Entomological Survey of Himalaya

Part XXVI. A Contribution to our Knowledge of the Geography of the High Altitude Insects of the Nival Zones from the North-West Himalaya

PART 5

BY

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(*With thirteen text-figures*)

[*Continued from Vol.* **59** (2) : 381]

IV. PECULIARITIES OF THE DISTRIBUTION OF THE NIVAL INSECTS

Correlated with the specific ecologic characters and the topography of the Himalaya, the distribution of the nival insects above the timber line shows many striking peculiarities. Some of these are characteristic of the distribution of mountain autochthone species in general, but many are also to be attributed directly to the massiveness of the trend lines of the mountain ranges and the high altitudes of the elevated areas in the NW. Himalaya. When we carefully examine the distributional range of the individual species, we may recognize the following important features : 1. Localization ; 2. Discontinuity ; 3. Concentration ; and 4. Isolation (Fig. 42).

Localization. Localization results when the range of a species is small and restricted wholly to a relatively small area, often along a single spur of a given mountain range, and the species does not occur anywhere else. The range is often so small that the species may be said to be scarce in the NW. Himalaya. Sometimes this localized area of the species is comparatively large. In discussing the distribution of the different orders, we have already had occasion to refer to numerous examples of localization of species and genera. We may therefore consider here only a few examples. *Tibetocoris*, an endemic genus of Heteroptera, occurs, for example, only on the Chang Chenmo spurs in the neighbourhood of Pongong Tso (Fig. 43) and is never found below an elevation of 5000 m. *Phimodera rupshuensis* Hutchinson (Fig. 10), another endemic

Heteroptera that never descends below an elevation of 4000 m., is similarly strictly localized on the Zaskar Range in the Tso Morari area. The area of the endemite *Bembidion hutchinsoni* Andrewes (Fig. 44), which

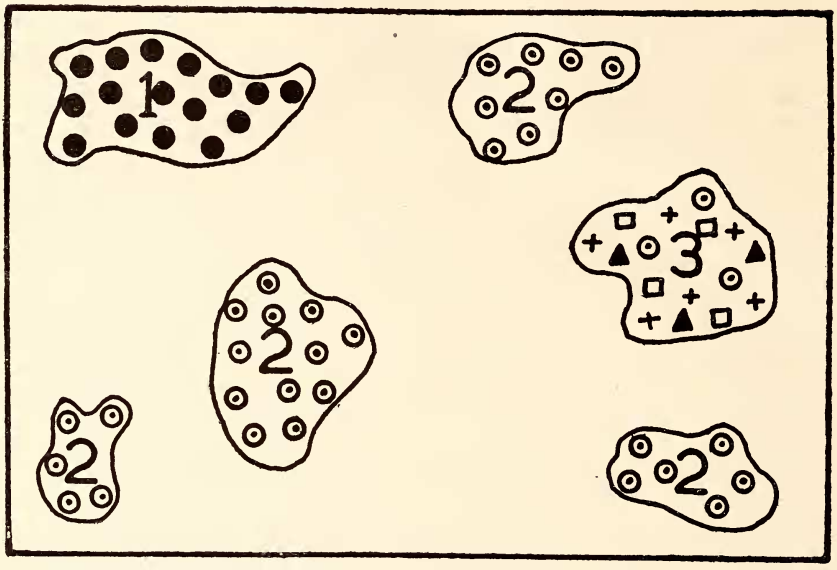

Fig. 42. Distribution patterns of nival insects in NW. Himalaya above timber line : 1. Localization ; 2. Discontinuity ; 3. Concentration

is an inhabitant of elevations above 4500 m., is likewise localized in a most interesting manner near Kyam Hot Spring on the Chang Chenmo spurs north of the Pongong Tso. A great many endemic species of *Atheta* are also localized. The two endemic species of *Blaps* are strictly localized on a spur from the Ladakh Range in the Pongong Tso area. Not only are most of the endemites localized in this manner in one area or the other, but the distribution of the non-endemites is also mostly localized. *Colias leechi* Gr.-Gr., of the Pamir-central-Asian faunal element, is strikingly localized in the Kardong Pass area of the Ladakh Range. Another Pamir form, *Bembidion petrimagni* Net., is localized in the area of the Baltoro Glaciers. The interesting central Asian Diptera, *Ephydra glauca* Meigen (which is also known from south Russia and Romania), is strictly localized in the Tso-Kar area in Rupshu. The Tibetan-Himalayan *Amara brucei* Andrewes and *Bembidion nivicola* Andrewes are localized in the Pongong and Karakorum Pass area.

Discontinuity. Although several species are localized in a single more or less small area, a considerable proportion of both endemites and others are generally localized in more than one, irregular, unequal, and often more or less widely separated patches. The range of these species, though relatively extensive, is conspicuously discontinuous. The

distribution of nearly 80% of the endemites is in such localized, discontinuous, and isolated patches. *Bembidion irregulare* Net., an endemite from the mountain ranges drained by Indus River and occurring generally above an elevation of 4500 m., is localized for example in two widely separated and unequal patches (Fig. 45), one of which is situated on the central Karakorum and the other on the Great Himalaya in the neighbourhood of Nun Kun Peaks. The total range of another extremely interesting endemite, *Bembidion luntaka* Andrewes, is similarly broken up into two irregular discontinuous patches, a larger patch (Fig. 45) on the spurs between the Ladakh and Zaskar ranges and a smaller patch on the south slope of the Great Himalaya in the neighbourhood of Bara Lacha La. The ranges of *Bembidion ladas* Andrewes, *Bembidion leve* Andrewes, *Bembidion livens* Andrewes, and *Bembidion ixion* Andrewes, all of which are endemites, are similarly characterised by the same patchiness and discontinuity. *Bembidion aquilum* Andrewes, an endemite occurring at elevations ranging from 3000-4500 m., has its total range broken up in four isolated and widely separated patches (Fig. 46), the largest of which lies on the north slope of the Great Himalaya near Nun Kun Peaks. The localized range of the central Asian *Bembidion fuscicrus* Motsch. is broken in three patches in the Indus drainage area (Fig. 47).

Localization and discontinuity characterize the distributional ranges of nearly 210 endemites. Nearly 153 non-endemic species also exhibit a similar pattern of distribution. The remaining 7 endemites, though widely distributed in the whole of the NW. Himalaya, still have their total range broken into numerous isolated patches on all the mountain ranges. The ranges of 14 non-endemic species, which occur throughout the NW. Himalaya, are again split up into many isolated patches, scattered likewise on all the mountain ranges. This pronounced tendency for severe localization and discontinuity, a characteristic of mountain insect life, has been observed by Holdhaus (65) and several others in the Alps, and is greatly exaggerated in the case of the insect fauna above the timber line in the more massive NW. Himalaya. References to some of these peculiarities have already been made by us in another connection (100).

Concentration. Owing to the peculiar ecologic conditions, the nival species are localized in areas where alone they find the specific optimal conditions for existence. Localizations of large numbers of species of different orders tend to condense into certain centres. The centres of localization of several species thus superimpose to a greater or lesser extent, and we therefore find corresponding concentrations of species. Several species are thus localized in the same area. Some of the localized and isolated concentrations contain as many as 40 species belonging to several orders like Heteroptera, Coleoptera, Hymenoptera, Lepidoptera, Diptera, Thysanura, and Collembola. The great majority of the species

of such localized concentrations do not occur outside the area of concentration. Localized concentrations in the Tso Morari area include, for example, about a dozen species like *Bryodema luctuosa* Stoll., *Phimodera rupshuensis* Hutchinson, *Microplax hissarensis* Kiritsch., *Atracthelophorus frater* d'Orch., *Aleochara* (*Coprochara*) *bilineata* Gyll., *Atheta* (*Bessobia*) *submetallica* Cameron, *Atheta* (*Microdota*) *ladakiana* Cameron, *Parnassius acco tagalangi* Bang-Haas, *Parnassius actius yelyangi* Bang-Haas, *Parnassius simo zarraensis* (Bang-Haas), and *Ephydra glauca* Meigen.

The localized concentrations of species are generally grouped in a most significant manner along the main ranges of the NW. Himalaya or on its major spurs. Nearly 170 endemites and 115 non-endemites are thus localized in concentrations on the main ranges and about 55 species on the major spurs. Localizations of species of *Bembidion* are concentrated along the Ladakh, Zaskar, and the Great Himalaya Range (Fig. 44). *Bembidion ladas* Andr., *Bembidion leve* Andr., *Bembidion livens* Andr., and *Bembidion ixion* Andr. are, for example, concentrated on the Ladakh and Zaskar ranges. The general pattern of localized concentrations of the insect fauna of the nival zones in the NW. Himalaya is an unmistakable indication that the distribution of various species follows the general trend line of the Himalayan ranges. In other words, we have the general average picture of a more or less parallel series of linear arrangements of localized and discontinuous concentrations of species (Fig. 48). The concentrations of species on the different mountain ranges are also on the whole in the immediate vicinity of and around the high peaks and crest lines. In areas with a close group of several high peaks (Fig. 49), the concentrations are extensive and massed. A map of peaks above an average elevation of 6000 m. would more or less exactly reflect the pattern of distribution of nival insects. The massing of the nival insect species around high peaks is so constant that chance coincidence cannot explain it. An unmistakable connection exists between the distribution of peaks of an average altitude of 6000 m. and the distribution of nival insects. From ecological considerations and on the basis of the available evidence of past distribution, such a massing of the greatest bulk of the nival forms around high peaks should naturally be expected.

Massed concentrations of species around high peaks is particularly conspicuous in areas which were formerly more or less heavily glaciated and from which the Pleistocene ice sheets and valley glaciers have since receded (27). Several species occur so constantly in such areas alone that they may be considered as indicator species. We thus find a remarkable wealth of species around many of the glacial lakes like Pongong Tso (29) and Tso Morari (Fig. 50). In these areas are also grouped together a very large number of peaks rising above an elevation of 6000 m.

The single largest massing of localized concentration of nearly 43 species in the NW. Himalaya is perhaps in the vicinity of Pongong Tso. The following species are massed around high peaks in this area:

SOME TYPICAL INDICATOR SPECIES OF FORMERLY GLACIATED AREAS

1. *Hyphinomus fasciata* Uvarov
2. *Dolmacoris deterrana* Hutchinson
3. *Emblethis horvathiana* Hutchinson
4. *Lamprodema brevicollis* Fieb.
5. *Nysius ericae* (Schill.)
6. *Nysius ericae alticola* Hutchinson
7. *Chlamydatus pachycerus* Kiritsch.
8. *Dicyphus physochlaenae* Hutchinson
9. *Dicyphus senggae* Hutchinson
10. *Tibetocoris margaretae* Hutchinson
11. *Chiloxanthus alticola* Kiritsch.
12. *Amara ambigene* Bates
13. *Amara brucei* Andrewes
14. *Bembidion hutchinsoni* Andrewes
15. *Bembidion nivicola* Andrewes
16. *Cymindis championi* Andrewes
17. *Cymindis rubriceps* Andrewes
18. *Potamonectes* (*Potamonectes*) *griseostriatus* (Deg.)
19. *Agabus* (*Gaurodytes*) *adustus* Guignot
20. *Helophorus* (*Helophorus*) *splendidus immaensis* d'Orch.
21. *Helophorus* (*Lihelophorus*) *ser* Zaitz.
22. *Helophorus* (*Meghelophorus*) *aquaticus* Linn.
23. *Laccobius* (*Laccobius*) *hingstoni* d'Orch.
24. *Atheta* (*Dimetrota*) *hutchinsoni* Cameron
25. *Blaps ladakensis* Bates
26. *Blaps perlonga* Bates
27. *Bombus alticus* Eversm.
28. *Subterraneobombus melanurus* (Lepel)
29. *Doliphilodea tibetana* Kimmins
30. *Parnassius delphius ladakensis* Avinoff
31. *Colias cocandica thrasibulus* Frusch.
32. *Colias leechi* Gr.-Gr.
33. *Ephydra tibetensis* Cresson
34. *Ctenolepisma* sp.
35. *Machilanus hutchinsoni* Silv.
36. *Friesea excelsa* Denis
37. *Isotoma spinicauda* Bonet
38. *Proisotoma ladaki* Denis
39. *Mydonius hutchinsoni* (Denis)
40. *Orchesellides boraoi* Bonet
41. *Seira brahmides* (Denis)
42. *Sminthurides aquaticus* (Bourlet)
43. *Sminthurides* (*Stenacidia*) *violaceus* (Reuter)

The environs of Tso Morari contain another large concentration of about 16 species, of which *Nysius ericae*, *Chlamydatus pachycerus*, and

Potamonectes (*Potamonectes*) *griseostriatus* also occur near Pongong Tso.

It is also extremely interesting that in the distribution of species, we can readily recognize a very pronounced tendency for clustering near present day glaciers (Fig. 51). Localized concentrations of several species are massed together in areas where there are larger glaciers, more than in case of some of the smaller glaciers. The extensive occurrence of many species in the neighbourhood of the present day larger glaciers justifies us in calling them indicators of the glacier localities. The following species are, for example, exclusively massed near present day glaciers :

SOME TYPICAL INDICATOR SPECIES OF AREAS OF PRESENT GLACIERS

1. *Bembidion bucephalum* Net.
2. *Bembidion pamiricola* Lut.
3. *Atheta* (*Acrotona*) *fungi kashmirensis* (Gr.)
4. *Ocyusa* (*Ocyusa*) *quadrisulcata* Bernh.
5. *Myrmeca smythiesi cachmirensis* Forel
6. *Parnassius delphius shigarensis* Bang-Haas
7. *Parnassius delphius workmani* Avinoff
8. *Colias eogene francesca* Watkin

Isolation. The existence of considerable ecologic isolation in the insect life above the timber line was described by us in an earlier paper (100). The pronounced localization and discontinuity of concentrations have the concomitant result of isolation in the greatest majority of species.

The isolation is either geographical, topographical, or also ecological. The populations of each of the species with discontinuous patches of distribution are truly allopatric. Though macrogeographically apparently sympatric, in actual practice the distribution is a case of microgeographically allopatric. Isolations are brought about by a variety of conditions like steepness, slope (aspect), altitude, topography, habitats, and other ecological conditions. Though thus often not geographically separated, most species are actually completely separated topographically, or ecologically. In some cases however the isolation does not appear to be total, and hybrid populations are met with at the areas of contact of the two species or subspecies, especially among *Parnassius* and *Colias*. Though allopatric populations are the general rule, such hybrid populations in areas of contact of two ranges in the Lepidoptera of the Alps have also often been described (118, 119, 120). The high endemism and the existence of numerous local geographical subspecies are without doubt to be correlated with the pronounced isolation and rapid evolution on high massifs. The extensive researches of several workers like Bäbler (7), Lindroth (84, 85, 86, 87), Holdhaus (57, 58), Janetschek (75, 76), and others have shown that discontinuity and isolation characterize the distribution of nival insects, especially the terri-

colous Coleoptera, from the Alps also. Most of these alpine distributional peculiarities are more or less conspicuously exaggerated in the case of the much more massive NW. Himalaya.

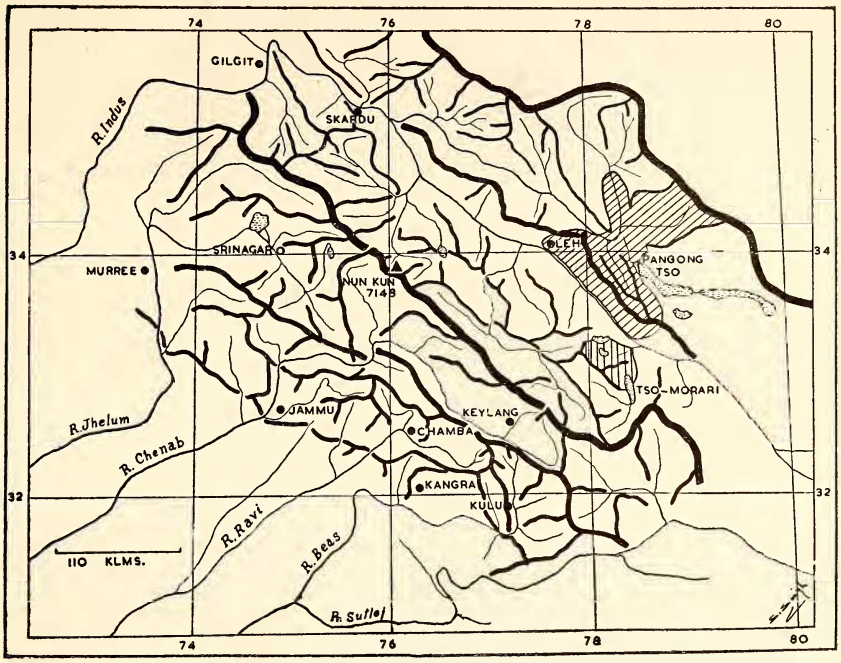

Fig. 43. The localization of the endemic nival Heteroptera in areas, which were under heavy valley glaciers during the Pleistocene : for example, the Pongong Valley area, with *Tibetocoris* (area obliquely striped) district and the Tso Morari area (vertically striped) with *Phimodera* district. The *Tibetocoris*-group of species are distributed on the Ladakh Range and across the Chang Chenmo spurs to the southern slopes of Karakorum. In this and in the following figures, the thick black lines indicate the crest lines of the mountain ranges, and the thin lines, the ridges.

V. The Factors governing the Distribution of Nival Insects

The peculiarities of distribution and the faunal characters of the nival insects, which we have outlined above, are closely linked up with their past distribution, their special ecologic characters, some of the more recent phases of the orogenic movements leading to the uplift of the Himalaya, and a number of other factors. Some of the major factors governing the distribution of these insects can partly be observed in the field and others can be readily deduced from their known distribution. A great many of the distributional peculiarities may be traced to the high ecologic specialization of the nival insect fauna (100). The nival insects are cold-adapted species, which inhabit the montane tundras above an elevation of 3000 m. They are predominantly endogeous or terricolous, flightless, hygrophiles, with a pronounced preference for

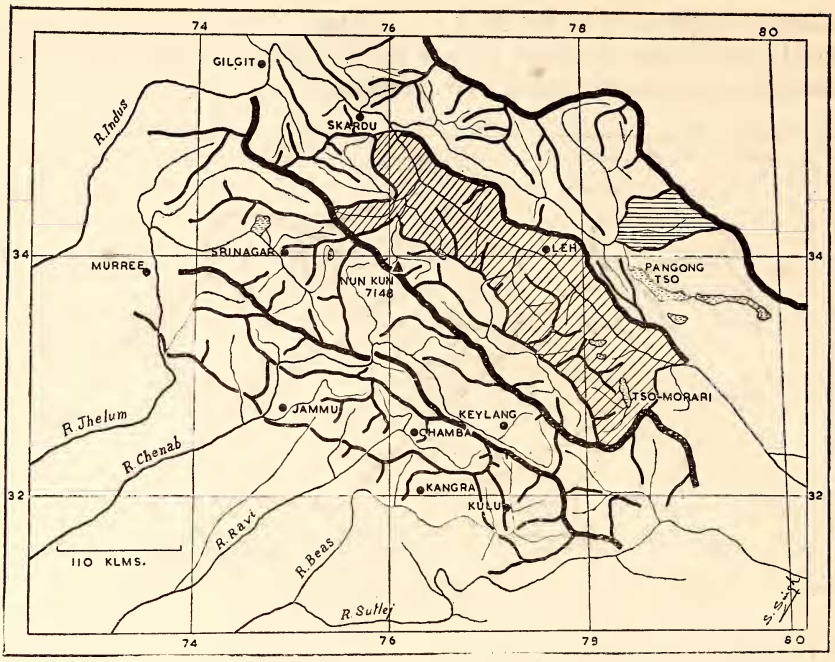

Fig. 44. The distribution of *Bembidion ladas* Andr., *Bembidion ixion* Andr., *Bembidion leve* Andr., and *Bembidion livens* Andr., which are localized between the Ladakh Range and the Zaskar Range in the area drained by R. Indus (Indus Valley glacier of the Pleistocene) (striped oblique). Note the extension to the north slope of the Great Himalaya on the spurs near Nun Kun Peak. The Chang Chenmo area (striped horizontal), north of the Pongong Tso is the centre of localization of *Bembidion hutchinsoni* Andr.

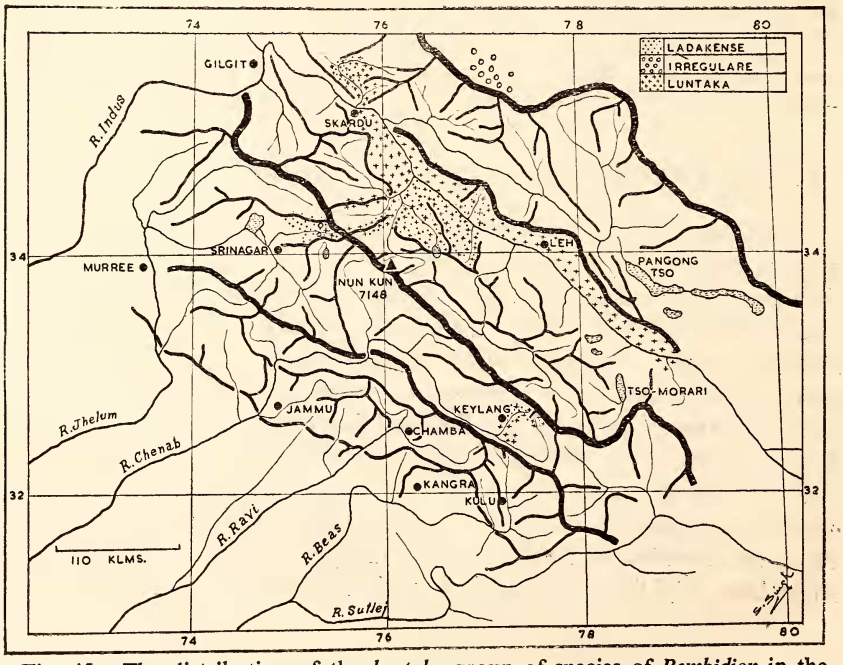

Fig. 45. The distribution of the *luntaka*-group of species of *Bembidion* in the NW. Himalaya. Note the discontinuity of distribution along the main ridges and spurs. The crest line of the Great Himalaya (with Nun Kun Peak) is crossed only at two points, viz. near the Baralacha Pass and the Zojila Pass.

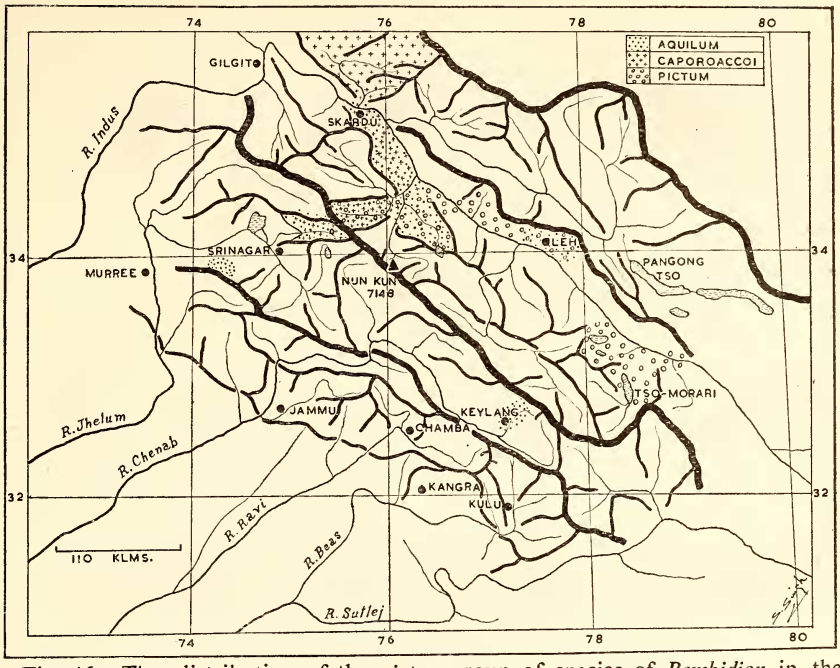

Fig. 46. The distribution of the *pictum*-group of species of *Bembidion* in the NW. Himalaya.

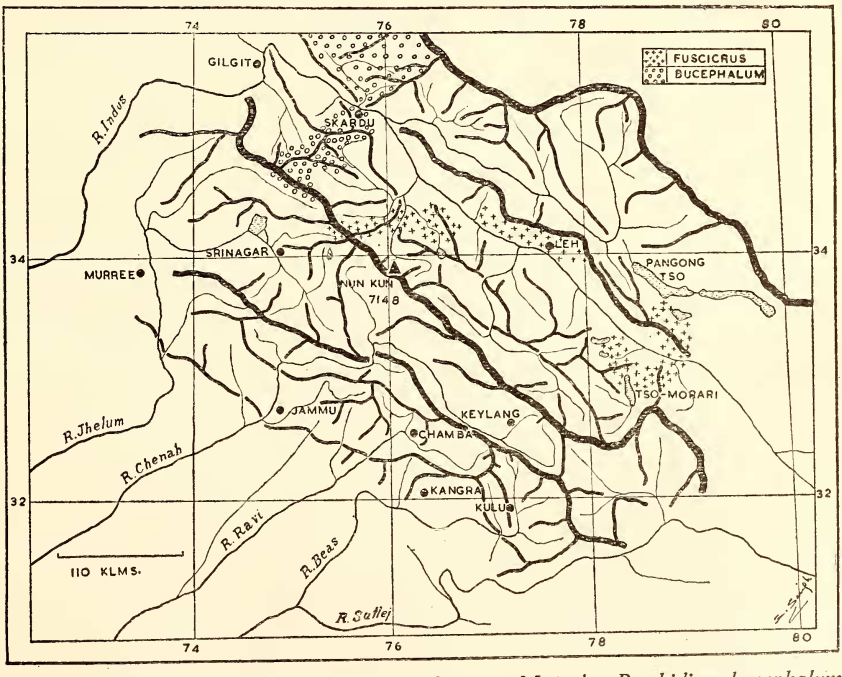

Fig. 47. The distribution of *Bembidion fuscicrus* Motsch., *Bembidion bucephalum* Bates, *Bembidion dardum* Bates, *Bembidion pamiricola* Lutch., and *Bembidion petrimagni* Net. in the NW. Himalaya.

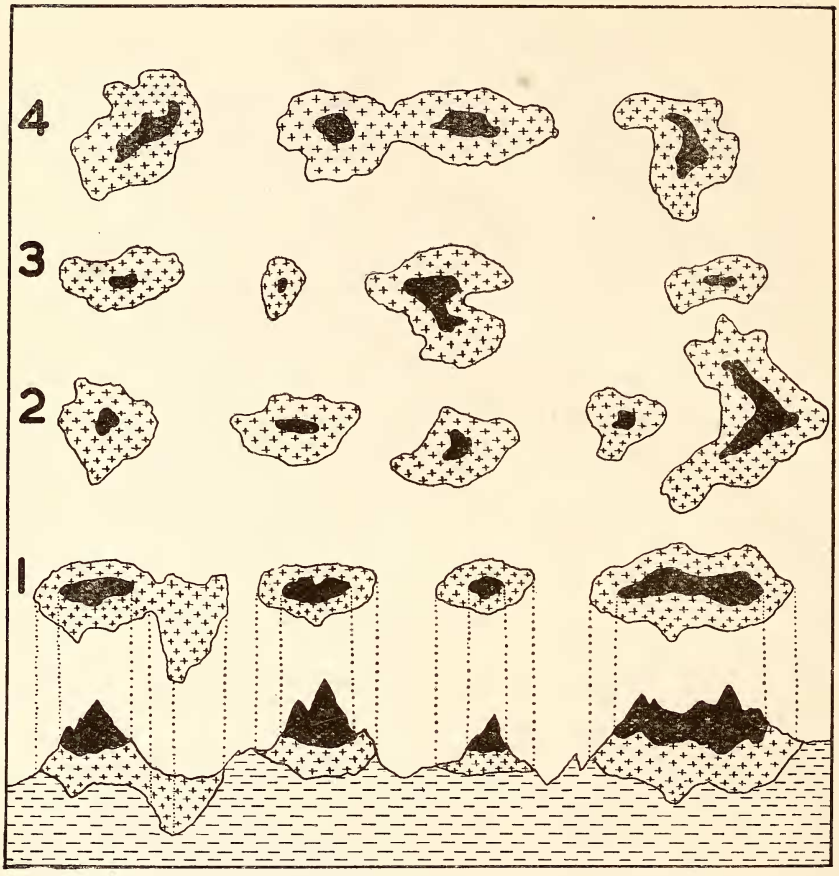

Fig. 48. Parallel series of linear, localized, and discontinuous concentrations of nival species in the neighbourhood of high peaks.
Peaks with permanent snow shown black ; concentrations of nival insects with +. Bottom row shows elevation, and rows 1-4 on different ranges as viewed from the air.

areas seasonally under snow cover. The maximum ecologic stability in the majority of the species is reached at about an elevation of 4000 m. above m.s.l. but many species are integral parts of the environment far above the permanent snow line. All the species are characterized by prolonged hibernation under snow cover, with a relatively short and active period of rapid development in the brief summer. The specific optima of ecologic requirements for nearly all the species are found only in irregular, discontinuous, greatly isolated patches or islets, which alone have the concentrations of population. These ecologic specializations have largely contributed to the localization, discontinuity, and concentration in isolated patches. The factors which admittedly govern the distribution include the means of dispersal, topography, the massiveness of the NW. Himalaya, permanent snow line, geology, and Pleistocene glaciations. We shall briefly consider some of these factors.

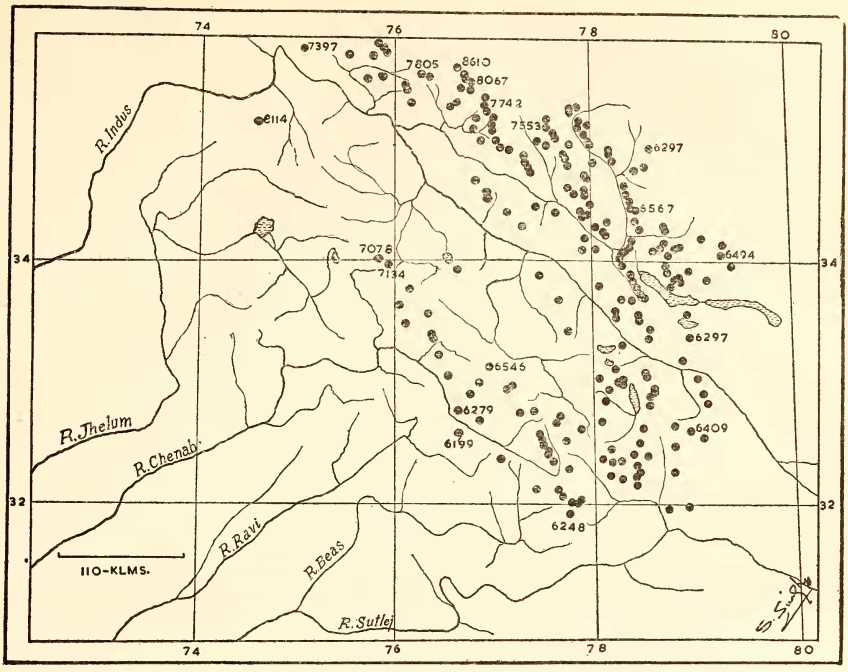

Fig. 49. Map of the region of the NW. Himalaya, showing the location (black circles) of the high peaks of an average altitude of 6000 metres above mean sea level and higher. Note that the areas of masses of peaks are also the areas of heavy concentrations of the nival insect species.

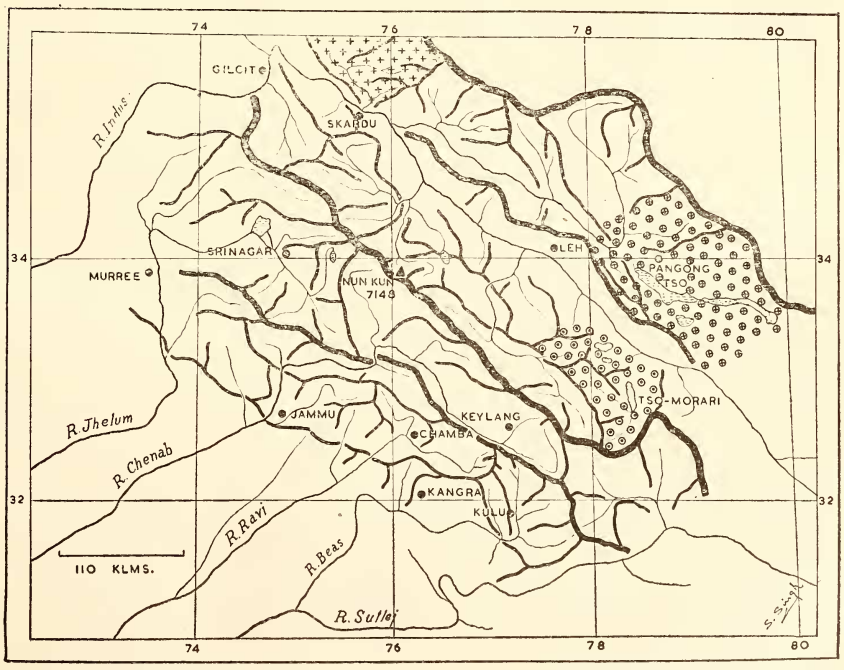

Fig. 50. Map of the region of the NW. Himalaya, showing the concentrations of species in areas which were formerly glaciated (+ inside circles) and areas of the present day glaciers (+)

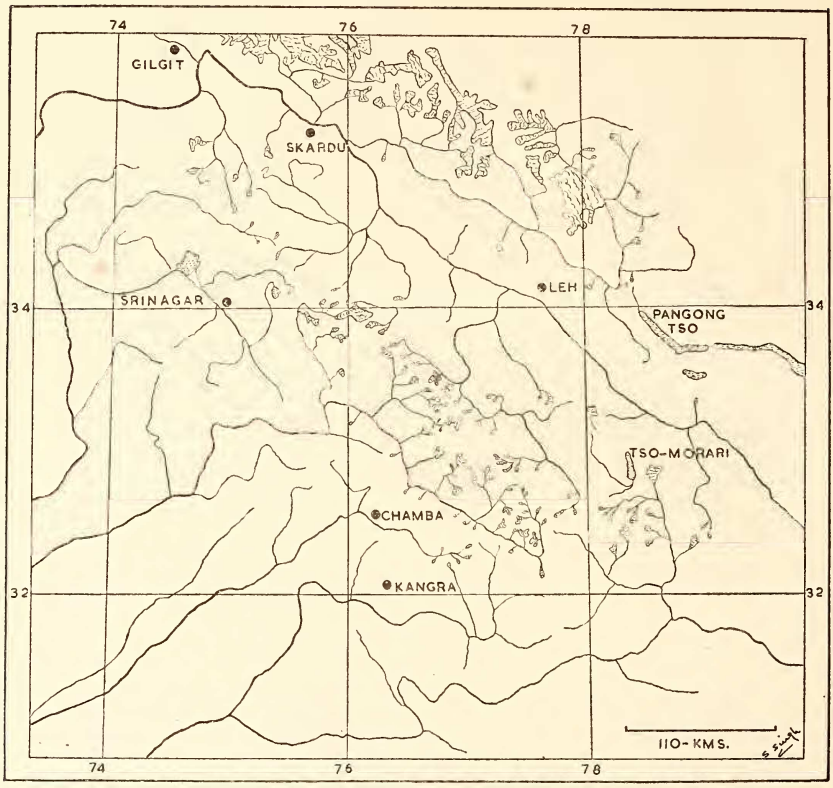

Fig. 51. Map of the region of the NW. Himalaya, showing the more important present day glaciers.

Means of Dispersal. An ecologically highly specialized group of insects, comprising predominantly flightless, endogeous or terricolous forms, have greatly limited means of dispersal. The dispersal of the greatest majority of the nival species is more or less purely passive and is often brought about by glacier movements, erratics, avalanches, etc. The slow sliding of the submerged stones helps the passive dispersal of most torrential types. The active dispersal of species, which still retain wings and are thus capable of sustained flight, such as is the case with Lepidoptera and many Diptera, is mostly restricted by the localization of their larval food plants and limited flight range and is therefore not appreciably faster than passive dispersal. It is indeed interesting that in the case of species with active means of dispersal, the distribution is more localized and the isolation greater than in those with passive means of dispersal. The dispersal is in all cases limited to the short and fleeting summer, when the snow cover is temporarily lifted for a brief period. The actual range of the greatest bulk of the nival species therefore persists substantially unchanged, often for prolonged periods.

Topography. The topographical peculiarities, which are important from the point of view of the distribution of the nival insects, centre around the trend lines of the parallel and more or less converging mountain ranges, the disposition of the inter-connecting spurs and ridges, the water partings and the location of the high peaks. These peculiarities act not merely as physical barriers to dispersal but have often also favoured and in many cases routed the distribution of different species and of faunal exchanges with neighbouring regions. The effects of topographical differences may often be more or less masked at lower elevations, but are generally greatly exaggerated above the timber line. The nival species, especially the endemites, the Pamir-central-Asian elements and the Tibetan-Himalayan elements are distributed along the trend lines of the main ranges and their spurs. The parallel series of discontinuous localized concentrations of species, with greater or less isolation and microgeographically allopatric populations, described above, are mostly mirror images of the locations of the massive high peaks along the trend lines and main crest lines of the different mountain ranges. It is only where the southern slope of a mountain range impinges on the northern flank of the neighbouring range as, for example, in the mountain knot of the Bara Bangahal in the Chenab-Beas drainage system, or when sufficiently high spurs connect the ranges, as for example, near the Nun Kun Peak in the Indus drainage area, that the distribution is at right angles to the general trend line of the Himalaya. These places are also the actual lines of inter-communication between the species complex of the different mountain ranges. Particular attention should, in this connection, be drawn to the fact that the endemites are mostly associated with the high massifs, the Mediterranean elements have spread mostly on the southern slopes, and the Indo-Malayan elements have penetrated through the valleys. Another point of interest is that the crest line of the Great Himalaya continues unbroken and unpierced by the rivers, right from the River Sutlej to the River Indus, the whole length of the NW. Himalaya. The mass of granite of the Great Himalaya seems to constitute an effective barrier to faunal exchanges between the Indus drainage area and that of the Chenab-Beas and Jhelum in the south. Such faunal exchanges occur only near the Baralacha La and the Zojila Pass. Localizations and discontinuous concentrations are admittedly the result of the ruggedness of the terrain and the differences in the ecologic optima on the different mountain ranges, their major spurs and ridges. The major details of the distribution of any species change only when the topography becomes altered conspicuously in any part of its total distributional range.

The permanent snow line. The distribution of a great many species is undoubtedly limited by the permanent snow line. Many species like *Dolmacoris deterrana* Hutchinson, *Nysius ericae* (Schill.), *Colias eogene*

francesca Watkins, *Argynnis algaia vitatha* Moore, and *Proisotoma subornata* (Denis) may be considered as indicators of the permanent snow line and are never found at lower elevations. There are numerous other species which occur exclusively at elevations far above the permanent snow line. The Heteroptera, *Emblethis horvathiana* Hutchinson (5520 m.) and *Tibetocoris margaretae* Hutchinson (5180-5365 m.) are, for example, confined to elevations above the permanent snow line. *Nysius ericae alticola* Hutchinson (5000-5300 m.), and *Chlamydatus pachycerus* Kiritschenko (4525-5335 m.) are found immediately below the permanent snow line and also at higher elevations. The same is the case with the Carabid, *Amara brucei* Andrewes (4350-5300 m.). The Staphylinid *Atheta* (*Dimetrota*) *hutchinsoni* Cam. is confined to elevations from 5300 to 5600 m. above m.s.l. and naturally much above the permanent snow line. Five local subspecies of *Parnassius delphius* Eversm. occur at elevations ranging from 5330 m. to nearly 5800 m., all above the permanent snow line. *Parnassius simo zarrensis* (Bang-Haas) and *Parnassius stoliczkanus stoliczkanus* Bang-Haas ascend up to nearly 5600 m. *Colias leechi* Gr.-Gr. and *Colias stoliczkanus* Moore both occur at elevations higher than 5600 m. Numerous Collembola like *Friesea excelsa* Denis (5500 m.) and *Orchesellides boraoi* Bonet (5200-5600 m.) also belong to the areas above the permanent snow line. The distribution of these species above the permanent snow line is confined to nunataks (*vide infra*). The permanent snow line on the different mountain ranges of the NW. Himalaya seems to greatly influence the abundance and extent of the seasonal snow cover which, as discussed in an earlier paper (100), is an important favourable factor for the distribution of most species of nival insects. The permanent snow line on the different mountain ranges thus exerts a profound influence on the abundance of species and the elevations at which they occur. Most species ascend higher where the permanent snow line is high. The wealth of species is however distinctly large where the permanent snow line is relatively low. We have, for example, a much larger concentration of species at elevations on the Ladakh Range (permanent snow line 5640 m. on the north slope and 5790 m. on the south slope) than on the Zaskar Range (permanent snow line above 6000 m. on the south slope and 5940 m. on the north slope). The south slopes of the Karakorum, drained by the River Indus, with the permanent snow line at about 5640 m., are the areas of the distribution of much larger numbers of species than the Zaskar Range. The minor fluctuations in the permanent snow line from year to year are generally reflected in similar fluctuations in the distributional pattern of the species immediately above and below.

Geology. As is well known, geologists generally recognize three more or less distinct stratigraphical zones. The northern or the so-called Tibetan stratigraphical zone lies mostly to the north of the main

crest line of the Great Himalaya and comprises continuous series of marine fossiliferous sedimentary rocks ranging from the Palaeozoic Era to the Eocene. A central Himalayan zone of crystalline and metamorphic rocks like granite, gneiss, schists, etc., often also with ancient unfossiliferous sedimentary rocks, comes next. We then have the so-called sub-Himalayan zone comprising mostly the Upper Tertiary river sedimentaries and conglomerates (Figs. 52, 53). The geological characters

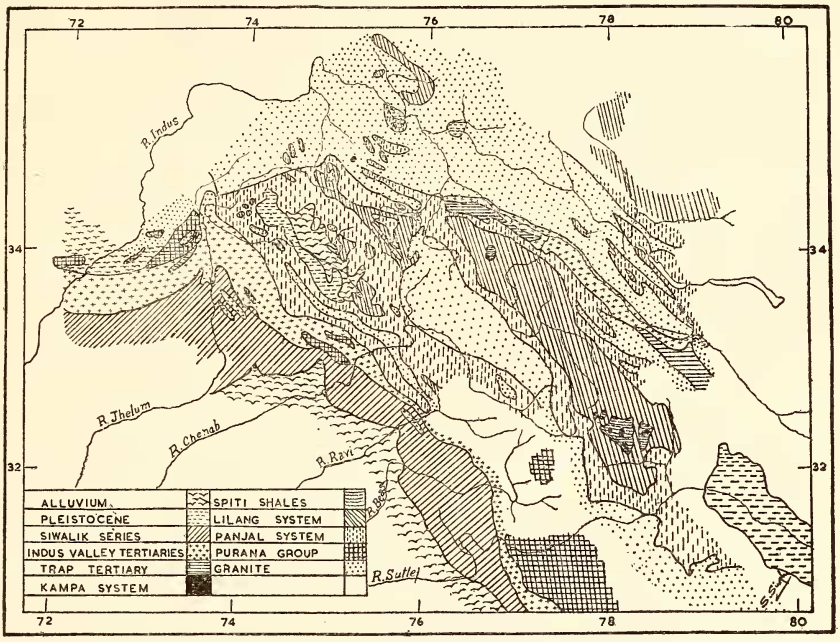

Fig. 52. Geological map of the region of the NW. Himalaya. (*After Burrard & Hayden*,'18)

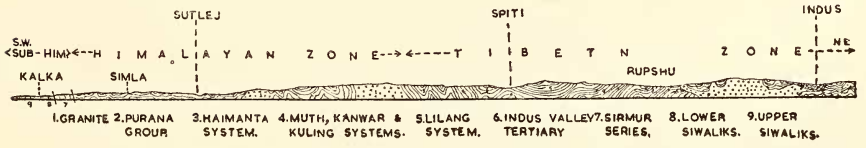

Fig. 53. Diagrammatic section of south-north through the region of the NW. Himalaya, showing the general geological structure.

of the substratum are likely to influence the distribution of a number of species through their action as limiting factors on the distribution of their larval food plants. The marine sedimentary strata north of the crest line of the Great Himalaya, with the typically arid *Artemisia*-steppes, are, for example, characterized by a remarkable community of species, which are, as far as is known at present, apparently confined wholly to these areas. Both the Indo-Malayan and the Mediterranean faunal elements also appear to be more or less restricted to the Indus Valley

shales and the Spiti shales. The relation between the distribution of the nival insects and the geological peculiarities of the NW. Himalaya is discussed further below.

Pleistocene Glaciations. The Pleistocene climatic changes are probably also at the back of the dominance of several typical nival groups like Diptera, Lepidoptera, and Coleoptera and the total or almost complete absence of others like Odonata (118). The large valley glaciers of the Pleistocene occupied the gorges and the valleys and remoulded them in many localities, transported large boulders and other erratics, and profoundly altered the general topography of the region and thus indirectly influenced the spread of most species. The effects of the Pleistocene glaciations on the nival insect fauna from the NW. Himalaya are referred to again further below.

VI. Faunal Sub-Divisions

The analysis of the distribution of the endemites and of the concentrations of species in general, presented in the foregoing sections, shows an unmistakable tricentric pattern. There are three general centres of species endemism and massing of species, coincident with the three major drainage areas and separated from each other by more or less well-marked water partings. The main water parting largely coincides with the main crest line of the Great Himalaya Range.[1] To the north of this is the vast area drained by the River Indus. South of the main crest line of the Great Himalaya we have the areas drained by two distinct systems, separated by another water parting, viz. the Chenab-Beas system (including Ravi River) in the east and the River Jhelum in the west. The three chief drainage areas constitute also three natural faunal sub-divisions or faunal provinces of the NW. Himalaya (Fig. 54). The nival insect fauna have apparently had different histories in the three provinces.

The Indus province includes the mountain ranges drained mainly by the River Indus in its upper reaches, before turning south near Bunji, viz. the north slopes of the Great Himalaya, the Ladakh Range, the Zaskar Range, parts of the Karakorum and Kailas ranges. The whole of Ladakh, Baltistan, Zaskar, Rupshu, northern parts of Kashmir in the area of Nanga Parbat, Deosi, and parts of Gilgit are within the Indus faunal province. Its boundaries are defined in the north by the main crest line of the Karakorum and in the south by the main crest line of the Great Himalaya, from the Shipki Pass in the area drained by River Sutlej on the India-Tibet border in the east and stretching north-westward to

[1]The water parting lies north of the crest line of the main range in the portion of the Himalaya east of River Sutlej ; it is only in the NW. Himalaya that the water parting and the crest line coincide, so that none of the rivers cut across the main range from the north, but run parallel to it for great distances.

the River Indus after its Bunji bend to the south, to the north-west of Nanga Parbat. This faunal province contains the maximum number of high peaks and present-day glaciers and also the largest number of areas which were more or less heavily glaciated during the Pleistocene. The

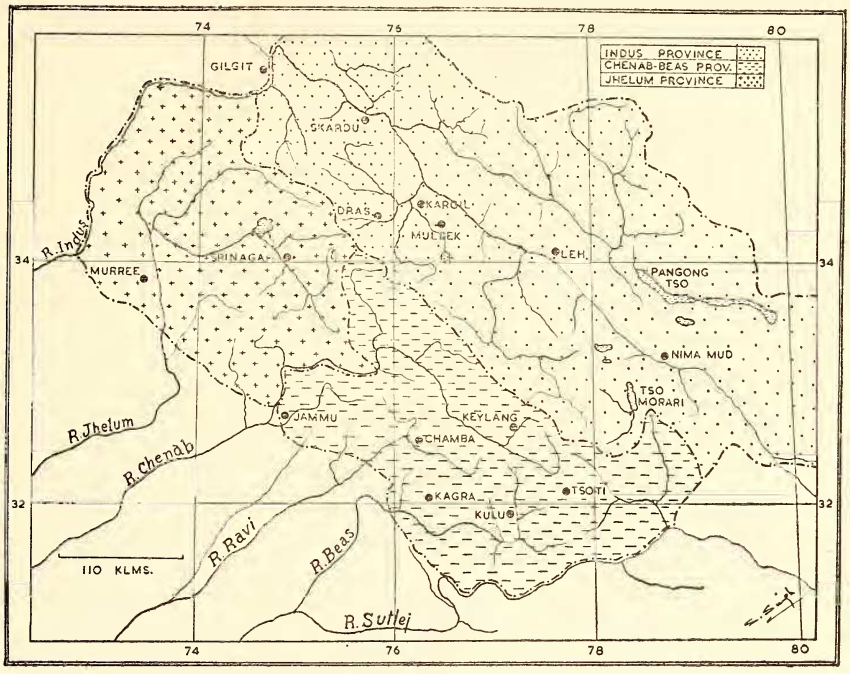

Fig. 54. The faunal sub-divisions of the region of the NW. Himalaya. The three faunal provinces coincide with the three natural drainage areas.

Indus province is also more arid than the Chenab-Beas and the Jhelum faunal provinces. Nearly 240 species have been collected from about 100 localities in the Indus province. The Chenab-Beas faunal province comprises the mountain ranges drained by the rivers Beas, Ravi, Chenab, and partly also the Sutlej, viz. the southern slopes of the Great Himalaya Range, the Great Pir Panjal Range, and the Dhaula Dhar. Lahaul, Spiti, Kulu, Kangra, Mandi, and Chamba are within the limits of this faunal province. The crest line of the Great Himalaya demarcates the northern boundary and in the west the water parting between the Jhelum and Wadhwan (a tributary of Chenab River) to Kishtwar. There are fewer high peaks than in the Indus faunal province and also fewer and shorter glaciers. Atmospheric aridity is high but not so high as that of the Indus province. The general elevation is high in the east and shows a general tendency to diminish in the west. Nearly 150 species have been collected so far from about 60 localities in this faunal province. The Jhelum faunal province contains the areas drained by the River Jhelum

and its tributaries, viz. the western parts of the south slopes of the Great Himalaya, the western end of the Pir Panjal, Kashmir Valley, and parts of Pakistan. The number of high peaks and glaciers is lowest as also the general elevation. Aridity is least marked in the whole region. About 160 species have come from about 30 localities.

The percentages of the nival species of the different orders and their faunal component elements in the three faunal provinces are summarized in tables XI and XII respectively.

TABLE XI

Analysis of the percentage abundance of species in different orders in the three faunal provinces

Serial No.	Order	Total species	Indus Prov.	Chenab-Beas Prov.	Jhelum Prov.
1	Plecoptera	5	—	100.0	—
2	Odonata	4	—	25.0	75.0
3	Orthoptera	14	46.1	7.6	46.1
4	Dermaptera	3	33.3	66.6	33.3
5	Heteroptera	17	94.1	5.8	—
6	Homoptera	1	100.0	—	—
7	Coleoptera	187	53.0	33.0	49.0
8	Hymenoptera	36	75.0	28.1	15.6
9	Neuroptera	1	100.0	—	—
10	Trichoptera	11	54.0	9.0	63.7
11	Lepidoptera	91	76.0	36.2	37.3
12	Diptera	7	57.1	—	57.1
13	Thysanura	3	100.0	—	—
14	Collembola	15	60.0	40.0	6.6

Note.—The percentages are calculated out of the total species of the order in the NW. Himalaya ; in the case of Hymenoptera the percentages are out of only 32 species, because the exact distribution of the 4 remaining species is not known at present.

TABLE XII

Analysis of the faunal elements in the three faunal provinces

Serial No.	Province	Total species	Autochthone %	Palaearctic		Indo-Malayan %
				Total %	Medit. %	
1	Indus	240	42.6	97.0	4.0	2.0
2	Chenab-Beas	121	26.0	97.0	58.0	3.0
3	Jhelum	155	22.0	95.0	5.0	5.0

Note.—The percentages are out of total species from the province, except in the case of the Mediterranean elements, where it is out of the total Palaearctic of the province.

A reference to Table XII will show that the largest number of autochthone species is found in the Indus province, in other words the species endemism is here at the maximum. There are as many as 102 endemites (47%) and about 60 non-endemites on the mountains drained by the River Indus. The Indus province is also a region of maximum localized concentrations of nival species. Among Coleoptera nearly 54% of the nival Carabidae, 86% of Hydrophilidae, the whole of Tenebrionidae, and about 70% of Chrysomelidae are found in the province. About 75% of the Bombidae and 92% of the Formicidae are Hymenoptera of the Indus province. In Lepidoptera, it is interesting to observe that the percentage of species in the major families is similarly high, viz. Papilionidae 71%, Pieridae 95%, and Nymphalidae 63%. Almost all the central-Asian elements so far known from the NW. Himalaya occur in the Indus province. Localizations to the south of the crest line of the Great Himalaya in the Chenab-Beas province include about 32 endemites and 30 non-endemic species. In the Jhelum province we have about 37 endemites and 25 non-endemites. About 14% of the species found in the Indus province also occur in the Chenab-Beas province and about 28% in the Jhelum province. The percentage of the Indo-Malayan element is highest, viz. 5%, in the Jhelum province. The Mediterranean elements are high (8%) in the Chenab-Beas province. The Indo-Malayan and the Mediterranean elements are low (2% and 4% respectively) in the Indus province. The area of contact of the Indo-Malayan and the Palaearctic Realms thus appears to be situated between the crest lines of the Great Himalaya and the Pir Panjal ranges.

(*To be continued*)