and experiments on this blood are in progress at Cambridge. It is hoped that a full account will be published shortly in "Discovery Reports".

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Limnological Studies at High Altitudes in Ladak

IN his studies of the Alpine lakes of Central Europe, Pesta¹ has characterised the smaller lakes at the highest altitudes as pan-oligotrophic. Such lakes, despite their small size, show a very high oxygen content in the hypolimnion and have a poorly developed bottom fauna and plankton. Recently, during the work of the Yale North India Expedition under the leadership of Dr. H. de Terra, it has been possible to make limnological studies on a number of lakes in Ladak lying at altitudes between 4,267 m. and 5,274 m. In waters more than 10 m. deep at

limits of those derived for some of the lakes of north-eastern Wisconsin from the data of Juday and Birge.²

In two other small lakes, Khsagar Tso and Mitpal Tso, considerable oxygen deficiencies were also observed in the hypolimnion. Since the water is brackish and no bathymetric maps are available for these lakes, it is not possible to use the chemical data obtained so completely as in the case of Yaye Tso.

A fourth glacial lake, Ororotse Tso, lies at 5,274 m., and is apparently the highest lake yet studied limnologically. When visited on July 11, 1932, Ororotse Tso was still covered with ice save at the extreme edge and it seems doubtful if it ever becomes entirely clear. The water was probably being disturbed by convection currents from the margin, but a bottom sample from 14 m. showed a slight oxygen deficit. The lake contains, moreover, considerable amounts of plankton and has a quantitatively rich bottom fauna, approximately 8,900 animal organisms, all chironomid larvæ, occurring per square metre in 14 m. of water. This number is considerably greater than the estimate for the Yaye Tso, in which lake there were approximately 4,800 organisms per square

metre, mostly chironomid larvæ and tubificid worms. Such figures may be compared with that for the oligotrophic Tso Moriri, in which but 450 organisms per square metre, all chironomid larvæ, were found at a depth of 50 m.

Since the area studied is largely semi-desert, the Ladak lakes might be expected to resemble those of other semi-arid regions. This expectation is to some extent fulfilled in that lakes in such regions frequently lack outlets and accumulate large quantities of electrolytes. The Ladak lakes, however, differ markedly from those of other semi-arid regions³ in that they show no trace of a paratrophic condition. It appears, therefore, that the smaller high altitude lakes of Ladak have more in common with the less extreme eutrophic or mesotrophic lakes of the lowlands

FIG. 1. Thermal and chemical stratification in Yaye Tso, Ladak.

such altitudes the surface temperature in August and the beginning of September lay between 11.73° C. and 14.19° C., that is within the ranges recorded for the pan-oligotrophic type by Pesta.

Two types of basin are to be found in the region studied. The first type comprises the tectonic depressions containing the Pangong Tso, Tso Moriri and Pangur Tso. The first two of these, though lacking outlets and therefore rich in accumulated electrolytes, are comparable to normal oligotrophic lakes. Pangur Tso is very shallow, is not thermally stratified and appears to be entirely carpeted with flowering plants.

The second class of basin is of glacial origin and includes a number of small lakes in kars and kettle holes. Of these, Yaye Tso, a freshwater lake lying at 4,686 m. and draining into the Indus just south of Mahe, was most intensively studied. It is clear from Fig. 1 that this lake has a quite well-developed eutrophic oxygen curve. Calculations based on a bathymetric map made from two lines of soundings indicate that on August 11, 1932, the lake had an actual oxygen deficit of 1.1 mgm. per square cm. of hypolimnion surface. This figure lies within the

of Europe and North America than they have with the pan-oligotrophic lakes of the Alps or with the lakes of less mountainous semi-arid regions.

I have great pleasure in expressing my thanks to Dr. de Terra for continual opportunities for prosecuting these studies and for his never-failing help and encouragement in the field. A full account of the limnological work of the expedition will be published as soon as taxonomic studies have been completed by various specialists.

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¹ *Die Binnengewässer*, 8. "Der Hochgebirgsee der Alpen", Stuttgart, 1929.

² *Trans. Wisc. Acad. Sci. Art. Lett.*, 27; 1932.

³ Decksbach, *Verh. Int. Ver. theor. angew. Limnol.*, 2; 1924. Stanković, *ibid.*, 5; 1931. Hutchinson, Pickford and Schuurman, *Arch. Hydrobiol.*, 24; 1932.