A Contribution to the Knowledge of the Physiology of the Australian Freshwater Mussel *Hyridella australis* Lamarck.

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2. INTRODUCTION.

The relationship between an aquatic animal and its environment was realised about 1885, due mainly to the work of Frédéricq (1885) and Claude Bernard who realised the remarkable constancy of the internal chemical environment. From his studies of Frédéricq's work, Bernard wrote; "Chez tous les êtres vivant le milieu intérieur, qui est un produit de l'organisme, conserve des rapports nécessaires d'échange et d'équilibre avec le milieu cosmique extérieur, mais à mesure que l'organisme devient plus parfait, le milieu organique se spécifie et s'isole en quelque sorte de plus en plus du milieu ambiant."

In recent years, research on this osmotic relationship in aquatic animals has been concerned chiefly with (1) finding the relationship between the concentration of the blood or body fluids of the animals (the internal environment) and the concentration of the media which they inhabit (the external media). 2) locating the organs responsible for the osmotic regulation and (3) correlating the effectiveness of the mechanism with the actual needs of the animal in its normal environment.
The external medium can be extremely stable (oceanic sea-water), fairly stable (fresh water) or extremely variable (in estuaries). There is strong evidence to suggest that the maintenance of optimum internal chemical conditions is most easily accomplished by those animals which are strictly marine in habitat. The ability to change the habitat to a less stable one involves either the development of a new regulatory system or the coming into operation of a mechanism previously unused. The possible methods of accomplishing this have been suggested by Beadle (1943).

Most marine invertebrates maintain an internal medium which is closely allied to their external medium (Pantin, 1931, from various authors), both in relation to ions in solution and to osmotic pressure. In media more concentrated or more dilute than seawater, two main physiological types can be distinguished, viz. (1) animals which change their internal medium to correspond closely to that of the external medium -- poikilosmotic (Dakin 1908, Ellis 1937, Maloef 1938) and (2) animals which maintain their internal medium at a level different from that of the external medium -- homoiomotic (Schlieper 1930, Dakin and Edmonds 1931).
The latter group show the beginnings of osmotic control and are widespread in nature, especially in habitats where considerable change in the external medium occurs regularly, e.g. estuaries. The adoption of a freshwater habitat necessitates a greater development of regulatory mechanisms and in invertebrates an internal medium which is much more dilute than that found in marine types (Frédéricq 1885).

The possible mechanisms and their function have been fully discussed by Dakin (1912, 1935), Schlieper (1930, 1935), Pantin (1931), Krogh (1939), Baldwin (1940) and Beadle (1943). Briefly they include (1) the permeability of the body surface to salts and water (2) the various excretory organs (kidney, antennary glands, etc.) (3) the active absorption of ions from the external medium and (4) exact data are not available yet of the osmoregulatory energy requirements for any aquatic animal, but oxygen consumption is probably connected with osmoregulation. This has been suggested by Raffy and Fontaine (1930), Beadle (1931), Bouxin (1931), Duryee (1932), Fox and Simmonds (1933), Löwenstein (1935), Malouf (1937) and Hopkins (1949).

In the freshwater mussels, these mechanisms have been investigated in various ways:—
1. The permeability of the body surface to salts.
   a. Philippson et al. (1910) demonstrated that in external media of \(\Delta\) greater than 0.1°C, Anodonta cygnea became homosmotic.
   
   b. Duval (1925) showed that the \(\Delta\) of the blood of Anodonta followed closely that of external media which were more concentrated than the normal blood level.
   
   c. Ellis et al. (1931) showed that the blood of a number of species of North American freshwater mussels varied with and in the direction of the concentration of the salts in the external medium.
   
   d. Florkin (1938) claimed that the body surface of A. cygnea was permeable to water from the inside outwards but not in the opposite direction.
   
   e. Florkin and Duchateau (1948) showed that the body surface was permeable to both salts and water.

2. The osmoregulatory function of the excretory organ has been investigated:
   
   a. Picken (1937) showed that the kidney of A. cygnea produced a urine which was hypotonic to the blood.
   
   b. Florkin (1938) showed that the 'Bojanien fluid', i.e. fluid from the organ of Bojanus, of A. cygnea was isotonic to the blood, and believed that reabsorption of salts must take place in the ampullar portion of the organ.
c. Florkin and Duchateau (1948) showed that the ampullar fluid was actually less concentrated in chloride, calcium and inorganic phosphorous, though more concentrated in both protein and non-protein nitrogen, than the blood.

3. The active absorption of ions from the external medium has been demonstrated by Krogh (1939) in *A. cygnea*, but only when the blood ionic level had been reduced by prolonged immersion in distilled water.

4. The only data on respiration in freshwater mussels found by the author are :-

a. Weinland (1919) showed that the oxygen consumption in *A. cygnea* diminished under starvation conditions.

b. Gartkiewicz (1922) showed that *Anodonta* spp. existed in one of two states, active or 'sleep', the rate of oxygen consumption being related in the ratio of 3/2.

It has not been demonstrated that oxygen consumption in freshwater mussels is related to their osmoregulation. The present work represents a further investigation of these several aspects of osmoregulation in freshwater mussels. The mussel used in all of the experiments was *Hyridella australis* Lam.