BIOLOGY OF THE SWAN RIVER ESTUARY

Western Australian estuaries are almost unique hydrologically. This is mainly because significant river flow is confined to a few months in winter and spring, with negligible flow in summer. The estuaries are flushed by a heavy flow of river water for a few months only in winter and spring whilst in summer there is little in flow of fresh water and virtually no discharge to the sea. Indeed the net transport of water is in the opposite direction in summer, from the sea to the estuaries because of evaporation from the lagoons, which may become more salt than the sea. Other important characteristics are the small tidal exchange, the broad lagoons or 'inlets' of the lower reaches, the narrow and often shallow channels that connect these to the sea, and the shallow bars where the rivers discharge to the lagoons.

Looking at the hydrology in greater detail it must be emphasised that the following picture is true only of the Swan, the other estuaries of the south west display a quite different picture. Particular physiographic features of the Swan are: the great depth of much of the lower estuary (below Perth Water) such that there is a large body of water below the level of the sill at Fremantle; the great length of the tidal estuary (37 miles); and the wide, shallow reaches of the upper estuary where wind mixing is effective.

The hydrological sequence is as follows:-

1. With the first heavy winter rains the whole upper estuary rapidly becomes 'fresh'. This change from brackish to fresh may be very rapid; less than a week.

2. This is followed by a slower, but still quite rapid flushing of the surface water of the lower estuary. In a dry winter this water remains brackish, but in a wet winter the surface 15 feet or so becomes fresh and isolates the deep water, which persists as a pool of stagnant marine water that becomes deoxygenated.

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3. When river runs off decreases in spring sea water is pumped in by the tide, the surface water of the lower estuary becomes brackish and the deep marine water is renewed.

4. About December this brackish water begins to advance gradually up the estuary and by about March there is a gradient from fully marine (35‰ S) at the narrows to about a quarter sea water strength (9‰ S) at Midland, and the salinity may continue to rise until the first heavy rains again flush the estuary.

5. When early autumn rains cause the Avon River or tributaries to flow (as in 1971) the upper estuary becomes stratified, a layer of 'fresh' water flows over brackish bottom water and this condition may persist for some weeks. It should be noted that Avon water is seldom really fresh. In 1969 it was only briefly less than about one tenth sea water salinity (3.5‰ S). This is important for the plant and animal life.

The plants and animals of the Swan River can be grouped into three broad categories: 1. Those which live on or in the bottom - the benthic flora and fauna. 2. Those which move passively with the water mass - the plant and animal plankton. 3. Actively swimming animals, mainly fish - the nekton. Most aquatic plants and animals are very sensitive to changes in salinity and the number of species which can live in estuaries is small, although those which do so are often very abundant.

Conditions in the Swan are particularly harsh because of the seasonal changes described above. In consequence very few species of benthic plants or animals survive in the upper estuary and their number decreases as one goes upstream. A crab, two shrimps, two mussels, a snail, three worms are the principal resident animals (Blackwell et al, 1969); three rather reluctant algae and a pond weed are almost the only fixed plants (Allender, 1970). The number in the lower estuary is considerably greater, but still very small as compared with that of the sea.

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Actively swimming animals can choose favourable conditions; a few, like the cobbler, appear indifferent to salinity changes, but most do not tolerate low salinity and leave the estuary in winter.

There are two main groups of planktonic animals:
1. Those which live their whole lives in the plankton. By far the most abundant of these are the copepods, small Crustacea of the order of size of 0.1 to 1 mm in length. There are only four common species in the Swan estuary. They depend mainly on the plant plankton for food. We now have a fairly detailed knowledge of the copepod fauna of the estuary (Bhuiyan, 1966, Hodgkin and Rippingale, 1971). 2. The eggs and larvae of bottom living animals and fish. At times these are abundant and form an important part of the plankton, but of course the greater part of their lives is spent as benthic or nektonic animals. The larval development of a mussel Wilson, (1968) and a crab Lucas, (1970) have been studied in some detail, but almost nothing is known of the other benthic animals or about the breeding cycles of fish in the estuary. The crab larvae and small fish feed largely on copepods. Mussel larvae feed on plant plankton.

The principal species of plant plankton found in the estuary are listed in Serventy (1955) but very little is known about their physical and seasonal distribution and abundance or about their nutritional requirements. One filamentous diatom, Melosira, often forms dense blooms, turning the water brown, particularly in brackish water in the basin in spring. Another very small diatom, Cyclotella, was shown to be an important item of food for one copepod in low salinity water and its distribution was followed and shown to be related to the presence of vitamin B12 in solution (Bhuiyan, 1966). However, many other species are abundant and occasionally bloom unexpectedly as did the dinoflagellate Gymnodinium in March-April 1971.

Most planktonic organisms have a preferred salinity within which they flourish best and they move up and down the estuary only multiplying where conditions are favourable. The fresh water in winter is particularly poor in plankton, partly because of low salinity, partly because of lack of nutrients, and partly because of low temperatures. With the rapid rise of temperature in spring and influx of marine water the phytoplankton blooms and a great increase in zooplankton follows, with one species succeeding another as salinity increases. Just what combination of events initiates these blooms is not known. Essential nutrients are certainly contributed by the river runoff, but the poverty of the plankton in this water suggests that some essential factor is lacking. Perhaps this is supplied by the brackish water, although the sea water is also relatively poor in nutrients, or the bottom mud may itself be an important source of nutrients as suggested by (Spencer, 1956).

Most estuarine organisms are of necessity very tolerant of environmental conditions, but there is a limit to what they will tolerate. Even to a casual observer, the gross impoverishment of the fauna and flora of European and North American estuaries which receive industrial wastes is obvious. Most of these are subject to much greater tidal flushing than is the Swan and there is river discharge the year round. One can only conclude that because of the peculiar hydrological conditions here, the Swan is even more vulnerable to the effects of pollution than are most estuaries.

Although most species of plants and animals do not tolerate polluted water, a few species flourish and are good indicators of pollution. Some of these are present in the lower estuary (eg. Ulva bracilaria) and there may perhaps be others in the upper estuary. Their presence, by itself, does not indicate that there is pollution.

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