The fact that the cells of the proximal tubule can produce acidification suggests that the process in this region is different from the process of acidification in the amphibian tubule. The rapidity with which dibasic phosphate is acidified may give some weight to the suggestion that the process, at least as far as the proximal tubule is concerned, may be one of secretion of acid.

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STUDIES OF THE BODY FLUIDS AND SERA OF SOME MARINE INVERTEBRATES

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This study of the chemical composition, pH and freezing point of the body fluids and blood of several species of marine invertebrates was undertaken because no data have heretofore been published for forms living in Mount Desert Island waters.

The animals were removed from sea water, dried with a clean towel to prevent contamination of the collected samples with sea water, and the body fluids were immediately collected. Measurements of pH were made with the glass electrode within a few seconds of collection and also after thorough stirring or whipping of the fluid. Determinations of the freezing point were made with the Beckman thermometer on pooled samples of fluid which had been in the refrigerator not more than 24 hours. Analyses for Na, K, Ca, Mg, SO_4, and Cl were done by Dr. J. D. Neuss at Rutgers University on pooled samples of fluid containing about 1 ml. per 100 of toluene preservative. A description of the analytical procedures will be included in the complete report of the work to be published elsewhere.

The results are shown in Table I. In accordance with the procedure preferred by many oceanographers the inorganic composition is presented in terms of chlorinity; i.e., millimoles of ions per liter of fluid divided by millimoles of chloride ions per liter of fluid.

The freezing point of all of the fluids closely approaches that of the sea water in which the animals live. For the echinoderms and *Venus* the difference is less than 1%; for *Limulus* the maximum difference is less than 2%, which is the maximum variation of the method as used. It may be concluded, therefore, that the fluids of the echinoderms, of *Venus* and of *Limulus* are isomotic with the sea water in which they live. For the lobster and crab the difference is about 4%, indicating a small hypertonicity of the sera as compared to sea water, a result reported several times by others for European and American crustacea.

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TABLE 1. FREEZING POINTS, pH AND COMPOSITION OF SOME INVERTEBRATE FLUIDS AND ENVIRONMENTAL SEA WATER

Species	Fluid	$-\Delta$ °C.	pH	mM/liter	Chlorinity ratios in mM/liter				
				Cl	Na/Cl	K/Cl	Ca/Cl	Mg/Cl	SO_4/Cl
Sea water, Mt. Desert Island		1.759	8.10	492	0.931	.0173	.0197	.0687	.0516
Cucumaria frondosa	Coel.[1]	1.750	7.80	501	.910	.0147	.0178	.0663	.0509
Cucumaria frondosa	Amb.[1]	1.749	7.75	494	.962	.0158	.0180	.0628	.0514
Asterias vulgaris	Coel.	1.762	7.54	505	.911	.0164	.0178	.0608	.0503
Strongylocentrotus drobachiensis	Coel.	1.776	7.84	510	.904	.0188	.0173	.0608	.0496
Venus mercenaria[2]	Mantle	1.760	7.90	514	.856	.0144	.0185	.0486	.0496
Homarus americanus	Serum	1.811	7.45	472	.962	.0197	.0362	.0191	.0106
Homarus americanus[3]	Serum	1.829	7.44	444	.966	.0310	.0546	.0189	.0094
Cancer borealis	Serum	1.825	7.81	479	.960	.0213	.0240	.0457	.0392
Limulus polyphemus[2]	Serum	1.783	7.47	478	.956	.0207	.0195	.0605	.0442
Sea, water, Harpswell		1.758	7.89	491	.925	.0165	.0195	.0668	.0511
Limulus polyphemus	Serum	1.767	—	473	.971	.0232	.0188	.0634	.0476

[1] Coel = coelomic; amb. = ambulacral.

[2] These animals, collected at Harpswell, Maine, in mid-June, were kept in running sea water at Mt. Desert until August 21, when their fluids were collected for analysis.

[3] These analyses were made in 1938 and reported in the 1939 BULLETIN.

The pH of pure Mt. Desert sea water, measured many times during the three-month season of 1939, averaged 8.10, with an average variation of 0.10. Extreme variations were +0.19 and —0.30, each of which were found only once. The pH of the body fluids and sera was consistently below that of sea water and varied somewhat more than that of sea water in the case of the echinoderms and *Venus*. Less variation appeared in the lobster, crab and *Limulus*. It seems safe to conclude that the crustacea and *Limulus* control the pH of their blood more effectively than the echinoderms and *Venus* control the pH of their body fluids. For none of the fluids did the pH change significantly after thorough whipping. The crustacean and *Limulus* sera sometimes showed a slight increase (0.05 to 0.15).

As has been found for these and other invertebrate fluids by other workers, the inorganic chemical composition varies considerably even when the animals are kept in sea water of constant composition. Further analyses are needed to delimit individual variations for each ion. However, it seems quite clear from the data in Table I that all the fluids contain about the same concentration of sodium, chlorine and potassium ions as does the sea water. The fluids of the echinoderms, *Venus* and *Limulus* contain also the same amount of calcium as does the sea water. The sera of the lobster and crab, however, contain significantly more calcium than the sea water. The echinoderm and *Limulus* fluids show the same magnesium content as sea water, but the sera of the crustacea and fluid of the clam contain significantly less magnesium than sea water, especially the lobster. For the sulfate ion, the fluids of echinoderms and *Venus* are similar to sea water, but the sera of crustacea and *Limulus* have a significantly lower sulfate content than that of sea water, especially the serum of the lobster. It may be tentatively concluded that the lobster accumulates calcium from the sea water to a significant extent, and similarly excludes magnesium and sulfate ions. The analysis of lobster serum reported by Cole and Kazalski (1939) showed more K and Ca ions than does the present analysis. It is likely that some of the difference is due to normal variation in the composition of lobster serum. However, it is believed that the new values are more accurate, due to improvement by Dr. Neuss of the techniques for determining K and Ca.

Reference

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FURTHER STUDIES ON PERFUSING SOLUTIONS FOR THE LOBSTER HEART

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Using the same procedures described by Cole and Kazalski (1939) for perfusing the heart of *Homarus americanus*, additional solutions were tested (1) to delimit the ranges of concentrations of potassium

[1] We are indebted for financial assistance in this work to the Permanent Science Fund of the American Academy of Arts and Sciences.