reduce the amount of work necessary to stimulate done by the electrical current while the second agent is acting. The usual statement in such a case is to the effect that the second agent has increased the irritability of the tissue in question. There is a general reluctance in some quarters to consider, or admit, that the second agent has done any work on the tissue. Consider the consequences of the denial that the second agent has done any work on the tissue.

Under control conditions, a quantity of work W is necessary to stimulate while, under the second set of conditions, a quantity of work W_1 less than W is sufficient. Then, without doing any work upon the system represented by the tissue, but merely by increasing its irritability, we have induced a change of state such that the application of a smaller amount of work applied to the system in the form of a stimulus gets the same amount of work out of the system as before. That is, we have somewhere gained work without any corresponding expenditure of work. Such a condition would constitute a veritable perpetuum mobile.

It does not seem necessary, however, to postulate perpetual motion in biological processes. If we were to proceed on the assumption that some principles of mechanics, physical or chemical or both, apply even in irritability, we would suppose that our second agent, say a drug, which, by itself, will not produce any typical excitation of the given tissue, would do work W_d upon the tissue. The work done by the electrical current now need be only W_e, less than W. Our equation would become

$$I = \frac{1}{W_e + W_d},$$

in which $W_e + W_d$ might be equal to, or even greater than, W. (The inequality of $W_e + W_d$ and W would arise from the fact that the action of drugs is not 100 per cent. efficient thermodynamically.) Neither total quantity of work nor irritability need change.

A physical analogy might be a rock in the air, but so situated that it might be completely surrounded by water at will. A quantity of work x would be necessary to raise the rock when in the air, but only x–y units of work would be necessary when it was in the water. The water would not raise the rock by itself, but it would do y units of work on the rock.

Neither the total quantity of work nor the irritability of the rock need change. The converse of this case is also true. If the rock were originally surrounded by water which could be pumped off or drained off by the fall of the tide, more work would be necessary to raise it in the air. But we need not postulate any decrease of irritability in the rock. Nor would we say that the presence or absence of water added to or subtracted from the "levitation" in the rock.

We would probably get along faster and acquire somewhat clearer ideas of the processes involved if we were to consider the general case of two or more agents acting simultaneously upon a tissue or organism from the point of view of work done upon the system, even though our measurements at present are inadequate to give the notion quantitative exactness, than we would if we were to retain the seventeenth century concept of irritability and invent new words to show how the postulate of perpetual motion is to be avoided.

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THE EFFECT OF FLUORINE IN NATURAL WATERS ON THE TEETH OF SMALL FISH

THE world-wide dental distrophy known as "mottled enamel" has been definitely proved to follow the ingestion of drinking water containing small amounts of fluoride ion, during the formative period of the teeth.[1]

It has also been shown that the toxic concentrations of fluoride ion involved are of the order of one to five parts per million.[2]

It is difficult to get representative water analyses of fluoride ion at such low concentrations, and it is necessary to extend the analyses over a period of time to allow for variability in concentration. However, if small fish, found in practically all waters, should reflect in their teeth the average fluoride ion concentration of their habitat, they could serve as a criterion of fluoride ion concentrations.

With this aim in view, the teeth of *Gambusia affinis* (mosquito-fish) were examined from: (1) A region in which no mottled enamel had been reported in the children; (2) a region where mottling had been found; and (3) a region where the children showed severe cases of mottled enamel.

It was found that in passing from region 1 to region 3, the pulp cavities of the fishes' teeth became broader or wider in proportion to the length of the teeth, and the teeth took on an increasing "roughened" appearance, the roughening being extreme in some cases. In one section the teeth showed extreme wear, indicating a soft structure.

There thus seems to be a relationship between the amount of fluoride ion in a given water and the condition of the teeth of the fish living therein.

Fish are being raised in known concentrations of fluoride ion, and it is hoped that from them definite data will be available.

[1] M. C. Smith, *University of Arizona Tech. Bul. 45.*

[2] H. V. Smith, *Jour. Ind. Eng. Chem.*, Anal. Ed., 7: 23, 1935.

As an aid to further study along this line, small fish preserved in 10 per cent. formalin, from regions where mottled enamel is endemic, will be greatly appreciated.

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THE CYTOLOGY OF THE DIFFERENTIATING SPIRAL VESSEL IN RICINUS COMMUNIS

ALTHOUGH spiral vessels are probably considered the most commonplace elements in plant anatomy, I have been unable to find any detailed account of their differentiation. In spiral vessels the spiral thickening may extend uninterrupted throughout an entire developing internode. This continuity of the spiral appears comprehensible only if the spiral is laid down as a continuous unit, and is not a composite resulting from the fusion of spirals in vertically adjacent cells.

In *Ricinus communis* all stages of differentiation of the spiral vessels may be found. As soon as the future xylem elements, cut off from the cambium, begin to vacuolate, to expand and to elongate, the end walls of the vertically superimposed cells break down. The result is a coencyte traceable often throughout the entire length of the internode. The protoplasm is granular and is seen in all stages of vacuolation. The nuclei lie in vertical series numbering from ten to twenty and very often increase markedly in size. As is well known, the spiral thickening is laid down only when expansion is complete, and appears first as a faint unlignified cellulose band. Lignification follows, while protoplasm and nuclei remain intact and are observed in the fully differentiated element. The occurrence of the coenocytic phase of development explains the continuity of the spiral.

Further details of the process will be published shortly.

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MOTION-PICTURE SPEED NOMENCLATURE

DOES the translation of a simple, well-understood and widely used expression, "slow motion," into its Greek equivalent "bradykinetic" result in "a uniform terminology *which precludes confusion,*" as stated by Dr. Richards in SCIENCE for August 2, 1935, in the last paragraph of his article? Or does it result in the confusion evident in the immediately preceding paragraph, which states, "A *'bradykinetic'* film can not be obtained by *projecting* rapidly an 'isokinetic' film, *except within very narrow limits. . . .*"

Now any one mechanically inclined knows one can not obtain a slow motion picture by speeding up the projector, as the effect would obviously be the opposite of that desired. Would not this error have been noted by the proofreader if it was not "Greek" to him?

If the number of frames per second projected be placed over the number of frames per second photographed and the word "actual-speed" be added an expression will result that will be self-explanatory and give all the desired information at a glance. Example: "This is a 16/256 actual-speed film." This obviously means a sixteenth speed film and that everything moves in the projected picture at one sixteenth the speed the actual objects did. In a 16/8 actual-speed film they move at twice the actual speed.

MARTIN A. RYAN

BIRCH-BARK CANOES

I HAVE recently returned from Golden Lake, Ontario, where Indians still make birch-bark canoes for use, and sell them cheaper than factory-made canoes. They can make them for museum specimens without using such modern materials as nails.

Some museums may not know that such canoes are still made and available. Some owners of lakeside summer homes may not know that they can still get such canoes for use or merely as romantic lake-shore objects or lodge or dining-hall decorations, to be placed over mantels, etc.

I would be glad to help such museums and/or people to get in touch with Indians that I consider reliable, in order to help both parties concerned, especially as the Indian need of money and market would help keep alive a primitive North American industry.

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SCIENTIFIC BOOKS

BIOCHEMISTRY

Annual Review of Biochemistry. Edited by JAMES MURRAY LUCK. Vol. IV, Annual Review of Biochemistry, Ltd., Stanford University P. O., California, 1935.

THIS "Annual," now in its fourth year, has already taken its place as one of those indispensable books without which a biochemical library is no library at all. We biochemists are deeply indebted to Professor Luck, the editor of all four volumes, upon whom rests the main responsibility of production. Instead of covering each year the fathomless ocean known as bio-