

found by Jones and Guy. Solutions of hydrated salts were in general more transparent than pure water, especially at the centers of the absorption bands. Solutions of non-hydrated or only slightly hydrated salts are more opaque than pure water, especially at the centers of the bands."

The quantitative conclusions are based on the two assumptions that the van't Hoff formula holds absolutely when the true concentrations are used, and that the percentage dissociation can be calculated from the conductivity. Unfortunately, neither of these assumptions is true. There are many who think very highly of Jones' work and there are those who are more critical. All will agree, however, with the words of Professor Reid in the biographical sketch, that Jones was an advocate rather than a judge. WILDER D. BANCROFT

SPECIAL ARTICLES

COMPARATIVE PERMEABILITY OF FERTILIZED AND UNFERTILIZED EGGS TO WATER

IN general the rate of the osmotic entrance or exit of water, in any living cell, after transfer from its normal medium to another non-injurious medium (*i. e.*, one not impairing semi-permeability) of lower or higher osmotic pressure, varies directly (1) with the gradient of osmotic pressure between the interior and the exterior of the cell, (2) with the area of the semi-permeable membrane enclosing the cell, and (3) with the permeability of this membrane to water. It is to be expected that this permeability to water will vary in different physiological states of the cell; and that the same species of cell, placed in the same medium, will show variations in the rate of the osmotic transfer of water, *i. e.*, in its rate of swelling or shrinkage, according to its physiological condition or state of functional activity at the time of the transfer. There is in fact a definite and constant difference between the fertilized and the unfertilized eggs of the sea-urchin *Arbacia* in this respect, fertilization being followed regularly by a marked increase in the permeability of the egg-surface to water—as

may readily be shown by bringing the eggs into either dilute or concentrated sea-water; in the former medium they swell, in the latter they shrink, but in both cases the rate of the process is much greater in the fertilized than in the unfertilized eggs. In the unfertilized eggs both swelling and shrinkage are surprisingly slow, so that in a medium whose osmotic pressure differs from the normal by so much as ten or twelve atmospheres these eggs show little apparent alteration of size at a time (*e. g.*, two minutes after placing in this medium) when the fertilized eggs are conspicuously swollen or shrunken. This difference of behavior relates entirely to the *rate* at which water either enters or leaves the egg; the *degree* of swelling or shrinkage when osmotic equilibrium is reached is approximately the same in both cases. It is clear therefore that this difference has nothing to do with any possible change in the osmotic pressure of the egg-protoplasm, resulting from fertilization, but is determined simply by the greater readiness with which water enters or leaves the fertilized as compared with the unfertilized egg. According to former measurements made on the rate of swelling of fertilized and unfertilized eggs in dilute sea-water, the resistance to the passage of water across the plasma-membrane is decreased approximately four times as a result of fertilization.¹

The most striking and convenient method of showing this difference is to place a mixture of equal numbers of unfertilized and fertilized uncleaved eggs (the latter fertilized at least 15 minutes previously) in a somewhat strongly hypertonic sea-water (*e. g.*, 1 volume of van't Hoff's artificial sea-water of 2.5 m concentration *plus* 4 volumes normal sea-water). The fertilized eggs at once shrink rapidly and undergo crenation, and within less than one minute exhibit a collapsed, shrunken, and angular appearance; at this time the unfertilized eggs show little change, so that a striking contrast is presented. Shrinkage continues slowly in the unfertilized eggs, and becomes well marked in the course of five or six minutes, but a curious

¹ *Amer. Jour. Physiol.*, 1916, Vol. 40, p. 249.

difference is that the eggs remain smooth and spherical during the entire period of shrinkage, the surface showing none of the folds and crenations so characteristic of the fertilized eggs. Evidently the properties of the plasma-membrane have undergone profound changes during fertilization, so that by the above simple osmotic method the fertilized eggs are immediately and sharply differentiated from the unfertilized. One incidental effect of the rapid shrinkage of fertilized eggs (which involves a corresponding increase in density) is that they sink at first in the hypertonic sea-water more rapidly than unfertilized eggs; and in fact a partial separation of the two kinds can readily be accomplished in a test-tube or graduate by taking advantage of this difference in the rate of sinking.

Shrinkage, if not too pronounced, has little or no injurious effect upon the eggs, and fertilized eggs after return to sea-water continue their development. The osmotic properties of the plasma-membranes are apparently unaffected by the process of shrinkage. If mixed eggs that have been well shrunken by exposure to the above hypertonic sea-water for five minutes are returned to normal sea-water, it is observed that the fertilized eggs regain their normal water-content much more rapidly than the unfertilized; after a minute in the normal sea-water they are distinctly the larger of the two. Later, as the unfertilized eggs also approach osmotic equilibrium this difference disappears.

Experiments similar to the above were also performed with the fertilized and unfertilized eggs of the sand-dollar, *Echinarachnius parma*. These eggs were found similar to those of *Arbacia* in their behavior in dilute and concentrated sea-water.

Artificial membrane-formation by treatment with butyric acid produces the same kind of change as normal fertilization in the osmotic properties of *Arbacia* eggs, but the degree of the effect is much more variable. It was interesting to find that the rate of shrinkage in hypertonic sea-water shows a definite correlation with the character of the membrane

separated from the egg; when this is well separated and sharply defined in appearance the rate of shrinkage, the crenation, and the other features of the behavior approach closely those of sperm-fertilized eggs; on the other hand, eggs with poorly formed membranes show more gradual shrinkage and relatively little crenation; while eggs which show little or no indication of membrane-formation (some of which are always present) show the slow shrinkage and lack of crenation characteristic of unfertilized eggs. Such gradations of behavior, indicating gradations in the degree to which permeability has been increased by the treatment, are always found. This variability is probably correlated with the variability in the developmental capacity of artificially activated *Arbacia* eggs, which typically yield only a small proportion of normal larvæ.

The above change in the properties of the plasma-membrane does not take place suddenly, but begins gradually and requires about 20 minutes after fertilization (at 20°–22°) to reach an approximate final stage. The change is thus progressive and continues long after the separation of the fertilization-membrane. At five or six minutes after insemination there is little apparent difference from unfertilized eggs, *i. e.*, the eggs shrink slowly in hypertonic sea-water and do not crenate; at nine or ten minutes shrinkage is considerably more rapid and there is some crenation; at thirteen to fourteen minutes the majority show well-marked crenation within one minute; at twenty minutes both rate of shrinkage and degree of crenation are still further increased, although the maximum is not reached until considerably later. It is evident that some special process is initiated by the spermatozoon, having the effect of changing the properties of the plasma-membrane in the direction of increased permeability to water and increased liability to crenation.

The intimate nature of this process can not be defined clearly at present, but it was found to be checked or arrested, reversibly, by anesthetics or high concentrations of cyanide.

Eggs placed within two or three minutes after insemination in sea-water containing the following anesthetics were found to retain the condition of low water-permeability (the state characteristic of unfertilized eggs) during the period of exposure to the anesthetic, *e. g.*, 30 minutes or more; if they were then brought back into normal sea-water the permeability underwent the usual increase and development continued. Chloral hydrate, chloroform, alcohols (methyl, ethyl, propyl, isobutyl, i-amyl), ethyl urethane, ether, all show this effect in appropriate concentrations, which are approximately the same as those required for anesthetizing the cleavage-process. It is clear therefore that the permeability-increasing phase of the activation-process, after it has once started, may be temporarily inhibited by anesthetization. Potassium cyanide has a similar effect, but only in relatively high concentrations (above $n/200$, with some slight effect at $n/400$); in lower concentrations, *e. g.*, $n/1,000$ (which is many times greater than that required to arrest cleavage completely), no evident effect was observed. It is probable that the anesthetics inhibit the permeability-increasing process by a different kind of influence from that exerted by cyanide.

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THE AMERICAN SOCIETY OF NATURALISTS

THE thirty-fifth annual meeting of the American Society of Naturalists was held in the Carnegie Museum, Pittsburgh, January 1, 1918. In affiliation with the society this year were Section F of the American Association for the Advancement of Science and the Botanical Society of America.

The report of the treasurer, stating a balance on hand of \$657.11, was accepted.

The following changes in the constitution, recommended by the executive committee, were authorized.

Article II., Section 1, the following sentence to be added: A nomination for membership in the society shall remain in the hands of the executive committee for at least one year before action is taken upon it.

By-law 2 to read: Each president on retiring shall appoint a committee of five to nominate officers and this committee shall present names for action by the society at its next annual meeting.

The following new by-law to be added: A publication committee, consisting of the three past-presidents, the secretary and the treasurer may select and arrange for the publication of papers presented before the society, provided that the society thereby is not involved in financial obligations.

It was recommended by the executive committee that the American Society of Naturalists co-operate with other biological organizations by electing two botanical members to serve on the committee on botanical abstracts, and that these members shall be nominated by the executive committee. This recommendation was adopted by the Society and the following were elected to represent the American Society of Naturalists on the committee on botanical abstracts: J. Arthur Harris (1919-20), Edward M. East (1919-22).

A resolution, as follows, framed by a committee consisting of Albert J. Blakeslee and Leon J. Cole, was adopted, and the secretary was instructed to forward a copy of it to the National Research Council.

Realizing the importance of placing all men who enter the national service where their training and abilities may be utilized to the maximum in the prosecution of the war, and in view of the experience of our allies, who at first failed to take advantage of the technical fitness of recruits for special war activities both at home and at the front and who later found it necessary to make readjustments at great loss of time and energy—be it

Resolved, That the American Society of Naturalists urge upon the National Research Council the desirability of taking such steps as may be necessary to secure the detailing to special scientific duty of men with technical training and ability who may have been called to military service, but who are found essential to scientific activities of the war.

There were elected to membership: Ethan A. Andrews, Johns Hopkins University; Ernest B. Babcock, University of California; Frank S. Collins, North Eastham, Mass.; Thomas H. Goodspeed, University of California; William H. Gregory, American Museum of Natural History; Heman L. Ibsen, University of Wisconsin; Karl F. Kellerman, U. S. Department of Agriculture; Vernon L. Kellogg, Stanford University; Richard S. Lull, Yale University; Robert K. Nabours, Kan-