Chapter 3

ECOLOGY OF HYPERSALINE ENVIRONMENTS

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INTRODUCTION

About 30 years ago ZoBell (1946) reported some observations, parts of which are quoted in Table 3-1 and which might aptly serve as a starting point for the present discussion. ZoBell observed the ability of bacteria from habitats of different salinity to grow on nutrient media of different salinity. By salinity of the nutrient medium was meant the content of NaCl. Using sewage (low or no salt) as inoculum into the nutrient media, he found the highest number of bacteria developing in the media with the lowest salt concentrations. Increasing salt concentrations prevented the growth of an increasing proportion of the bacteria. These findings were not surprising: NaCl is well-known as an agent against bacterial growth; this is the basis for its widespread use as a preservative against bacterial spoilage. When using sea water as the source of bacteria, the highest number developed in the nutrient media at sea water salinity. Much lower numbers developed both at higher and lower salinities. At saturating salt concentration none of the bacteria from sea water developed. Samples from Great Salt Lake gave the highest viable count of bacteria on media saturated with NaCl. Lowering the NaCl concentration gave decreasing viable counts. At the lowest NaCl concentration tested (0.5%) was found 1/50 of the count at saturation. The findings when using marine saltern as the source of bacteria, were strikingly similar to those from Great Salt Lake.

TABLE 3-1.

Comparative bacterial counts obtained by ZoBell (1946) by plating from habitats of different salinity on nutrient media of different salinity.

Source of bacteria	Salinity of nutrient media (%)					
	30	15	7	3.5	2	0.5
	Average growth index					
Sewage	0	3	6	14	45	100
Sea water	0	7	38	100	62	19
Great Salt Lake	100	72	26	14	8	2
Marine Saltern	100	65	30	19	13	4

The figures of Table 3-1 deal with bacteria only, and even limited to those developing on a specified nutrient medium. The findings lead, nevertheless, to a postulate for which a good deal of additional evidence has accumulated since ZoBell made his observations more than 30 years ago: The indigenous population of hypersaline environments are, as a rule, rather special organisms adapted to live in the strong brine, and they even prefer, or require, the high salinity in their environment for growth and reproduction.

NaCl is the dominating salt component of the hypersaline environments, ponds and lakes, throughout the world. There are, however, some exceptions to this rule. The Dead Sea contains, in addition to Na^+, a high concentration of Mg^{++}. In some cases Na_2CO_3 may be a dominating component; so has also been found for $CaCl_2$. The hypersaline environments are mostly aerobic, but also anoxic situations are encountered. The acidity may differ considerably from one environment to another.

Through the years many observations have been reported on life in hypersaline environments. We are, however, still far from a thorough understanding of the ecology of such environments. The observations are sparse and scattered and often irrelative so that they are difficult to compare. Still a rough picture is emerging from somewhat more detailed studies of a few geographically well-known hypersaline environments, namely Great Salt Lake (Utah), the Dead Sea (Israel), and the alkaline lakes of Wadi Natrun (Egypt). A survey of the known ecological relations of these environments is given in the following, together with those of the marine salterns which are situated in coastal areas various places around the world. These environments have some major ecological properties in common, but there are also characteristic differences.

GREAT SALT LAKE

Great Salt Lake is predominantly a NaCl lake. The saline water also contains a relatively high, but not dominating, amount of SO_4. Twenty years ago Great Salt Lake contained about 20% solids throughout the lake, the only dominating chemical component being NaCl, as mentioned. In 1957 a rock-filled railroad causeway was completed across the lake, dividing it into a northern and a southern basin. The only connection between the two basins are two small culverts, each about 5 m wide and 3 m deep. About 95% of the water from watershed streams flow into the southern part of the lake. During the past 20 years the salt concentration has decreased to about 12–13% in the southern part, and is estimated to reach about sea water salinity in another 20 years. On the other hand, in the northern basin evaporation has caused the salt concentration to reach saturation (Table 3-2), and thus created an interesting ecological situation which has recently been studied in some detail by Post (1977).

In the southern part of the lake there is at present a fairly rich population of organisms comprising a wide variety of types, as compared to the northern part where only a few but characteristic types of organisms occur in conspicuous numbers.

In the northern basin the hypersaline water column is not more than 10 m deep. Most of the brine is aerobic although the concentration of O_2 in the brine is modest. At the bottom, however, and certainly in the sediment, the condition is for the most part anoxic