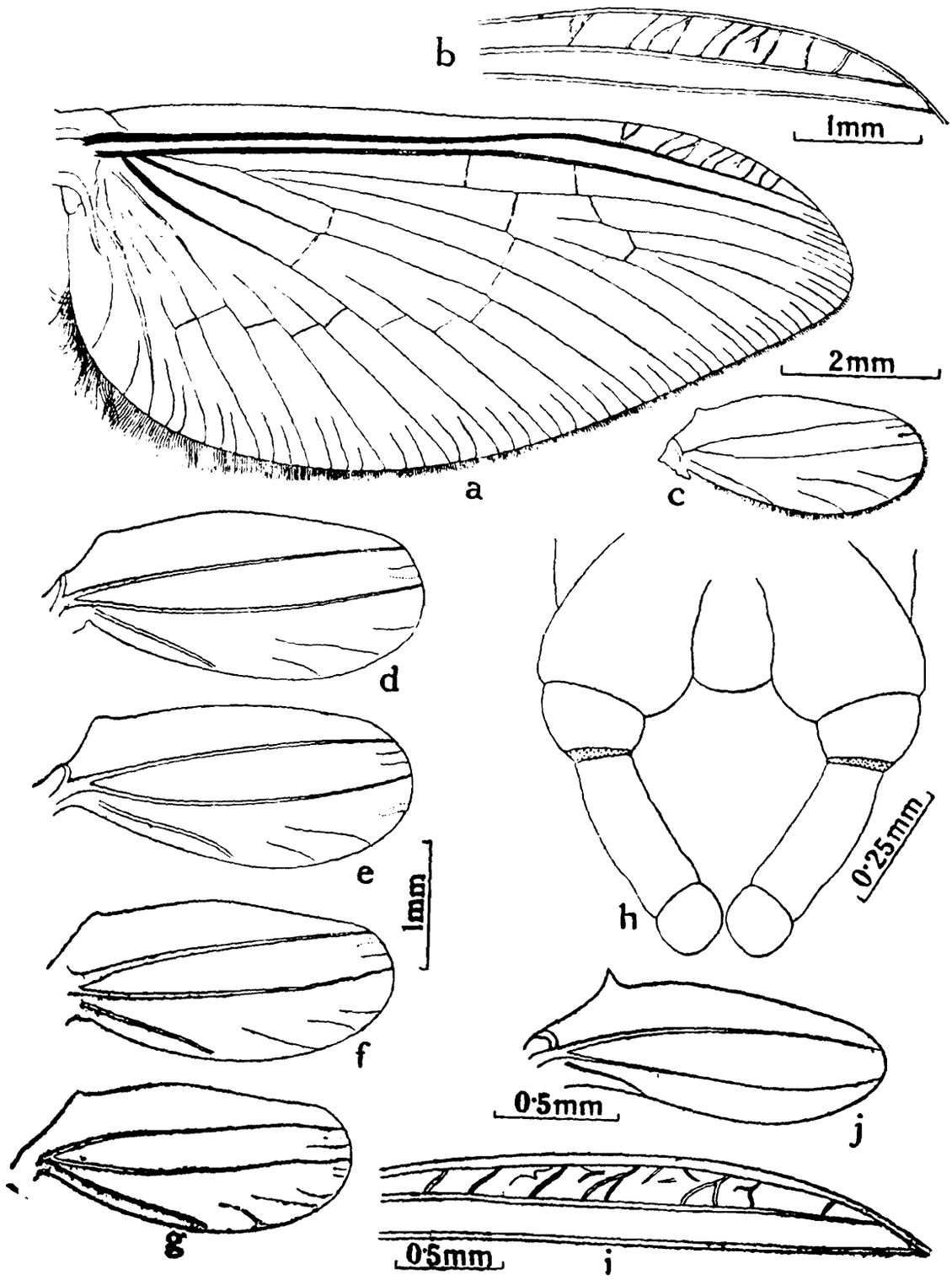
8.	Abdominal tergites red and yellow, bimaculate pigment in wings (♂+♀) (Darjeeling district N. Bengal)	*tigroides* Gillies
	Abdominal tergites and pigment in the wings not as above	9
9.	Costal spur of hind wing acute, abdominal tergites 2—6 light brown, veins 1 and 2 of hind wing convergent apically, (♂) (Kothi, Kulu Valley)	*simplex*, sp. nov.
	Costal spur of hind wing not acute, abdominal tergites 2—6 dull brown, veins 1 and 2 of hind wing not convergent apically, (♂) (Ralha, Kulu Valley)	*punjabensis*, sp. nov.
10.	Fore wing 8 mm., long, stigmatic area with 9 veins, area below this without cross veins, (♂+♀) (Sissu, Lahaul Valley)	*himalayana*, sp. nov.
	Fore wing 6-6.5 mm., long stigmatic area with 10—15 veins, area below this with cross veins	11
11.	Abdominal segments dull brown, stigmatic area with 10—12 cross veins, area below it with 7 cross veins, (♂) (Ralha, Kulu Valley)	*bifurcatus*, sp. nov.
	Abdominal segments golden brown, stigmatic area with 15 cross veins, area below it with 5 cross veins, (♂) (Ralha, Kulu Valley)	*festivus*, sp. nov.

Baetis chandra, sp. nov.

(Plate 7 ; and Text-fig. 2)

Male subimago.—Length of body 10 mm., fore wing 10·5 mm. Head brown ; turbinate eyes large and oval, stalk short, stalk and upper surface orange in alcoholic specimens ; lower portion black ; ocelli bluish-white, antennal segments brown, basal segment short and broad, second longer. Thorax generally chocolate-brown with white pattern (Plate I), pronotum chocolate-brown with white dots laterally, mesonotum with 3 white stripes, the central broader than the other two, all the three joining anteriorly ; pleurites with a few irregular, dark-brown patches, sternites pale brown except the meso and metasternum which are brownish laterally. Legs whitish, coxae dull brown, femur sometimes with dull brown patches at proximal end. Wings transluscent greyish with violet tinge, veins brown. Stigmatic area of fore wing (Text-fig. 2, *a*, *b*) with 8-9 simple, or very occasionally forked, slanting cross veins and without granulations, marginal intercalaries short, absent in the 1st interspace. Hind wing (Text-fig. 2, *c*, *g*) 3·5 × 1·4 mm., with 3 veins, 2nd not forked, third short, running close to the hind margin, tip of wing broadly rounded, two indistinct intercalaries between vein 1 and 2 usually present, 2-3 veins between vein 2 and 3 always present, costal projection not acute. Abdominal tergites 2-9 brown, slightly lighter medianly, with 4 whitish spots except on the 9th which is with only 2 spots, 10th tergite yellowish, sternites much lighter in colour, 4 rounded spots on sternites 2-8. Genostylas (Text-fig. 2, *h*) whitish, basal segment longer than broad, the second broader than long, but about one third the length of the first segment and without tubercle, third segment long, uniformly wide and abou

two and a half times longer than the second, fourth segment roundish. Terminal filaments two, whitish.



TEXT-FIG. 2.—*Baetis chandra*, sp. nov.

(*a*). Fore wing. (*b*). Stigmatic area of forewing. (*c*). Hind wing. (*d*) and (*e*). Hind wings of 2 males. (*f*) and (*g*). Hind wings of 2 females. (*h*). Genostyles of holotype : *Baetis simplex* (sp. nov.). (*i*). Stigmatic area of forewing. (*j*). Hind wing.

Female subimago.—Length of body 11 mm., forewing 11·5 mm., colour and pattern exactly like that of the male subimago.

Holotype.— ♂subimago, INDIA : Chhatoru, (*Ca.* 11,000 ft.=3,353 m.) Chandra River, Lahaul-Spiti Valley, N. W. Himalaya, 16. vi. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2457/H8).

Allotype.—♀subimago, INDIA : With the same data as the holotype. In the Zoological Survey of India.

Paratypes.—Several ♂ and ♀ subimagos from the N. W. Himalaya as follows : 26 ♂ subimagos, 62 female subimagos with the same data as the holotype ; 10 ♀ imagos, Khoksar, (*Ca.* 10,800—11,000 ft.=3,048—3,353 m.) Lahual Valley, 11. vi. 1955 (*A. P. Kapur*) ; 1 ♂ subimago, Ralha, (*Ca*, 9,000 ft.=2,743 m.) 26. V 1955 (*V K. Gupta*) ; 1 ♂, 1 ♀ subimago, Ganddapu, (12,000 ft.=3,658 m.) 7. vi. 1955 (*V K. Gupta* and *H. N. Baijal*) ; 9 ♂, 19 ♀ subimagos, (Chhatoru, *Ca.* 12,000 ft.=3,658 m.) 16. VI. 1955 (*H. N. Baijal*). All in the Zoological Survey of India.

Nymphs.—Many nymphs of this species have been collected from Ganddapu, Dorni Thach and Chhatoru, Spiti Valley, N. W. Himalayas, and are described in the next part dealing with nymphs.

Remarks.—The species is characterised by the presence of 3 veins in the hind wing, vein 2 being simple, presence of intercalaries between veins 2 and 3, and by the large size of the fore wing. From *Baetis transiliensis* Brodsky, from Central Asia, it is distinguished by the 9 cross veins in the stigmatic area and character of forceps. *B. transiliensis* has 5 cross veins in the stigmatic area and a distinct tubercle situated on the median side of the first segment of genostyles ; such a tubercle is wanting in *B. chandra.*

Ecological notes.—The species was found more commonly in the Chandra River, at various places in the Lahaul-Spiti Valley. At Chhatoru (*Ca.* 11,000 ft.=3,353 m.) where the bulk of the material reported above was collected, enormous quantity of water, mainly from rivulets fed by melting snow, ran at great speed. The nymphs of *B. chandra* were found literally in hundreds beneath stones and boulders at the bank. When a stone was lifted out of water the nymphs would at first wriggle backward and then laterally and would drop down in the water invariably to swim back to the undersurface of stones inspite of the great flow of the river. The subimagos of the species were collected from over the stones at the bank of the river.

At Khoksar (*Ca.* 10,800—11,000 ft.=3,292—3,353 m.) the species was collected from a torrential to fast flowing stream which fell into Chandra about hundred yards away. The subimagos and nymphs were found together.

Messrs Gupta & Baijal have collected the subimagos from Ralha in the Kulu Valley and it appears that the species is fairly widely distributed in these parts of the Himalaya.

Baetis simplex, sp. nov.

(Text-fig. 2)

Female imago.—Length of body 7 mm., fore wing 8·5 mm. Head brown ; oculli black with mauvish tinge ; ocelli bluish white ; antennal segments brown, basal segment short and broad, second longer. Thorax

generally brown without any conspicuous markings, pleurites slightly shaded with brown, sternites light brown. Legs light brown, coxae darker. Wings hyaline, veins light brown. On fore wing stigmatic area (Text-fig. 2, *i*) with about 8 veins, simple or forked, with slight tendency to anastomose, aslant and with a few granulations ; the subcostal area, immediately below stigmatic area, without any cross veins ; first cross veins between Sc—R_1, R_1—R_2, R_2 and the space behind it forming a more or less a straight line ; marginal intercalaries short none in the 1st and only one in the 2nd space. Hind Wing (Text-fig. 2, j) 1·1 × 0·2 mm., with 3 veins ; second not forked, third short, running close to the hind margin, and ending at about basal one third of that margin ; tip of margin rounded, no intercalaries ; costal projection present and acute. Abdominal tergites 2-8 brown, the 9th lighter, rather pale white, the 10th darker. Sternites very much lighter in colour. Terminal filaments two.

Holotype.— ♀ imago, INDIA Kothi (*Ca.* 8,000 ft.=2,438 m.) Kulu Valley, N. W Himalayas ; 20. vi. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2471/H8).

Paratypes.—6 ♀ imagos with the same data as the holotype. All in the Zoological Survey of India.

Nymphs.—Four nymphs of the species have been collected from the same locality as the adults and are described in the next part of the paper.

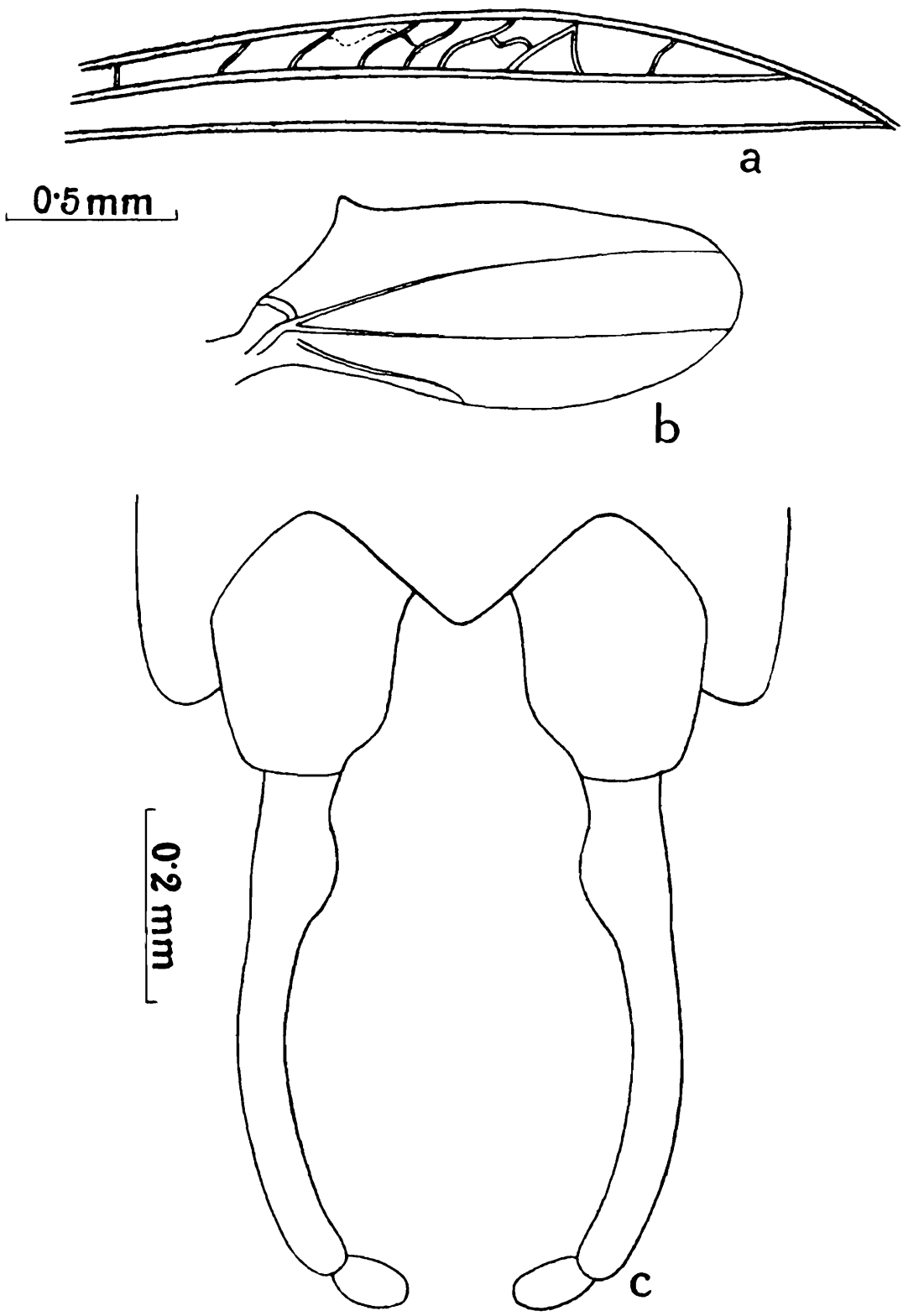
Remarks.—The species is characterised by its hind wing being long and narrow, second vein being simple and not bifurcated, absence of intercalaries and by the presence af acute spur of the hind wing. Its smaller size, acute spur and absence of intercalaries in the hind wing easily distinguish it from *Baetis chandra*, sp. nov. which is distinguished by larger size, a blunt spur, and the presence of intercalaries in the hind wings. The absence of intercalaries in the hind wing easily distinguish *simplex* from *B. transiliensis* Brodsky from Central Asia.

Baetis punjabensis, sp. nov.

(Text-fig. 3)

Male imago.—Length of body 6 mm., wing 7 mm. Head light reddish brown ; turbinate eyes large and oval, stalk very short and upper surface dark brown in colour ; ocelli whitish ; basal antennal segments brown, basal segment short and broad, second longer. Thorax nearly uniformly dark brown. Coxae brownish. Wings hyaline, veins brown. In fore wing area around wing root and outer one-third of costal and subcostal areas slightly darker ; stigmatic area with 7 cross veins (Text-fig. 3*a*), simple or forked, with slight tendency to anastomose, aslant without granulations ; without any cross veins in the area immediately behind the stigmatic area ; the 1st cross veins between Sc—R_1, R_1—R_2, R_2 and the space immediately below it, not forming a straight line ; marginal intercalaries short, none in the 1st and only one in the 2nd space. Hind wing (Text-fig. 3*b*) 1.1 × 00.25 mm., with 3 veins, 2nd not forked, third short and running close to the hind margin and

ending about basal one-third of that margin, vein 1 and 2 not convergent distally, tip of margin rounded, no intercalaries ; costal projection present and not acute. Abdominal tergites 2-6 dull brown, posterior



TEXT-FIG. 3.—*Baetis punjabensis*, sp. nov.
(*a*). Stigmatic area of forewing. (*b*). Hind wing. (*c*). Genostyles.

margins not whitish, sternites practically of the same colour as tergites, segments 8 to 10 dark brown. Terminal filaments two. Genostyles brownish (Text-fig. 3*c*), basal segment short and broad, directed slightly

laterally and nearly as long as second, second evenly narrowed and without any tubercle on the inner side near the base, third segment long and of uniform breadth, slightly longer than second, fourth segment elongate and slightly more than one-third of the length of the third segment.

Holotype.—♂ imago from INDIA : 2 miles south of Ralha, (*Ca.* 10,000—11,000 ft. =3,048—3,353 m.) Kulu Valley, N. W. Himalaya ; 28. v. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2473/H8).

Remarks.—In the complete absence of intercalaries in the hind wing, the species resembles *Baetis simplex* (from Kothi), which is represented by female imagos only. It is, however, distinct from the latter in the having different general colour pattern as described earlier, in the spur of hind wing being blunt, the 1st and 2nd veins being not covergent distally, and finally, in the 1st cross veins between Sc—R_1, R_1—R_2, R_2 and the space below it in the forewing, not forming a straight line. In *Baetis simplex*, the spur of hind wing is acute, the 1st and 2nd veins of hind wing convergent distally, and the 1st cross veins between Sc—R_1, R_1—R_2, R_2 and the space below it in the forewing form more or less a straight line.

Baetis himalayana, sp. nov.

(Text-fig. 4)

Male subimago Length of body 7 mm.; wing 8 mm. Head dark brown ; turbinate eyes large and oval, stalk of moderate height, stalk and upper surfaces blackish mauve in colour ; basal antennal segment reddish brown, short and broad, second longer. Thorax dull brown with whitish lines dorsally, one median and two lateral, pleurites and sternites lighter. Legs light brown. Wings transluscent dusky, veins brown. In fore wing, stigmatic area (Text-fig. 4*a*) with 9 slanting cross veins, with a slight tendency to anastomose. Hind wing (Text-fig. 4*c*) 1·1 ×0·3 mm., with 3 veins, second bifurcated, 3rd quite short and running close to the hind margin and ending about basal one-third of that margin, tip of wing rounded, 3 intercalaries, one short and indistinct between 1 and 2, one long and one short in the fork of 2nd vein, costal projection prominent and narrow. Terminal filaments two, brownish. Genostyles (Text-fig. 4*e*) brownish, basal segment longer than broad, second segment broader than long, but about one-third in length to that of the first and with a distinct tubercle on the inner side near the base, third segment longer and of uniform width, about 3 times longer than the second, fourth segment roundish.

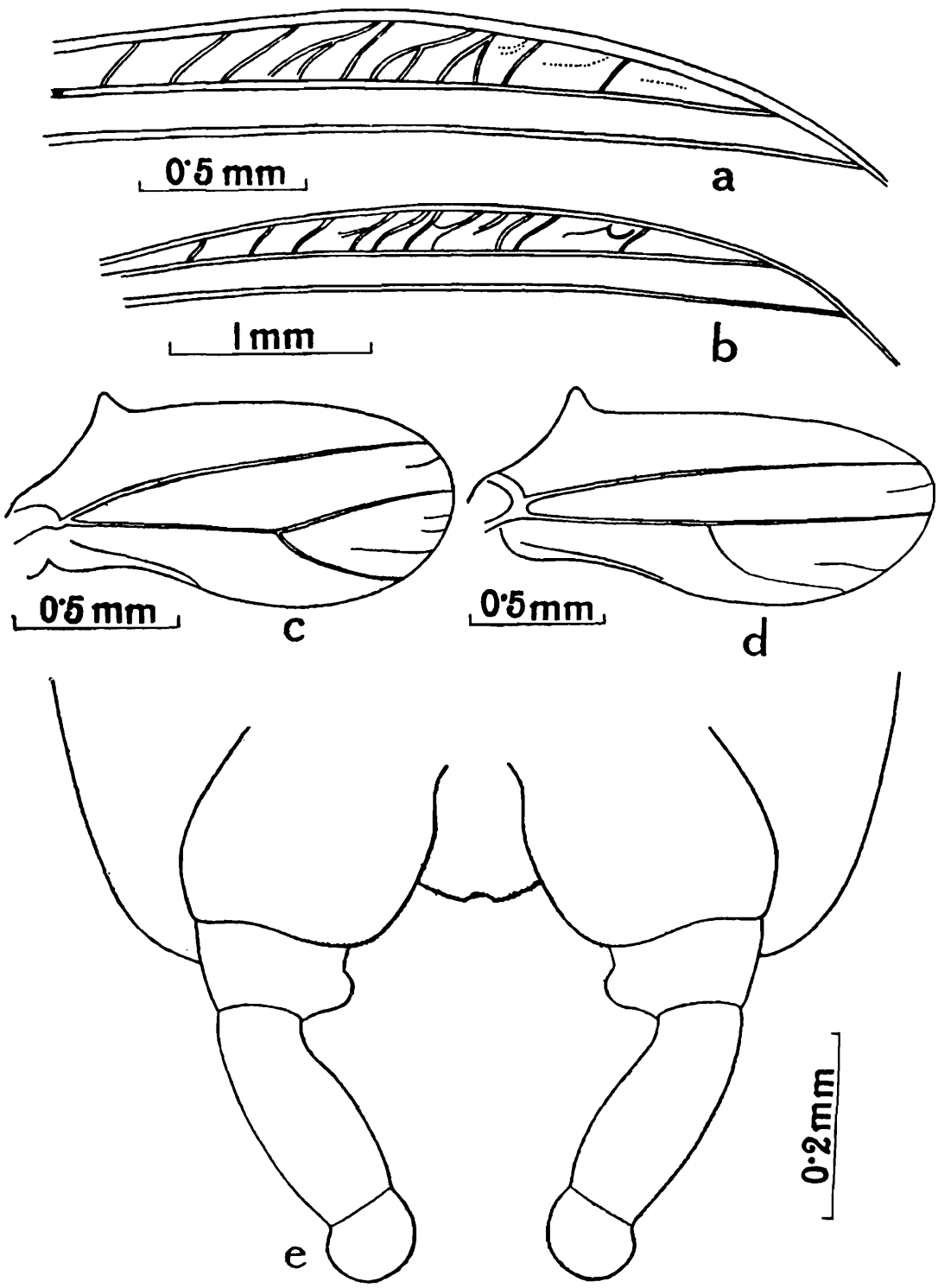
Female imago : Length of body 8 mm., wing 9 mm. Colour and pattern exactly like the male subimago. Wings hyaline (Text-fig. 4 *c, d*).

Holotype.— ♂ Subimago, INDIA : Sissu (*Ca.* 10,500 ft.=3,200 m.); Lahaul Valley, N. W Himalayas ; 10. vi. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2474/H8).

Allotype.— ♀ imago from INDIA : with the same data as holotype. In the Zoological Survey of India.

Paratypes.—2 male subimagos, 3 female imagos with the same data as the holotype. All in the Zoological Survey of India.

Remarks.—The species is generally characterised by having second vein of hindwing bifurcated and by its characteristic forceps, as described

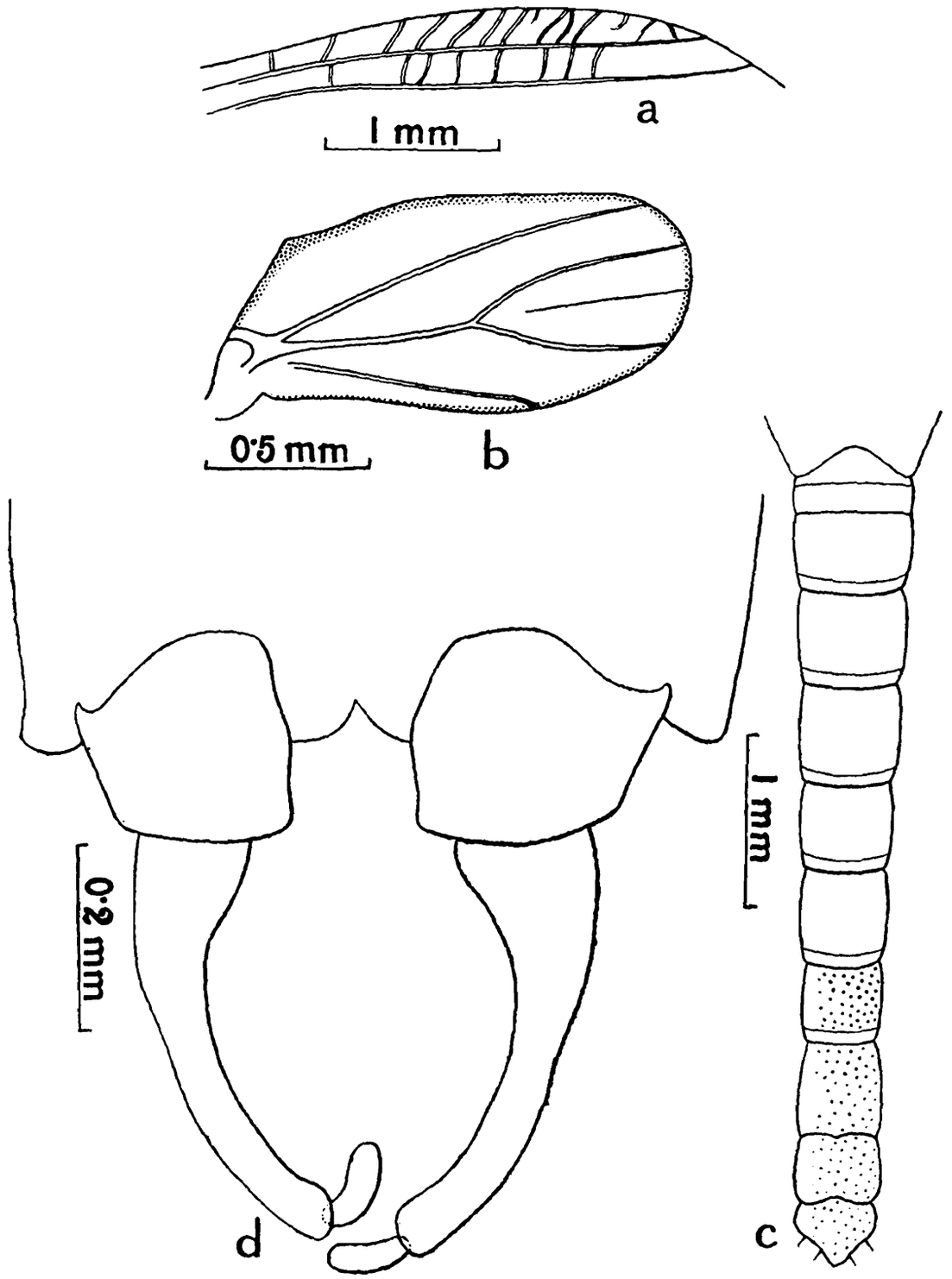


TEXT-FIG. 4.—*Baetis himalayana*, sp. nov.

(*a*). Stigmatic area of forewing of Holotype. (*b*). Same of allotype. (*c*). Hind wing of Holotype. (*d*). Hind wing of allotype. (*e*). Genostyles.

above. It resembles *Baetis bifurcatus*, described hereafter, in having bifurcated second vein of its hindwing. It is however, distinguished

from the latter by the different outline of the genostyles and by the absence of cross veins in the area below the stigmatic area of the fore-wing. The forked nature of second vein easily distinguishes it from *B. chandra,* described earlier.



TEXT-FIG. 5.—*Baetis bifurcatus*, sp. nov.

(*a*). Stigmatic area of forewing. (*b*). Hind wing. (*c*). Abdomen. (*d*). Genostyles.

Baetis bifurcatus, sp. nov.
(Text-fig. 5)

Male imago: Length of body 7·5 mm.; fore wing 6 mm. Head light reddish brown ; turbinate eyes large and oval, stalk of moderate

height, stalk and upper surface orange in alcoholic specimens, lower portion black ; ocelli whitish ; antennal segment brown, basal segment short and broad, second longer. Thorax uniformly dark brown ; sternites slightly lighter. Wings transluscent, longitudinal veins brown. Fore wing slightly darker around wing root and at outer one-third of costal and subcostal areas ; stigmatic area (Text-fig. 5*a*) with 10-12 cross veins, the latter with slight tendency to anastomose, somewhat aslant, and without granulations ; the subcostal area, immediately below stigmatic area with 7 cross veins ; marginal intercalaries short, none in the first and second space. Hind wing (Text-fig. 5*b*) 1·2×0·3 mm.; with 3 veins, vein 2 bifurcated, vein 3 quite short, running close to hind margin and ending at about basal two-thirds of the margin ; tip of the wing broadly rounded, with usually 2 intercalaries in the form of 2nd vein ; costal projection not well developed. Abdominal tergites 2-6 dull brown, posterior margins whitish ; sternites rather dull brown, segment 7—10 opaque, light brown, tergites shaded with indistinct darker pattern (Text-fig. 5*c*). Terminal filaments two, broken. Genostyles (Text-fig. 5*d*) brownish, basal segment short and broad, directed slightly laterally, nearly as long as the second ; second segment evently narrowed and without tubercle ; third segment long, uniformly wide, slightly longer than the second ; fourth segment oblong about one-third the length of the third segment.

Holotype.—♂ imago, INDIA : 2 miles south of Ralha, (*Ca.* 10,000—11,000 ft.=3,048—3,358 m.) Kulu Valley, N. W. Himalaya ; 28. v. 1955 (*A. P Kapur*). In the Zoological Survey of India (Reg. No. 2478/H8).

Paratypes.—2 male imagos with the same data as the holotype. Both in the Zoological Survey of India.

Remarks.—Baetis bifurcatus is easily distinguished from other species from India, by its vein 2 of the hind wing being forked and by its characteristic forceps. From its closest ally *Baetis festivus*, sp. nov., described below, it is distinguished by having 10-12 cross veins in the stigmatic areas and 7 cross veins in the area immediately below it and by the 10th abdominal segment being not of different colour than other segments. The forked nature of 2nd vein of hind wing separates it from Brodsky's *B. transiliensis* from Central Asia.

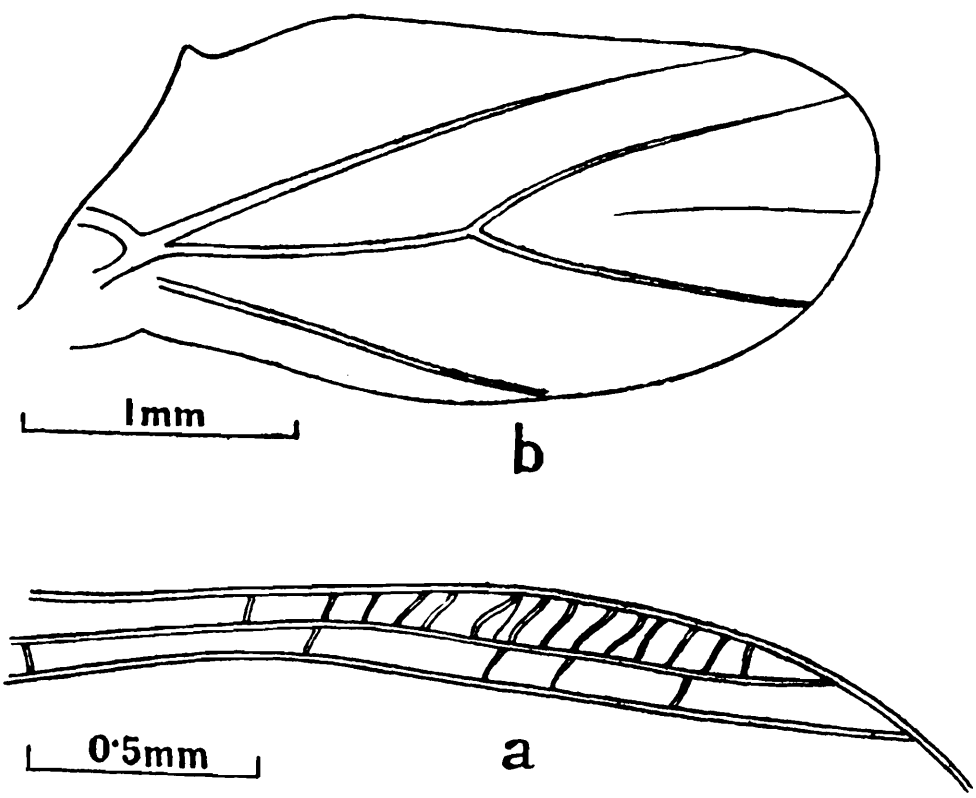
Baetis festivus, sp. nov.

(Text-fig. 6)

Female imago : Length of body 7·5 mm., wing 6.6 mm. Head brown ; oculi blackish ; ocelli whitish, basal two external segments brown, first broad and short, second longer. Thorax generally chocolate brown, metanotum posteriorly with whitish specks ; pleurites and sternites nearly of the same colour. Legs light brown. Wings transluscent, longitudinal veins pale brown, in fore wing area around wing root, costal and subcostal areas slightly darker. Stigmatic area (Text-fig. 6*a*) with 15 veins with slight tendency to anastomose, some aslant, no granulations ; immediately below stigmatic area, the subcostal

area with 5 cross veins, marginal intercalaries short, none in the first and second space. Hind wing (Text-fig. 6*b*) 1·2×0·4 mm., with 3 veins, costal projection not pointed, vein 2 bifurcated, vein 3 quite short and running close to the hind margin and ending at about basal two-thirds of the margin, tip of wing rounded, 2 intercalaries in the fork of vein 2. Abdominal tergites 9-6 golden brown, posterior margins whitish ; sternites slightly lighter, golden brown, segments 7—10 dark brown, 10th darkest. Terminal filaments two.

Holotype.—♀ imago, INDIA : 2 miles south of Ralha, (*Ca.* 10,000—11,000 ft.=3,048—3,353 m.), Kulu Valley, North-Western Himalaya ; 28. v. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2480/H8).



TEXT-FIG. 6.—*Baetis festivus*, sp. nov.
(*a*). Stigmatic area of forewing. (*b*). Hind wing.

Paratype.—A female imago with the same data as the holotype. In the Zoological Survey of India.

Remarks.—*Baetis festivus* is closely related to *Baetis bifurcatus*, in having the second vein of hind wing bifurcated. It is, however, easily distinguished from the latter by having 15 cross veins in the stigmatic area and 5 cross veins in the area immediately below it, and by the 10th abdominal segment being the darkest.

FAMILY ECDYONURIDAE

Genus **Epeorus** Eaton

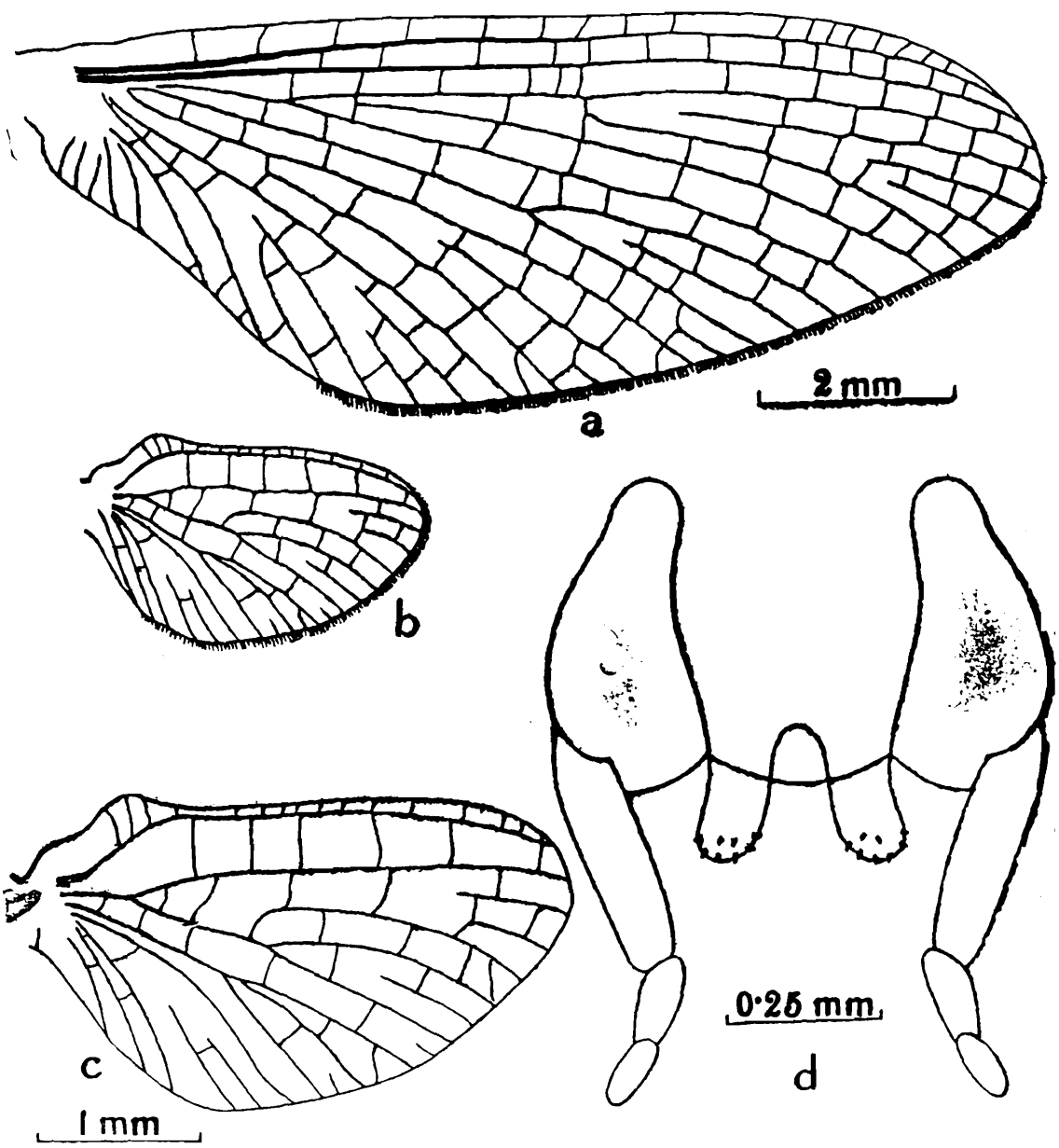
This holarctic genus has already been known from India and Nepal (In the latter from nymphs only). In India it has been recorded from adults as well as the nymphs. The latter are recorded from Kulu,

Kangra Valley, Ladakh (N. W. Himalaya) Pashok and Khasi Hills (E. Himalaya). So far the adults are known from only one species, *E. psi* Eaton, from "Kooloo" [kulu]. *E. lahaulensis*, sp. nov., from Lahaul Valley, N. W Himalaya is the second species to be recorded from India.

Epeorus lahaulensis, sp. nov.

(Text-fig. 7)

Male subimago.—Length of body 7.5 mm. ; wing 10 mm. General colour brown. Frontal margin of head paler ; eyes black, quite large,



TEXT-FIG. 7.—*Epeorus lahaulensis*, sp. nov.

(*a*). Forewing. (*b*). Hind wing. (*c*). Hind wing enlarged. (*d*) Genostyles with hooks on penes.

not contiguous apically ; ocelli lighter. Thorax uniform red brown ; pleurites and sternites much paler. Legs brownish ; proportions of fore leg femur : tibia : tarsus, 36 : 35 : 38 , 5 tarsal joints—9 : 8 : 8 : 7 : 6. Wings translucent brownish, veins brown. In fore wing (Text-fig. 7*a*) the costal space before bulla with 5 cross veins, slightly aslant ; stigmatic

area with 14 cross veins, simple and slightly aslant ; basal subcostal cross veins 3 ; below stigmatic area 10 cross veins ; two parallel pairs of cubital intercalaries, the pair nearer the hind angle longer. Hind wing (Text-fig. 7*b*, *c*) 3 × 1·8 mm. ; outer fork of RS (*Of*) present. Abdominal tergites brownish, each tergite darker posteriorly ; sternites much paler. Terminal filaments two. Genostyles 4 segmented, the first segment longest, fourth segment slightly shorter than third, the latter two combined being shorter than the second segment ; apical margin of genostyle base convex, as shown in Fig. 7*d* ; penes long, broad apically and slightly divergent laterally, spines present ventrally just below the apex.

Holotype.—♂ subimago from INDIA : Sissu (Ca. 10,500 ft.=3,200 m.) Lahaul Valley, N. W Himalaya ; 10. vi. 1955 (*A. P. Kapur*). In the Zoological Survey of India (Reg. No. 2507/H8).

Remarks.—The species is distinctive by its colour and the shape of penes. Eaton in his monograph on the group in 1888 described *Epeorus psi* from " Kooloo ", [Kulu] Himalaya. Traver in 1939 gave a description of a male imago (in very poor condition) of an unidentified species of the genus from Kashmir. *E. lahaulensis* is different from *E. psi* in not having characteristic markings of the abdominal segments ; it is also different from the male imago described by Traver (as stated above), which has lobbed penes. In the new species described above the penes are not lobed apically and have short spines ventrally, just below the apical margin.

IV—Description of Nymphs

Family Leptophlebiidae

Genus **Paraleptophlebia** Lestage

This holarctic genus was hitherto not known from India. It is for the first time that the genus is being recorded from Manali (*Ca.* 6,000 ft. =1,829 m.), Kothi (*Ca.* 8,000 ft.=2,438 m.) and Ralha (*Ca.* 9,000 ft.= 2,743 m.) in N. W Himalaya of India from a few nymphs which seem to belong to two different species.

Paraleptophlebia sp. 1

A nearly mature ♂ nymph. Length of body 7 mm. ; terminal filaments missing. General colour brown on the darker side, ventral parts of body and legs paler. Body rather flattened. Head somewhat strongly depressed, longer than broad ; a big conspicuous white patch between the antennae, also dorsal to antennae ; eyes lateral ; basal two segments of antennae brown, rest yellowish. Mouth parts as in family Leptophlebiidae. Pronotum practically of the same width as the head. Mesonotum with two white spots posteriorly. Foreleg dark brown, mid and hind legs brown. Claws slender and pectinate.

Abdominal tergites 1—8 with conspicuous pattern. A median whitish streak, broadened at the posterior end of tergites ; a pair of submedian longitudinal spots on tergites 1—4 and 8, the spots elongated and directed laterally on tergites 5—7. Lateral spines present on segments 8 and 9, spine on the 9th longer but not more than 1/4 the length of that segment. Seven pairs of gills present on abdominal segments 1--7 ; all bifid and narrowly lanceolate ; gills of 1st pair similar in form to those of the following pairs.

Terminal filaments three, outer fringed on both sides.

Material examined.—1 ♂ nymph, INDIA : Manali (*Ca.* 6,000 ft.= 1,829 m.) Kulu Valley, N. W. Himalayas ; 23.v. 1955 (*A. P. Kapur*).

Remarks.—No species of *Paraleptophlebia* has been recorded earlier from India. The present nymph from Manali is the first Indian record of *Paraleptophlebia.*

Paraleptophlebia, sp. 2

Three nymphs. Length of body 6·5 mm. These are a little different from *Paraleptophlebia* sp. 1 in general colour, being brown, basal antennal segment being not dark and abdominal tergites being without any conspicuous markings.

Material examined.—3 nymphs from INDIA : as follows. Kothi (*Ca* 8,000 ft.=2,438 m.), Kulu Valley, N. W. Himalayas, 20.vi.1955 (*A. P. Kapur*), 1 nymph ; Ralha (Ca. 9,000 ft.=2,743 m.), Kulu Valley, N. W Himalayas, 26-27. v. 1955 (*A. P. Kapur*), 2 nymphs.

Family EPHEMERELLIDAE

Genus **Ephemerella** Walsh

This holarctic genus was hitherto known from Nepal (Ueno 1955) and India (Hora, 1930 ; Traver, 1939) from nymphs only. *Ephemerella indica* sp. n. has been described earlier in this paper from an adult caught at Ralha (*Ca.* 9,000 ft.=2,743 m.) in the Kulu Valley, Punjab. A few nymphs, of the genus *Ephemeralla* were collected from Manali (*Ca.* 6,000 ft.=1,829 m.) in the same valley. Apparently these examples also do not belong to *E. indica* but to some unidentified species of the genus.

Ephemerella sp.

Three nymphs, including one well grown ♂ nymph. Length of body 9 mm., excluding 6 mm. terminal filaments. General colour brown, lighter ventrally. Body somewhat arched dorsally. Head not flattened ; frontal shelf present, covering the mouth parts ; a notch on each side present, base of antenna lying in each notch, a short blunt projection present above base of each antenna on the inner margin, anterior to median ocellus ; a low rounded projection, the occipital tubercle, pre-

sent but very small ; eyes lateral. Pronotum wider than the head, quadrangular, a little widened posteriorly ; surfaces of pro-anal mesonota uneven. Hind legs longest, the forelegs shortest, femora rather flattened, anterior margin of fore femur toothed, tibial spines very small and blunt at tip, posterior margins of femora of middle and hind legs with small serrations, a few fine serrations also present on the posterior margin of femur, near the base.

Abdomen with short, postero-lateral spines on the middle and apical segments ; well-developed, paired submedian spines present on tergites 2—9, the two rows of spines converging, slightly towards the apical tergites. Five pairs of gills present on the abdominal segments 3—7, gills wholly dorsal in position and bilamellate, the 7th smallest, each anterior lamella obtuse ovoid, tracheation not distinct, each posterior lamella cut into many small loblets. Terminal filaments three, outer ones fringed on both sides. Described from a weil grown male nymph.

Materials examined.—3 nymphs from INDIA : N. W Himalaya : Manali (*Ca.* 6,000 ft.=1,829 m.), Kulu Valley, 23. vi. 1955. (*A. P. Kapur*) 2 nymphs ; Manali to Kothi (*Ca.* 6,500 ft.=1,981 m.), on broad leaves of plant in the stream, 24.v.1955 (*A. P. Kapur*), 1 nymph.

Remarks.—The present nymphs do not seem to belong to the adult *E. indica*, described earlier from Ralha (*Ca.* 9,000 ft.=2,743 m.). From the areas adjoining N. W Himalayas, Brodsky (1930) reported adults and nymphs of *E. submontana* Brodsky but as he did not describe the nymphs, it is not possible to compare our material with the latter. The nymph of *Ephemerella* described by Traver (1939) from Ladakh (Kashmir State), seems to be close to our material which is, however, distinct from *Ephemerella* nymphs described by Ueno (1955) from Nepal, in having only roughened and irregular surfaces on the thorax and being devoid of distinct tubercles which are so characteristic of our material.

Family BAETIDAE

Genus **Baetis** Leach

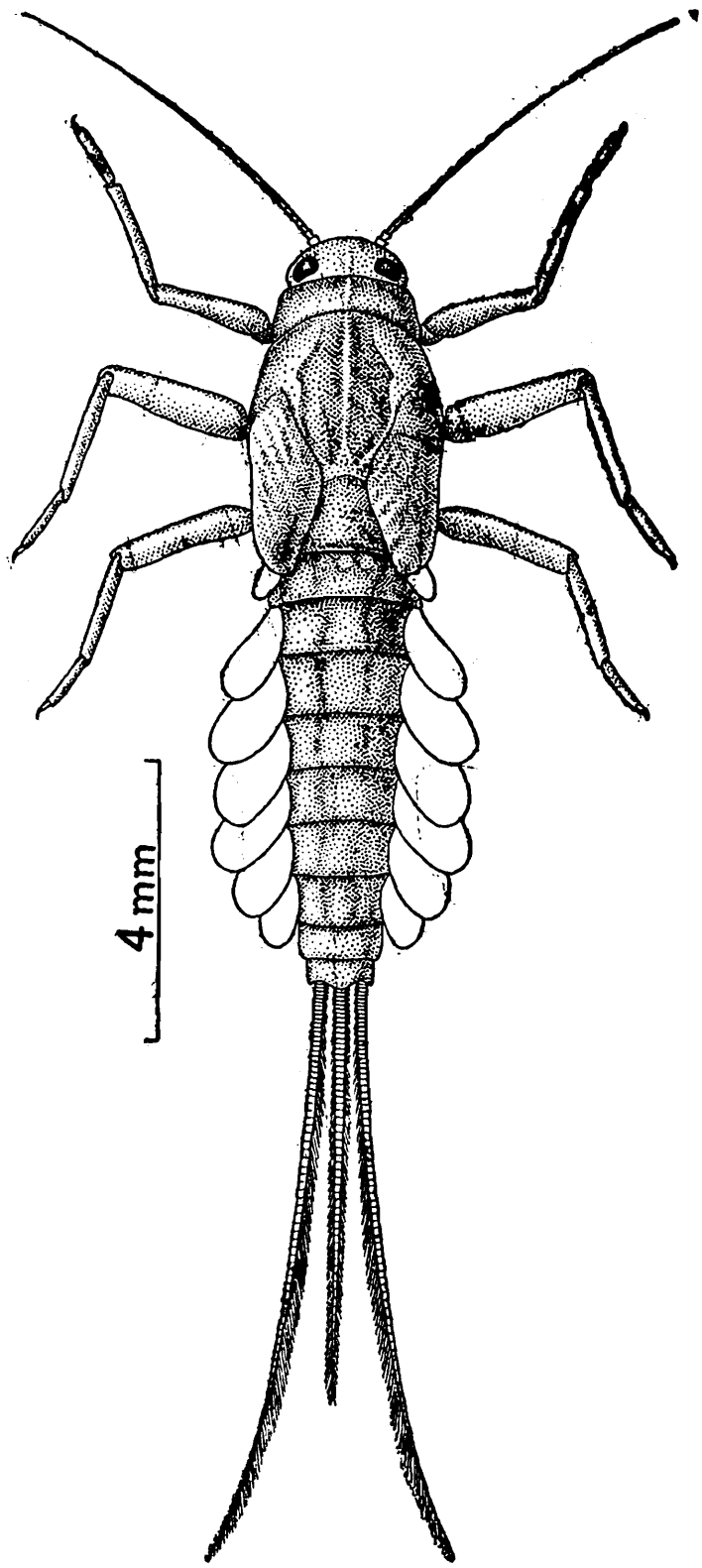
Hora (1930) recorded nymphs of *Baetis* spp. from torrential stream in India. Traver (1939) also reported nymphs of *Baetis* from Kashmir and Nepal. Here nymphs of a number of species of *Baetis* collected from most of the stations mentioned earlier in the Lahaul and Spiti Valleys are being dealt with. Of these the nymphs belonging to *B. chandra* and *B. simplex* could be definitely associated with the imagos or subimagos as a result of observation in the field and the camp laboratory, but the remainder of the nymphal material, presumably belonging to two hitherto unknown species, could not be associated with the adults.

Baetis chandra Kapur and Kripalani

(Text-figs. 8—10)

About 200 nymphs, mainly well developed ; an example of the latter with length of body 10 mm.; lateral terminal filament, 6 mm., medial

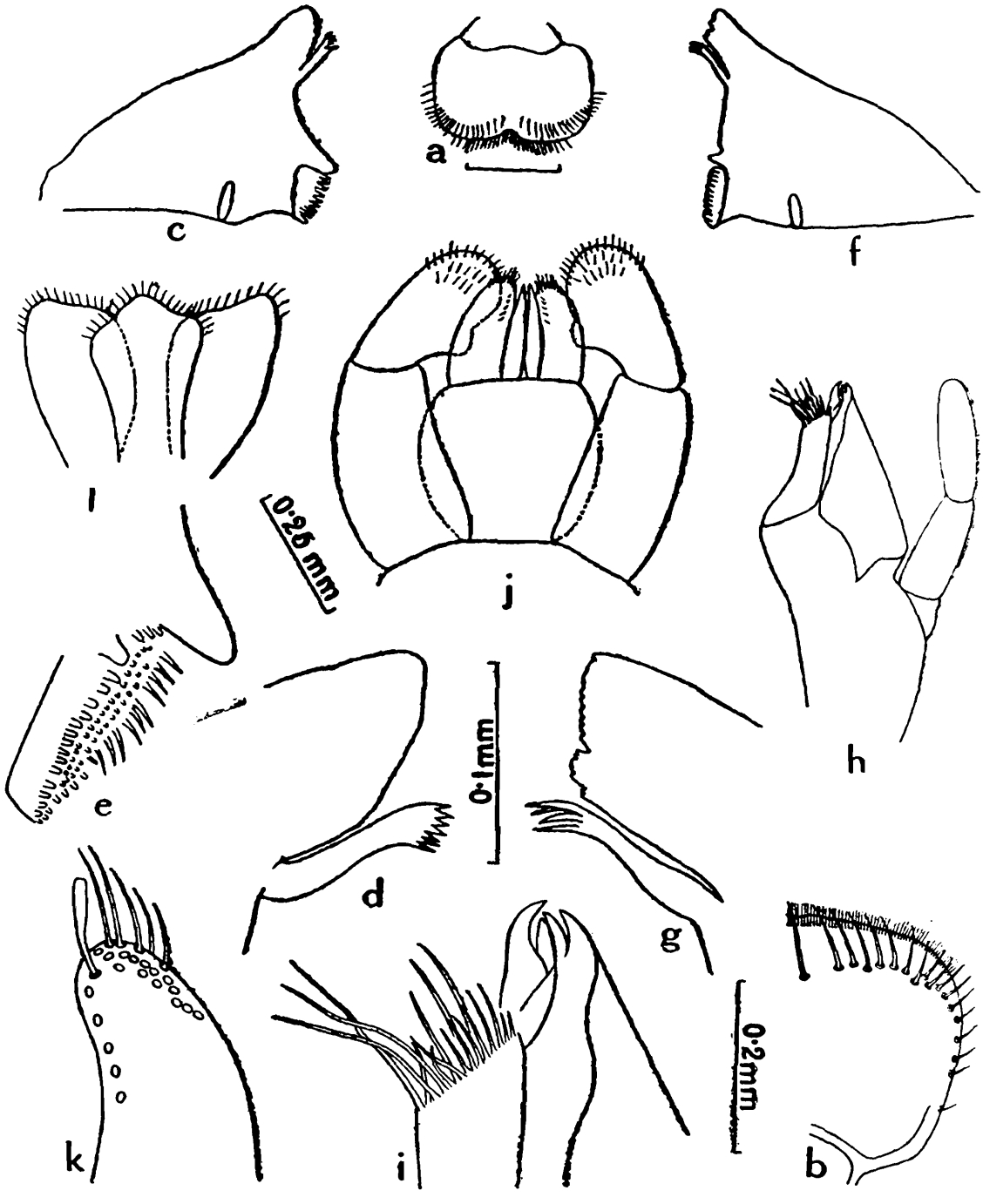
terminal filament ; 4 mm. body slender, not strongly flattened, streamlined ; brownish with the head and thorax darker and the venter paler (Text-fig. 8). Head directed downwards, slightly narrower than posterior margin of pronotum, antennae rather slender.



TEXT-FIG. 8.—*Baetis chandra* Kapur and Kripalani.
Dorsal view of Nymph.

Labrum (Text-fig. 9*a*) rather large, quadrangular, wider than long, with a shallow median notch on the rounded apical margin ; just inside

the apical margin there is a row of numerous plumose bristles, inserted closely together, and another row of bristles on the apical margin ; on the upper surface near the antetior margin there is a transverse row of stouter and longer bristles which reach the lateral margin on each side ; in all with about 17 bristles in the row (Text-fig 9*b*).

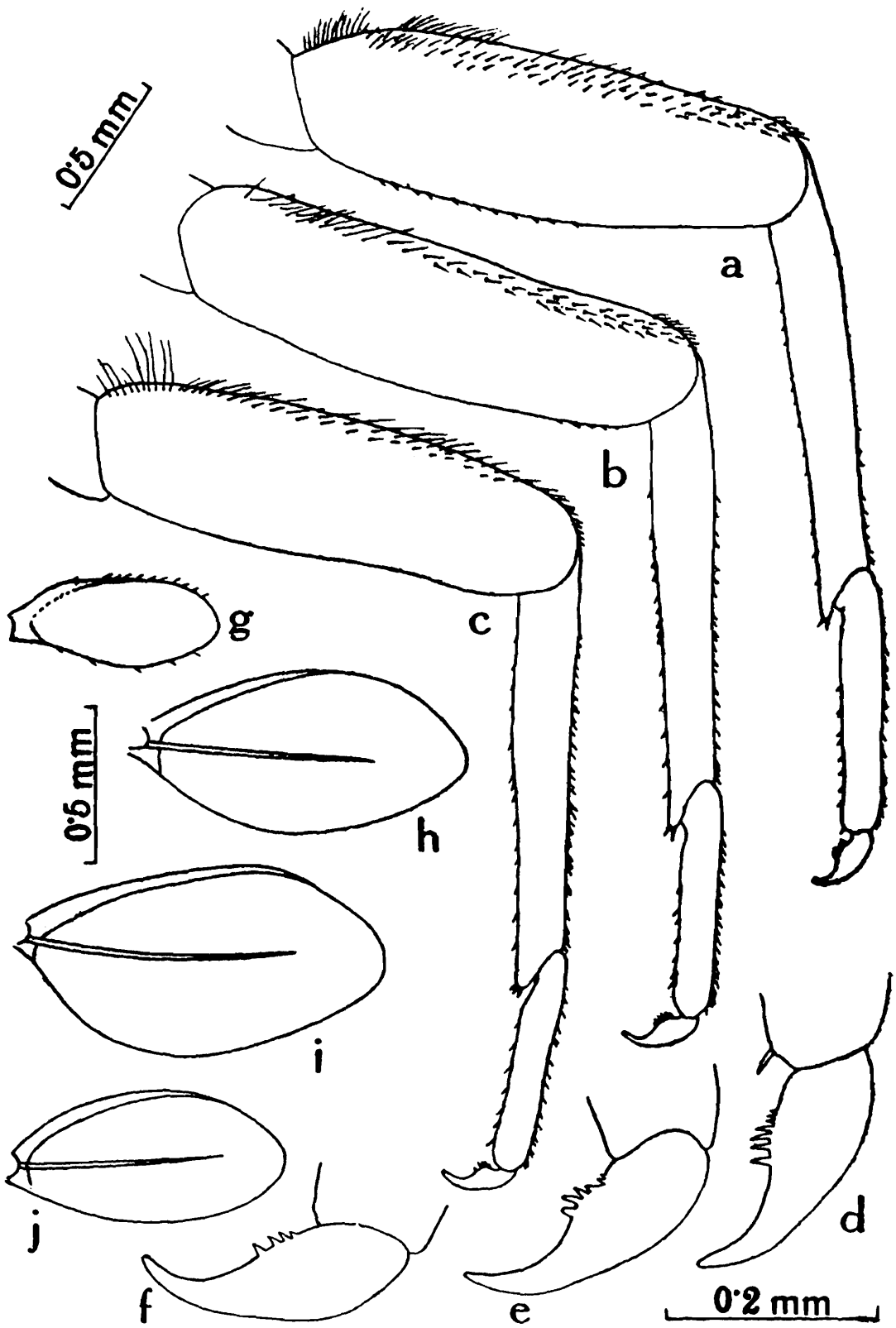


TEXT-FIG. 9.—*Baetis chandra* Kapur and Kripalani.

(*a*). Labrum. (*b*). Upper Surface of the right half of Labrum. (*c*). Left mandible. (*d*). Canine area. (*e*). Molar surface. (*f*). Right mandible. (*g*). Canine area. (*h*). Maxilla. (*i*). Apical part of galea-lacinea. (*j*). Labium. (*k*). Tip of paraglossa. (*l*). Hypopharynx.

Mandibles (Text-fig. 9*c-g*) robust and pyramidal in shape ; canines with very blunt teeth, those of the outer most longer and rather rounded ta apical margin. Prostheca of the left with seven teeth (Text-fig. 9*d*)

on its outer margin ; that of the right mandible more slender and with 4 teeth on its outer margin (Text-fig. 9*g*).



TEXT-FIG. 10.—*Baetis chandra* Kapur and Kripalani
(*a*)—(*c*). Fore, mid and hind legs. (*d*)—(*f*). Fore, mid and hind claws. (*g*)—(*j*). Gills 1, 4, 5 and 7 numbered from front.

Maxillary palp 3 jointed, not extending beyond the tip of galea-lacinia (Text-fig. 9*h*) ; terminal joint nearly as long as the proximal two

joints put together. Galea-lacinia terminates into 4 large and stout teeth (Text-fig. 9*i*) and two rows of long and short bristles on the apical margin.

Paraglossae of labium (Text-fig. 9*j*) extending slightly beyond glossae ; outer apical margin with 1—4 rows of feathered bristles , a well-spaced row of 5-6 long bristles inside the inner margin ; close to the outermost one a large clavate spine. (Text-fig. 9*k*). Labial palp 3-jointed, second joint with a blunt process on its inner distal corner , terminal joint rounded, tip with numerous spines and fine bristles. Median and lateral lobes of hypopharynx nearly equal in width (Text-fig. 9*l*).

Thorax with exactly same pattern as in the adult.

Legs (Text-fig. 10 *a-c*) brown with darker markings on the distal end of each femur ; distal end of tarsus and claw dark. The ratio, femur : tibia : tarsus , Fore-leg 61 : 44 : 28 ; mid leg 56 : 50 : 24 ; hind leg 55 : 45 : 22. A row of stout spines along the outer margin of each femur ; similar row of less stout bristles on outer margins of tibia and tarsus. A row of minute spines on inner margin of femur. Claws with 7 teeth on the inner margin (Text-fig. 10*d-f*).

Abdomen cylindrical, somewhat depressed, dorsum with pattern as in the adult.

7 pairs of gills (Text.-fig. 10 *g-j*) on segments 1—7. All simple lamellae, 1st and 7th much smaller than the others. Tracheation not distinct. Tails three, median shorter than outer ones, the former fringed with rather long hairs on both sides and the latter only on the inner side.

Described from a well developed nymph from Chhatoru.

Material examined.—Several nymphs from N. W Himalaya as follows: Ganddapu (*Ca.* 11,000 ft.=3,353 m.), Spiti Valley ; 8 and 9. vi.1955 (*A. P. Kapur*), 44 nymphs ; Dorni Thach (*Ca.* 11,800 ft.=3,597 m.), Spiti Valley ; 12. vi. 1955 (*A. P. Kapur*), 82 nymphs , Chhatoru (*Ca.* 11,000 ft.=3,353 m.), Spiti Valley ; 15.vi.1955 (*A. P. Kapur*), 76 nymphs.

Remarks.- The imagos and subimagos of the species have already been described earlier Ueno (1955) described two different forms of nymphs of unnamed species of *Baetis* from Nepal ; one of these has three tails. The present nymphs can, however, be distinguished from Ueno's *Baetis* sp. (1) in the pattern of abdominal segments, and the shape of canine teeth and prostheca.

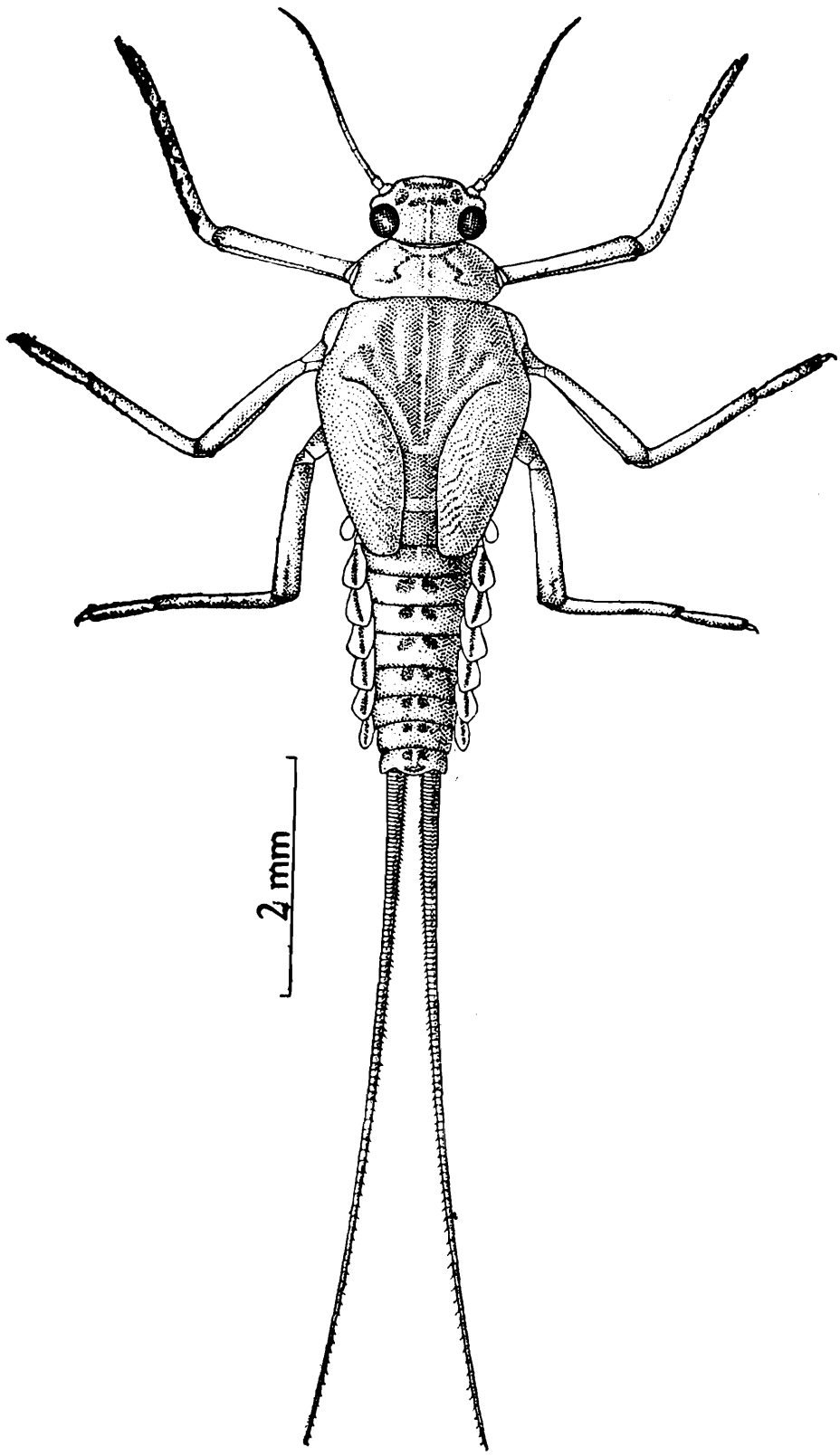
Baetis simplex Kapur and Kripalani

(Text-figs. 11-13)

Four nymphs, well developed , length of body 6 mm.; terminal filaments 6 mm. Body slender streamlined in form, and brown. Head directed downwards, slightly narrower than posterior margin of pronotum, antennae rather slender.

Labrum rather large (Fig. 12*a*), quadrangular, wider than its length, with a shallow median notch on the rounded apical margin ; just inside the apical margin a row of numerous plumose bristles inserted closely, and another row of bristles on the apical margin ; on the upper surface

near the anterior margin a transverse row of stouter and longer bristles which reach the lateral margin on each side, about 17 in total number (Text-fig. 12a).

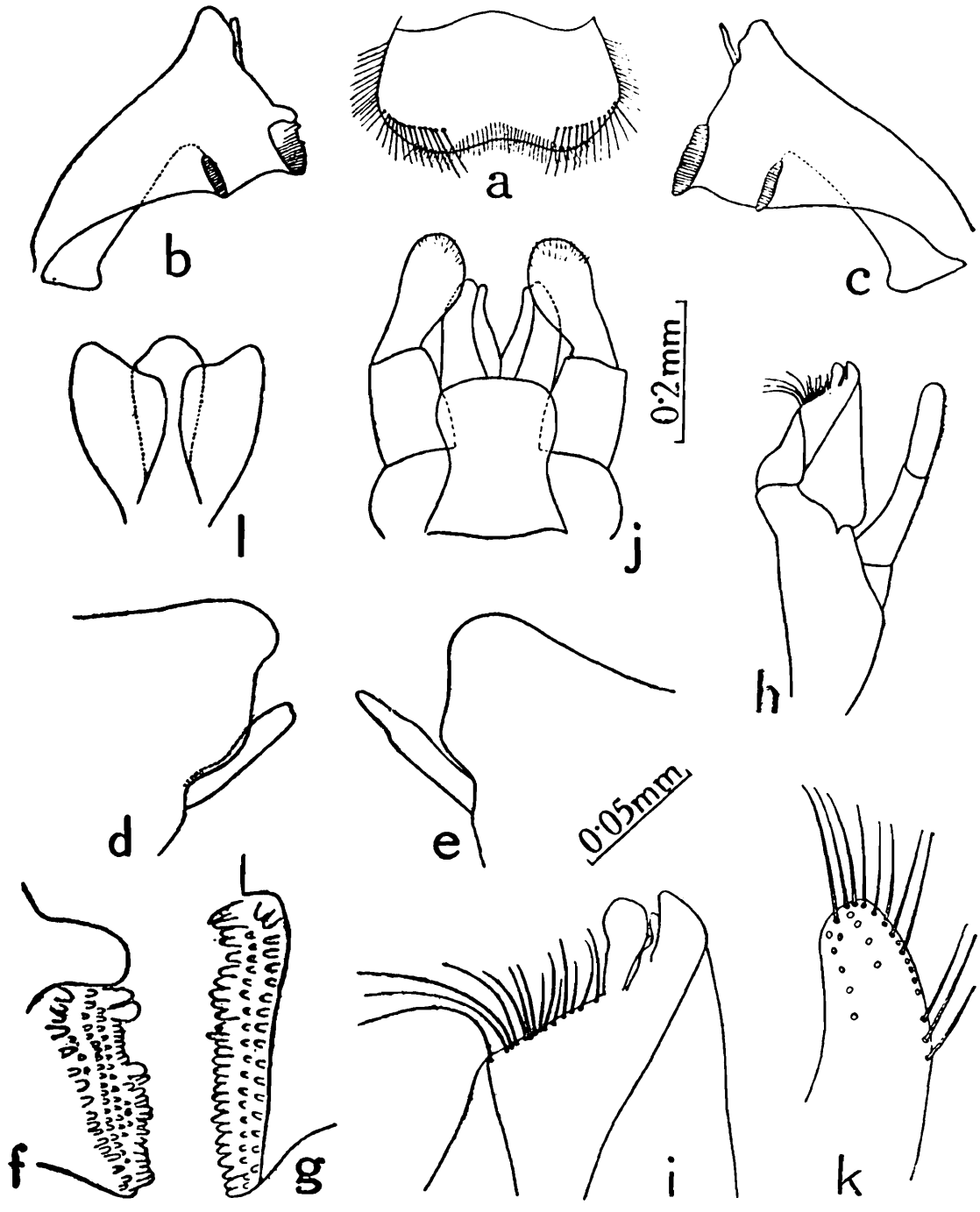


TEXT-FIG. 11.—*Baetis simplex* Kapur and Kripalani
Dorsal view of Nymph.

Mandibles robust (Text-fig. 12*b-g*) and pyramidal in shape ; canines with indistinct teeth, the outermost rounded, prostheca of the right with 2

blunt teeth on its outer margin, that of the left more slender and bluntly pointed at tip.

Maxillary palp (Text-fig. 12*h*) three-jointed, not extending beyond galea-lacinia ; terminal joint nearly as long as the 2nd joint. Galeae-



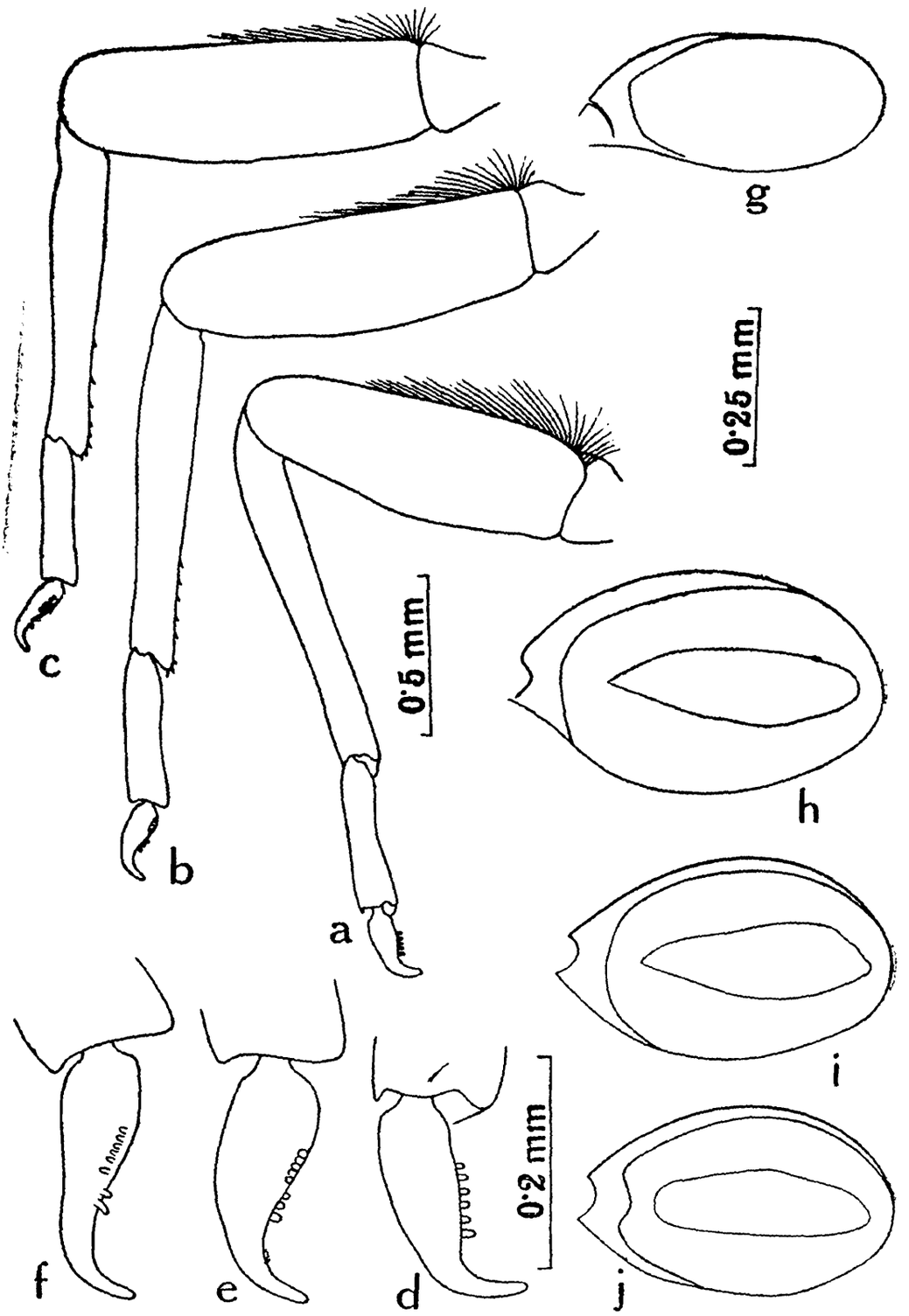
TEXT-FIG. 12.—*Baetis simplex* Kapur and Kripalani

(*a*). Labrum. (*b*). Left mandible. (*c*). Right mandible. (*d*)—(*e*) Left and right canine areas. (*f*)—(*g*). Left and right molar areas. (*h*). Maxilla. (*i*). Apical part of galea-lacinia (*j*). Labium. (*k*). Tip of paraglossa. (*l*). Hypopharynx.

lacinia terminates into four large and stout teeth (Text-fig. 12*i*) and two rows of long and short bristles on the apical margin.

Paraglossae of labium extending slightly beyond glossae (Text-fig. 12*j*) ; outer margin beset with feathered bristles arranged in 1—3 rows ; a well spaced row of 5—6 long bristles inside the inner margin

(Text-fig. 12*k*). Labial palp 3, jointed without second joint any blunt process ; terminal joint rounded, tip beset with numerous spines and



TEXT-FIG. 13.—*Baetis simplex* Kapur and Kripalani

(*a*)—(*c*). Fore, mid and hind legs. (*d*)—(*f*). Fore,, mid and hind claws. (*g*)—(*j*). Gills 1, 4, 6 and 7 numbered from front.

bristles (Text-fig. 12*j*). Median lobe of hypopharynx slightly narrower than the lateral ones (Text-fig. 12*l*).

Legs (Text-fig. 13*a-c*) brown, distal ends of femur and tibia and the claws darker. The ratio femur : tibia : tarsus in fore leg is 57 : 59 : 26 ; mid leg 61 : 58 : 24 and hind leg 61 : 56 : 24. Along the outer margin of each femur a row of stout bristles, similar row of less stout bristles on outer margins of tibia and tarsus. A row of minute spines on the inner margin of femur. Claws with 7-8 teeth on inner side (Text-fig. *d-f*).

Abdomen depressed, dorsum brown, no characteristic pattern, posterior margins of all terga darker till 9th, 10th tergum lighter.

Seven pairs of gills, all simple lamellae, the 1st smallest. Tracheation not distinct (Text-fig. 13 *h-j*).

Two terminal filaments brown and fringed on inner side only.

Described from one of the well grown examples.

Material examined.—4 nymphs from INDIA : N. W Himalayas : Kothi (*Ca.* 8,000 ft.=2,438 m.), Kulu Valley, 20.vi.1955 (*A. P. Kapur*).

Remarks.—The imagos of the species have already been described earlier. It is however, distinct from the nymph of *Baetis chandra*, in possessing only two termial filaments, different colour pattern, and in detailed structure of the mouth parts.

Other *Baetis* species

There are a number of *Baetis* nymphs, collected from the following localities, which cannot be associated with any described species and which being mostly in very immature stages, have not been described further These may belong to one or probably more, species.

Material examined.—Several nymphs from INDIA : N. W Himalayas : Manali (*Ca.* 6,000 ft.=1,829 m.), Kulu Valley, 25. vi. 1955. (*A. P. Kapur*) 2 nymphs ; Kothi (*Ca.* 8,000 ft.=2,438 m.), Kulu Valley, 20. vi. 1955. (*A. P. Kapur*) 15 nymphs ; Ralha (*Ca.* 9,000 ft.=5,743), Kulu Valley, 26. v. 1955. (*A. P. Kapur*) 4 nymphs ; Two miles N. E. of Ralha (*Ca.* 11,000 ft.=3,353m,.), 27. v. 1955. (*A. P. Kapur*) 23 nymphs , Near source of Beas river (*Ca.* 11,000 ft.—12,000 ft.= 3,353 m.-3,658 m.), 2. vi. 1955 (*A. P. Kapur*), 7 nymphs ; Ganddapu (*Ca.* 11,000 ft.=3,353 m.), Spiti Valley, 8. vi. 1955. (*A. P. Kapur*) 7 nymphs ; Sissu (*Ca.* 10,500 ft.=3,200 m.), Lahaul Valley, 10, vi. 1955. (*A. P. Kapur*) 4 nymphs ; Purana Khoksar Nalla (*Ca.* 13,000 ft.=3,962 m.), 17. vi. 1955. (*A. P. Kapur*), 3 nymphs.

Family Ecdyonuridae

Genus **Ecdyonurus** Eaton

This holarctic genus has been known from India (adults & nymphs) and Nepal (nymphs only). In India the adults have been reported from ' Hindusthan ', Assam (E. Himalaya) and Bengal. Hora (1930) recorded nymphs of this genus from ' hill streams of India ' Many nymphs of one species are now being recorded from Manali (*Ca.* 6,000 ft.=1,829 m.), Kothi (*Ca.* 8,000 ft.=2,438 m.), Ralha (*Ca.* 9,000 ft.=2,743 m.), and Ganddapur (*Ca.* 11,000 ft.=3,353 m.).

Ecdyonurus sp.

36 nymphs of various stages. Body 11 mm. General colour brown abdomen with darker pattern, legs and ventral surface lighter. Body distinctly flattened.

Head flattened about 1½ times as wide as long, frontal margin rounded frontal portion of median ocellus paler. Pronotum short, slightly wider than head, with dilated and rounded lateral margins which are prolonged behind and fused to the sides of mesonotum. Legs paler than body with 1 dark band on the upper surface of femora which are flattened.

On each abdominal segment 2—7 there is a central dark rather, triangular marking end on either side of median line on tergite 5 there is a pale, v-shaped area towards the hind margin, the shape of this area breaks up into 3 spots on the 6th tergite, on the 7th tergite the three spots, are very pale and on tergite 8 and 9 they become large and triangular on either side ; the 10th tergite nearly dark.

Seven pairs of gills on abdominal segments from 1-7, all lamellate. with filamentous gills, except the 7th which consists of lamellae only ; the first pair the smallest and rather lanceolate in shape, lamellae 2—6 broadly oval, margins of each lamella fringed and with sparse, minute bristles.

Terminal filaments three, nearly equal in length and a little longer than the body. Described from a specimen from Kothi.

Material examined.— 36 nymphs from INDIA : N. W Himalaya :

Manali (*Ca.* 6,000 ft.=1,829 m.), Kulu Valley, 23 and 25. vi. 1955, (*A. P. Kapur*), 8 nymphs ; Kothi (*Ca.* 8,000 ft.=2,438 m.), Kulu Valley, 20, vi. 1955, (*A. P. Kapur*), 8 nymphs ; Ralha (*Ca.* 9,000 ft.=2,743 m.), Kulu Valley, 20. v. 1955, (*A. P. Kapur*), 16 nymphs , 2 miles S. of Ralha. (*Ca.* 10,000 ft.—11,000 ft.=3,048 m.—3,353 m.), 29. v. 1955, (*A.* P. *Kapur*), 18 nymphs ; Ganddapu (*Ca.* 11,000 ft.=3,353 m.), Spiti Valley, 8. vi. 1955, (*A. P. Kapur*), 1 nymph.

Remarks.—The nymph agrees in general with *Ecdyonurus* sp. 1 described by Ueno (1955, p. 308), but differs from it in the absence of the three typical spots on the head, the first gill being not longer than the 7th, and by the absence of the small lanceolate apical appendage of gill lamallae.

Genus **Iron** Eaton

This holarctic genus has already been reported from India from nymphs only. Hora (1930) recorded them from Himalaya and Khasi Hills and Traver (1939) from Kashmir State. The genus is now being recorded from Manali (*Ca.* 6,000 ft.=1,829 m.), Kothi (*Ca.* 8,000 ft.= 2,438 m.), Ralha (*Ca.* 9,000 ft.=2,743 m.), near source of the Beas river (*Ca.* 11,000 ft.= 3,353 m.), Ganddapu (*Ca.* 11,000 ft.=3,353 m.), Sissu (*Ca.* 10,500 ft.=3,200 m.), Khoksar (*Ca.* 10,800 ft.=3,292 m.), Purana Khoksar Nalla (*Ca.* 13,000 ft.=3,962 m.) in the north-western Himalaya.

Iron sp.

A large number of nymphs from 8 stations. Body 8 mm., terminal filaments 6 mm. General colour brown, without conspicuous markings. Body strongly flattened ventrally, slightly convex dorsally. Head flattened $1\frac{1}{2}$—$1\frac{3}{4}$ wider than long, frontal margin almost straight, frontal and lateral margins of head enlarged, covering the mouth parts. Labrum rather small. A triad of spines on tip of galea and lacinia. Pronotum not wider than the head, lateral margins slightly dilated from the anteroir to the middle. Legs slightly lighter than body. Femora flattened, femoral flange short and blunt. Postero-lateral spines on abdominal segments 1—7 short. Abdominal segments with a pair of submedian spines on the segments 1—5 ; a single median spine on 6—9th. Paired spines on tergite 1 and 2 very short, and separated by a wide space, those on segment 3 longer and closer. Progressively longer and closer together on tergites 4 and 5. The single spines on tergites 6—9 rather long and stout and directed backwards. 7 pairs of gills on segments 1—7, consist of lamellar and fibrillar portions, each overlaps the one behind it· Gills of 1st and last pairs meet beneath the body of nymph. Described from a ♀ nymph from Ganddapu.

There is a considerable variation in the number of paired and single spines. Paired spines may be present at the maximum on the first nine segments and at the minimum on the first five segments. A careful examination of the material seems to show that the number of paired spines gradually decreases in older of nymphs.

Material examined.—Several nymphs from INDIA : N. W Himalayas Manali (*Ca.* 6,000 ft.=1 ,829 m.), Kulu Valley, 23. vi. 1955. (*A. P. Kapur*). Kothi (*Ca.* 8,000 ft.=2,438m.), Kulu Valley, 20. vi. 1955. (*A. P. Kapur*). Two miles N. E. of Ralha (*Ca.* 11,000 ft.=3,353 m.), 27. v. 1955. (*A. P. Kapur*). Two miles S. of Ralha (*Ca.* 10,000—11,000 ft. =3,048 m.—3,353 m.), 28. v. 1955. (*A. P. Kapur*). Near source of the Beas river, 11,000 ft.=3,353 m., 2. vi. 1955. (*A. P. Kapur*). Ganddapu (*Ca.* 11,000 ft.=3,353 m.), Lahaul-Spiti Valley, 8 & 9. vi. 1955. (*A. P. Kapur*). Sissu (*Ca.* 10,500 ft.=3,200 m.), Lahaul Valley, 10. vi. 1955 (*A. P. Kapur*). Khoksar (*Ca.* 10,800 ft.=3,292 m.), Lahaul Valley, 11. vi. 1955. (*A. P. Kapur*). Purana Khoksar Nalla (*Ca.* 13,000 ft.=3,962 m.), Lahaul-Spiti Valley, 17. vi. 1955. (*A. P. Kapur*).

Remarks.—These nymphs differ from those of typical *Iron* in possessing median spines on the abdominal segments. As suggested by Traver (1939), they might belong to an undescribed genus of Ecdyonuridae (Heptageniidae). She designated these as " double spine *Iron* ally"

Genus **Ironopsis** Traver

This nearctic genus is being recorded from India for the first time from Kothi (*Ca.* 8,000 ft.=2,438 m.), Ganddapu (*Ca.* 11,000 ft.=3,353 m.) and Chhatoru (*Ca.* 11,000 ft.=3,353 m.) in the N. W Himalayas.

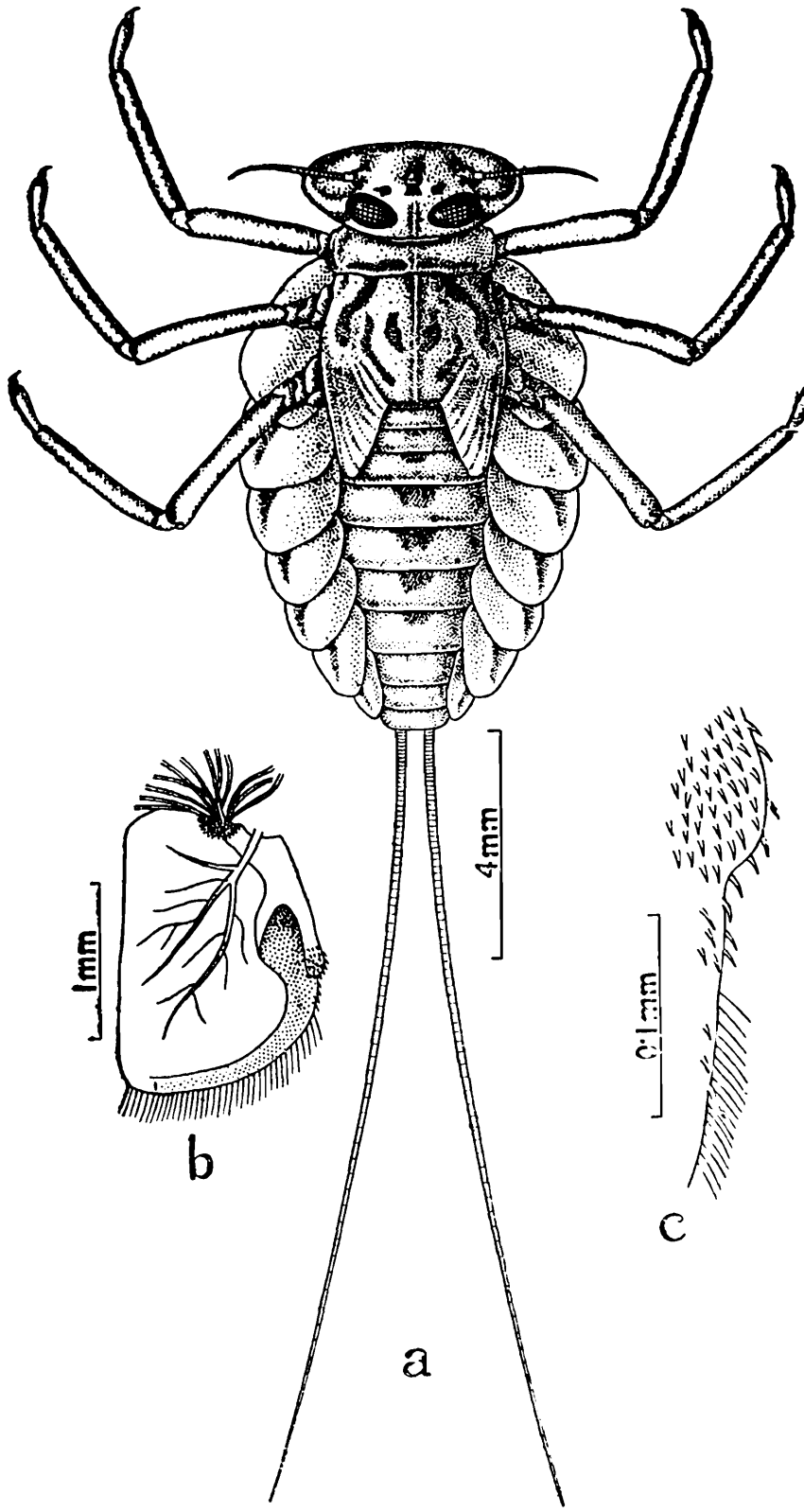
Genus **Ironopsis** Traver

Ironopsis sp. 1

(Text-figs. 14—16)

25 nymphs, some nearly mature. Body 14 mm., terminal filaments 16 mm. General colour brown.

Body (Text-fig. 14*a*) slightly convex dorsally, flattened ventrally. Head large and flattened. Frontal and lateral margins of head expanded, covering the mouth parts completely.

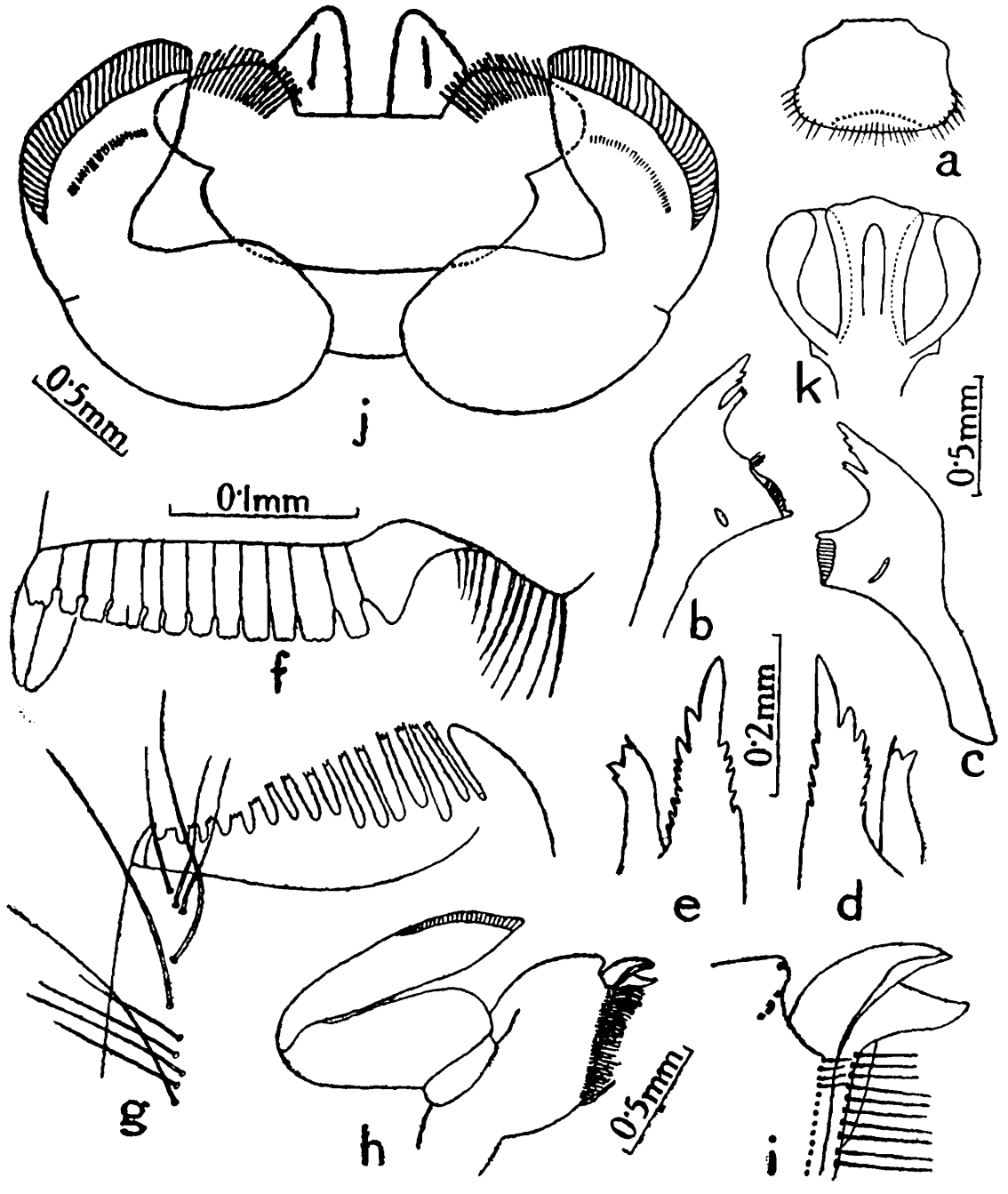


TEXT-FIG. 14.—*Ironopsis* sp.
(*a*). Dorsal view of Nymph. (*b*). Ventral view of gill No. 2.
(*c*). Part of gill Magnified to show spines.

Labrum (Text-fig. 15*a*) rather small, about 12 times as wide as long, antero-lateral margins rather angulate ; a shallow excavation on the

median line, along the almost straight anterior margin ; a little inside it are a few hairs, behind which is a regular row of small teeth (Fig. 15*a*).

Mandibles (Text-figs. 15 *b-g*) slender in basal half ; canines two in number, the inner about three-fourths as long as the outer ; both distinctly scoop-shaped, their margins more or less crenate. Lacinia represented by 4-5 hairs ; without fringe of hairs along lacinial region ; with a row



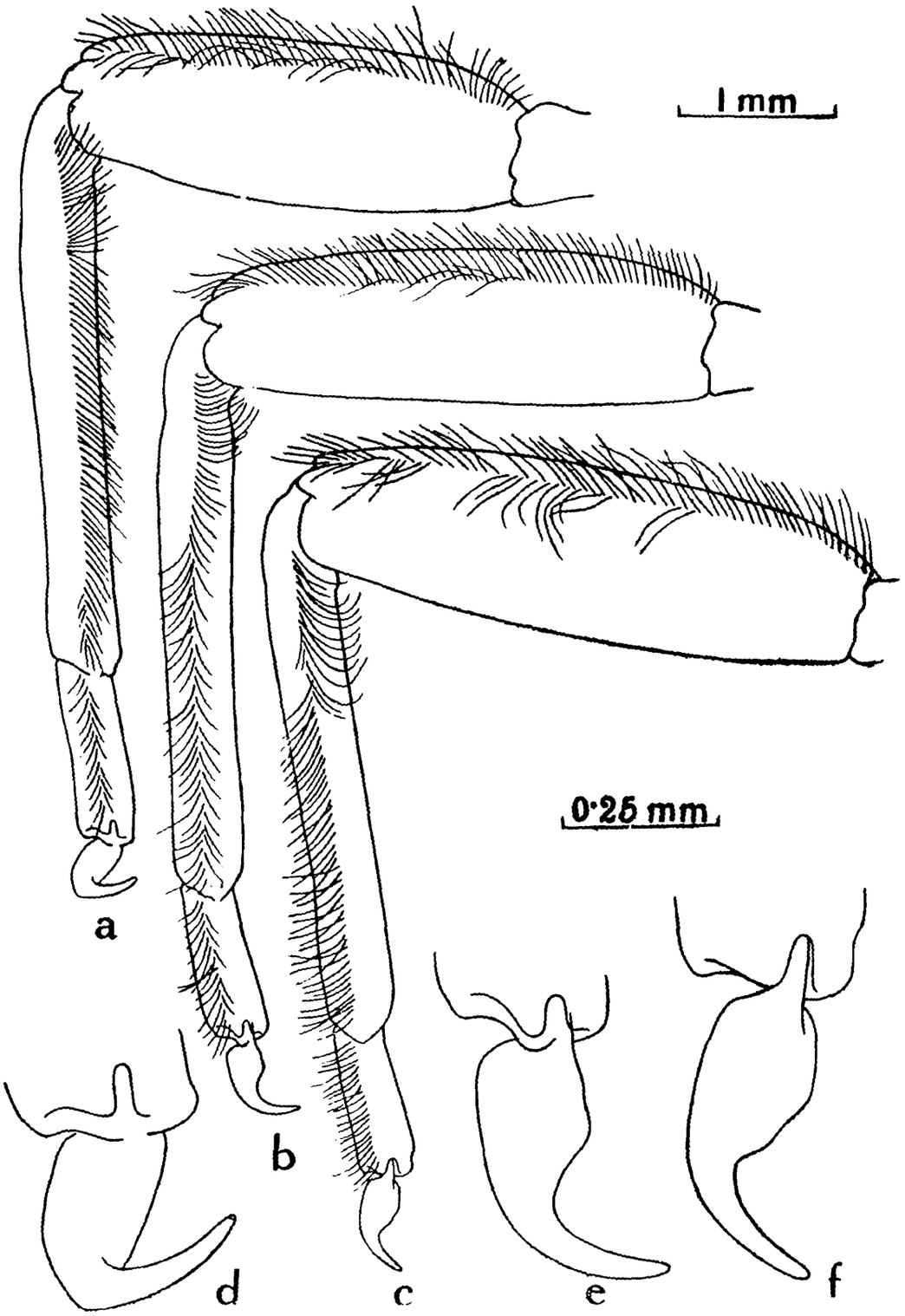
TEXT-FIG. 15.— *Ironopsis* sp.

(*a*). Labrum. (*b*)-(*c*). Left and right mandibles. (*d*)-(*e*). Canine areas. (*f*)-(*g*). Molar areas. (*h*). Maxilla. (*i*). Apical part of galea-lacinia. (*j*). Labium. (*k*). Hypopharynx.

of 7—8 bristles beneath each molar surface and a thick row near the base of the outer canines.

Maxillary palp two-jointed (Text-fig. 15*h*), distal joint thickly set with spines in the apical portion. A triad of stout spines, each slightly incurved present at the inner apical margin of galea-lacinia ; a group

of 5—7 slender spines present near their base. On the inner margin of galea-lacinia there are two rows of bristles, one of which is on the margin



TEXT-FIG. 16.—*Ironopsis* sp.
(*a*)—(*c*). Fore-, mid- and hind-legs. (*d*)—(*f*). Fore-, mid- and hind-claws.

and the other at a short distance behind and parallel to the latter. (Text-fig. 15*i*).

Labial palps short and broad, two jointed ; distal joint bearing about 20 series of pectinate spines on the outer margin. Glossae conical, divergent apically, rather widely separated at base, bearing 7-8 long to short spines on the inner margin, near the apex (Text-fig. 15*j*).

Median lobe of hypopharynx (Text-fig. 15*k*) rounded, slightly longer but somewhat narrower than the lateral lobes which are somewhat dilated distally and rounded at the apex.

Pronotum not wider than head, antero-lateral margins rounded. Legs yellowish brown, with a fringe of long hairs on the outer margins of femur, tibia and tarsus; femoral flange (apical extension of femur) blunt. Claws with 3 lateral pectinations near the apex (Text-fig. 16*d-f*).

Abdominal segments with a prominent ridge of rather long hairs along the mid-dorsal line of all tergites. Extensions of postero-lateral margins of segments very short and blunt.

Gills of the first segment very large ; anterior lobes greatly expanded, meeting beneath the body of nymph ; intermediate pairs of gills very well developed and overlapping. A much thickened oblong pad on the ventral surface of anterior margin bears a short thumb-like projection (Text-fig. 14 *b-c*). Gills of the 7th pair meet beneath the body ; fibrillar portion of gills short ; two terminal filaments present.

Described from a nymph from Chhatoru.

Material examined.—Several nymphs from the N. W Himalaya as follows.

Ganddapu (*Ca.* 11,000 ft.=3,353 m.), Lahaul Spiti Valley, 8. vi. 1955. (*A. P. Kapur*) 5 nymphs ; Chhatoru (*Ca.* 11,000 ft.=3,353 m.), Lahaul Spiti Valley, 15. vi. 1955. (*A. P. Kapur*) 20 nymphs.

Remarks.—Ironopsis Traver is so far known only from N. America. Although closely related to the genus *Iron* it is easily distinguished from the latter by the prominent ridge of rather long hairs along the mid-dorsal line of all tergites. It is being recorded from India (Ganddapu and Chhatoru, N. W Himalaya) for the first time.

Ironopsis sp. 2.

A well developed ♀ nymph. Body 15 mm. ; terminal filaments 14 mm. General colour dark brown. It has all the typical characters of *Ironopsis*. It differs from the fore-mentioned species from Chhatoru and Ganddapu in colouration and relative size.

Material examined.—I ♀ nymph from INDIA : Kothi (*Ca.* 8,000 ft. =2,438 m.), Kulu Valley, 20. vi. 1955. (*A. P. Kapur*).

V—Remarks on adaptations and geographical distribution

Adaptations.—Hora (1930) in his paper entitled " Ecology, bionomics and evolution of the torrential fauna with special reference to the organs of attachment ", discussed in considerable detail the adaptations of nymphs belonging to the families Ecdyonuridae (Heptageniidae), Baetidae and Ephemerellidae in India. Our material of nymphs also belongs to these three families and to the family Leptophlebiidae. According to him the genera *Ecdyonurus*, *Heptagenia*, *Epeorus*, *Iron* and *Rhithrogena* of the

family Ecdyonuridae, form a homogenous group as these have a profile adapted to afford little resistance to a rapid flow of water while facing the stream. He gave detailed descriptions of the body form and various organs of attachment in the genera mentioned above and concluded that as the swiftness of the current increases the gill lamellae have better frictional pads and seem to have evolved in the following order : *Ecdyonurus* and *Heptagenia*, *Epeorus*, and then *Iron*. He believed *Rhithrogena* to have secondarily inhabited currents less swift and less oxygenated than those inhabited by *Iron*. Hora further found the nymphs of *Baetis* in different habitats in the hill streams and observed that these cling to rocks and weeds with the help of their powerful claws and have stream lined bodyform which was better developed in some species than in others. His material of nymphs of Ephemerellidae was collected from swift streams and he observed several characters by which the nymphs seemed to be adapted to the said environment but as his material was not determined even up to the genus, it may be inadvisable to refer to it further in any detail.

Brodsky (1930), working on nymphs of Ephemeroptera from Tashkent and neighbouring areas, stated that while the genera *Iron* and *Rhithrogena* were components of mountain torrent communities, the genera *Ephemerella* and *Baetis* were found in less rapid streams and the genus *Ecdyonurus* inhabited lower course of mountain streams. Imanishi's (1940) findings on the Ephemeropteron nymphs in the torrential streams of Japan generally agree with those of Brodsky. Ueno (1955), working on the material from Nepal, considered the nymphs of *Rhithrogena* to be representatives of the fauna of the cold water, spring-fed brooks at a much greater altitude, *Ca.* 650-700m., where the Mayfly fauna consisted of nymphs of *Ephemerella*, *Baetis*, *Ecdyonurus* and *Epeorus*.

In so far as the collection of nymphs under report is concerned, it appears that between *Ca.* 6,000 ft (=1,829m.)and *Ca.* 9,000 ft. (=2,743m.), the streams have representatives of the genera *Paraleptophlebia*, *Ephemerella*, *Baetis*, *Ecdyonurus*, *Iron* and *Ironopsis*. In the streams beyond 9,000 ft., the nymphs of *Paraleptophlebia* and *Ephemerella* were not collected and were probably absent. Nymphs of these two genera and of *Baetis* attach themselves to rocks, etc., with the help of their well developed claws and are able to swim in running water. *Baetis* nymphs have stream-lined body and are able to swim actively in fast running water. Nymphs of the remaining genera, namely *Ecdyonurus*, *Iron* and *Ironopsis*, have flattened body shape and have gills modified for the purpose of attachment to stones in torrential streams. The gills in *Ironopsis* are obviously better adapted for the purpose as these have better developed spinous pads than is the case in *Ecdyonurus* or *Iron*.

Geographical distribution.—The material reported upon earlier in this paper is of some interest from the point of geographical distribution of Mayflies in India.

Of the imagos and subimagos, the species described as *Ephemerella indica* and recorded from the Kulu Valley, is of special interest as the holarctic genus *Ephemerella* Walsh was hitherto known from India and Nepal from nymphs only. The nymphs were first recorded by Hora (1930) from Dalhousie and Chamba in the Punjab, by Traver (1939) from Ladakh (N. W Himalaya) and by Ueno (1955) from Nepal. *E*

indica was obtained from Ralha at an altitude of about 2,743 m. (-9,000 ft.) but a few nymphs, of apparently another species of *Ephemerella*, were also collected from relatively lower altitute of about 1,829 m. (=6,000 ft.) at Manali.

The genus *Baetis* Leach which is widely distributed in the holarctic, neotropical and Indo-Australian regions, was first recorded from India (" Hindostan ") by Eaton (1888) who however, did not give any specific identification of his material and named it as " *Baetis* sp." Hora (1930) recorded nymphs and adults (not specifically determined) from Kashmir and Ladakh in the N. W Himalaya. Gillies (1949) described two species of *Baetis* from Poona (Bombay State), one from Poona and Hoshangabad (Madhya Pradesh) and three from Darjeeling district (Northern West Bengal). Ueno (1955) also recorded nymphs of " *Baetis* spp." from Nepal. The six new species described in this paper, from Kulu Sub-Division (including the Kulu, Lahaul and Spiti Valleys) in the north western Himalaya are of interest from the geographical point of view, in that the specifically determined material of the genus was not known from there earlier. *Baetis* is apparently a wide-spread genus in India and may be found in most places with fast running to torrential streams.

Epeorus Eaton is an holarctic genus which has already been recorded from India and Nepal. Eaton (1888) described *E. psi* Eaton from, " Kooloo " in the N. W Himalaya and it is worth noting that our material of *E. lahaulensis* also comes from the neighbouring valley of Lahaul in the Kulu Sub-Division. Traver (1939) also recorded a male imago of *Epeorus* sp. from Ladakh in the N. W Himalaya, while Hora (1930) recorded its nymphs from both the western and eastern Himalaya (Khasi Hills) and from Palni Hills in southern India. More recently Ueno (1955) recorded its nymphs from Nepal.

Among the new records from India based on nymphs only may be mentioned two species of *Paraleptophlebia* Lestage which is essentially holarctic in distribution. It is being recorded from Manali (*Ca.* 6,000 ft.= 1,829 m.), Kothi (*Ca.* 3,000 ft.=2,438 m.), and Ralha (*Ca.* 9,000 ft.= 2,743 m.) in the N. W Himalaya. The allied genus *Leptophlebia* Westwood is, however, already known from N. W Himalaya from one nymph (*vide* Needham, 1909). *Ironopsis* Traver (1935), a nearctic genus, is likewise being recorded for the first time from India and is represented by nymphs of two distinct species of the genus. Several nymphs of these species were collected from Kothi (*Ca.* 8,000 ft.=2,438 m.) in the Kulu Valley and from Ganddapu (*Ca.* 11,000 ft.=3,353 m.) and Chhatoru (about the same altitude) in the Lahaul-Spiti valley of the Kulu Sub-Division. It may, however, be stated that the allied genus *Iron* Eaton, is already known from the Himalaya from nymphs only (Hora, 1930 ; Traver, 1939).

VI—Summary

The paper deals with Mayflies (Ephemeroptera) of the north-western Himalaya in the Kulu Sub-Division of the Punjab, India. The following eight new species are described from imagos or subimagos. (1) *Ephemerella indica* from Ralha (*Ca.* 9,000 ft.=2,743 m.) Kulu Valley. (2) *Baetis chandra* from Chhatoru (*Ca.* 11,000 ft.=3,353 m.) Chandra

River, Lahaul-Spiti Valley and Kulu Valley. (3) *Baetis simplex* from Kothi (*Ca.* 8,000 ft.=2,438 m.) in Kulu Valley. (4) *Baetis himalayana* from Sissu (*Ca.* 10,500 ft.=3,200 m.) in Lahaul Valley. (5) *Baetis Punjabensis*. (6) *Baetis bifurcatus* and (7) *Baetis festivus*, all from near Ralha (*Ca.* 10,000 ft.—11,000 ft.=3,048m.—3,353 m.) in Kulu Valley. (8) *Epeorus lahaulensis* from Sissu (*Ca.* 10,500 ft.=3,200 m.) Lahaul Valley.

Detailed descriptions of the nymphs of the following genera or species, as the case may be, are given. Two species of *Paraleptophlebia* Lestage ; one species of *Ephemerella* Walsh ; *Baetis chandra* Kapur and Kripalani ; *Baetis simplex* Kapur and Kripalani and several other undetermined species of *Baetis* ; one species each of *Ecdyonurus* Eaton and *Iron* Eaton, and two species of *Ironopsis* Traver.

Some remarks are offered on the geographical distribution and adaptation to life in the fast running and torrential streams at high altitudes of the north-western Himalaya. All the genera recorded are either holarctic or nearctic except *Baetis* which occurs also in the neotropical and Indo-Australian regions. The species described are of endemic origin. The genus *Ephemerella* Walsh, hitherto known from India from nymphs only, is now recorded from the imago, while the genera *Paraleptophlebia* Lestage and *Ironopsis* Traver are recorded, from nymphs only, for the first time from India.

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