group was to render assistance to the civilian population of a people at war and to acquire information on communicable disease in a war-time port.

DR. OTTO STRUVE, professor of astronomy at the University of Chicago, director of the Yerkes Observatory and of the McDonald Observatory, gave on March 29 the eleventh Joseph Henry Lecture before the Philosophical Society of Washington. He spoke on "The Constitution of Diffuse Matter in Interstellar Space."

DR. GEORGE R. COWGILL, professor of physiological chemistry at Yale University, lectured at Iowa State College on March 25. The subjects of his lectures were "Nutrition in Tropical America" and "Studies of Vitamin B_2 Deficiency." The former lecture was given at a meeting of Sigma Xi.

THE forty-first annual meeting of the American Association of Pathologists and Bacteriologists will be held at the College of Medicine of New York University on April 10 and 11, under the presidency of Dr. Stanhope Bayne-Jones, of Yale University.

DISCUSSION

ANOTHER NOTE ON THE ISOSTATIC CONTROL OF FLUCTUATIONS OF SEA LEVEL

THE purpose of this note is to supplement an earlier one dealing with the effect of the loading and unloading of the earth's crust by continental glaciers.[1] It discusses very briefly the effect of orogenesis and of erosional degradation upon the level of the ocean. In the absence of accurate data necessary for rigorous discussion and for positive numerical results, certain assumptions are made, the departure of which from the truth is unknown. The writer disclaims, however, any attempt to arrive at numerically reliable results. It is his intention rather to show that sea-level changes with the uplift of mountains and with their degradation, as well as with continental erosion, under the control of isostasy. The problem might be presented in algebraic form without the handicap of numerical assumptions; but there is some advantage in using assumed concrete values and in obtaining even very rough approximations for the measure of fluctuation of sea level. It seems to be more important to sketch a picture of the causes and processes of that fluctuation than to pretend, with defective data, to estimate accurately its amount. The effect on sea level of shift of load in or on the earth's crust is presented from a qualitative rather than a quantitative point of view. The figures used are to be regarded merely as those of an illustrative example.

Effect of orogenesis on sea level.—The great mountain ranges which diversify the surface of the globe have been elevated for the most part since the beginning of Tertiary time. They are sometimes referred to in geological literature as the Tertiary mountains; but some of them were uplifted in post-Tertiary time. The aggregate length of these ranges is about 64,000 km, and their mean width may be assumed to be about 160 km. The altitude of their crests varies greatly. Some of them have suffered degradation throughout a large part of Tertiary time, while others of later uplift have been reduced by erosion relatively little. It is assumed, however, that the "Tertiary" mountains in general had an initial mean height, in transverse profile, of 3 km. That is to say, the mean altitude of the orogenic belt was increased 3 km, its surface prior to uplift having been that of a lowland; or shallow sea-floor.

The mean initial uplift of the mountains being 3 km in transverse profile, the light rock of which they are composed was depressed 21.75 km into the deeper heavier rock for flotation, according to the equation: $3.3x = 2.9\ (3 + x)$ where x is the amount of depression. This means that the light rock of the crust (mean density 2.9) was concentrated to a thickness of $3 + 21.75 = 24.75$ km, or 253,440,000 cu. km, in excess of the normal, where no mountains exist. But the 21.75 km of light rock, which was pushed down into the heavy rock, displaced $64{,}000 \times 160 \times 21.75 = 222{,}720{,}000$ cu. km of the latter, and this was distributed in depth to the rest of the earth beyond the mountains; so that the volume of light rock that came into the mountain belts in the orogenic movement exceeded the volume of heavy rock which was displaced and redistributed by $253{,}440{,}000 - 222{,}720{,}000 = 30{,}720{,}000$ cu. km. This lowered the surface of the earth beyond the orogenic belts, sea and land alike, $\frac{30{,}720{,}000}{494{,}080{,}000} = .062$ km, the denominator being the area of the earth less that of the mountains.

Effect of erosion and sedimentation on sea level.—Let us suppose now that the "Tertiary" mountains have to date lost by erosion the equivalent of a layer 2 km thick over their entire area. This amounts to $64{,}000 \times 160 \times 2 = 20{,}480{,}000$ cu. km. The area of the land surface of the earth is 140,800,000 sq. km. Deducting from this the area of mountain belts, 10,240,000 sq. km, leaves 130,560,000 sq. km of lowlands that have been degraded at a much slower rate, let us say one fifth of the rate of reduction of the mountains. Then the discharge of sediment to the ocean has been $\frac{130{,}560{,}000 \times 2}{5} = 52{,}224{,}000$ cu. km from the continental lowland; and the total discharge to the ocean has

[1] SCIENCE, August 23, 1940.

been 20,480,000 + 52,224,000 = 72,704,000 cu. km. Since the ocean has an area of 363,520,000 sq. km, its floor has received a load equivalent to a layer $\frac{72,704,000}{363,520,000} = .2$ km in mean thickness. This would raise the sea surface, but the load of sediment would depress the sea floor, and consequently the sea surface, and at the same time cause the rise of the continental column by way of compensation. The deposit on the sea floor is reckoned as a layer .2 km thick of density 2.7, and its load would displace in depth a layer of heavy rock $.2 \times \frac{2.7}{3.3} = .1636$ km thick, and so cause a fall of sea level of .1636 km. The net rise of sea level relative to the center of the earth is thus .2 − .1636 = .0364 km. The equivalent of the heavy rock displaced in depth beneath the ocean is transferred to the region beneath the continents, but in different proportions to mountains and lowlands. To the mountain belts goes the equivalent of a layer $2 \times \frac{2.7}{3.3} = 1.6363$ km thick of rock of density 3.3; and the mean altitude of the ranges is increased by 1.6363 km, so that, although 2 km has been eroded away, the reduction in mean altitude is only 2 − 1.6363 = .3636 km with reference to the center of the earth.

To balance the erosional removal of a layer $\frac{2}{5} = .4$ km thick from the lowlands a layer of heavy rock of density 3.3, having a thickness of $.4 \times \frac{2.7}{3.3} = .3272$ km, is supplied to those regions in depth and raises their surface that much. So that, although they have lost by erosion a layer having a mean thickness of .4 km, the reduction of mean altitude is only .4 − .3272 = .0728 km, with reference to the center of the earth. It thus appears that, with reference to the center of the earth, the sea level has risen .0364 km, while the surface of the mountain belts has been reduced in mean altitude .3636 km. That is, the distance apart, measured on the earth's radius, of the sea surface and the mean surface of the mountain belts has diminished by .0364 + .3636 = .4 km. To one who believes the earth is so strong as to be incapable of yielding, except elastically, to stresses caused by shift of load, this can only mean that sea level has risen .4 km. Similarly, the distance apart of the sea surface and the mean surface of the lowlands has diminished by .0364 + .0728 = .1092 km, and the apparent rise of sea level is .1 km. That is to say, on the theory of a perfectly strong earth, the surface of the sea would appear to have risen four times more in one place than in another.

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THE POSSIBILITIES OF SYSTEMIC INFECTION WITH DERMATITIS-PRODUCING SCHISTOSOMES[1]

FREQUENT inquiry has been made as to whether the "swimmer's itch" or dermatitis-producing schistosome cercariae of the United States continue their development and set up a systemic infection in man. Brackett[2] has discussed the "mass of evidence which almost surely indicates that such a thing does not happen." A portion of the evidence discussed evolves from the fact that nowhere, not even in the regions most severely afflicted with "swimmer's itch," have there appeared systemic infections resembling schistosomiasis following the dermatitis.

In order to obtain information concerning the suitability of primates as hosts of *Schistosomatium douthitti* (Cort, 1914), Brackett exposed the extremities and face of a young female rhesus monkey to the penetration of the cercariae and noted a very mild dermatitis on the exposed areas. Three weeks after the last exposure the animal was autopsied, but no trace of a schistosome infection was seen. Brackett's assumption was that if *S. douthitti,* which develops readily in a wide variety of laboratory mammals, developed readily in man, it would probably have been found in the one monkey used.

Believing the cercaria of *S. douthitti* to be the most likely one of the dermatitis-producing forms to continue development in man, the author exposed a healthy young rhesus monkey to cercarial baths over a period of two weeks' time during the fall of 1939. The exposures were light, and a mild dermatitis was produced after each exposure. The monkey was autopsied four weeks after the last exposure and after a complete and careful examination was found negative for schistosomes. In June, 1940, a second healthy young rhesus monkey was placed for one hour in a 10-gallon metal milk can with the 24-hour cercarial output of 28 snails. The number of cercariae used was estimated to be approximately 28,000. The monkey showed signs of distress and did considerable scratching from shortly after time of exposure until time of autopsy five and one-half days later. A marked dermatitis was evident but mild, considering the number of cercariae that must have penetrated the skin. On autopsy the migrating worms were found to be abundant in the lungs and slight hemorrhage was noted. A third rhesus monkey with a latent case of malaria, estimated to be about three years old, was exposed to *S. douthitti* by having a bottle containing about 400 cercariae inverted on the abdomen. A mild dermatitis was observed the next day, but this rapidly disappeared. Whether the

[1] Aided by a grant from the American Academy of Arts and Sciences.

[2] S. Brackett, *Am. Jour. Hyg.*, 31: 49–63, 1940.