THE SECOND ENTOMOLOGICAL EXPEDITION TO THE HIMALAYAS

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DURING May-June 1955 I led the Second Entomology Expedition to Lahoul-Spiti in the North-West (Punjab) Himalayas. There were a team of seven members and more than a ton of equipment and supplies of food. The University of Agra made a small grant towards a part of the expenses of the Expedition. Leaving Agra on May 18, we reached Manali at the end of the Beas Valley. Owing to unexpected and unusually late snow-fall, we were greatly delayed and held up for several days at about 9,000 ft. Our original plan of establishing a supply base at about 15,000 ft. on Kanzam La in the Spiti border had to be abandoned. The base camp was established a little below 13,000 ft. in a meadow opposite the Kulti Nal glaciers. After overcoming numerous difficulties and considerable delays, some essential supplies were pushed to an advance base camp below the Great Ice Fall Mountains of the Purana Khoksar Nal. Although not specially organized for spectacular peak-climbing, the Expedition climbed several unnamed and unclimbed peaks in search of high-altitude insect life.

Although the climbing programme had to be greatly curtailed owing to continued bad weather, more than five thousand specimens were brought back, some of them being taken at altitudes never before reached by an entomologist in this part of the Himalayas. We also studied the various conditions under which the high-altitude insect life flourishes and made observations on the habits and peculiarities of life-cycles. Several hundred close-ups in 'Kodachrome' and black-and-white were also made of the high-altitude flowers and insects in their natural surroundings with the help of a 'Leica' camera and its accessories.

The collections, which will ultimately be deposited with the Zoological Survey of India, are now being sorted out and card-indexed. Nearly every specimen has been microfilmed. The identification of the material, descriptions of the new forms and detailed reports of the Expedition's findings will not be ready for some time. I may, however, direct attention to certain interesting features of the high-altitude insect life of the Himalayas.

Although the variety and abundance of insect life as a whole rapidly fall off beyond the limits of tree-growth, the zone of permanent snows immediately above these limits is by no means barren. On the permanent snow at altitudes rarely ever reached by ordinary human beings, there habitually live a remarkable variety of insects. They thrive well under conditions of glare (great radiation especially in the ultra-violet part), intense cosmic-ray activity, reduced pressure, great oxygen deficiency, constant fierce cold dry winds, frequent avalanches and snowstorms, absence of plant life, relative scarcity and lack of variety of food and restriction of the feeding period to the very brief summer, etc. Dry barren rock that often gets heated to an uncomfortable degree in the summer sun even at great elevations, damp moss-covered stones, snow-fields, glaciers, glacial torrents, cracks and crevices in rock, caves and other spots have each their characteristic insect inhabitants.

While nearly every order of insects with which we are familiar in the plains also occurs at high altitudes, the species are different in almost all cases. The high-altitude insects of the Himalayas superficially resemble the alpine type; but actually they show closer affinities to the Tibetan and Central Asian faunal elements rather than to European. There are also sufficient indications to believe that the insects of this region represent, at least partly, a geographical relict of the Pleistocene life of Central Asia. Deep infiltrations of the subtropical and often also of the tropical faunal elements may be detected as high as 10,000 ft. above the mean sea-level.

Among the high-altitude insects of the Himalayas, Collembola, Diptera, Coleoptera, Dermaptera, Plecoptera and Ephemerida (given in order of abundance) stand foremost. Between 8,000 and 14,000 ft., Plecoptera, Ephemerida and Trichoptera are dominant types, especially in the glacial torrents. Some of these ascend right up to the edge of the permanent snow. Remarkably enough, the insect population of all kinds is far more dense in the glacial torrents than in stagnant waters. This concentration in the torrents is perhaps due to the more uniform though lower temperatures of the torrents than in the still waters. From 12,000 ft. upwards we come across Dermaptera-Coleoptera associations, and beyond 15,000 ft. above sea-level Collembola, Coleoptera and Diptera replace the Dermaptera-Coleoptera complex. The last-mentioned three orders seem to have successfully taken up permanent abode at much higher altitudes than any other insect and also occur at greater elevations than 15,000 ft. Collembola are perhaps the only forms which may be found as high as 18,000 ft.

In addition to the species that occur habitually at great altitudes, the Expedition came across great swarms of migrating Lepidoptera. *Colias ladakensis* and *Argynnis claudi* were taken at about 17,000 ft. on snow-fields. Upper-air currents and the afternoon winds blow up millions of minute insects like aphids, fruitflies and even larger forms like noctuid moths from the plains of India on to snow-fields and glaciers between 14,000 and 17,000 ft., especially on the southern aspect.

A most remarkable variety of adaptations can be correlated to the peculiar conditions of life. Widely unrelated groups occurring on exposed boulders, in glacial torrents and on wind-blown snow-fields and glaciers exhibit considerable adaptive convergence in the development of devices for securing firm anchorage. The great majority of the truly high-altitude insects show extremely low tolerance of even slight increase in temperature, due undoubtedly to long acclimatization to the generally sub-zero temperatures. Some of them are capable of surviving under 30 ft. of snow for several months without apparent harm.

A striking feature of the high-altitude insects of the Himalayas is the greatly prolonged larval life, with hibernation and diapause often extending to one or even two years. The adult is extremely short-lived. We came across a great number of forms still hibernating towards the end of June under stones covered by several feet of snow. *Calosoma madeirae kashmirensis* is, for example, a common carabid beetle that was hibernating in this way at about 13,000 ft. On an enormous glacier at about 14,000 ft. on the Dhauladhar I found on a previous occasion a mass assemblage of hibernating adults of Coccinellids. At

relatively lower altitudes just beneath the permanent snow line, with the advance of summer and the gradual melting of the snow, the scene becomes one of a mad race of different species against time. The noon-day sky with the air 4° below zero becomes filled with gigantic swarms of may-flies, stone-flies, caddis-flies, butterflies, gnats and various other insects which mate, lay eggs and perish before the same evening. The few that survive may be destroyed in a blizzard the next afternoon. Unlike polar forms, most of the high-altitude insects here are heavily pigmented as a protection against the glare and

ultra-violet radiation. This may also be the result of crowding during development in sheltered spots. While only a small fraction of them thrive on lichen, moss or algal slimes, the great majority of the species are either scavengers or carrion feeders or devour each other. As one goes higher and higher the increasing proportion of the carnivorous species can be recognized, until at altitudes above 15,000 ft. they are the only types that occur permanently. The wind-borne organic matter already referred to also contributes to the food resources of the high-altitude insect life.

A MODIFIED METHOD OF TWO-DIMENSIONAL ZONE ELECTROPHORESIS APPLIED TO MUCOPROTEINS IN SERUM AND URINE

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DURRUM¹ has described a technique of two-dimensional zone electrophoresis on paper in which the analysis in the first buffer is transferred on a strip of paper to the surface of a sheet of paper soaked in the second buffer. The strip is placed in such a position that the substances on it migrate in a direction at right angles to that in the first buffer. We wished to use two-dimensional electrophoresis to obtain direct confirmation of the positions of serum mucoprotein fractions in the serum protein pattern obtained by electrophoresis at pH 8.6. Two serum mucoprotein fractions may be isolated from all other serum proteins by electrophoresis at pH's between 4.4 and 4.6² (Fig. 1). Since in the latter technique filter paper is sandwiched between glass plates, the following modification of Durrum's method was developed.

Instead of placing the strip on the surface of the paper, a slot to receive it of corresponding width and slightly greater length was cut in the centre of the second sheet at right angles to the direction of the second separation. The strip was partially dried at room temperature before being placed in position. The edges of the two pieces of paper were then carefully teased together, except at either end of the strip where a gap was left. The sheet of paper had been soaked in buffer, blotted, and placed on the lower glass plate before receiving the strip, and the flow of the new buffer into the strip concentrated the material in it as a narrow band along its centre. The absence of buffer flow inwards at either end of the strip prevented disturbance of spatial distribution along it. The upper sheet of glass was then placed over the paper, the second electrophoresis carried

Fig. 1. Serum mucoprotein fractions *M-1* and *M-2* isolated by electrophoresis at pH 4.6 in a citric acid-sodium phosphate buffer. Paper stained by periodic acid-Schiff technique

Fig. 2. Two-dimensional electrophoresis showing position of mucoprotein fractions in serum protein pattern obtained with veronal buffer, pH 8.6

(A) First separation transferred on paper strip, position of strip indicated by dotted line. Second buffer citric acid-sodium phosphate, pH 4.4

(B) Veronal buffer removed by 66 per cent acetone, second buffer citric acid-sodium phosphate, pH 4.6

Stained with naphthalene black. *M-1* spots intensified for reproduction

out after a short period of equilibration, and the paper—minus the strip—was then stained. The results obtained are shown in Fig. 2 (A). The occurrence of *M-1* and *M-2* in the α_1 - and α_2 -globulin positions respectively is clearly indicated. The pH of the second buffer is chosen to ensure that the fractions to be studied are carried clear of the transferred strip. With other combinations of buffer systems the buffer on the strip may alter the pH on the remainder of the paper; but this can generally be avoided by adjustment of the buffer concentrations or by transferring a narrower strip.