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PRELIMINARY REPORT ON THE YALE NORTH INDIA EXPEDITION

By Dr. H. DE TERRA

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SCOPE OF THE EXPEDITION PLAN

THE idea that geological and biological sciences may support each other in research on related problems may at first appear strange, especially if they are supposed to cooperate in a task of exploration in a region so little known as the Himalayas. However, for me, who had explored formerly as a geologist in western Central Asia and northern India, it seemed quite obvious that a study of fresh-water life in these highly elevated mountain ranges would help to throw new light on the geographical conditions of the Himalayas during the Pleistocene and postglacial periods. For it was in comparatively young geological times that the Tibetan plateaus and the adjoining highlands were uplifted to form the "Roof of the World," and it was to be expected to find a peculiar faunal character with endemic forms which would reveal faunal relations to Central Asia or to India.

The geological work was to be focused on the study of those diastrophic events which resulted in the earth's highest mountain structure, north of peninsular India. Investigation of such a wide scope which was to be carried out on difficult territory required careful selection of particularly promising mountain sectors. These were to be found in Kashmir proper, where a thick Pleistocene sequence of strata in a structural basin could furnish evidence on Pleistocene orogeny. On the other hand, the eastern Karakoram, north of the Himalayas, seemed to be most profitable for an investigation of the structural outlines of this northern neighbor of the Himalayas. Geomorphological observations were to support the structural studies. A topographical survey was to facilitate this work. Finally, there was a good chance for collecting vertebrate fossils in the richly fossiliferous Siwalik formations south of the Himalayas.

Owing to the great interest which this plan of mine found at Yale, and thanks to the kind support it received by its President, of Professor Ch. W. Warren, dean of Sheffield Scientific School, of Pro-

fessors R. S. Lull and R. G. Harrison, I could start with the field work on March 1, 1932.

The biological work had been entrusted to Mr. E. G. Hutchinson, assistant professor of biology at Yale; the paleontological collecting to Mr. G. E. Lewis, of the Peabody Museum at New Haven. Temporary additional members of the staff were: Mr. A. M. N. Ghosh, of the Geological Survey of India, and Khan Sahib Afraz Gul Khan, surveying officer of the Survey of India.

Collecting and Studies in the Salt Range

The first field trip led to the Salt Range in the Punjab, where each of the members pursued their own scientific tasks. Following a personal request from Professor Charles Schuchert, of Yale University, a collection of invertebrate fossils in the well-known and highly fossiliferous Permian and Triassic limestones of the Salt Range was to be made. Owing to the generous help of Dr. L. L. Fermor, director of the Geological Survey of India, Mr. Ghosh from the Survey was made available for this work. He collected first under my supervision and later independently near Warcha, Amb and Chideru. New sections of the Permian formation were also studied at these places, and it is hoped that these new data will throw additional light on the age of the Permian glaciation. In Professor Schuchert's opinion this collection turned out to be very satisfactory, as almost all Waagen's types and additional genera are represented.

Hutchinson studied some salt lakes on the central plateau of the Salt Range northwest of Kushab. The paleontological collecting continued in the area of the upper Soan River until the middle of May.

Geological and Biological Work in Kashmir

On March 18, my wife, Mr. Hutchinson and I moved from the Punjab to Srinagar, Kashmir. This city through its central location in the Kashmir Valley made a convenient place for expedition headquarters. Here camp and other additional equipment could be purchased for the summer trip to western Tibet and the Karakoram Ranges. Furthermore, all excursions into the Kashmir Valley, be it by houseboat, car or pony caravan, could be arranged from Srinagar. Hutchinson spent from March 24 until May 10 on the large lakes: Dal-, Anchar-, Manasbal- and Wular-lake and on the Jhelum River as well. I could almost devote the same amount of time, though frequently interrupted by preparations for the coming summer trip, to the geological study of the Valley of Kashmir. Middlemiss had already found through former studies that the so-called Karewa formation (Pleistocene) of the Kashmir Valley had been disturbed and folded along the southern flank of the basin. The exact age of these clay, sandstone and gravel series had since Godwin Austin's time always been disputed. Lack of fossil evidence and of a closer field study prevented the stratigraphic classification of these interesting strata which evidently had taken part in Hamalayan diastrophism. During the spring and later again in the fall of 1932, I found several new and highly important fossil localities in the Karewa. In gray fat clays, presumably belonging to an interglacial period (of Illinoian-Wisconsin age), I found three rich plant localities. Prominent amongst the plants are, besides *Almus, Populus, Quercus,* the genera *Buxus, Trapa* and *Charophytes,* and Cinnamon, indicating a climate similar but somewhat warmer than Kashmir enjoys nowadays. These plant-bearing clays were found overlain by moraine material of the last glacial stage. The upper Karewa beds yielded a great number of fresh-water shells, plants, and the remains of a straight tusked Proboscidian. The latter was found near Sombur, being probably the first Himalayan representative of a mammoth. Only six miles distant from this locality I came across some prehistoric artefacts lying in the upper Karewa beds. On another locality I believe to have found similar, although somewhat doubtful, implements. As not only the lower but also the upper Karewa have been tilted and dragged high upward along the Pir Panjal Range, it seems obvious that a diatrophic phase of late Pleistocene, and even possibly of later date, resulted in renewed uplift of the flanking Himalayan Ranges in the region of the upper Jhelum River. This uplift may be estimated from 6,000 to 8,000 feet.

Hutchinson's work in the lakes in Kashmir resulted in a large collection of fish and various fresh-water forms and in gathering chemical and other biological data. The faunal character appeared to be different from that of the Indian lowlands, with quite a number of endemic forms. As the ancient lake beds of subrecent and Quaternary origin contain a great number of fossil shells, it should be possible to find considerable amount of evidence on the late Pleistocene-alluvial history of the Kashmir Lake basin.

Expedition Activities in the High Himalayas and Eastern Karakoram

Around the middle of May the expedition members united at Srinagar to prepare for the start to the highlands of western Tibet. A caravan carrying food and biological apparatus was sent ahead to Leh, capital of Ladakh, in the upper Indus Valley. Khan Sahib Afraz Gul Khan, our surveyor, with his two servants, had joined us here and we all left Srinagar on May 16. Within two weeks we crossed the northwest Himalaya on the "High Treaty Road" into Ladakh, and arrived at Leh on June 2. An excursion to the great monastery of Hemis proved to be a unique

experience, as we witnessed the lamaistic mystery play. This short trip into a side glen of the Indus Valley brought me also a large collection of old Tertiary plants, of which I had found a few traces during my first journey in 1927. On June 21, we left Leh for the Panggong Lake and crossed the southern Karakoram Ranges, taking the route *via* Digar- and Shakya Pass (18,100 feet) to Tankse and Lukong. The great Panggong lake basin (13,915 feet), extending from Ladakh into the Tibetan province of Rudok, and containing one of the largest, high mountain lakes north of the Himalayas, afforded good possibilities for our geological and biological work. The lake, now salty, must have been a fresh-water lake of considerable depth and extension during the last interglacial period. Shell-bearing lake beds containing fish vertebrae are overlain by morainic boulder. As in the case of the Kashmir Valley, the fossil remains of fresh-water life will help to reconstruct the changes in biological conditions during postglacial times.

From the Panggong an excursion led to the high valley of Koh-lungpa (17,250 feet) and across the main Karakoram Range to Ororotse Tso. This lake (17,383 feet) was found still solidly frozen on July 12, but it proved to be very rich in fresh-water life. The main axis of the Karakoram Range, bending here from a northwest-southeast into a west-easterly trend, was crossed a second time on our way to the upper Chang-Chenmo Valley (17,000 feet). A line of higher snow peaks, all ranging over 21,000 feet in altitude, was found continuing south of this valley toward the Tibetan frontier, where it gradually passes over into a broken line of monadnock-like snow massives surmounting the western Tibetan plateau. This range is regarded by me as the easternmost outpost of the high Karakoram Range. Our route led us from here along the Tibetan frontier *via* Nyagzu back to the Panggong Lake.

The geological structures in this part of the Karakoram are characterized by heaving, folding and steeply inclined thrusts; the latter being between nice granite and metamorphic rocks on one hand, and fossiliferous young Paleozoic to marine Triassic and Cretaceous formations on the other. The pressure of folding must have acted vertically, but from the Mustagh-Karakoram Range on northward it seems to have thrown the folds towards Central Asia. In comparison with my former observations, I am inclined to believe that the southern Karakoram Ranges (Mustagh- and Kailas-) represent "root-zones" of large thrusts, while the adjoining highlands between the northern Karakoram and the K'un-lun Mountains are made of lesser folded portions of the Himalayan region. Evidences of thrusting on a large scale were also found in the northwest Himalayas near Karghil, where thick Triassic limestone series have been moved upon Cretaceous formations. These observations, of which only very little can be related on the occasion, lead me to believe that the geological structure of Himalaya and Karakoram is dominated by thrusting in alpine fashion. Although it still remains to be seen whether this thrusting led to a regular "Deckenstructure," the evidence rather leads to the conclusion that these highest mountain ranges show themselves not only morphologically but also structurally as true alpine ranges, which have been folded up from the bottom of the former Tethys Sea at various times in intervals from the close of the Cretaceous up to the close of the Tertiary period. The geomorphic features of this highest relief are composed of four main elements: (1) Remnants of a preglacial relief consisting of plateau relicts and piedmont levels between 16,000 and 20,000 feet altitude. (2) Glaciated high ranges and massives (20,000 to 22,000 feet), surmounting the former widely extended plateaus. (3) The glacial relief which dominates the landscape. (4) Postglacial features bearing evidence of wide-spread and most intense rejuvenation of rivers through broad uplift at intervals.

It was surprising to find plenty of evidences for a recent rise in the lake level of most high mountain lakes. This became especially apparent along the shores of Panggong and Tso Moriri Lake, where trigonometrical stations, religious buildings, roads and lower beach levels had been inundated by what appears to be a recent increase in precipitation. It is to be hoped that these observations, together with Dr. Haude's meteorological work in Central Asia (Swedish-Chinese Expedition of Sven Hedin), will help toward an ultimate solution of the problem of the "desiccation of Central Asia." From the Panggong we worked our way southward along the Tibetan frontier to the Pongur Tso, to Chushul, the Indus Valley, Moriri Lake in Spiti, and back to Leh.

The total route of 1,300 miles by pony and caravan, with nine important mountain lakes on our way and 4,600 square miles of newly surveyed territory, gave us ample opportunity to follow the original plan of field researches. Much credit for this undisturbed field work has to be given to my companions, my wife and Professor Hutchinson, and to our surveyor, who in spite of his strenuous work was always willing to assist me greatly in expedition matters.

During my geological investigations a great number of invertebrate fossils were collected. Aside from limnological material and a number of smaller mammals a few hundred plants have been gathered by Professor Hutchinson. He also succeeded in getting many data on the ecology of the invertebrate ground fauna at altitudes over 17,000 feet. "It is hoped,"

he says, "that a study of the zoogeographic realm of the invertebrates living at high altitudes will throw much light on the history of these regions. As far as it is possible to judge at present, the rather large number of species endemic to these elevated regions argues against any wholesale glaciation of the region."

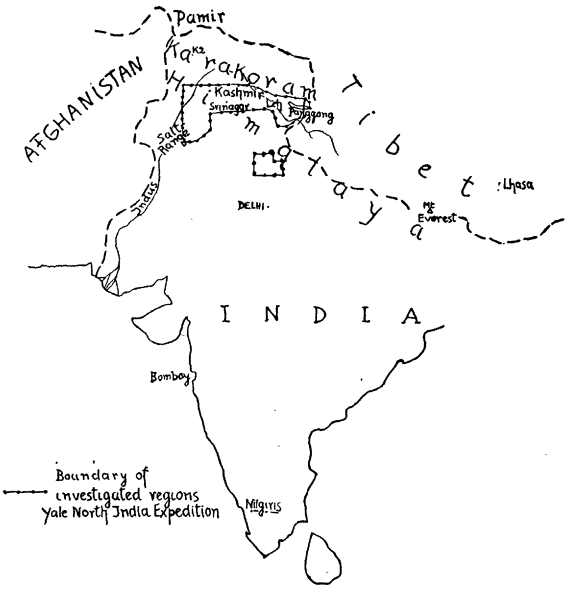
The expedition returned from Ladakh to Srinagar, Kashmir, on October 2.

VARIOUS ACTIVITIES OF THE EXPEDITION UNTIL JANUARY, 1933

During the last five months the various expedition members were busy in Kashmir, the Punjab, Calcutta and the Nilgiri Hills of southern India. Although the latter region was out of the general field of our studies Hutchinson was anxious to get some zoogeographical data on the fauna of the Nilgiris in relation to the "pluvial relict" hypothesis.

Mr. Lewis, who had started back in June to the more promising fields of the Siwalik formations, collected in Bilaspur State in the Simla Hills and adjacent portions of the Punjab. He also worked in the Siwalik Hills proper, from the Sutlej River to the Kaluwala Rao near Dehra Dun (United Provinces). He reports about his results as follows, "An abundance of excellent material was collected in the time available, and in addition to the large vertebrate fauna numerous invertebrates and paleobotanical specimens were secured; all of which will be added to the collections of the Peabody Museum of Natural History of Yale University."

My field work in Kashmir continued until November 23 and was then transferred partly back to the Salt Range and partly to the Siwalik foothills in the Rawalpindi district. The last excursion to the southwestern Salt Range undertaken for the sake of the tilted Pleistocene strata made me come across a prehistoric site. This was discovered first by Mr. Hutchinson, who had done biological work on the salt lake Kalakahar. A second locality was found near-by on an ancient lake terrace with three layers of implementiferous soil containing coup de poing, scrapers and rejects of presumably early paleolithic age. A human skull was found in between the upper two



layers. With the kind permission of the director of the Indian Archeological Survey I was able to collect these traces of what appears to be the earliest settlement of prehistoric man in India.

Around the middle of January, 1933, the field work of the expedition was terminated and the members left India shortly after. The scientific collections have safely arrived at New Haven and shall be worked upon by the members of the expedition and with the aid of scientific experts.

As this undertaking was being carried out in countries which offer many natural hindrances to scientific exploration, the success of the expedition was due in great part to the help of the Government of India and various Indian scientific institutions. I greatly appreciate all the support that has been so generously extended toward us by British-Indian government officials.

H. DE TERRA

YALE UNIVERSITY

A HISTORY OF THE NATIONAL RESEARCH COUNCIL 1919–1933

III. DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH[1]

By Professor DUGALD C. JACKSON

CHAIRMAN

THE Division of Engineering was established as one of the Council's divisions in 1919 for the purpose of organizing and coordinating engineering research in industry. Its membership consists of representatives

[1] This is the third of a series of ten articles prepared to describe briefly the nature of the activities with which the National Research Council has been engaged during the past fourteen years.