growth to occur, though it seemed necessary for the two embryos to be close to each other. In cultures in which the medium either had been "conditioned" by having nondiapausing embryos cultured in it for 2 days or had been prepared from nondiapausing eggs at the stage of appendage formation, there was no sign of increase in survival or growth of diapausing embryos (*3*).

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Partitioning of Body Water in Sea Lamprey

Abstract. Measurements were made of the partitioning of total body water in the sea lamprey, *Petromyzon marinus*, between intracellular and extracellular compartments and the division of the latter into interstitial fluid and plasma. The apportionment of body water in agnathans is very similar to that in elasmobranchs, and both of these primitive groups differ from what is known of the more advanced teleosts.

Until a recent study of the fluid compartments of Chondrichthyes (*1*), only the body water partitioning of mammals, among the vertebrates, had received more than passing attention. Existing studies of body fluid measurements on nonmammalian vertebrates have been reviewed by Martin (*2*), Prosser and Weinstein (*3*), and Sturkie (*4*). For the class Agnatha, apparently the only fluid compartment measurement on record is that made by Welcker (*5*), who measured the blood volume of a single sea lamprey, *Petromyzon marinus*. The smaller variety of this species found in the Great Lakes has been used in this study for measurement of the fluid compartments of a representative agnathan (*6*).

Details of the methods employed have been described elsewhere (*1*). Briefly, known quantities of Evans blue (T-1824) and sucrose were injected simultaneously by cardiac puncture into the bloodstream of lampreys anesthetized with tricaine methanesulfonate, also known as M.S. 222-Sandoz (*7*). Over a period of 25 to 30 minutes, which allowed for complete circulation of the dye, samples of blood were drawn to make colorimetric comparison of the diluted dye with standard solutions for calculation of plasma volume. After a longer period (40 to 235 minutes), to allow filtration and complete equilibration of the sucrose in the plasma and interstitial (tissue) fluid, blood samples were drawn for similar calculation of the space occupied by the sucrose, which should approximate the extracellular fluid volume. The employment of more than one sample in each case allowed extrapolation of optical density readings to zero time, thus revealing the hypothetical volume before inevitable losses of dye or sucrose had taken place. The animals were dried completely in an oven at a temperature of 105°C for determination of total body water.

Twelve complete sets of results are summarized in Table 1. The animals were all of fairly large size for the fresh-water variety in the Great Lakes. Four were male and eight female, but consistent differences were not detected, so sex has been disregarded. All volume values are expressed as percentages of body weight, although the original measurements were in milliliters. Specific gravity of plasma was used in converting volume to percentage of body weight for plasma and extracellular fluid, and specific gravity of blood was used for the same purpose in blood volumes. The hematocrit reading was used to calculate whole blood volume from plasma volume.

The only comparison that can be made with previous work on agnathans is with the single blood volume determination made by Welcker (*5*) on the marine variety of the sea lamprey. His value, 4.16 percent of the body weight, was about one-half of the present mean for 12 animals (8.5 percent, with a range of 6.5 to 10.9). Although this low figure may stem from an extreme individual variation, or from differences in technique, it more likely reflects the inverse relationship between relative blood volume and body size demonstrated in elasmobranchs by Martin (*2*). No effect of size is evident within the range employed in this study. No check over a large size range was possible, for the largest lamprey available weighed less than one-fourth as much as Welcker's specimen (261 g versus 1094 g). The possibility remains that there may actually be a difference in the body fluid partitioning between the marine and fresh-water varieties, possibly associated with the salinity of the habitat.

When the fluid measurements of the lamprey are compared with those of *Squalus acanthias* (*1*), a remarkable similarity becomes evident. The 75.6 percent body water of the lamprey and 71.7 percent of the dogfish are apportioned among the fluid compartments, respectively, as follows: intracellular water, 51.7 and 50.5; extracellular water, 23.9 and 21.2; interstitial water, 18.4 and 15.7; plasma, 5.5 and 5.5; whole blood, 8.5 and 6.8. Since the plasma volumes are identical, the higher blood volume of the lamprey can only be a reflection of its higher average hematocrit value (33 percent cells) than that of the dogfish (18.2 percent).

The similarity of the fluid compartments of these two relatively primitive groups is striking in view of the very low values obtained by those who have measured the plasma or blood of the more advanced teleost Osteichthyes (*2, 3, 5, 8*). The values for the latter range from about 1 to 4 percent of the body weight, with an average of approximately 2 to 2.5 percent. The only published figure for extracellular fluid in teleost fish is that of 4.0 percent (Prosser and Weinstein, *3*) obtained with the use of NaCNS in the yellow bullhead, *Ictalurus natalis*. Extensive data accumulated but not yet published by myself will raise that figure appreciably, but it will not approach that of *Petromyzon* or

Table 1. Summary of data on fluid volumes of 12 sea lampreys.

Measurement	Mean value for 12 animals	Range	Standard deviation
Weight (g)	190.0	154 to 261	9.05
Length (cm)	46.0	42 to 50	0.66
Respiration rate (per minute)	122.0	80 to 178	7.51
Pulse rate (per minute)	31.0	24 to 44	1.65
Specific gravity, plasma	1.018	1.017 to 1.019	.0002
Specific gravity, blood	1.040	1.034 to 1.048	.0014
Hematocrit (percentage of cells)	33.0	28 to 37	.87
Plasma volume* (T-1824 space)	5.5	4.1 to 7.3	.32
Blood volume*	8.5	6.5 to 10.9	.43
Extracellular fluid* (sucrose space)	23.9	20.0 to 28.7	.79
Interstitial fluid* (sucrose space minus plasma)	18.4	13.6 to 21.8	.66
Total body water*	75.6	73.7 to 79.8	.51
Intracellular fluid* (total water minus sucrose space)	51.7	46.3 to 58.0	.90

* Expressed as percentage of body weight.

Squalus. It can safely be said then that agnathans and elasmobranchs are also alike in sharing a larger extracellular fluid volume than that of Osteichthyes. Other fluid compartment data are not available for the bony fishes.

Whatever may be the physiological significance of the reduction in circulating fluid volume in bony fishes, it would appear that such a reduction is found only in this more advanced group, while the greater plasma and interstitial fluid volumes are associated with the two most primitive of the aquatic vertebrate classes.

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Clay Minerals in Playas of the Mojave Desert, California

Abstract. Montmorillonite, illite, chlorite, and kaolinite in the playas of southern California are traceable directly to the source areas surrounding the basins. No evidence found in this investigation suggests that these clay minerals are unstable in the sodic or calcic saline lake environment, but this conclusion may not be directly applied to marine evaporite facies where the minerals are rich in potassium and magnesium.

In the last decade several papers have treated clay minerals in sedimentary rocks and the effect of diagenesis on clay minerals in various sedimentary environments. Several investigators (*1, 2*) have suggested that some clay minerals are changed by diagenetic processes in the marine environment, while others (*3*) have reported that clay minerals in most sedimentary rocks are primarily the product of their source and have undergone little diagenetic change even in the marine environment. Millot (*1*) suggested that the fibrous clay minerals such as attapulgite and sepiolite are formed in the supersaline environment, but Millot, Radier, and Bonifas (*4*) recently suggested that attapulgite is formed in the marine environment.

I have undertaken a study of the clay-mineral composition of playa sediments in the western United States and of the effect of the saline environment on diagenetic changes in clay minerals. The Mojave Desert and the surrounding area in southern California contain over a hundred playas ranging in size from a few acres to over 200 square miles. These lakes have a wide range in chemical character, from almost fresh water to very saline, in which deposits of calcium and sodium salts (carbonates, sulfates, halites, borates, and others) are found. Many types of source rocks surround the playa basins and furnish sediments to playas with different chemical environments. By comparing the clay mineral composition of the source rocks and the playa sediments, important data concerning the diagenesis of clay minerals in the saline environment can be obtained. Over 300 samples of sediment were taken from 45 playas and from the source material being transported into the playa basins. This report is concerned with the general conclusions of this study.

Several groups of clay minerals are present in the playas, and their identification is based on standard x-ray analytical techniques. Montmorillonite is present in all samples and ranges in abundance from one to seven parts in ten. A 10-A clay mineral described as illite (*5*) is present in every sample and ranges in abundance from two to six parts in ten. Chlorite is present in about 75 percent of the sediments of the playas and ranges in abundance from one to six parts in ten. In only one lake, Mirage (San Bernardino County), is it the dominant clay mineral, and here it makes up six parts of the total clay mineral composition in ten. Kaolinite is recognized in the sediments in twelve playas, and its abundance ranges from one to two parts in ten. All four of these clay minerals are present in some lakes. For example, in Bristol Lake (San Bernardino County), illite, montmorillonite, chlorite, and kaolinite are found in the playa muds from which halite (NaCl) is being mined. The mother liquor of Bristol Lake is rich in calcium chloride. In every playa studied, no change was seen between the clay mineral composition of the detritus being carried into the basin and the clay mineral composition of the saline muds.

The chemistry of the saline and supersaline evaporite salts in the playas of southern California is complex, but in every case the dominant cations are sodium and calcium. Magnesium and potassium are very abundant in the minerals that are precipitated as the last phases of marine evaporite deposition; however, magnesium and potassium are not in very strong concentration in any of the saline lake deposits in southern California. Therefore the conclusions of this study cannot be applied directly to diagenesis in late-phase marine evaporite deposits. Little work has been done with the clay mineral composition and variation in marine evaporite facies, but it is in marine facies that the regular interstratification of two different clay mineral structures has been found (*6*). These rare, regular, mixed-layered clay minerals are usually high in magnesium and very probably are diagenetic products (*7, 8*).

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Gas Diffusion in Porous Media

Abstract. A method has been proposed for deriving a characteristic determining flow in porous systems. This characteristic combines both area and path-length factors used by earlier authors. For a gas, diffusive flow is proportional to the 4/3 power of the gas-filled porosity, and this function has been derived from consideration of the planar distribution of spherical pores and the interaction of two adjacent planes.

The flow of liquid and gas in porous solids has long received attention. In agriculture, irrigation practice and estimation of the possible significance of soil aeration in plant growth depend on accurate definition of the parameters limiting mass and diffusive flow. In the oil