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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References and Notes

1. T. B. Thorson, *Physiol. Zoöl.* 31, 16 (1958).
2. A. W. Martin, *Studies Honoring Trevor Kincaid* (Univ. of Washington Press, Seattle, 1950).
3. C. L. Prosser and S. J. F. Weinstein, *Physiol. Zoöl.* 23, 113 (1950).
4. P. D. Sturkie, *Avian Physiology* (Cornell Univ. Press, Ithaca, N.Y., 1954).
5. H. Welcker, *Z. rationelle Med.* 4, 145 (1858).
6. Studies from the Department of Zoology, University of Nebraska, No. 313. This work was supported by the U.S. Public Health Service (grant No. H-3134). Experimental animals and laboratory facilities were provided by the Hammond Bay Fishery Laboratory of the U.S. Fish and Wildlife Service, Rogers City, Mich. Appreciation is expressed to the director, Vernon C. Applegate, the laboratory staff, James W. Moffett, chief of Great Lakes fishery investigations, and to A. S. West, director of the Queens University Biological Station, Opinicon Lake, Ontario.
7. T. B. Thorson, *Copeia*, in press.
8. M. B. Derrickson and W. R. Amberson, *Biol. Bull.* 67, 329 (1934).

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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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References and Notes

1. G. Millot, *Géol. appl. et prospect. minière* 2, 352 (1949).
2. R. E. Grim, R. S. Deitz, W. F. Bradley, *Bull. Geol. Soc. Am.* 60, 1785 (1949); R. E. Grim, *J. Sediment. Petrol.* 21, 226 (1951); R. E. Grim and W. D. Johns, *Natl. Acad. Sci.–Natl. Research Council Publ.* 395, 81 (1953); W. D. Keller, *Bull. Am. Assoc. Petrol. Geologists* 40, 2689 (1956); R. E. Grim, *ibid.* 42, 246 (1958).
3. C. E. Weaver, *Bull. Am. Assoc. Petrol. Geologists* 42, 254 (1958); I. H. Milne and J. W. Eardley, *ibid.* 42, 328 (1958); J. B. Droste and J. L. Harrison, *Bull. Geol. Soc. Am.* 69, 1556 (1958).
4. G. Millot, H. Radier, M. Bonifas, *Bull. soc. géol. France* 8, 425 (1957).
5. R. E. Grim, R. H. Bray, W. F. Bradley, *Am. Mineralogist* 22, 813 (1937).
6. D. B. Honeyborne, *Clay Minerals Bull.* 1, 150 (1951); F. Lippmann, *J. Sediment. Petrol.* 26, 125 (1956); W. F. Bradley and C. E. Weaver, *Am. Mineralogist* 41, 497 (1956); W. F. Bradley, J. B. Droste, R. E. Grim, in preparation.
7. The U.S. Geological Survey has drilled to depth in excess of 1000 ft in some of the playas of southern California. Samples from these cores have been made available to me.
8. Many of the lakes sampled are on private land, military reservations and national reserves of various kinds. Permission to enter these areas is gratefully acknowledged. The field work could not have been done without the support of grant G-5659 from the National Science Foundation.

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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