TO MAKE A SNOWFLAKE†

WILLIS E. KEITHLEY*

In the infinity of space, whirls an infinity of stars, galaxies and universes of a magnitude that dwarfs our wildest dreams. What an infinite interaction of chemical and physical energies God initiated in those celestial nuclear reactions!

Then one day, God tired of the titanic, and sought a design that would bring His cosmos to a perfect climax.

So He made a snowflake.

By bringing together all those great forces that had formed the worlds themselves, He forged this delicate mini-meteor. With the flaming power of the sun, He drew from the ocean a few drops of water and dissected them into a pure breath of vapor. Then with a mighty gust of wind He blew them high above the world into the clear non-resistant environment of the upper atmosphere. There in that pristine heaven, where no earthly influence could hinder their outward growth, He began to reassemble those misty molecules, atom by atom; as Isaiah would describe it, "line upon line, line upon line, here a little, and there a little."

But line by line seemed a bit monotonous. Then came a magnificent thought—why make them all the same? Why not program the design computer for a chain reaction and let each line punch the card for the next, and adjust the output for infinity?

Yet there should be some overall trademark which would identify their Creator. It was clearly evident that God should be presented in His triune nature; so a perfect triangle was programmed. Then God in His eternal foreknowledge saw the day when He would assume the human trinity of man's body, soul and spirit. Why not combine the two triads into a perfect six-pointed star?

What a triumphal triunity to reflect Christ as the morning Star of hope!

Does that sound a bit idealistic? Secular philosophy says all natural phenomena result from the casual cast of some capricious crap game. And here is a chance to exploit that conjecture of chance. It is reported that no two snowflakes are exactly alike; of course no one has ever verified that by examining all of them. Certainly the ones shown on the front cover are all different. But their manifold variety points to infinity. Would not that diversity seem to suggest the randomness upon which all the facets of nature could be built?

Yet these spontaneous anomalies of snow exhibit no tendency to develop into anything but a snowflake. With such infinite variation, surely they should at least have developed a wheel, as Henry David Thoreau described them so expressively, "There they lie, like the wreck of chariot wheels after a battle in the skies . . . these glorious spangles, the sweepings of heaven's floor." If unlimited randomness be the script for the cosmos, here should be enough deviation to prove both polemic and platitude.

But we must not neglect the evidence of design and purpose. Could it be mere chance that the heart of each snowflake is the very essence of geometry? Those sets of sixes and their precise sixty degrees reveal not only the holy Star of David, but witness the centrality of plan and pattern. Even Thoreau was compelled to look beyond the caprice of nature when he wrote in his journal, "Nature is full of genius, full of divinity. Nothing is cheap and coarse, neither dewdrop nor snowflake. A divinity must have stirred within them before the crystals did thus shoot and set."

*Mr. Willis E. Keithley is an evangelist and nature photographer. His address is 1819 N.W. 25th, Lincoln City, Oregon 97367.

†An account, similar to this, is given on pages 3-5 of Mr. Keithley's book, *Portraits on Nature's Palette*, available from the author at the address given above. The book was reviewed on page 76 of the *Quarterly* for June 1977.

MARINE LIFE AND THE FLOOD

E. NORBERT SMITH*

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Stenohaline plants and animals could not have survived a global homogeneous flood. Since salt water is more dense than fresh water, a situation in which dense salt water is overlaid by less dense fresh water is stable. Stenohaline organisms might have survived the flood by inhabiting extensive pockets of salt water lying underneath the predominantly fresh-water deluge. Brine pockets have been described in recent literature. A simple experimental model showed the plausibility of a heterogeneous flood.

How Salinity Affects Marine Creatures

Terrestrial animals, including man, survived the catastrophic deluge described in Genesis by God's provision of the Ark. The Biblical account is silent regarding survival of fresh water and marine organisms. It is true that many kinds of organisms can survive marked changes in salinity. Howe[1] provided evidence that at least some plant seeds can survive long period of soaking in varying concentrations of salt water. Salmon, striped bass and several other fish hatch in fresh water,

*E. Norbert Smith, Ph.D., is with the Division of Natural Science and Mathematics, Northeastern Oklahoma State University, Tahlequah, Oklahoma 74464.

mature in the sea, then return again to spawn in fresh water. Young eels hatch in the sea, mature in fresh water and return to the sea to spawn. Many crustaceans and other invertebrates survive marked daily and seasonal changes in salinity. Whitcomb and Morris noted the problem and cited examples of tolerance to changes in salinity of a few fish.[2] They suggested that if salinity changes were slow enough at least a few individuals would be able to adapt. Certainly many fish (and some invertebrates) can adapt to wide changes in salinity if the changes are slow.

There are however, many kinds of plants and animals that cannot tolerate marked salinity changes no matter how slow. Such animals are called stenohaline and must live within a narrow range of salinities. There are also many fresh water organisms that cannot tolerate an influx of sea water. How did they survive the flood?

The Bible tells us there were two sources of water for the flood. The windows of Heaven were opened (or rain) and the fountains of the deep were broken up. The latter statement probably refers to juvenile water trapped beneath the earth's crust since creation. One would hardly expect rain to contain significant amounts of salt. Juvenile water could contain varying amounts of inorganic salts, but would probably be qualitatively and quantitatively dissimilar to the sea. However, the problem remains; a homogeneous fresh-water deluge would kill stenohaline marine forms and a homogeneous salt-water deluge would destroy many fresh-water organisms. One is then left with but two alternatives: Organisms that cannot tolerate marked changes of salinity have radiated since the flood; or the flood waters were not homogeneous with respect to salinity. Since many complex physiological changes are necessary to change a eurohaline organism into a stenohaline organism, this author does not believe the multitude of osmoregulatory mechanisms described today have developed in the short span of time since the flood. Let us, therefore, examine the other possibility, namely, that of heterogeneous flood waters.

Existing Nonhomogeneous Situations

The density of seawater increases linearly with the salt content. Salt water is more dense than fresh water. A stable configuration exists if salt water is overlaid by fresh water. Natural occurrences of this type are not uncommon. An interesting example was related to the author by Dr. Vernon Proctor, Texas Tech. University. About 10 km Southwest of Cuatrocienegas, Coahuila, Mexico, a spring-fed creek is formed near the base of the Sierra de Los Alamitos mountains. The creek contains considerable salts in solution. Occasional flooding leaves small pools typically 1-3 m across and about ½ m deep. During periods of drought, evaporation increases salinity in the isolated pools near the flowing creek. On one occasion, flooding of the creek resulted in fresh water spilling over the salt water in the pools. The duration of this situation was undetermined but Dr. Proctor and his students made two interesting observations. First, a marked thermocline was obvious, the lower salt water being too hot to hold one's hand in and the surface water being relatively cool. Secondly, they observed an unidentified species of fish living in the surface fresh water. When frightened, the fish would swim momentarily into the lower hot salt water and immediately return to the cooler fresh water on top. If forced to remain in the lower water the fish would quickly die, due, probably, to the high water temperature. The author visited the area a few years later. Unfortunately, prolonged local flooding had purged the depressions of the bottom brine.

A similar situation has been described in the Venezuelan Antilles on the Island of Gram Rogue about 150 km north of Caracas, Venezuela.[3] A small brackish lagoon, roughly circular, with a diameter of about 0.5 km, was found to consist of hot brine overlaid with about 25 cm of seawater. The two densities were relatively constant above and below the 25 cm thermocline despite observed shallow-water circulation due to dominant easterly winds. Density-stratified lakes having a sharp thermocline were first described in Somaliland[4] and later in Washington[5] and Antarctica.[6] It is interesting that solar ponds of Israel, used to produce electricity, consist of about 50 cm of brine topped with fresh water.[7] It is widely known that rivers flowing into the sea ride atop a wedge of salt water. The depth of the wedge (from the surface) changes with the ebb and flow of the tides. Each of these situations is stable because, even when hot, the lower salt water is more dense than the surface water. Under natural and artificial conditions density stratifications will survive surface mixing by wind.

Possible Nonhomogeneity During the Flood

Could not this simple phenomenon account for the survival of marine organisms during the flood? Certainly preflood seas would have been overlaid by rain and continental run-off. Large basins of seawater of extent measured in km would have been immensely stable if overlaid by tens or hundreds of meters of fresh water. Turbidity, and the depth of the surface water, would have minimized radiant heating of the lower seawater. A stable situation would result, facilitating survival of stenohaline organisms for the duration of the flood. It is conceivable that in many places enough light would filter through to enable photosynthetic plants to produce oxygen. Certainly diverse food chains would abound from the continual "rain" of detritus from the surface water.

The survival of marine organisms during the flood can then be accounted for in terms of a heterogeneous flood. Survival of surface fresh-water life is straightforward. Continental uplift and mountain formation toward the end of the flood would result in many isolated fresh-water lakes, rivers and streams. These would be populated with fresh-water organisms remaining and colonizing new areas until the present time.

How did the pockets of marine life survive and populate the seas? During the first forty days of the flood, juvenile water no doubt brought with it varying quantities of brine. Some were probably toxic and some may have been considerably more salty than today's seas. These pockets of brine would have survived the flood water intact due to their very high density.

Toward the end of the flood, continental uplift would have again released juvenile water and additional salts. The natural salts would begin mixing with the seawater. As the continents were uplifted our present global patterns of winds and ocean currents would gradually be estabished and consequently much of the sea would become homogeneously mixed. The density gradient would be reduced and the "pockets" of marine organisms would be released. One might predict that if the flood was indeed heterogeneous complete mixing of the brine would not have happened for many years. In fact, if certain brine basins were very dense, sheltered from oceanic currents, and deep enough to be protected from surface mixing, one might expect to find some today. Hypersaline water has been found in deep boreholes in the Gulf of Mexico;[8] and bottom waters from three Red Sea Basins[9] are hypersaline.

It is interesting to note that a hypersaline basin was recently reported in Science.[10] The basin, named Orca, is in the Northern Gulf of Mexico (about 27 °N, 91 °W) and extended from a depth of about 2200 meters to the bottom at about 2400 meters. Its area is approximately 400 km^2. (Table 1 compares selected water chemistry differences of Orca with sea water and Red Sea Basin.) Salinity of Orca approaches that of the Red Sea Basins; and it is over eight time more salty than the sea.

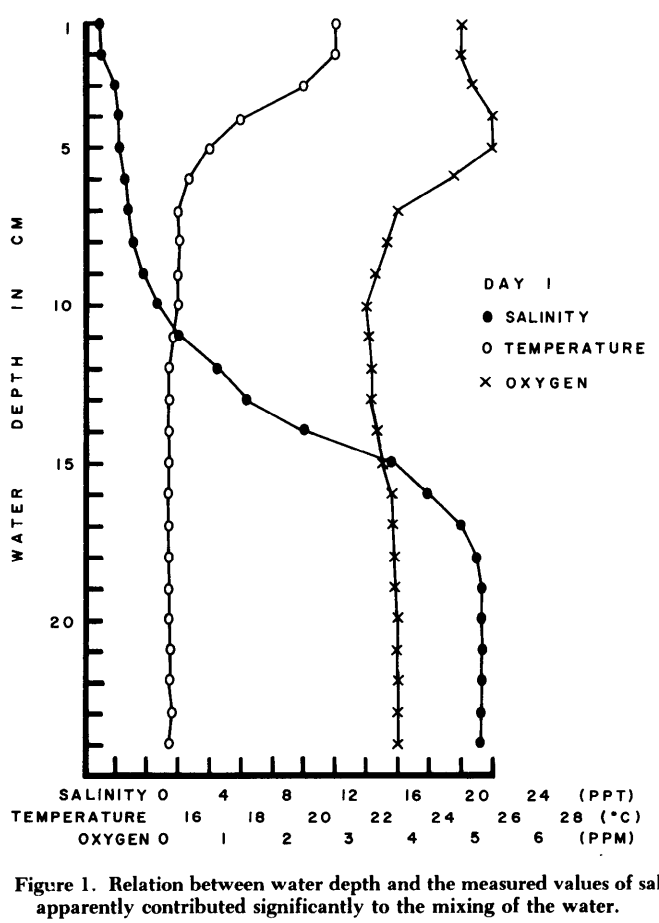
While the Orca Basin may have been formed by some non-flood mechanism, it does indicate a strong stability of natural density gradients and clearly shows that even today the ocean is not homogeneous. Certainly marine life could have survived the flood by simply being overlaid by fresh water. Obviously, more work needs to be done. Geologically, qualitative estimates of available salts and final densities need to be made and compared with sea water. Biological studies need to be made to establish the limits stenohaline organisms can tolerate.

Table 1. Comparison of chemistry of sea water with water from two naturally occurring hypersaline basins. See Reference 10.

	Salinity g/L.	Cl^- g/Kg	Na^+ g/Kg	Density g/ml
Sea water	36.3	19.4	10.8	1.025
Red Sea Basin	317.1	155.3	92.9	1.199
Orca Brine	308.5	149.5	91.5	1.85

Experimental Arrangement

A simple experiment was performed to test the survival and extent of mixing in an aquarium containing sea water overlaid with fresh water. A small all-glass aquarium measuring approximately 16 cm x 16 cm and 30 cm high was filled to a depth of about 24 cm. The lower half was filled with natural sea water (collected from a bay having a salinity somewhat less than water in the ocean). A hermit crab, and natural sea sand



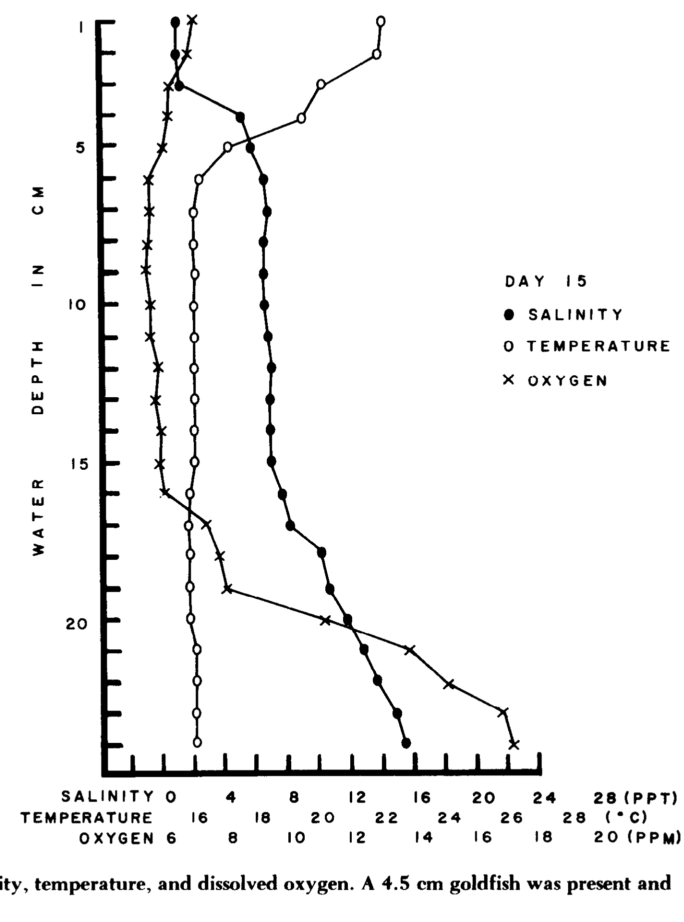


Figure 1. Relation between water depth and the measured values of salinity, temperature, and dissolved oxygen. A 4.5 cm goldfish was present and apparently contributed significantly to the mixing of the water.

containing algae, were introduced into the salt water. A sheet of paper was placed on the salt water and fresh water added slowly (to minimize mixing). A 4.5 cm goldfish, fresh water snails, duckweed and *Elodea* were introduced in the surface water. The aquarium was placed near a north window (December and January). The water temperature, oxygen, and salinity were measured from time to time at 1 cm intervals of depth for 15 days. Temperature was read and conductance (read out as salinity in ppt) was measured on a YSI Model 33 S-C-T Meter. Oxygen was measured on a YSI Model 57 oxygen meter. Measurements were taken in the afternoon between 4:00 and 6:00 p.m. Since it appeared that the goldfish contributed significantly to the mixing of the boundary layer a second experiment was conducted without the goldfish.

Experimental Results

The goldfish swam (with great difficulty, due to high buoyancy) through the salt water to the bottom when first released. It soon left the bottom and remained in the fresh-water portion of the tank. Most of the time was spent in the upper 5-10 cm. After a few days it would often swim rapidly down into the upper few cm of salt water but was not seen near the bottom after the first day. It fed at the surface on fish food. Food dropping on to the bottom was eaten by the hermit crab. The fresh-water plants survived and showed growth.

Figure 1 shows the relation between water depth and the measured water parameters with the goldfish. The salinity gradient was steep on day 1, but by day 15 the gradient was almost gone. Oxygen concentration increased toward the end of the experiment especially in the salt water, due to photosynthetic activity of algae. No thermocline was found at the fresh-salt water boundary because solar radiation was unavailable.

Figure 2 shows the same relation without the goldfish. Surface and bottom water remain considerably less mixed. Oxygen concentration is again high due to photosynthetic activity of Marine Algae. A small amount of foam was present on the surface due to oxygen bubbles coming from the lower water.

Figure 3 shows isohaline depths during the course of the two experiments. Clearly the goldfish contributed to mixing in the first experiment. In the second experiment a stable condition exists and the experiment could probably have been continued for several weeks with little change.

Discussion of Results

It is apparent that marine organisms can indeed survive if overlaid with fresh water. Photosynthetic activity can supply adequate oxygen if light is available. In the very small experimental model described here the movements of one goldfish resulted in mixing of the fresh and salt water. During the flood the large extent of

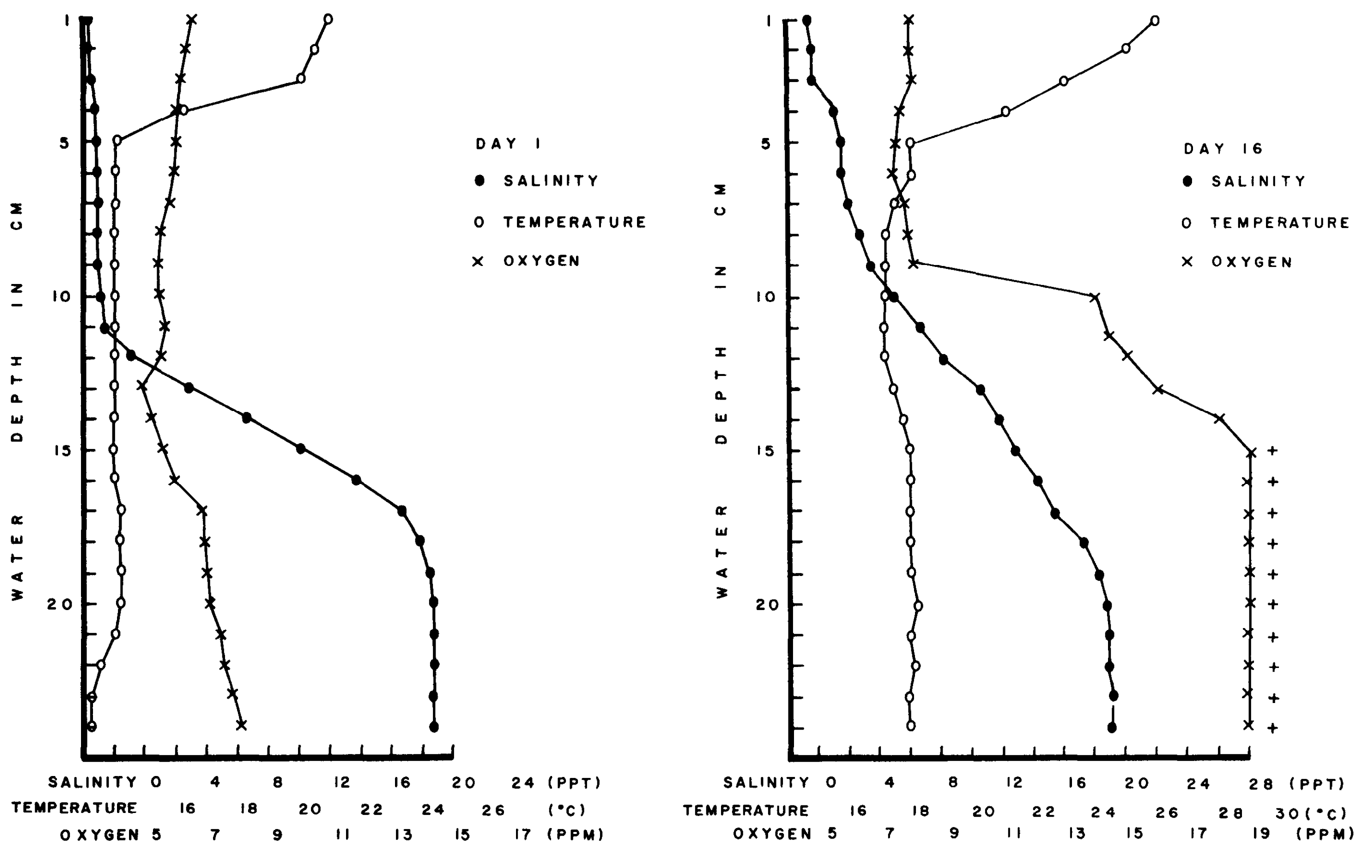


Figure 2. Relation between water depth and the measured values of salinity, temperature, and dissolved oxygen in a second trial. The goldfish was not present. The oxygen meter only measured to 20 ppM, so plus signs (+) indicate full scale reading of oxygen, i.e., 20 ppM or more.

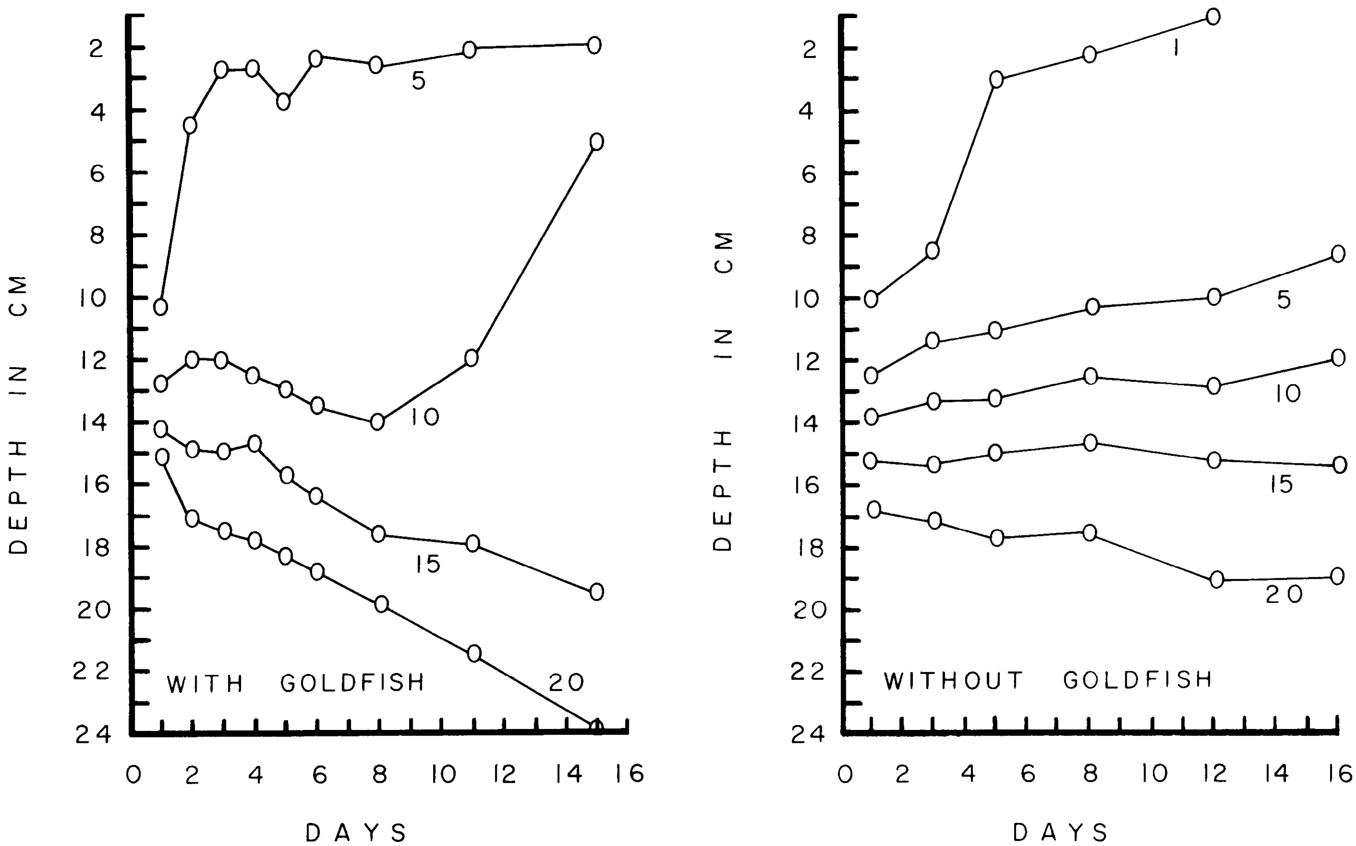


Figure 3. Isohaline depths shown as a function of time with and without the goldfish. The curved marked "10", e.g., shows the depth at which, at the respective times, the concentration of salt was 10 parts per thousand.

interface region would no doubt allow stability for a period far exceeding the year of the flood.

Conclusion

It is suggested that fresh-water and marine stenohaline organisms could have survived a heterogeneous deluge simply because dense salt water can be overlaid with lighter fresh water. This phenomenon occurs naturally and can be produced artificially. A simple experimental model illustrated that marine and fresh-water organisms can indeed live in the same aquarium without undue mixing of the two media. Clearly research is needed to ascertain the geological implications of this model. Additional biological studies to determine survival of marine organisms under low light and low oxygen concentrations are needed.

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QUOTABLE QUOTE

"Hence all the nonsense . . . that the *élan vital* is capable of surmounting all obstacles . . . as if we could believe that any social or biological development on this planet will . . . reverse the second law of thermodynamics."

C. S. Lewis, in a sermon,
The Weight of Glory, given at Oxford.