

THERMAL STUDIES ON LAKES PETERS AND SCHRADER, ALASKA*

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Limnologists have attempted many times to classify lakes according to their thermal cycles. Most of the time these systems of classification have carried geographic implications as is suggested by Forel's use of the term "polar lakes" (quoted by Hutchinson and Löffler, 1956). Limnologists have found, however, that many factors other than latitudinal geography can modify the thermal cycles of lakes. Among these factors are altitude, protection from sun and wind, past history of the lake, depth of the lake, and amounts of dissolved and suspended solids in the water.

Two field seasons of investigations of Lakes Peters and Schrader, Alaska, have revealed some interesting effects of the arctic environment on the thermal cycles of the lakes. The results illustrate how variable the cycles may be in the Arctic, and how much the local conditions may influence them.

Location and Description

The two lakes are located in northeastern Alaska, on the northern slope of the Brooks Range. At this point the Brooks Range swings north a little, so although the lakes are in the mountains, they are only 65 miles southwest of Barter Island, on the coast. The lakes were formed when the end moraine of a mountain glacier blocked a narrow glaciated valley. Lake Peters lies towards the head (southern end) of this valley and is surrounded by high peaks, while Lake Schrader lies at the northern end of the valley and is surrounded by low hills. Connecting the lakes is a narrow channel, some 5 to 8 feet deep. Both of the lakes are at the same altitude, about 2800 feet. Some other characteristics of the lakes are given in Table 1.

TABLE 1. MORPHOMETRIC DATA FOR LAKES PETERS AND SCHRADER

	Peters	Schrader
Surface area (mile ²)	1.8	3.4
Greatest length (miles)	4.0	5.0
Greatest breadth (miles)	0.9	1.5
Mean breadth (miles)	0.6	1.0
Greatest depth (feet)	164	187
Mean depth (feet)	79	108

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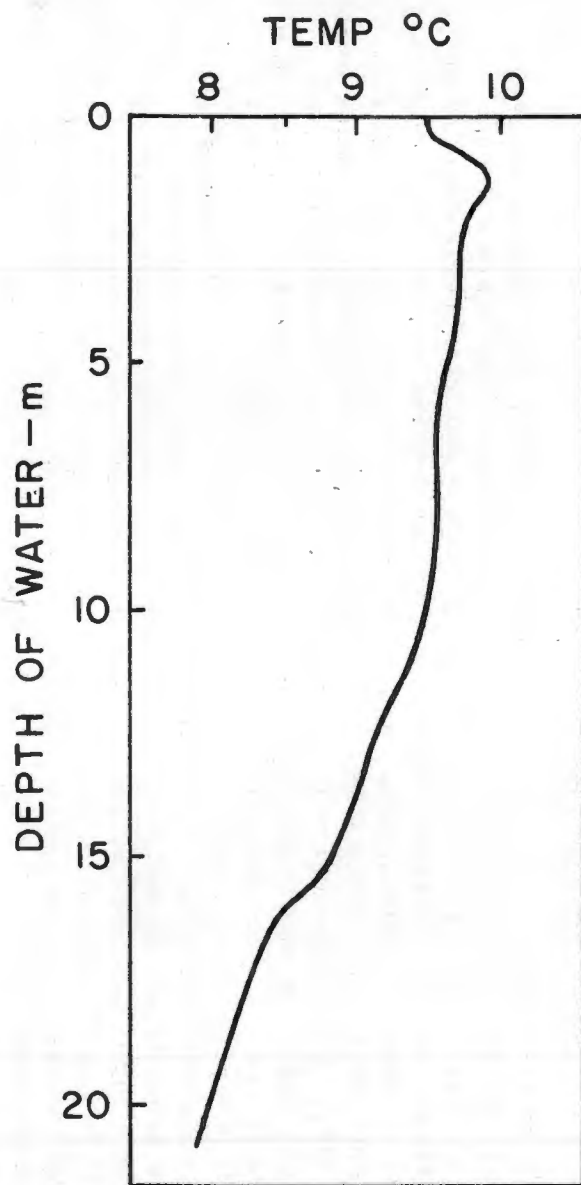


Fig. 1. Temperature profile at Station 1, Lake Peters, on August 23, 1958.

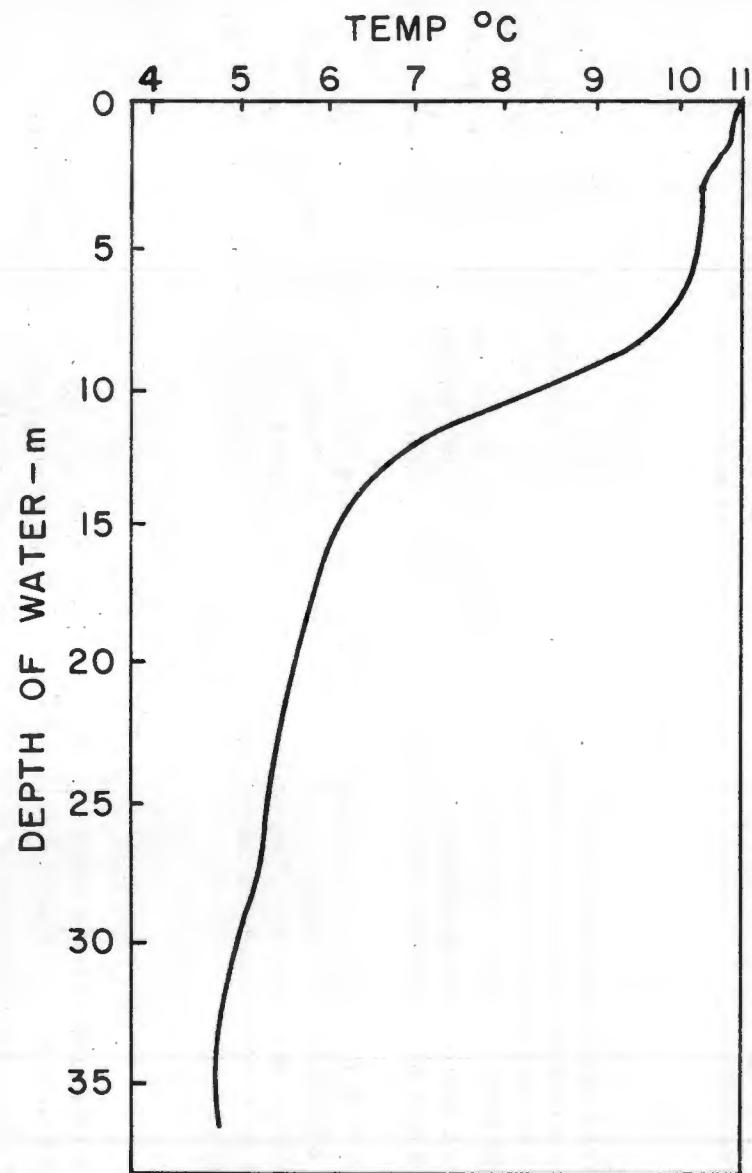


Fig. 2. Temperature profile at Station 3, Lake Schrader, on August 23, 1958.

From the table it is obvious that Schrader is bigger and deeper than Peters. However, the water movement is from Peters to Schrader and most of the inflowing water enters Peters. These influent streams are almost all glacial in origin and carry large quantities of glacial rock-flour into Lake Peters, coloring it a milky green during the summer. Schrader remains quite clear.

Thermal Cycles

When investigations were started, June 26, 1958, the ice on Lake Peters was almost melted and the water temperature (as measured by thermistors) was close to 4°C. By the middle of August when the lake reached its maximum temperatures, the whole lake was between 8°C and 10°C. While the lake was heating to this temperature there were brief periods of stratification, but on the whole, the general picture was one of unstable stratification and a small gradient from top to bottom.

Lake Schrader, on the other hand, shows a very different type of thermal cycle. Thawing at the same time as Lake Peters, by the end of July well developed stratification was noted. This was stable, and by August 23 the lake was between 4.5°C and 10°C with a thermocline, or region of rapid temperature change, at 33 feet (10 meters).

Discussion

The summer temperature profile of Lake Peters is fairly typical of some other northern lakes reported (e. g. Chandler Lake, in Livingstone et al. 1958), and this type, with stratification not developed or weakly developed, has been called a sub-polar type of lake (Hutchinson, 1957). Lake Schrader, on the other hand, exhibits a well developed thermocline and stratification that lasted over the summer -- a type of thermal cycle common to temperate zones (Ruttner, 1953), and not reported before from so far north. Thus, these two contiguous lakes had quite different summer temperature regimes.

There are several reasons for the difference between the lakes and the most obvious is the difference in the water entering the lakes. The Peters influents contain glacial sediment, as already noted, and this material increases the density of the stream water. Therefore, at times when the streams will be warmer than the lake, the density relationships create a density current that flows at some distance below the surface of the lake and not at the surface where the warm water would usually stay. So large amounts of heat were added to the lower layers of Peters in this way and there was little chance for a large thermal gradient to develop. Both lakes would receive approximately the same amount of heat from radiation, but as the surface layers became heated in Peters, the density gradient remained small and the wind was able to mix the whole lake. In Schrader, most of the influent came from the upper layers of the north end of Peters. This water was the warm water of that lake and in addition had lost much of its sediment load as it passed down the lake. This water did not form density currents in Schrader, and, as shown by the low temperatures at the bottom of Schrader, did not add much heat to the lower layers. Thus, when a temperature gradient did develop in Schrader, the wind was not able to mix the whole lake and the bottom layers were undisturbed for the entire summer.

Schrader is less protected than Peters, and receives more radiation. This too adds to the temperature gradient and improves the chances for stratification. However, this lack of protection means that Schrader receives more wind than Peters. In fact, measurements during August of 1959 showed that Lake Schrader had over twice as many miles of wind as Peters. If other factors were not more important, this could well have reversed the conditions in the two lakes.

Perhaps the most important factor influencing the thermal cycles of the lakes is one that was not noticed during the 1958 field season. This was the time of the thaw, determined by weather conditions from March to June. In 1959 the ice left the lakes on July 26 (against June 28 in 1958). At this late date the amount of daily radiation was decreasing rapidly and the lakes were not able to pick up much heat. By the middle of August both lakes were between 4° and 5° C and were being completely mixed by the wind. When the spring and summer temperatures are low, as in 1959, the glaciers show little melt and correspondingly small amounts of glacial sediments are carried into the lakes.

In conclusion, Lakes Peters and Schrader exhibited entirely different thermal cycles during the summer of 1958 and show that under certain conditions there is little correlation between thermal cycles of lakes and their geographical location. The time of the thaw, as determined by weather conditions, was perhaps the most important factor in deciding the type of thermal regime. In these two lakes, local conditions such as the glacial influents and shelter from the sun and wind also affected the thermal cycles. Variation in one or several of these factors can completely change the type of thermal cycle in these lakes.

References Cited

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