milliliter was obtained from the National Bureau of Standards. The solution was prepared from a carbonate with a $C^{14}$ ratio determined mass-spectrometrically at four different laboratories with results agreeing within 3 percent. Ten milliliters and 15 ml of this solution were added to 22.335 g and 23.148 g of $Na_2CO_3$, respectively, for conversion to $C_2H_2$. A third sample, serving as a blank, was prepared from the same carbonate without the addition of a spike. The results are listed in Table 2.

Assuming 5568 yr for the $C^{14}$ half life (*5*), one obtains from the $C^{14}$ ratio of $(1.238 \pm 0.03) \times 10^{-12}$ for standard wood carbon, a specific activity of $14.7 \pm 0.4$ disintegrations/min, which is in good agreement with the value of $15.3 \pm 0.5$ as determined by Anderson and Libby (*6*). The lower values reported by Hayes *et al.* (*7*) and by Fergusson (*8*) of $12.9 \pm 0.2$ and $12.5 \pm 0.2$ disintegrations/min, respectively, can be brought into agreement with the reported measurement only by assuming a correspondingly longer half life.

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### References and Notes

1. Publication authorized by the director, U.S. Geological Survey. The assistance of Meyer Rubin in carrying out the measurements is greatly appreciated. Thanks are also due to Harmon Craig, not only for providing the necessary $C^{13}$ analyses, but also for valuable discussions concerning the geochemistry of carbon isotopes. Corrinne Alexander carried out the technical procedure of sample preparation.
2. H. E. Suess, *Science* 120, 5 (1954).
3. ———, *Proc. Conf. on Nuclear Processes in Geologic Set*, Williams Bay, 1953.
4. H. Craig, *Geochim. et Cosmochim. Acta* 3, 53 (1953); *J. Geol.* 62, 115 (1954).
5. W. F. Libby, *Radiocarbon Dating* (Univ. of Chicago Press, Chicago, 1952).
6. E. C. Anderson and W. F. Libby, *Phys. Rev.* 81, 64 (1951).
7. F. N. Hayes, D. L. Williams, A. B. Rogers, *ibid.* 92, 512 (1953).
8. G. F. Fergusson, *Nucleonics* 13, 18 (1955).
9. The samples were obtained through the following: Alaska spruce, T. L. Péwé, U.S. Geological Survey; white pine, A. C. Redfield, W.H.O.I.; incense cedar, J. C. Preston, National Park Service; cedrela, J. Arnold, Univ. of Chicago, and B. F. Kukachka, U.S. Department of Agriculture; sargassum, D. R. Norton, U.S. Geological Survey. The sample of *Venus mercenaria* was collected by H. J. Turner.

7 June 1955

## Sharks in Fresh Water

In a recent number of *Science* [**121**, 759 (27 May 1955)] is a note on the occurrence of sharks and sawfish in Lake Sentani, Dutch New Guinea. In it I read "How these salt-water fish became acclimated to fresh water in a lake 500 ft above set level is unknown."

There is no mystery about this at all. That certain species of sharks and rays, including sawfishes, enter fresh water freely and travel long distances into lakes and rivers has been known for a long time. It is now 75 years since I first read of the Ganges shark (*Carcharias gangeticus*) and its attacks on people bathing in the Hugli and Ganges rivers. Long ago A. B. Meyer, a celebrated German naturalist, recorded [*Nature* **13**, 167 (1875)] that sawfish (*Pristis microdon*) up to 20 ft in length were abundant in Laguna de Bay, Luzon. In 1870 Günther recorded this same sawfish in the Amazon and its tributaries, in the Zambezi below the great falls, and in the great rivers of Borneo and Sumatra.

For the past 35 years I have been familiar with the presence of sharks and sawfish in the rivers and lakes of the tropics. In the Philippines, the Ganges shark and the sawfish mentioned previously occur in all rivers of any size and in all fresh-water lakes where there is a good-sized outlet, unimpeded by a dam or waterfall, leading to the sea. They pass through rapids to reach the upper Agusan at least 150 mi from the sea by the winding river. I found the Papuans familiar with sawfish along the Sepik River, New Guinea, more than 300 mi from the sea; these fish undoubtedly go very far beyond that point. Far from being astonished at the presence of sharks and sawfish in Lake Sentani, I would be surprised if they did not occur there. There is no obstacle to the free passage of sharks and sawfish to and from Lake Sentani and the sea, especially in the rainy season. At that time several drainage systems become one vast sheet of water.

One must remember certain facts concerning fishes found in fresh water in the rainy tropics. First, an astonishing variety of marine fishes migrate up rivers and into lakes, many of them going to the remote interior as long as they are not stopped by waterfalls. Eels, mullet, and gobies may ascend in this way to elevations of 5000 ft. Second, in time of high water many rapids unsurmountable to migrating fishes during ordinary water stages become readily passable and are no longer a serious obstacle to them, no matter what Europeans or North Americans may think about it. Some kinds of these fishes remain but a short time, but most kinds remain until they are adult or nearly so and must return to the sea to breed.

The sharks and sawfishes mentioned do not breed in fresh water but, like many other marine fishes, find lacustrine life very attractive. The ecological conditions are very favorable to their existence and there is a great abundance of easily taken food, an altogether attractive situation. Unless cut off by huge permanent fish corrals, as at the outlet of Laguna Bombon, Luzon, sharks return to the sea to breed.

I have found that forest people, such as the Mandayas and Monobos in Mindanao, believe that the sharks they see in their rivers are females and that the sawfish are the males of the same fish. However this singular belief does not seem to be held by any people who are real fisherfolk, depending on fish for their main food supply.

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## Physiology of a Primary Chemoreceptor Unit

Progress in the physiology of chemoreception has been hampered by the fact that in most reported experiments the criteria of sensory excitation have been limited to behavioral responses of the animals studied. In some work on vertebrates (*1*), the responses of chemoreceptors have been approached somewhat more directly by recording afferent discharges in sensory nerve fibers that supply the receptor cells. However, these studies still leave in some doubt the nature of the response of the primary receptor surface to specific chemical stimuli.

Chemoreceptor cells of insects have special advantages for experimental work in this area of sensory physiology. These advantages include accessibility of the receptors, absence of a mucus coating over the receptor surface, the fact that the axon of the primary receptor serves as afferent fiber, and the unusually prominent development and sensitivity of the chemical senses of insects. Recent histological studies on single chemosensory hairs of insects have given new encouragement to the hitherto unsuccessful attempts to record electric activity associated with functions of the primary chemoreceptor cells of insects. Gabrowski and Dethier (*2*) found that the distal processes of two neurons extend to the tip of each tarsal chemosensory hair of the blowfly (*Phormia*), and similar observations have been made on the labellar chemosensory hairs of flies (*3*). Attempts to record electric changes in the region of the neurons at the base of the labellar sensory hairs met with some success (*4*), but the results were erratic owing to local shunting of potentials from the small fibers and unpredictability of electrode placement. The present method of recording potential changes between the small localized sensory surface on the tip of the chemosensory hair and the body of the animal has proved to be convenient and reproducible, and may have applications to other organisms and other sense organs.

A 15-mm length of 1-mm (outside