CHAPTER 1

INTRODUCTION
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Kashmir lies on the northern fringe of the Indian subcontinent. It has innumerable lakes differing in topography, altitude and situation. These lakes have a definite impact on the socio-economy of the State as they provide tourist recreation spots, fisheries, small game and floating islands for vegetable cultivation.

The freshwater lake ecosystems are of fundamental importance to human welfare inasmuch as they profoundly influence the food production. Recently, with the implementation of the International Biological Programme, much emphasis has been laid on the production studies in lakes throughout the world. Although the ultimate measure of the productivity of a lake is its ability to produce fish crop, yet the knowledge about the contribution of primary producers in an aquatic ecosystem is very much desirable and important. A good amount of work in this direction has been already done by
Hayne and Ball (1956), Ohle (1956), Fish (1960), Prowse (1962), Aruga (1963), Findenegg (1965) and Wetzel (1965). Though any detailed studies are, by and large, lacking in the tropical world, especially, in India yet the recent researches conducted by Zafar (1956), Ganapati (1970) and Sreeenivasan (1971) on fish ponds and lakes in south India are noteworthy.

The ecological studies on the lakes of Kashmir have received only little attention in the past. Mukeerjee (1921, 1925-26, 32) was the first to publish a few abstracts pertaining to a fragmentary account of the vegetation of Kashmir lakes. The reports, however, do not give any insight into the ecological behaviour of these lakes. Hutchinson (1937) came over to Kashmir with Yale North India Expedition and reported on some zooplanktons of the lakes of Indian Tibet. His studies on the whole pertained more to fish than to any hydrobiological aspects. The study of the physical, chemical and the biological characteristics in addition to certain other lake parameters was for the first time undertaken by Kaul and Zutshi (1966, 67), Zutshi (1968), Kaul and Vass (1970 a,b), Kaul et al. (1971) and Zutshi and Vass (1971a,b, 1972). The studies which mainly concentrate on the ecology of macrophytes, besides other lake parameters, can at the most be said to be far from complete.

The present investigation was undertaken to study the limnology of some Kashmir Valley lakes in order
to classify them according to dynamic-trophic concept of Lindemann (1942). In addition the estimation of the yearly production of both macrophytes and planktons was done for assessing the efficiency of the lake ecosystems.

Lakes on the scale of years or of human life span seem to be somewhat permanent features of landscape though geologically transitory and usually born of catastrophes, to mature and to die quietly and imperceptibly. The various lake basins may resemble each other in certain general characters yet differ markedly in size and depth and so, in their rate of maturation and senescence. And it is this diversity in unity that lends fascination to the subject of limnology. A group of lakes confronts the investigator as a series of very complex physico-chemical and biological systems, each having its own characters and yet much in common with the others. These lakes further form more or less closed systems and thus provide a series of varying ecological worlds (Hutchinson, 1957).

**AREA OF STUDY:**

The Central Himalyan axis, after its bifurcation near Kulu, runs as one branch to the north-west known as the Zanskar range, terminating in the high twin peaks of Nun-kun; the other branch runs due west, a little to the south of it, as the Dhauladhar range, extending further to the north-west as the high picturesque top of the Pir Panjal, so conspicuous from all parts of the Panjab. Between these two branches of the crystalline axis of the
Himalayas lies a longitudinal valley with a south-east to north-west trend, 135 Km long and 40 Km broad in its middle, the broadest part. The total area of this valley of Kashmir is 3040 sq.km., its mean level about 1600 m above the sea. The ranges of mountains which surround it at every part, except the narrow gorge of the Jhelum at Baramulla, 54 km south-east of Srinagar, attain to the north-east and north-west, a generally high altitude, some peaks rising above 6000 m. On the south-western border, the bordering ridge, the Pir Panjal is of comparatively lower altitude, its mean elevation being 4000 m.

Srinagar is the summer capital of the Jammu and Kashmir State and is situated between 34°5' and 34°10' North latitude and 74°8' and 74°9' East longitude in the heart of the valley of Kashmir. There are number of lakes, larger ones and smaller or tarns, both, in the Valley of Kashmir and in the bordering mountains, most of which are of recent glacial origin; though a few are of true rocky basin type. The present study pertains to the lakes in the valley lying at the altitude of 1600 m.a.s.l. The three lakes selected for the present study are the Dal, the Anchar and the Manasbal. The Dal lake and the Anchar lake are just in or near the Srinagar city, the former 4 km away while the latter is at a distance of 14 km from the city. The Manasbal lake lies towards the north of Srinagar and is situated at a distance of 32 km from the main city (Fig.1). All the three lakes are easily approachable, both,
by road and river and are of great economic importance in terms of their yield of food, fodder, fish and other useful plants. Bathing, aquatic sport, fishing and harvesting weeds for different uses are some of the common disturbances that these lakes are subjected to, though the magnitude and the type of disturbance vary from lake to lake. A brief description of these lakes is given below:

l. The Dal lake

This lake is situated on the eastern side of Srinagar at an altitude of 1587 m, covering an area of 11.5 sq. km. A small stream viz., the Telbal Nallah flows into the lake on its southern end; being its principal feeding channel. The other sources of water for the lake are a number of springs mainly on the eastern side of Hazratbal. A sizeable portion of the lake is covered by floating islands and marshes. On the north-west, near Drogjin at the foot of the Shankaracharya hill, the lake has an outlet for discharging water into the Tsunt Kuhl (local name for a stream), a tributary of the river Jhelum.

The shore line is mostly natural though interrupted here and there by man-made barricades. Hence the lake is not a continuous sheet of water but is divided into distinct but inter-connected parts, depicting a multiple basin (Fig.1). The chief divisions of this lake are:

a) The Gagribal basin

It extends from the Nehru Park channel to Kotar
Fig. 1 Location map of different lakes.
Khanna. This part of the lake touched the outer fringes of the Shankaracharya hill before 1930 when the present Boulevard Road was constructed (Khuihami, 1954). The road has cut off a sizeable portion of the lake that has been gradually reclaimed since. Roundabout that time an island known as Kotar Khanna was built in the lake for purposes of providing residential-cum-recreational quarters for tourists. A small bund projecting inwards from the western side and quite close to this island was also constructed simultaneously and this has resulted in the separation of the Gagribal part from the main body of the lake.

b) The Hazratbal basin

This part, facing the snow-capped Mahdev mountain, is flanked by three famous Moghul gardens i.e. the Shalimar and the Nishat on the western side and the Naseembagh on its eastern side. Telbal nallah flows into this part on the southern side and helps in the renewal of its water regularly. This nallah is also the source of the heavy content of suspended particles in the water. Another age old island, the Sona lank, lies in the centre of this part.

c) The Bod dal

This part of the Dal lake extends from Kotar-Khanna to Nishat Bund. A small island viz Rupa-lank in its centre is the conspicuous feature of this part. The bund which separates the Bod dal from the Hazratbal lake was constructed about 800 years ago during the reign of Sultan Sikandar. Another bund which separates the Nagin basin
from the Bod dal was erected in the 15-Century (Lawrence, 1895), (Khuihami, 1954).

d) The Nagin basin

This is the deepest of all portions of the Dal lake, being connected with the Hazratbal basin on the northwest and with various side channels on its north-east. Since early 19th Century this part is being used for aquatic sport (Saraf, 1970).

Quite a large part of the Dal lake has been reclaimed from time to time. This has yielded sizeable portions of land, which break the continuity of water. In fact this action has resulted in the formation of a number of channels which are used for irrigational and navigational purposes. The creation of new floating islands, (Kaul and Zutshi, 1966) are continuously giving rise to new channels. These channels present quite a different type of aquatic habitat from those of the other parts of the lake, chiefly because of their shallowness, and slowness of water movement. As the banks of these channels are thickly vegetated by willows, the air movement in these channels is almost negligible.

2. The Anchar lake

It is situated at a distance of 14 km south-west of Srinagar. The lake is fed by a net work of channels which flow from the river Sind and enter it on its eastern side. It has an outlet on its eastern side, away from the feeding channels, and it is through this outlet that the discharge
of water into the River Jhelum takes place. There is no regulating process to control the inward or outward flow of water as there is in the case of the Dal lake. Barring the stress associated with aquatic sport, the lake is exposed to all other biotic disturbances as in the case of the Dal lake.

3. The Manasbal lake

It is an oval-shaped sheet of water about 32 km north of Srinagar. The lake is surrounded by mountains on two sides and by a stretch of Karewashes (plateus) on the third. The absence of any feeding channel makes it a type different from those of the first two lakes. Excessive water is drained off into the River Jhelum through an outlet. This lake is the deepest of the valley lakes and hence much more interesting from the limnological point of view. It is free from weeding and aquatic sport. Fishing is done for the major part of the year. The lake has very steep shore line and the banks are thicketed by the species of Salix.

ORIGIN OF LAKES:

The origin of lakes in Kashmir is traced to interesting geological phenomena through which the valley has passed. Stein (1899) does not contribute to the theory of Kashmir Valley being a vast lake during the past geological age. Dianelle (1922) believes that the present lakes such as the Wular, the Anchar, the Manasbal and the Dal, have been formed from the progressive shrinkage of the ancient glacial lake. Wardle (1903) on the other hand,
Fig. 2 Climatic diagram for Srinagar (1970-71).
considered the valley of Kashmir, as a flat plain of pleistocene alluvium of a lake, which found its outlet at Baramulla. According to de Terra and Paterson (1939) the Kashmir lakes lie in the flood plain of the river Jhelum, whose broad meanders have cut swampy low lands out of the Kerewa terraces. The position of the lakes shows that they are derived from enlarged ox-bows and abandoned flood channels rather than from progressive shrinkage of a glacial lake. Wadia (1947) compared the lakes of Kashmir with the jheels and bheels of Bengal. The lakes according to him are formed from the inundated parts of the River Jhelum which have alluvial dams and marshy borders. Several tributaries of the Jhelum drop their silt into the lakes.

**CLIMATE OF THE AREA**

Climatically, Kashmir falls in sub-mediterranean type with three dry months in the year. The mean maximum air temperature in the summer (June - August) rises to $32^\circ C$ and in the winter (January - February) it falls below zero. There are four distinct seasons in the year viz., i) Spring (March - May) with frequent rains; ii) Summer (June - August) dry and humid; iii) autumn (September - November) cool with an average rainfall of 40 mm and iv) winter (December - February) chilly, with precipitation mainly received in the form of snow. The various seasons are almost of equal duration. The percentage relative humidity throughout the year ranges between 40 to 90 percent. The main climatic features are represented in fig.2.