NATURE OF SUBSTRATUM AS AN IMPORTANT FACTOR IN THE ECOLOGY OF TORRENTIAL FAUNA.

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In studying the ecology of the torrential fauna attention has so far been paid to the physico-chemical composition of the water (Hubault, 1927) or to the mechanical effects of the swift currents (Hora, 1930). In the course of my recent investigations another important factor—nature of substratum—has, however, appeared very potent in the distribution of certain types of animals. While grouping the torrential population into two sub-associations, namely, the plant-inhabiting animals and the rock-inhabiting animals, attention was directed (Hora, 1930, p. 177) to the fact that the distribution of the fauna is influenced by the nature of the bed. As an example, it was indicated that the occurrence of the Blepharocerid larvæ and the nymphs of *Iron* in the Pun-Wa-Sherra Stream could be correlated with the bare and smooth rocks in its bed, whereas their absence from the Dhud-Dhara fall was due to the thick growth of moss on the rocks. Both types of insect larvæ referred to above adhere by means of complete or partial suckers which can only function on smooth rocks, and this fact has an important bearing on the distribution of these animals.

While specially looking for Blepharocerid larvæ in suitable places during a recent visit to the Mussoorie Hills, the insects were found plentiful in certain streams while they were totally absent from others. Superficially all the streams appeared alike and the physical conditions seemed favourable for the occurrence of the Blephorocerid larvæ (Hora, 1931). The fauna of the Mossy Falls was investigated first and a large number of Blepharocerid larvæ were collected. Next a visit was paid to the Bhatta Falls but not a single Blepharocerid larva or pupa was found in this stream though there was no growth of moss on the rocks. In suitable places, however, there was a rich growth of long, filamentous algæ. On a closer examination of the problem, it was noticed that the rocks of the Bhatta Falls were covered with a deposition of lime which rendered the surface uneven and porous. Such a surface is certainly inimical to the occurrence of animals that use suckers for stemming strong currents, and is suitable for the growth of filamentous algæ. The rocks of the Mossy Falls, on the other hand, were smooth and did not harbour filamentous algæ.

Bearing this explanation in mind, several other streams were investigated and it was found that streams below Barlowganj had smooth rocks and were

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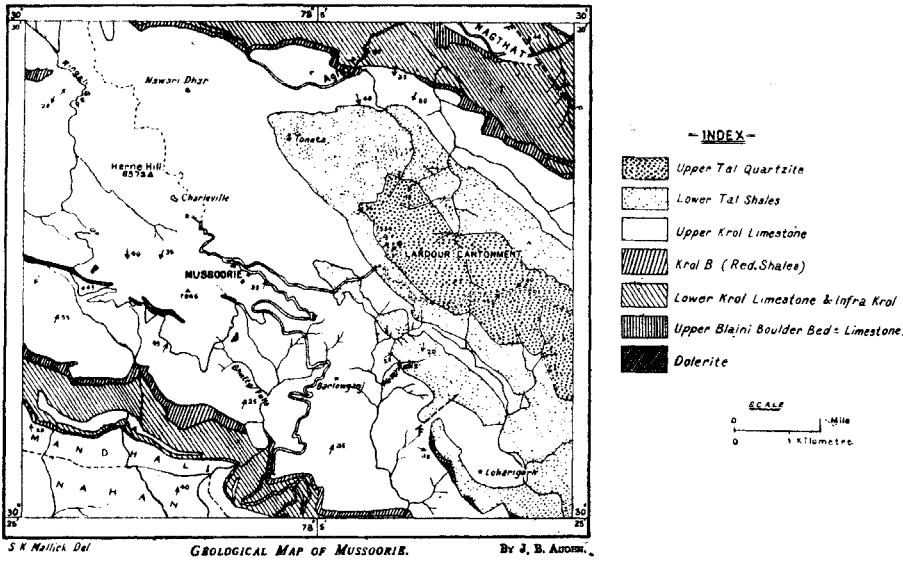
full of Blepharocerid larvæ in suitable places. At the Kamti Falls the nature of the bed was similar to that of the Bhatta Falls and in consequence no Blepharocerid larvæ were found in this stream. In the case of the Sansa Dhara stream, about 3 miles from Rajpur, Blepharocerid larvæ were found on smooth rocks while they were absent on adjacent rocks that had a pitted surface. These observations clearly show that the nature of the bed is an important ecological factor in the distribution of the Blepharoceridæ.



On my return to Calcutta, reference was made to the Geological Survey of India regarding the differences in the nature of beds of the various streams investigated. Mr. J. B. Auden, who has studied the geology of this area in recent years, has found that the differences are due to the geological formation of the rocks over which the streams flow. My conclusions regarding the distribution of the Blepharoceridæ from field observations are fully borne out by the geological data presented below by Mr. Auden. He states that

'Mussoorie and Landour are situated at the north-west end of a syncline of Krol and Tal rocks. The Upper Krol stage of the Krol series consists of dolomitic and calcitic limestones interbedded with shales. In contrast to the dominantly calcareous nature of the Upper Krols, the Lower Tal stage is made up almost entirely of dark micaceous shales, while the Upper Tal stage consists of quartzites. Limestones are almost entirely absent from the Tals.

Waters arising from springs in the Krol limestones are hard. Aeration of such waters leads to the decomposition of the unstable bicarbonate and the precipitation of the lime in the form of a rough and porous tufa, such as is seen on the Bhatta and Kampti falls. The water descending the Mossy falls is derived, on the other hand, from the Lower Tal shales which crop out on the Wellington ridge, and is consequently soft. It is true that, after leaving the shales, the water flows over the underlying Krol limestones, but the steepness of the descent and the certainty therefore of aeration is likely to prevent any

precipitation of tufa by inhibiting the initial solution of lime. Differences in the nature of the waters arising from springs situated entirely within the Krol limestones may be explained perhaps by the greater degree of solubility of the calcitic limestones compared with those that are dolomitic.

In addition to the chemical difference mentioned above there are physical differences between the Krol and Tal rocks. The Upper Krol limestones weather into rough boulders, while the Lower Tal shales are worn down by streams into smooth pebbles. The smoothness of these pebbles is probably in itself inimical to the deposition of lime, even were such present in the water as bicarbonate, while the rougher limestone boulders tend to favour the deposition of lime by virtue of the stirring up of the water flowing over them.'

The conditions presented by the Song River and Ray Nadi near Lachhiwala, about 11 miles from Dehra Dun, were quite different. The rocks forming the bed were smooth and there was no deposition of lime anywhere ; they were, however, covered with a very slippery growth of algal matter and in consequence not bare. The Blepharocerid larvæ were absent from these streams also, and it appears obvious that they occur only in such places where their suckers can function.

The observations recorded above show that the rocks of a torrential stream can be rendered unsuitable for the existence of the Blepharoceridæ if there is (i) rich growth of moss, (ii) deposition of lime, or (iii) slippery growth of algæ on them. The other conditions may appear very favourable, but if the rocks are not bare and smooth the Blepharocerid larvæ cannot live on them on account of physical reasons.

Such observations lead to the conclusion that in the study of ' Adaptations ' it is absolutely essential to examine in detail all the factors in an environment, otherwise, on a superficial examination, one is liable to believe that there is no correlation between a habitat and the fauna it supports.

In the end I have to thank Mr. J. B. Auden for his kindness in supplying a geological map and a short geological account of the area zoologically investigated by me.

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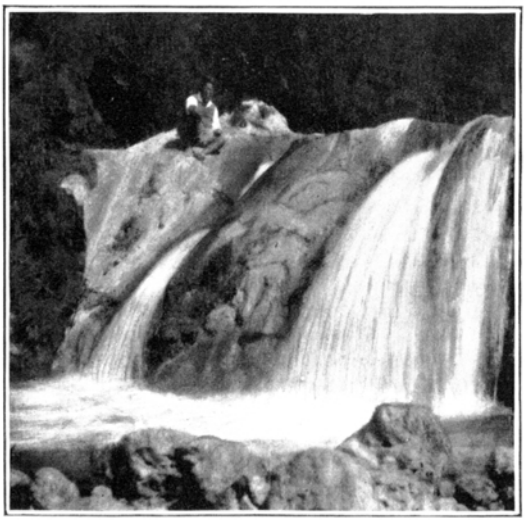

D. D. Mukerji, Photo.

Bhatta Falls, Mussoorie.

Stream below Barlowganj.

The two photographs illustrate a similar type of environment, but the fauna in the two streams was different, owing to the fact that the rocks of the Bhatta Falls were covered with rough and porous tufa, while those of the stream below Barlowganj were smooth.