

**\*TORRENTICOLE INSECTS OF THE HIMALAYA**  
**IV.— SOME OBSERVATIONS ON THE ECOLOGY AND THE**  
**CHARACTER-INSECT COMMUNITIES OF THE R. ALHNI**

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**ABSTRACT.** This paper summarizes the preliminary results of a faunistic sampling survey of the torrenticole insect communities of R. Alhni, a typical torrential stream of glacial origin in the Northwest Himalaya, carried out during 1969-1970. Descriptions of the eleven sampling Stations, which were selected on random basis, are given, with notes on the hydrology and ecology of the stream, the special habitats and character communities. Analysis of over two hundred random samples, representing over 3,500 specimens of eutorrenticole insects, is presented. The major high altitude rheobiont insect groups characteristic of the river are briefly considered, with notes on their habits and relative abundance. In addition to notes on Baetidae, Ecdyuridae, Plecoptera, Trichoptera, Chironomidae, Simuliidae and Blepharoceridae, the interesting family Deuterophlebiidae is being recorded here for the first time south of the Pir Panjal Range. The new forms contained in these groups will be reported on separately.

**I. INTRODUCTION**

This paper summarizes the preliminary results of a sampling survey of the ecology and character fauna of a torrential stream of glacial origin in the Northwest Himalaya, undertaken during 1969-1970, as a part of the programme of research financed by the Council of Scientific and Industrial Research, under Prof. Dr. M.S. Mani in the School of Entomology, St. John's College, Agra. The Himalaya is remarkable for the numerous torrential streams, fed exclusively by snowfields and glaciers at high altitudes. These streams are interesting for the diversity and complexity of ecological conditions and the abundance and specializations of insect communities (1, 2). The purpose of this survey was to investigate the major ecological conditions which determine the occurrence, abundance, habits, and structural adaptations of the typically rheobiont insect communities and to carry out a systematic sample survey of some of the major groups of insects occurring in these streams. Two major trips were undertaken, the first in October 1969 and the second during May-June 1970, to the drainage basins of the R. Beas and its major tributaries close to its source. Collections

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and observations were made not only in the higher reaches of the main R. Beas but also in its feeder streams like the R. Solang, Manalsu Nullah and R. Alhni. The survey was carried out according to the methods of random faunal sampling. Altogether over 200 sample surveys were made. The main hydrological and ecological observations and random collections were, however, undertaken in the R. Alhni, which is a typical Himalayan stream of glacial origin.

## II. THE R. ALHNI

The R. Alhni is the first main left-bank tributary of the R. Beas (Fig. 1). It is a relatively short roaring and highly turbulent torrent of a great series of larger or smaller waterfalls, great cataracts and cascades. Its course, about 36 km long, lies wholly within the narrow gorge between the Rahandhar and Hamta Spurs of the Pir Panjal Range. There are extensive snowfields and moderately large valley glaciers at its source, which lies at an elevation of about 4,000 m above mean sea-level in a vast boulder-strewn amphitheatre, surrounded by the mighty Himalayan Peaks of Dev Tibba and Inder Kila, with the Hamta Pass in between. From here, it rushes as a roaring and spray-filled stream through a narrow gorge between practically vertical rock walls and often disappears under more or less large snow fields that dam it, to reappear a few hundred metres below as a waterfall. Less than ten kilometres below its source, it receives two feeder glacial torrents on the right and emerges just below the Chhika shepherds' camping ground in the middle of a relatively wide, short U-shaped and nearly north-south Pleistocene glacier valley. A few kilometres below, its course is sharply deflected by the abruptly vertical rocky wall of Rahandhar spur to the left. Nearly three kilometres further down it receives on the left the Jobri Nullah glacial torrent, which is even more of a violent series of waterfalls and cataracts. Within about 2 km of its confluence with the R. Beas (3 km south of Manali Town), it turns sharply to the right and emerges through a very narrow gap between two enormously massive boulders as a thundering waterfall of about 30 m. In its widest part the river is about 50 m and narrowest part it is hardly 3 m wide. The mean fall of the stream bed is between 50 and 60 m per kilometre and the difference in altitude between its source and confluence is nearly 2200 m. The mean current velocity is about 0.3 m per second, with a maximum of 3-4 m per second. The mean diurnal fluctuation of water temperature is typically small, viz., 0.5°C; the minimum temperature is 0.1°C and the maximum 7°C. The water is supersaturated with oxygen by almost 150%. There are no rooted higher plants, but there is great profusion of diatoms, algae and moss on all submerged surfaces. During summer the water transports considerable rock debris in the shape of silt, sand and pebbles and organic detritus from the surface of snow fields. The total discharge increases in the evenings, but due to frequent snow-

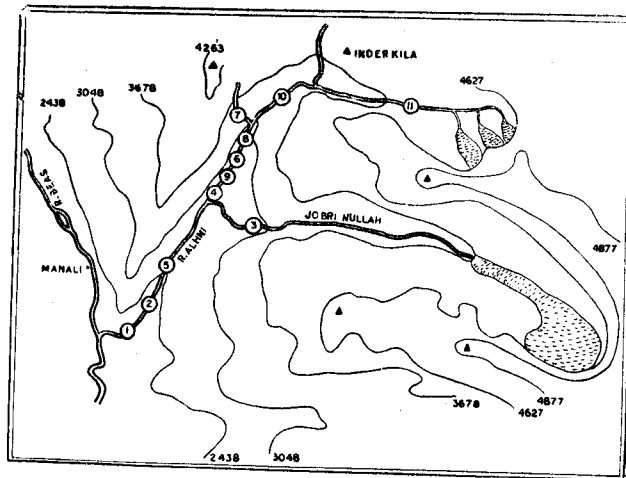


Fig. 1. Sketch map of Northwest Himalaya showing the glacial torrential stream surveyed during 1969-70. The locations of Stations are indicated in numbers in circles.

falls even during summer, there may be an appreciable fall in the discharge. It is a typical high altitude Himalayan torrential stream exclusively of glacial origin. Arising in the mid alpine zone and rushing most of its course through the lower alpine and subalpine zones and ending in the R. Beas in the upper temperate forest zone (less than 50 km from the source of the latter), it contains a great diversity of habitats and character species in each type of habitat. This offers unparalleled opportunities for detailed explorations of high altitude rheobiont insect communities and investigations of the complex ecological conditions influencing them.

A faunistic sampling survey of this stream is important not only from the point of view of high altitude entomology of the Himalaya, but is also of considerable fundamental importance in the study of the ecology of torrential streams in general.

This river was divided, on statistically random basis, into eleven sampling stations, approximately at mean intervals of 3 km and ranging from half to one kilometre long. Each station contains a complex of nearly all the diverse ecological conditions occurring in the whole system and determined by differences in the irregularities of substratum, steepness of the gradient, velocity of current and total discharge of water. Each station thus represents practically a mean of the general ecology of the R. Alhni as a whole. The difference in mean altitude of the lowest Station, close to the proximity of confluence of R. Alhni with R. Beas and the highest Station near the source glaciers is about 2,000 m. In nearly all the Stations there were special ecological niches asso-

ciated with waterfalls, cataracts, cascades, extremely turbulent vortices, relatively shallow gentle currents, and rock surfaces constantly wetted by spray and by dripping water below waterfalls. Many Stations were also characterized by more or less large and persistent snow banks and snow bridges. In nearly all the stations the river bed was characterized by rugged rocky bottom, with the flow of water violently impeded by enormous fixed boulders and massive loose stones, in addition to smaller or larger rolling pebbles. The flow and velocity were modified greatly by differences in depth of water and deflections of course by rocky wall. Nine of the Stations were established in the main R. Alhni. One Station was on a right bank feeder stream and another on the left bank feeder stream about 8 km downstream from the former. Each Station was visited on an average three times.

### III. DESCRIPTIONS OF STATIONS AND NOTES ON THEIR ECOLOGY

*Station 1* : About one km east-west, sunlit, open section of R. Alhni, above the bridge on the Manali-Nagar Road, and about 1.5 km above its confluence with R. Beas. Series of waterfalls and violent cataracts over massive fixed boulders. About half a kilometre from the lower end the flow divides into a right and a left branch, which reunite about 250 m further downstream. The left branch is deeper and faster than the right.

On the right bank a steep landslide has emptied masses of loose stones from the Rahandhar spur. The left bank is a Pleistocene river terrace, rising sharply above the stream bed approximately to about 20 m height and extending southwards as level cultivated paddy fields of the village Parini. The island between the two branches is covered with sparse growth of *Alnus nitidus*, and *Quercus dilatata*. The eastern end is marked by a narrow gorge, about 5 m wide, and about 20 m deep, into which empties a foaming waterfall from an elevation of 1,900 m M.S.L. Mean gradient in this Station is 70 m per km.

The special ecological factors in this Station are determined by waterfalls, violent cataracts, cascades, highly turbulent deep whirlpools and constantly wetted rock surfaces.

*Date visited* : 19.x.1969.

Nearly full-grown larvae and subimago of Ephemera, half-grown larvae of Plecoptera and a great abundance of Trichoptera cases containing full-grown larvae and pupae were collected. Some Plecoptera adults were also collected. The Trichoptera cases were characteristically large, heavy, about 2-3 cm long and about 8 mm thick and constructed of moderately large pebbles.

*Station 2* : Approximately 300 m and nearly north-south, sunlit and wide section of the river above the wooden bridge on the mule-track to the Hamta Pass. A series of miniature waterfalls, gigantic cataracts, and violent cascades over boulders and stones of all sizes. The northern end with a cascade over a

boulder approximately 4 m high. The right bank with large landslides from the perpendicular Rahandhar and the left bank with dense woods of *Quercus*, *Acer*, *Prunus*, *Prinsepia utilis*, *Berberis vulgaris* and *Rubus*. Elevation about 2,000 m above M.S.L.

The special characters of this Station include foaming cataracts and rushing cascades of relatively deep and turbulent vortices and relatively gentle flow over shingle.

*Dates visited* : 20 & 24.x.1969 ; 14 & 15.v.1970 ; 4 & 8.vi.1970.

*Notes on ecology* : Mean current velocity 0.9 m per sec. Mean water temperature 7.7°C. In most groups the adults were as numerous as immature stages and rather relatively far numerous in Psychodidae, more Simuliidae, Chironomidae and Trichoptera. Though a few adults were found, the Blepharoceridae were largely still in larval stage at the time of visit. Pupae were nearly as common as larvae. The Ephemera, comprising mostly Baetidae, were full grown larvae or there were also subimago. The larvae of Ecdyuridae were also moderately common. Most of the adults had apparently emerged in between the dates of the two visits in 1970.

*Station 3* : Approximately half a km east-west, narrow, deep section of Jobri Nullah, a left-bank feeder stream draining the Hamta spur, about 30 m above its confluence with R. Alhni, and bounded by a wooden bridge on the bridle path to Hamta Pass. A generally shaded, humid and sheltered gorge. The stream is here a foaming milky-white, turbulent mass, cascading over large boulders and with incessant rolling down of loose stones falling to the bottom of cascades and waterfalls with a constant series of dull thuds. The ridges on both sides are covered by dense forest of *Q. semecarpifolia*, *Betula*, *Acer* and *Juniperus*. Gradient approximately 300-400 m/km. Mean elevation 3,300 m above M.S.L.

The special features include numerous cataracts and deep highly turbulent vortices.

*Dates visited* : 22.x.1969 ; 25, 26 and 27.v.1970.

*Notes on ecology* : Nearly 150 specimens, comprising Ephemera, Plecoptera, Simuliidae and Blepharoceridae were collected. Though representing a small part of the total collections, material found in this Station is remarkable for the relative abundance of adults which were nearly as numerous as larvae. The Ephemera, almost wholly Baetidae, were equally common both as larvae and as adults. The Plecoptera adults were nearly twice as numerous as larvae. Blepharoceridae were largely larvae. Although some adults were found, there were no pupae. The larvae were, however, full-grown and were nearly all found in the upper end of the Station. The few adults found downstream were devouring adult Psychodidae.

*Station 4* : About half a km, approximately north-south section of Alhni above the confluence of Jobri Nullah, with the right bank formed by the abruptly vertical wall of Rahandhar and the left bank a subalpine meadow of the Hamta

spur, sparsely covered by *Betula* and *Q. semecarpifolia*. This section of the river is on the whole a relatively gentle flow over more or less flat and level rocky bottom; the stream with small boulders, pebbles and stones and some sandy patches near the bank. Altitude 3,200 m above M.S.L.

The special characters are the sluggish and nearly non-turbulent flow with locally semi-stagnant patches.

*Dates visited* : 22.x.1969 ; 25 & 26.v.1970.

*Notes on ecology* : Over 350 specimens, representing about 10 percent of whole collection and remarkable for the conspicuously high percentage of adults in all groups, come from this station. Chironomidae and Psychodidae were largely adults and only a very small percentage of Blepharoceridae were larvae. No pupae were found. Larvae of Trichoptera were sparse but adults were twice as numerous. In Ephemera, mostly Baetidae, the adults were about as common as Trichoptera. The Plecoptera were practically wholly found as adults, the emergence of which has apparently taken place a day or two before the second visit. The adults were found in various stages of mating. On the whole the males outnumber the females by three to four times.

*Station 5* : Roughly 1 km east-northeast section of R. Alhni, about half a kilometre upstream from the wooden bridge at Station 2; nearly 20 m wide; the upper end marked by vertical rocky wall of Hamta on the left bank. Stream bed with numerous enormous fixed boulders. Water mostly turbid and series of medium-sized waterfalls high cataracts and cascades. Gradient 80 m/km. The sides with dense forest of *Quercus*, *Cedrus*, *Prunus* and *Juglans*.

The special ecological features comprise waterfalls, cataracts and constantly wetted and dripping rock surfaces below overhanging ledge inside waterfall.

*Date visited* : 15.v.1970.

*Notes on ecology* : Water temperature 5.5-7.5°C. About 120 specimens of Ephemera, Trichoptera, Chironomidae and Blepharoceridae were collected. All these groups are remarkable for a relatively high proportion of adults, which were nearly four times as numerous as immature stages. Chironomidae were all only adults and the Ephemera were all exclusively Baetidae. The Ephemera adults were nearly four times as numerous as immature stages, which were practically all subimago. In Trichoptera and Blepharoceridae the adults were twice as common as larvae.

*Station 6* : One kilometre north-south section of R. Alhni at an elevation of about 3,600 m, occupying approximately the middle of a wide, U-shaped, open, sunlit Pleistocene glacial valley. On the west, the right bank with steep rocky wall of the main Pir Panjal and on the left relatively less steep and partly wooded but largely alpine meadow of Hamta. The mean width of the river bed, containing water, about 23 m. The northern end curved westwards and again curving to the east near the wooden bridge. The lower end abruptly narrowed and curving westwards. Substratum rocky, with relatively few fixed boulders of

moderate size but strewn with nearly equally large loose stones. Depth near the left bank varies between 3 and 4 metres.

This Station may be considered as fairly representative of the mean ecology of entire R. Alhni system. Lying within the upper reaches, closer to the source than to the confluence with R. Beas, the general ecology and biota of this Station are adequately representative. The striking differences from most other Stations may be traced to the following factors : 1. Absence of large waterfalls, 2. The wider amphitheatre in which it is located, 3. Absence of abrupt variations in gradients.

*Dates visited : 17-31.v.1970.*

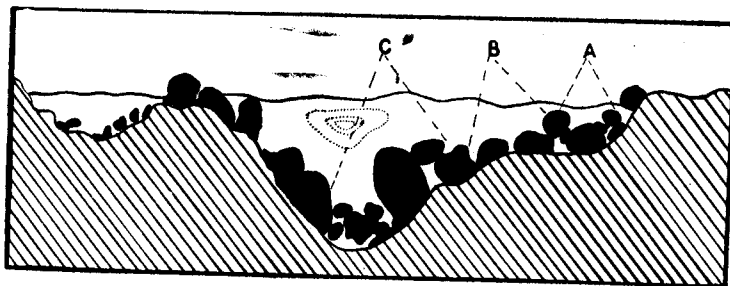


Fig. 2. Idealized diagram of the profile section of the R. Alhni at Station 6. A : Plecoptera zone, B : Ephemera zone, C : Diptera zone. Contour lines show the region of highest velocities at depths between 100-200 cm below the surface approximately in the middle of the stream.

*Notes on ecology :* A regular series of hydrological and ecological observations were made in three well marked sections, designated A, B and C in the Station, each readily recognized by distinct differences in hydrological and other conditions. Records of current velocities, water levels, water and atmospheric temperatures, wind, cloud, etc. were made. The current velocities were measured daily at 8 A.M. and at 5 P.M., in metres per second of the flow of water at the surface of the stream. The maximum current velocity was, however, met with at approximately a depth of 100-200 cm below the surface and at variable distances from the water edge, depending on shape of the channel and presence or absence of larger boulders in the bottom. Fig. 2 shows an idealized diagrammatic profile section at Station 6, with the zone of maximum current velocity indicated by contours of broken lines. The A section is about 80 m long and represents an area of medium current velocities and where the depth does not also exceed one metre. In this section the water flows over medium-sized loose stones. The B section, about 100 m long, represents a relatively swift flow over a series of large boulders and cataracts of moderate size. The mean depth

TABLE I. MEAN CURRENT VELOCITIES IN METRES PER SECOND IN THE A, B AND C SECTIONS OF STATION 6 OF THE R. ALHNI DURING MAY 1970.

Date	Velocity in the morning			Velocity in the evening			Diurnal fluctuation			Mean fluctuation		
	A	B	C	A	B	C	A	B	C	A	B	C
18	*0.64	—	—	*0.61	—	—	-0.03	—	—	—	—	—
18	*2.38	—	—	*1.13	—	—	-1.25	—	—	—	—	—
19	1.28	—	—	1.61	—	—	+0.33	—	—	—	—	—
20	1.31	—	—	1.35	—	—	+0.04	—	—	—	—	—
21	1.08	—	—	1.54	—	—	+0.46	—	—	—	—	—
22	—	—	—	—	—	—	—	—	—	—	—	—
23	0.89	—	—	1.16	—	—	+0.27	—	—	—	—	—
24	0.91	1.99	—	0.97	1.99	—	+0.06	0.00	—	0.28	—	—
25	—	1.35	—	—	1.67	—	—	+0.37	—	—	—	—
26	—	1.69	—	—	1.81	—	—	+0.12	—	—	—	—
27	—	1.61	—	—	1.72	—	—	+0.11	—	—	0.20	—
28	—	—	0.93	—	—	1.19	—	—	+0.27	—	—	—
29	—	—	1.13	—	—	1.15	—	—	+0.02	—	—	—
30	—	—	2.0	—	—	2.04	—	—	+0.04	—	—	—
31	—	—	1.5	—	—	1.63	—	—	+0.13	—	—	0.14

\*Data subject to considerable error, hence neglected in calculating the mean.

ranges between 3 and 4 m. The C section is a nearly straight stretch of about 30 m length of medium depth and violently turbulent and swift flow, unobstructed by projecting boulders. The surface velocities in the three sections at Station 6 are summarized in Table 1 (Fig. 3).

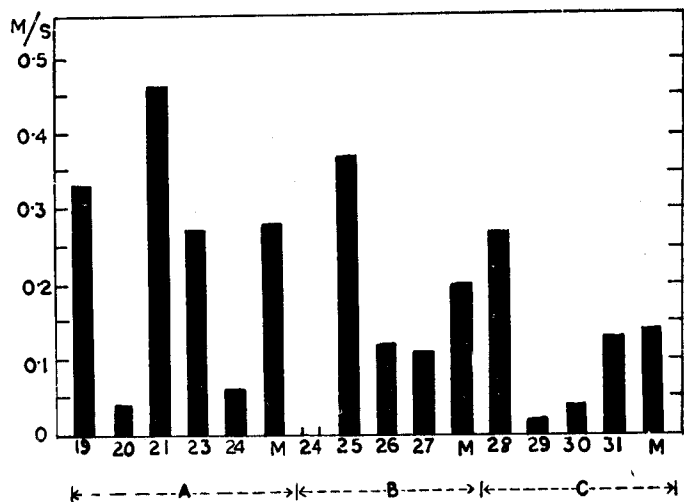


Fig. 3. Mean surface current velocities in metres per second, recorded at 8 A.M. and 5 P.M. between 19-31 May, 1970 in three typical sections A, B and C at Station 6. M=Mean.

A reference to Table I shows that the mean current velocities have steadily decreased from the 18th to the 31st of May. Normally the velocity rises in the late afternoon or evening during summer, when extensive melting of snow takes place, and falls in the early mornings. The steady fall recorded here is to be attributed to the fact that after the 21st there were regular snowfalls every afternoon. The mean atmospheric temperatures were also lower than on earlier dates, with corresponding fall in the rate of melting of snow and total discharge of the river. With the progressive melting of snow in summer, the water level rises in the evenings and falls during the morning hours and the mean diurnal fluctuation amounts to about 20-25 cm. During the period of observation, however, the water levels also fell steadily, corresponding to the fall in the main velocities. The water levels were measured at six posts, fixed at intervals of 10 m each in the A section, at 8 A.M. and 5 P.M. daily, and the data are summarized in Table II (Fig. 4).

TABLE II. RECORDS OF THE MEAN DIURNAL FLUCTUATIONS IN WATER LEVELS AT STATION 6 DURING MAY 1970.

<i>Date</i>	<i>Mean water level in the morning</i>	<i>Mean water level in the evening</i>	<i>Difference in Cm</i>
18	4.6	3.1	-1.5
19	4.6	2.2	-2.4
20	4.5	2.7	-1.8
21	5.5	3.8	-1.7
22	4.0	3.0	-1.0
23	0.0	0.7	+0.7
27	6.6	4.8	-1.8
28	2.7	4.0	+1.3
29	3.1	3.5	+0.4

Standard deviation=1.15

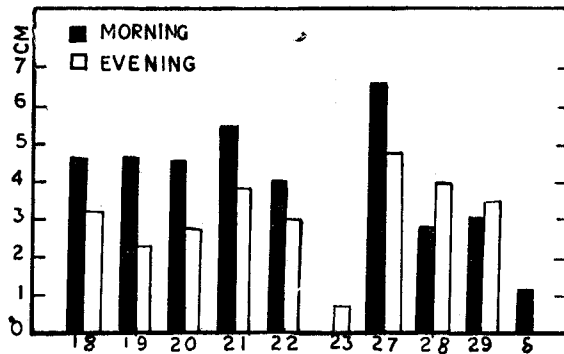


Fig. 4. Records of the mean water level in cm, at 8 A.M. and 5 P.M. daily between 18-29 May, 1970 at Station 6.  $\delta$ =Standard deviation.

The table shows that the water levels in the evenings were lower than in the mornings on most days. Between the 23rd and 27th of May, the level of water fell below the zero reference mark of the six datum posts fixed in the stream; these coincided with days of heavy snow-fall, low atmospheric ( $1^{\circ}\text{C}$ ) and water ( $0.3\text{-}0.4^{\circ}\text{C}$ .) temperatures and low current velocities. These were also the dates of maximum emergence of adult Plecoptera in the Station.

The records of temperature of water are summarized in Table III (Fig. 5)

TABLE III. TEMPERATURE IN °C OF THE WATER IN STATION 6 DURING MAY 1970.

<i>Date</i>	<i>Temperature at 8 A.M.</i>	<i>Temperature at 5 P.M.</i>	<i>Diurnal fluctuation</i>
18	3.5	3.5	0.0
19	6.0	7.0	1.0
20	3.0	5.5	2.5
21	3.5	4.5	1.0
22	0.3	4.0	3.7
23	0.4	0.4	0.0
24	0.5	1.2	0.7
25	0.4	0.4	0.0
26	3.0	3.0	0.0
27	3.0	3.0	0.0
28	3.0	3.5	0.5
29	3.0	3.5	0.5
30	3.0	—	—
31	4.0	4.5	0.5
Mean	2.6	3.1	0.5

It may be seen from this table that mean diurnal fluctuation of the temperature of water is characteristically small, *viz.*, 0.5°C, as usual in all torrential streams of glacial origin (2). The mean temperature in the morning is 2.6°C and in the evening 3.1°C. The highest temperature recorded during the survey was 7°C on the 19th of May, prior to which considerable melting of snow was also observed and this was reflected in the increased velocity of current in the evening of that day. Subsequent days were, however, characterized by repeated snowfalls and gradual lowering of water temperature till a fairly constant state was reached on the 26th of May.

The Station 6 is rich in Ephemera, Plecoptera, Trichoptera, Chironomidae and Simuliidae. The collection made in this Station amounts to nearly one-fourth of the total collections in the whole Alhni system. Except in Plecoptera, all other groups of insects were predominantly larvae or subimagos, representing nearly twice the abundance of adults. In Plecoptera not only many more

adults than the all other stations were collected but the adults also far outnumber the larvae. The bulk of the Ephemera are adults representing about three times the abundance of immature conditions. The larvae ranged from nearly full grown subimago to practically newly hatched ones. They belong mostly to Baetidae, but a certain proportion of nearly full grown subimago of Ecdyuridae were also found. In Trichoptera the proportion of immature stages to adults is about the same as in Ephemera. Chironomidae were largely larvae and no adult Simuliidae were found, although there was a great abundance of Simuliid larvae.

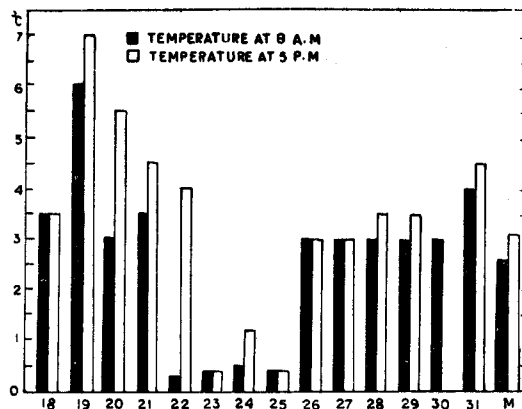


Fig. 5. Water temperature °C recorded at 8 A.M. and 5 P.M. daily between 18-31 May, 1970 at Station 6. M=Mean.

When the Station was first visited, the Plecoptera were all subimago or fully grown larvae. On the 22nd and 23rd May 1970, there was widespread snowfall, followed by pronounced fall in the rate of snow melting and an abrupt lowering of mean water level. The diurnal fluctuations usually characterized by the rise in the water level in late evening were either absent or negligible. The minimum atmospheric temperature dropped to 1°C and the water temperature on an average ranged between 0.3-0.5°C on these days. Enormous swarms of subimago crawled out of the shallow water at night and assembled in gregarious masses on stones and other suitable shelters. This was soon followed by emergence of great swarms of adults. The proportion of immature stages fell correspondingly low on subsequent days. There were five times as many more adults as larvae or subimago. There was also a striking predominance of males over females. There are apparently four different winged genera in the material, which emerged during these days. A number of adult Plecoptera and Ephemera were also reared in field traps, which were fixed in the B and C sections.

These traps consist of a sloping tent of fine cloth, kept stretched by suitable wire support over submerged stones containing larvae and subimago.

*Station 7* : Right-bank feeder torrential stream of R. Alhni from a snowfield on the main Pir Panjal, and flowing from a northern saddle, as a series of waterfalls, violent cataracts and cascades, often under larger or smaller patches of unmelted snow and in a wide exposed, sunlit, alpine meadow, at mean elevation of 3,700 m above M.S.L. 2 km north-east of Station 6. The confluence with R. Alhni is at a distance of 0.75 km from the lowest water-fall. Water temperature below snow 0.1°C, in the waterfall 0.5°C and near the confluence with R. Alhni 1°C.

The special features of the Station are waterfalls and gentle flow under snow-fields ; violent cataracts and cascades.

*Dates visited* : 20, 21 and 31.v.1970.

*Notes on ecology* : Current velocity 5-6 m at the head of the waterfall. Nearly 450 specimens, comprising Ephemera, Plecoptera, Trichoptera, Chironomidae, Simuliidae and Blepharoceridae, come from this Station. Except in Plecoptera, the immature stages predominate over adults and in particularly Ephemera and Simuliidae adults were practically absent. The larvae of Ephemera were also mostly small and the subimagos were exceedingly few. Though the bulk of Ephemera belong to Baetidae, very immature larvae of Ecdyuridae were fairly common. The Plecoptera were either subimagos or equally numerous adults. Trichoptera were mostly very immature larvae but some older larvae and very few adults were also collected. The greatest bulk of Chironomidae was larvae. Simuliidae were either pupae or somewhat more abundant larvae. Although a small number of Blepharocerid adults were collected in a miniature cave just close to the water edge, the submerged stones were swarming with nearly full-grown larvae in gregarious masses. Many of the Blepharoceridae larvae were overgrown with fine short threads of filamentous green algae, making them practically indistinguishable from the background of algae-covered stones.

*Station 8* : About half a kilometre section of R. Alhni above the wooden bridge below the Chhika camping ground and extending nearly upto confluence of the right-bank feeder stream described in Station 7. This part of the river is rugged with rather steep gradient and is wholly a series of cataracts. The direction of flow is mainly east-west. Mean elevation 3700 - 3900 m. Right bank a gentle boulder-strewn alpine meadow on the Pir Panjal and left bank is formed by steep subalpine zone of *Rhododendron campanulatum* and *Betula utilis*.

The special feature of the Station is the series of cataracts.

*Date visited* : 23.v. 1970.

*Notes on ecology* : Water temperature 3°C. About 200 specimens, mostly immature stages, come from this Station. The Ephemera were largely larvae

but some adults, which had emerged shortly before the visit, were also collected. Plecoptera were on the whole found either as full-grown larvae or as subimago but the adults were nearly nine times more numerous. Trichoptera, Simuliidae and Chironomidae were still in larval condition. Some larvae of Blepharoceridae were also collected and the few adults were found.

*Station 9* : About [half a kilometre section of R. Alhni, about 200 m west of Station 6 ; lying in a relatively flat narrow trough in a forest of *Acer* and *Q. semecarpifolia* on the left bank and bounded on the right bank by high vertical mountain wall. At the eastern end there is high cascade over large boulders, below which the flow is relatively gentle and close to which there is a small snowfield in a sheltered valley.

The special characters of this Station include the moderately high cataracts and cascades over large fixed boulders and medium-sized loose stones sheltered from strong wind. Sunshine partial.

*Dated visited* : 24 and 26.v.1970.

*Notes on ecology* : Of the nearly 200 specimens collected in this Station, the adults are in great abundance except in Ephemera. Adults of Plecoptera, Trichoptera and Blepharoceridae were found in considerable abundance in sheltered localities and in the left bank of the station. Most of the Simuliidae had already emerged as adults previous to the visit and only one pupa was found.

*Station 10* : About a kilometre east-west section of R. Alhni, about half a kilometre above Station 8 and to the east of huge tent-like boulder erratic, in a vast amphitheatre below and west of the Inder Kila Pillar. Left bank subalpine zone of *Betula* and *R. campanulatum*. The *Betula* trees conspicuously bent westwards in the direction of the prevailing strong wind. Right bank close to high vertical rock wall. Eastern extremities marked by a huge snow field that spans the river as snow bridge. This Station is 4 km east of north of the camp laboratory at Station 6. The upper end beyond the snow bridge narrows abruptly into a deep gorge that leads further east to Station 11.

The special characters of this Station include the series of high cataracts, fast cascades and branching turbulent flow under the snow bridge. Open, exposed to full sunshine. Prevailing wind, strong, from the east down the narrow gorge.

*Dates visited* : 28 and 29.v.1970.

*Notes on ecology* : Water temperature 0.5°C. Most of the biota in this station was larvae. Very few adults of Ephemera, Chironomidae and Blepharoceridae were found but these groups were as larvae. There was a great abundance of larvae of Trichoptera. The greatest bulk of Simuliidae were pupae, found crowded in clusters in small areas and small numbers of full grown larvae were found. In Plecoptera the adults were nearly eight times more numerous than larvae or subimagos.

*Station 11* : About 2 km section of the upper reaches of the main river Alhni and its small feeders immediately below the glacier and snow field from Hamta Pass. The western end marked by three high waterfalls and large cascades followed by a smooth flowing stream down an alpine meadow towards the snow bridge described in Station 10. Mean elevation 4,000 metre above M.S.L. This Station represents the source of the Alhni river, draining snow fields and glaciers grouped around the peaks Inder Kila, Dev Tibba and the Hamta Pass.

The special characters of this Station lie in the waterfalls, series of cataracts and cascades, and proximity to permanent and melting snow.

*Dates visited* : 29 and 30.v.1970.

*Notes on ecology* : The greatest bulk of the 400 specimens collected here are larvae and pupae. Ephemera, Blepharoceridae and Deuterophlebiidae were found at the time of visit here only as larvae. As in the other Stations, adult Plecoptera were common and were nearly ten times more numerous than larvae. Though some adults were collected in Trichoptera, Chironomidae and Simuliidae, the bulk of these groups were found either as mature larvae or as pupae. The larvae of Simuliidae were found in large gregarious assemblages in relatively small areas.

#### IV. NOTES ON THE TORRENTICOLE INSECT COMMUNITIES

The insect communities of R. Alhni comprises species of Ephemera, Plecoptera, Trichoptera and Diptera, associated with which are Hydracarina and Turbellaria. The size and composition of the communities differ within wide limits, depending upon the differences in the ecological conditions in different sections of river. Broadly speaking, three types of communities may be recognised :

1. communities of the water edge and shallow water,
2. communities of medium depths and
3. bottom communities.

#### **Ephemera (Fig. 6)**

This is one of the most widely distributed member of the torrenticole community, occurring throughout the entire course of the river. Owing to the wide range of conditions of velocity and irregularities of substratum, the relative abundance of larvae and adults, the frequency and date of emergence of adults, age of the larvae and a number of other differences in the general course of life cycle may be observed not only in the different parts of the same Station but also in different Stations. The group shows a high degree of specialization, characteristic of the river system. Though found in parts of the river, where the current velocity ranges from 0.5 to 3m per sec. the Ephemera larvae of the river

Alhni are largely not directly exposed to the full force of these high velocities. This is due to the fact that in nearly all the Stations the larvae are restricted in their distribution to moderate depths not exceeding one metre and midway between the water edge and the middle or the deepest part of the water flow. This has the result that in the special niches where the larvae occur the current velocity is greatly retarded and the water flow considerably slowed down under the massive stones where the larvae are found. There is, however, no stagnation of water, but the violence of the surface turbulence is absent in the immediate surroundings of the larvae. The special ecological niche of the larvae of Ephemera is, therefore, determined by the moderation of current velocity.

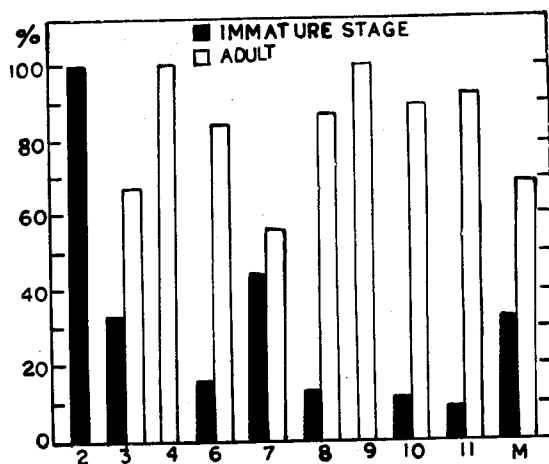


Fig. 6. Percentage frequency distribution of immature stages and adults of Ephemera in sampling Stations 2-11 in the Alhni river system, as estimated in 1970 Survey. M=Mean.

About 700 specimens, of which the adults are only half as numerous as the larvae, were collected. In the Stations 3, 4, and 5 there was a predominance of adults over the larvae, which were also mostly fully mature or subimago. In the Station 11 adults were absent and the larvae which were found in moderate numbers were also very immature. The Station 2 may be described as presenting perhaps the most optimum conditions for the dominance of Ephemera, and it was here that about the one-third of the whole collection was obtained. Although the bulk of Ephemera found during the entire survey belongs to family Baetidae, good numbers of Ecdyuridae were also collected in certain Stations.

The emergence of adults synchronizes with a calm spell mostly in the late forenoon. The emergence was observed in many Stations but mainly in Station

2 and 5. Two peculiarities in the behaviour of the subimago may be observed before the actual emergence of adults. In the Stations, where the water is fairly deep, the subimago comes out from under the shelter of the submerged stone, rises quickly to the surface of water and swims rapidly with zigzag movements across the stream to the water edge. Here it crawls out of the water over to a suitable stone, anchors itself firmly to its surface. Presently a crack appears on the dorsum, through which the adult crawls out head first and pulls the rest of the body free afterwards. It spreads its wings and flies off within a few seconds. In some cases, particularly where the water is relatively deep and the flow is characterized by violent and turbulent whirlpools, the adult emerges under the water, rises rapidly to the surface, where it wriggles about for a few seconds before flying off. Immediately after emergence, the adult rises vertically in the air, often ascending 5 to 7 m above the water. Some of the newly emerged adults may be found resting on grass blades a short distance away from the stream. The emergence of adults seems to be maximum during the hours of bright sunshine. This would explain the pronounced predominance of adults in the Stations 3, 4 and 5, where optimal conditions prevail on the dates of visit. It must also be remarked that the Stations in lower reaches of the river were characterized by emergence of adults in larger numbers than the Stations in higher reaches. This becomes particularly marked even in the Station 7, where there was still considerable unmelted snow at the time of visit. Both larvae and adults fall prey to the Himalayan dipper, that dives under the roaring torrent to pull out the larvae from under stones or snaps up the adult as it rises on its wings.

#### Plecoptera (Fig. 7)

This characteristically torrential group is well represented in the river and is particularly abundant in its upper reaches in subalpine and alpine areas. The Plecoptera are among the dominant elements of the insect communities in the river and one or the other of their species invariably constitutes the character forms of most communities. As known at present, at least four distinct species seem to be distributed in well defined and distinctive parts of the course of the river. Like Ephemera, the Plecoptera also seem to avoid parts of the stream where the current velocities are violently high and they occur at relatively moderate depths of less than a metre and closer to the water edge than Ephemera. This peculiarity seems to be closely correlated with the differences in the habits of emergence of adults of Plecoptera and Ephemera. The emergence of the adults of Plecoptera was observed on several occasions in the Station 6. It always takes place when the level of the stream water is lowest due to minimum melting of snow as a result of low atmospheric temperature, total cloudiness or limited sunshine and two or three days of snowfall. As the water level falls, the stones under which fully mature subimagoes occur, are more

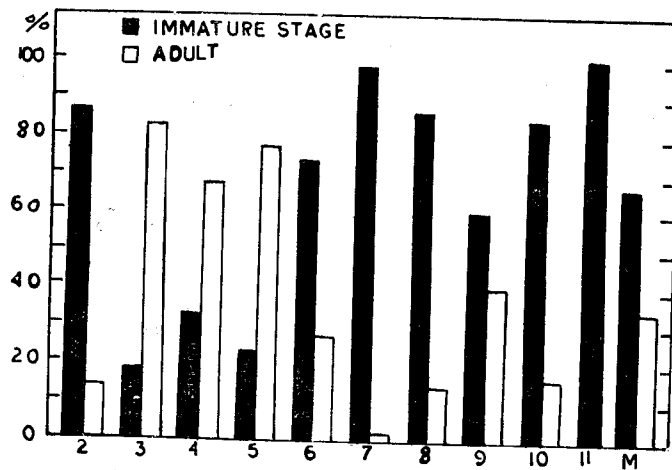


Fig. 7. Percentage frequency distribution of immature stages and adults of Plecoptera in sampling Stations 2-11 in the Alhni river system, as estimated in 1970 Survey. M=Mean.

or less exposed and the velocity of current also appreciably diminishes. This seems to act as a powerful stimulus for the subimago to crawl out of the water in enormous swarms. This event occurs usually at dusk or after nightfall. The subimago crawls out upto a distance of 4-5 metres on the bank, ascends boulders and rocks, where the adult emerges leaving large numbers of the cast skins on them. These factors and also the predatory nature of Plecoptera on Ephemerida larvae would explain the peculiarity that the larvae of Ephemerida and Plecoptera are never found on the same stone in any of the Stations. In most Stations the Plecoptera larvae were found in large gregarious masses.

About 1,500 specimens, of which the adults were seven times as numerous as immature stages, were collected. On an average, in each Station the adults were twice as numerous as larvae but in Station 2 only immature stages were found. This is probably due to the fact that the water was too warm and there was also superoptimal depth of water for emergence of adults. Maximum numbers of adults were collected in Station 6, where the conditions were also most optimum for the emergence of adults. Great numbers of adults may be found during the daytime, hiding under stones and loose soil, at distances of 1 to 1.5 m from the water edge; sometimes they had strayed even to the distance of 4 to 5 m. A peculiarity of adults in the Station 6 lies in the fact that nearly three-fourths of them are male. Mating takes place under stones and the females fly back over the water during the afternoon to drop the egg balls in it.

The adults collected in the Stations 4, 6, 7 and 9 are among the largest and measure about 2.5-3 cm long. Some of the adults were found with parasitic mites attached below the wings and ventrally on the thorax.

### Trichoptera (Fig. 8)

The Trichoptera must be considered as a minor element of the eutorrenticole communities of the R. Alhni. The order seems to be restricted in distribution to areas of optimal conditions for the occurrence of larvae in certain sections of the river, so that considerable difference in the abundance may be observed even within short stretches. Trichoptera larvae occur at greater depths than those of Plecoptera and Ephemera and may be found at the bottom in the part of the stream even where the surface velocity is maximum. While immature larvae seem to occur in deeper waters, the fully grown larvae migrate to the shallower zones before pupation. In most Stations the case-bearing forms were common, but in the Station 7 the non-case-bearing naked larva, about 3.5 mm long, was found. This larva is moderately hairy, brown dorsally, flattened and dark green ventrally.

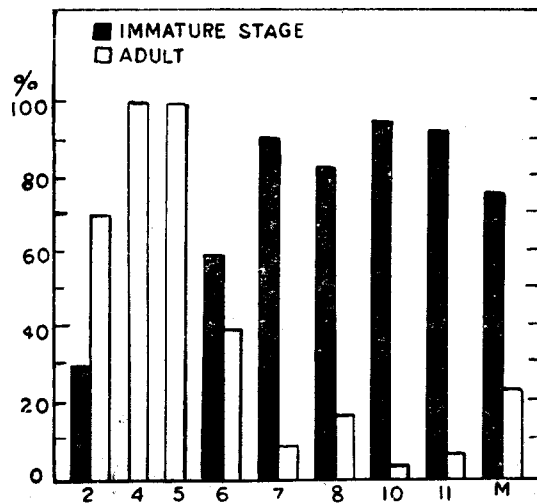


Fig. 8. Percentage frequency distribution of immature stages and adults of Trichoptera in sampling Stations 2-11 in the Alhni river system, as estimated in 1970 Survey. M=Mean.

About 250 specimens, of which 100 are adults and the rest larvae and pupae, were collected. Larvae were most abundant in the Station 11. In most of the Stations the larvae were also in an immature condition. During October 1969, the Stations 1, 2, 3 and 4 were remarkable for the great abundance of the fully grown larvae. Although in most Stations the larval cases were made either of sand grains or pebbles, quite a number of larval cases in Station 2 were made with sticks.

The adults may be collected from under sheltered stones close to the water.

### Diptera

The Diptera of the river Alhni comprise a great abundance of highly specialized eutorrenticole families like Chironomidae, Simuliidae and Blepharoceridae, widely distributed throughout the whole course of river and its drainage basins. Not only are they dominant in all communities, but many communities in nearly all the Stations are composed almost exclusively of Diptera. This order must also be described as the richest in species and genera in the entire biota of the river. The larvae and pupae occur in all depths, from the shallow zones near the water edge to the bottom and from the smooth gentle flow to the fastest current. In nearly all cases they occur completely exposed on the upper surface of submerged stones, directly in the line of force of high current velocities.

Of great ecological and biogeographical interest is the finding of perhaps the most highly specialized rheobiont family Deuterophlebiidae in the Alhni river at Station 11. This is the first record of this most interesting family south of the Pir Panjal Range, marking the extreme southern most limits of the family in India. All the earlier records of the family are north of the Pir Panjal.

Over 1,100 specimens of larvae, pupae and adults of Diptera, representing nearly one-fourth of the total, were collected. The adults are about two-thirds the number of larvae and pupae, but in Station 4 and 9 adults were far more numerous than larvae and pupae.

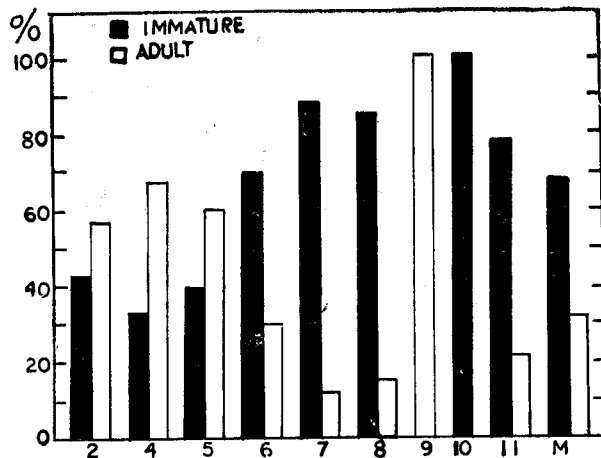


Fig. 9. Percentage frequency distribution of immature stages and adults of Chironomidae in sampling Stations 2-11 in the Alhni river system, as estimated in 1970 Survey. M=Mean.

### Psychodidae

The Psychodidae are the least specialized of the eutorrenticole Diptera and are also minor elements of the Diptera communities of the R. Alhni. The larvae and pupae that are likely to show torrential stream specializations were unfortunately not found anywhere since only adults were collected in the Stations 2 and 4 close to the water edge. In Stations 4 they were indeed taken in the act of being devoured by Blepharoceridae adults.

### Chironomidae (Fig. 9)

This family, representing about one-fifth of the collections of torrential Diptera, is nearly equally abundant in all Stations. The larvae are essentially found in the bottom and in zones of swift flow, but they were also fairly common in the shallower regions of moderate currents. The bulk of the adults comes from the Stations 4, 5 and 2 and in all other Stations the larvae were three times more common than adults. The smallest numbers of adults were found in the Stations 10, 11 and 7. In Station 6 the adults were only slightly less numerous than larvae. In most Station the larvae were found commonly in association with those of Trichoptera, Simuliidae and Blepharo-

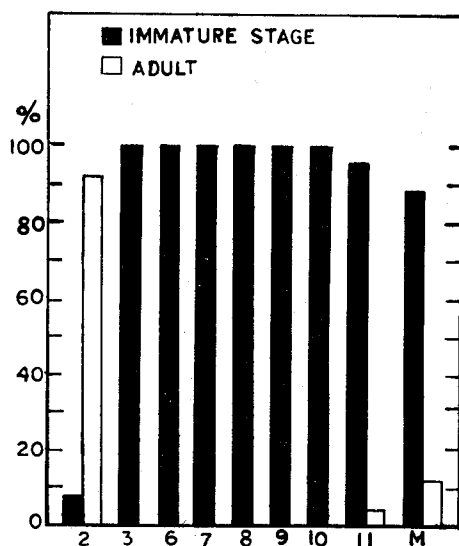


Fig. 10. Percentage frequency distribution of immature stages and adults of Simuliidae in sampling Stations 2-11 in the Alhni river system, as estimated in 1970 Survey. M=Mean.

ceridae. The larvae are typically found anchored by the posterior proleg to the streamlined surface of submerged stones in regions of high velocity current. The pupae found in Stations 10 and 11 appear to be different from those in other Stations. They are enclosed in a pale brown conical membranous cocoon, produced in front into a long, slender, tubular stalk, by which it is cemented to the stones at depths of 2-5 cm.

#### **Simuliidae (Fig. 10)**

The Simuliidae, constituting a dominant and constant member of torrential stream communities, are widely distributed throughout the course of the river. The larvae are typically inhabitants of shallow to moderate depths, where the current velocity is always relatively high. Nearly 350 specimens, mostly larvae were collected. Some adults come from the Stations 2 and 11. Except for the Station 4 and 5, larvae were abundant everywhere else. In the Station 11 the larvae were found in great gregarious assemblages. Considerable numbers of pupae inside the typically conical, yellowish, silken cocoon were found attached to rough surfaces of stones in the Stations 10, 11, 7 and 3. In the Station 6 numerous larvae were predatory on the larvae of Ephemera and Plecoptera.

#### **Blepharoceridae (Fig. 11)**

This family represents one of the most highly specialized of torrential-stream insects, distributed in the Alhni river, only in those Stations where optimal conditions exist for the adults to rest in sheltered localities close to the stream. The family is, therefore, conspicuous by its absence in sections of the river that flow in wide amphitheatres. The larvae and pupae inhabit typically open, shallow, but very swift waters, especially cascades, close to the water edge or on the boulders projecting more or less above the water in the mid-stream.

The larvae occur at depths of 10 cm or more, with the head pointing upstream. In some Stations they were coated with filamentous green algae. The younger larvae as a rule occur deeper than the older ones. The fully grown larvae gradually migrate closer to the surface of water and orientate themselves with the head pointing downstream, at depths of 3-4 cm, for pupation. Great lines of pupae may be found conspicuously on boulders just below the water level.

Soon after emergence, the adult flies to the shelter of miniature caves, overhanging rocks or low bushes, at distances of up to 100 m from the water. On bright sunny mornings, the adults rest with wings half folded at an angle of 40° to the body axis but at noon and in the afternoon the wings are spread out horizontally. The adults avoid strong sunshine and wind and in foul weather they assemble in miniature caves. They fly over the surface of water during

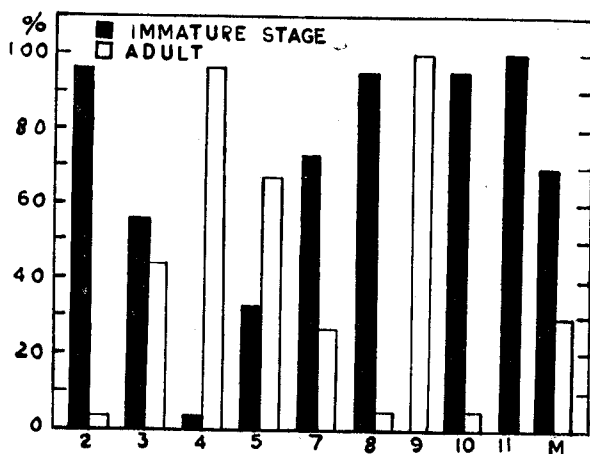


Fig. 11. Percentage frequency distribution of immature stages and adults of Blepharoceridae in sampling Stations 2-11 in the Alhni river system, as estimated in 1970 Survey. M=Mean.

the hours of bright sunshine, repeatedly touching the surface of water with the tip of the abdomen, apparently laying eggs in water. In the Station 4 the adults were captured preying on Psychodid flies.

This family represents nearly two-fifths of the total collections of Diptera. The adults are as numerous as larvae and pupae and in the Stations 3, 4 and 7 maximum number of adults were found. In Stations 2, 8 and 10 the larvae are far more numerous than adults. Though no adults were found in Station 11, larva was collected.

#### Deuterophlebiidae

This most highly specialized and remarkable family was found as larvae in Station 11. Large numbers of them were observed in gregarious associations with those of Chironomidae, Simuliidae, and Blepharoceridae, on the downstream side of smooth, algae-coated stones in cascades.

#### V. SUMMARY AND CONCLUSIONS

This paper summarizes the results of a sample ecological survey of the torrential-stream insect fauna of the R. Alhni, carried out during 1969-1970. Alhni is a left-bank tributary of the R. Beas, with its source in snowfields and glaciers on the Pir Panjal near the Hamta Pass and the peaks Dev Tibba and Inder Kila. Throughout its course in a rugged boulder-strewn valley it is a series of waterfalls and violent cataracts. It receives two principal feeder streams

on the right and one on the left. The fall in gradient is about 50 m per km. It is a typical Himalayan torrential stream of glacial origin, inhabited by characteristic insect communities.

For the purpose of this survey the whole course of the river was divided, on statistically random basis, into 11 sampling Stations, 0.5-1 km long and at mean intervals of 3 km. In each Station may be found a combination of nearly all the varied ecological conditions and typical torrenticole communities, representative of entire river. This has made possible a satisfactory random survey of the general ecology and fauna of the river. The torrential insects of the river belong to Ephemera, Plecoptera, and Diptera: Psychodidae, Chironomidae, Simuliidae, Blepharoceridae and Deuterophlebiidae. Detailed descriptions of the 11 Stations are given, with notes on the characteristic ecological conditions in each Station and of the insects.

The Station 6 may be considered as a statistical mean of the ecological conditions and torrential insect communities of the whole river. The Station 1 presents the minimum ecology of the river and the Station 11 epitomises the maximum ecological specializations. The mean temperature of water is 2.9°C, with a minimum of 0.1°C (at Station 7) and maximum of 7.7°C. The mean diurnal fluctuation of water temperature is 0.5°C. The mean surface velocity of current is 0.2 m per sec., with a maximum of 3-4 m per sec., and minimum of 10 cm per sec. The mean diurnal fluctuation of water level is 1.15 cm, with a maximum of 1.8 cm and a minimum of 0.4 cm at the Station 6. Daily collections of both larvae and adults were made. The larvae were collected at random in different parts of each Station. The adults were similarly collected on wings or when resting in sheltered localities. In some cases the adults were caught as soon as they emerged from water or they were also reared from breeding cages placed in situ in the stream. Altogether 3,500 specimens, about half of which are immature stages, were collected. Ephemera are widely distributed throughout the river and during the period of study they were largely in larval condition. The family Baetidae constitutes the dominant member but Ecdyuridae were also present. Plecoptera are well represented in the river and are particularly abundant in its upper reaches in subalpine and alpine areas. At the time of the survey the adults were emerging in great numbers, particularly in the upper regions. The ecological conditions which trigger the emergence of adults were studied. The Trichoptera constitute minor elements of the insect community. Most of them were found in larval condition.

Diptera are the most abundant in the insect communities of the river. Although the Psychodidae adults were found at some Stations, the larvae and pupae were not however found. Chironomidae are equally abundant both as adults and as larvae in all Stations. Simuliidae are widely distributed throughout the course of the river, mostly as larvae, some pupae and few adults. Blepharoceridae occur commonly as larvae in many Stations. Pupae were also

found in some Stations. A great abundance of the adults were also emerging during the period of survey. Some adults were caught while preying on Psychodidae. The larvae of the most highly specialized family Deuterophlebiidae were discovered in Station 11.

Many of the insects collected are new to science particularly in Ephemeroidea, Plecoptera and Blepharoceridae. The collection of large numbers of adults of Plecoptera and Blepharoceridae is of special importance, in view of the fact that on earlier occasions these groups were not found in such great abundance. The discovery of Deuterophlebiidae at the Station 11 is of great biogeographical importance, because this is the first record of this family south of the Pir Panjal Range. This marks the extreme southern most limits of the family in India.

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