while the actual measurements of Kannuluik[4] gave

$$0 \cdot 000329_4 \text{ cal. cm.}^{-1} \text{ sec.}^{-1} \text{ deg.}^{-1} \text{ C.}$$

A detailed account of the investigations will be published elsewhere in the near future.

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Effects of Hypertonic Media on the Contractile Vacuoles of Protozoa

IT has long been suspected that the contractile vacuoles of Protozoa maintain the internal osmotic pressure of the organism above that of the external medium, and it has been argued that, if this is correct, the rate of vacuolar output should be reduced when the external osmotic pressure is raised. This has been found to be true for various Ciliata, and recent work has made it necessary to examine evidence of this nature more critically.

In Peritrich Ciliates[1] and in *Paramecium*[2], it has been found that if the external osmotic pressure is raised sufficiently the body shrinks, but that the contractile vacuole may continue to eject water, although at a reduced rate, even after this shrinkage. Kamada[2] has argued from his results with *Paramecium* that since the body has shrunk, the internal osmotic pressure is no longer above the external osmotic pressure, and hence that no more water can be entering through the body surface, and therefore in turn that the water ejected by the contractile vacuole must be of internal and metabolic origin. This argument is open to criticism.

According to the osmotic control theory, the contractile vacuole acts as a pump which, by utilizing energy, ejects water and retains the salts of the organism. There is no reason whatsoever why the contractile vacuole should stop as soon as the external osmotic pressure is raised so as to equal or exceed the (original) internal osmotic pressure of the organism. Its continuance would lead to a raising of the internal osmotic pressure by a shrinkage of the body until a new and steady value was attained above that of the new external medium. One might, however, expect a decrease in rate of output owing to the increased energy required to separate water from a more concentrated internal solution. Only if the external osmotic pressure were raised very considerably above the original internal osmotic pressure of the organism would one necessarily expect the contractile vacuole to stop completely.

After an increase in the osmotic pressure of the external medium, in the process of reaching a new steady state (1) the body will shrink, and the internal osmotic pressure will therefore be raised, with the result that (2) the rate of vacuolar output will (probably) decrease, and (3) the rate of entry of water by osmosis through the body surface will increase (even from zero or from a negative value). The body volume will become constant when it has decreased to such a value that the rates of loss (2) and gain (3) of water are equal. There is no reason for expecting a linear relationship between rate of vacuolar output and external osmotic pressure. The rate of vacuolar output will be dependent on unknown internal factors such as the water content or salt concentration of the tissues. This theory is in good accordance with the data which are available for Ciliata.

The situation is more complicated for *Amœba*, and the evidence is more conflicting, although a similar explanation may be applicable. Adolph[3] found that the contractile vacuole of *Amœba proteus* maintained its rate of output undiminished when the organism was subjected to pure solutions of sodium chloride or other salts up to $M/20$ in concentration (that is, of osmotic pressure equal to about one-tenth of that of sea water). But Zuelzer[4] found that fresh-water amœbæ lost their contractile vacuoles when transferred to sea water, and Hogue[5] found that marine amœbæ developed contractile vacuoles when cultured on an agar medium made up with fresh-water.

It seems therefore probable that Adolph did not use strong enough solutions, and in any event pure sodium chloride is scarcely a suitable medium for the purpose. It may be stated in conclusion that the situation as regards amœbæ is still unsettled, but that the evidence so far available is not inconsistent with the osmotic control theory of the contractile vacuole.

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Colloid Osmotic Pressure of the Body Fluids of Freshwater Animals

THE fact that the colloid osmotic pressures exerted by the body fluids of marine animals arrange themselves in the order of their phylogenetic development[1], suggested that there exists a definite relationship between the general organization of an animal and the colloid osmotic pressure of its body fluids. The results of the measurements undertaken with the hæmolymphs of some terrestrial invertebrates confirmed this hypothesis; the values obtained[2] were indeed practically the same as those of the body fluids of the corresponding marine animals. I concluded from these observations that neither sea water nor air as surrounding media have any marked influence on the above-mentioned relation.

It was interesting to see whether this relationship is modified by life in fresh-water. I have therefore measured the colloid osmotic pressures of the body fluids of some freshwater animals and compared the results with the data previously found for the corresponding marine groups. The animals used were one species of lamellibranch Molluscs (*Anodonta cellensis*), two species of gasteropod Molluscs (*Limnœa stagnalis*, *L. auricularis*), one decapod Crustacean (*Astacus fluviatilis*), and three teleostean fishes[3] (*Cyprinus carpio*, *Esox lussius*, *Anguilla vulgaris*). The following table gives the average values of each of these groups (except the values obtained with the serum of the eel, which will be discussed below) and, for comparison, the average values of the corresponding marine animals :

	Marine animals (cm. H_2O)	Freshwater animals (cm. H_2O)
Lamellibranch molluscs	1·1	0·8
Gasteropod molluscs	1·5	1·2
Decapod crustaceans	3·6	3·1
Teleostean fishes	19·0	11·9