tween the morphological and biochemical changes and the possible effect on virulence are being studied.

The concentrates at present available are manifestly crude, but the active material (or materials) is non-volatile, readily soluble in water, 95 per cent. alcohol and acetone containing a trace of water, and is stable at 100° C. at pH 7.3. The concentrates are acid and contain nitrogen but no sulfur. They give a positive biuret reaction, but it appears likely that the protein is present as an impurity.

These experiments are being extended and will be reported in detail later.

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DIETARY REPAIR OF EXPERIMENTAL CARIES[1]

EXPERIMENTAL caries was produced by feeding rats a coarse-corn, caries-producing diet[2] for 100 days. Animals sacrificed at the end of this period showed evidence of carious disintegration in the molar teeth. By examination under binocular microscope, using a fine explorer to test the cavity formation, soft areas of exposed dentin could be noticed. Upon histological examination the lesions showed deep penetration with the cavity base in close proximity to the pulp chamber and with little evidence of secondary dentin formation. One group of rats which had been on the caries-producing diet during the same period (100 days) were continued for an additional 2 months, during which time they received the stock diet of this laboratory (finely ground fox chow) that has been shown to be adequate in every respect. After the two months on this diet, the rats were sacrificed and the molar teeth examined.

Unexpectedly, the caries process had not only stopped but under binocular examination the exposed dentin was found hard and polished. Histological study of these teeth showed an unusual picture. The dentin had a sclerotic appearance and beneath every place where the outer part of the tooth had been subject to attack a new thick layer of secondary dentin had been laid down, which reestablished a safe distance between the external tooth surface and the pulp. In some cases this protective layer had attained the thickness of the original dentin.

This experimental approach, which permits histological evaluation of the reparative processes associated with carious disintegration, should offer a new field of investigation of the dietary and other factors involved in the control of dental caries. If such defensive processes can be promoted and the acute caries penetration prevented, it should be possible to save many teeth from severe destruction and its consequences.

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[1] This work was carried out with a grant from the Carnegie Corporation of New York.

[2] C. A. Hoppert, P. A. Webber and T. L. Canniff, SCIENCE, 74: 77, July 17, 1931.

RATE OF SURFACE RETREAT OF SEA CLIFFS BASED ON DATED INSCRIPTIONS[1]

SINCE the time of cave man, people have responded more or less to an urge to draw pictures or cut inscriptions on walls. Although this habit is often objectionable, some use can be made of it geologically in estimating the rate of rock surface weathering and erosion.

Near La Jolla, California, the sea cliffs are largely composed of Cretaceous and Eocene rock. Much of this material is sandstone, consisting of medium to coarse-grained quartz and feldspar, moderately to firmly cemented by $CaCO_3$ when fresh, but friable when weathered. Along four miles of this coast a great number of roughly carved names or initials were found on the sandstone during August, 1940. Even though fewer than 10 per cent. were accompanied by the date on which the carving was made, a total of 163 dated inscriptions were located. Since beach vacationists have come to La Jolla for many years, an interesting frequency curve for such dated signatures can be made (Fig. 1). Enough data are available so that the effect of a few deeply cut carvings, of falsification and of errors in reading partly obliterated dates is minimized.

Most of the freshly cut letters are a sixteenth to a quarter of an inch deep. Within a few months after being cut, definite signs of solution and wearing away of the edges appear, until in about a year there remain no sharp edges whatever. In two or three years the lines usually become only broad shallow grooves in the rock surface and in four or five years they are partly obliterated and can be read only with difficulty. In several instances, where the grooves for old carvings had been almost completely destroyed, the lines are partly shown by rows of barnacles which had lived in the grooves probably because a water film was held there longer than on the flat rock surface.

Destruction of the carvings seems to take place largely through solution of the $CaCO_3$ cement in the rock. The loosened grains may be detached by the formation of salt crystals developed by the evaporation of spray or at some localities they may be carried away

[1] Contributions from the Scripps Institution of Oceanography, New Series, No. 138.

through direct erosion by sediment-laden waves. Interestingly enough, the dates which have remained legible for the longest time are those cut on the walls of caves or narrow inlets where the rock rarely becomes completely dry.

On the basis of carvings made in 1940, the depth of the average inscription was estimated to be one eighth inch. If six years are required to obliterate a carving (Fig. 1), a period of about 600 years would be necessary for surface weathering and erosion alone to cause the sandstone cliffs to retreat one foot. This figure probably represents a maximum rate for the sandstone, however, since obliteration takes place not only by retreat of the entire cliff front, but also by mere broadening of the letters into a wide hollow. A much higher rate of retreat exists for local cliffs of relatively unconsolidated terrace material near La Jolla. These are cut back by waves and rain wash so rapidly that only one or two 1940 carvings were found. An even lower rate for limestone (one foot in 6,000 years) was obtained by Goodchild[2] through the investigation of gravestones. The slowness of the retreat suggests that other processes such as undercutting by waves is primarily responsible for the cutting back of the cliffs at La Jolla. At the rate of retreat of one foot in 600 years, a cliff twenty feet high would contribute to the beach about 3.3 cubic feet of sand annually for each one hundred feet of its length. Although the method is subject to errors, it may be an approach for determining relative rates of surface weathering and erosion in other areas.

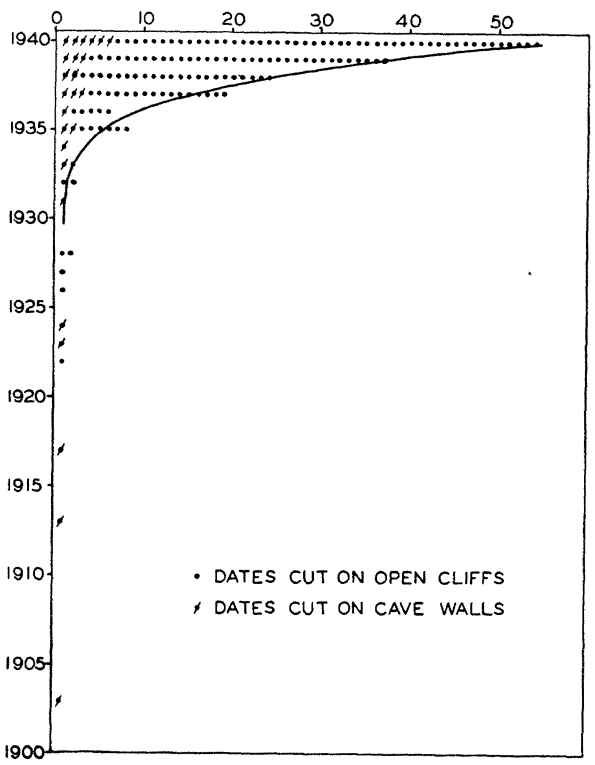

FIG. 1. Graph showing number of dated inscriptions found cut in sandstone sea cliffs near La Jolla, California.

[2] J. G. Goodchild, *Geol. Mag.*, 12: 326, 1875; *Geol. Mag.*, 27: 463–466, 1890.

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MAN'S BIOLOGICAL DESTINY

PROFESSOR ELIOT BLACKWELDER, speaking as retiring president of the Geological Society of America in an address published in SCIENCE for April 18, 1941, under the title "Science and Human Prospects," takes the view that man as a species is limited in power to improve native ability, except to such degree as may be accomplished by educational methods. However, no reason exists for so pessimistic a view because the human species is subject to biological laws that differ in no essential respect from the laws that govern animal and plant life. Surely, then, what has been accomplished with animals and plants can be repeated with man. Some of the work on animal and plant improvement was reviewed in the *American Naturalist*[1] not very long ago, and while this point was not discussed in that review, the work reviewed demonstrates that man holds his biological destiny in his own hands. And since the publication of the *American Naturalist* article, further gains have been made in the work at Mount Hope.

Purely voluntary action by a comparatively small number of people can develop a race of human beings whose brains would have most of the qualities which Professor Blackwelder wonders if man's successor on this planet may not possess, just as certainly as the abilities of animals have been improved. And the task will require such a small number of generations that it will doubtless seem like an instantaneous change to geologists. Nevertheless, a race of human beings whose poorest brains are superior to the best of to-day might have the same difficulties with human relationships as exist to-day because so many human relationships are governed by social inheritance rather than biological inheritance. As Professor Blackwelder puts it, ". . . and above all will his life and conduct be controlled by his intellect rather than by his feelings?"

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FURTHER COMMENT ON PRESERVATION OF NATURAL AREAS

THE comment of Dr. Willard G. Van Name in SCIENCE for May 2, 1941, emphasizes further the need

[1] H. D. Goodale, *American Naturalist*, 72: 740, 243, May–June, 1938.