next toxic diet to appease their hunger. Food intake was recorded daily. After ten days, the control diets were no longer offered in either group, and after fifteen days, the next least toxic diet was no longer offered. In every instance, the rats ate the least toxic food that was available and ate negligible quantities of the more toxic diets. The average food intake in grams per rat per day is indicated in Fig. 1. Since the diets were of identical compositon, the only variable in group I was the amount of toxic grain, and in group II, the only variable was the amount of sodium selenite. It is apparent that the rats were able to distinguish between diets which differed in selenium content by small increments. The animals were also able to distinguish between various concentrations of the natural toxicant, in spite of the fact that in this case the selenium is in organic combination (Painter and Franke[9]). Although constituents other than selenium may have furnished a clue to toxicity in the naturally toxic diets, there was certainly no other possibility in the diets used in group II.

No deaths occurred in the above experiment, although growth was subnormal. When killed, the animals showed typical pathologic effects for sublethal diets.

CONCLUSIONS

It has been quantitatively demonstrated that rats are able to detect and differentiate between small quantities of selenium in foodstuffs. Unpublished data in this laboratory have shown that sub-lethal injections of sodium selenite cause a voluntary starvation even when normal diets were offered. The question whether or not systemic effects may be the entire factor controlling this differentiation should not be ignored, although this selection of foods may be due to taste of the diets or even odor.

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SUBMERGED VALLEYS ON CONTINENTAL SLOPES AND CHANGES OF SEA LEVEL

BETWEEN 1893 and 1902 Spencer,[1] Hull,[2] Upham[3] and others advanced the hypothesis that certain topographic features discovered on the continental slopes of Europe, North America and Africa were submerged river valleys. Their ideas met with much hostile, though somewhat unfounded, criticism from their contemporaries[4] and, being thus discredited, were practically forgotten for thirty years. The work of Shepard in the last few years has reopened the whole problem and again brought it to attention. The development of sonic sounding has made possible detailed investigation of the topography of the sea bottom. The U. S. Coast and Geodetic Survey is at present producing charts with very accurately located bathymetric contours which leave no doubt as to the bottom configuration and presence of the valleys.

It now appears extremely likely that Spencer, Hull and Upham were correct in their conclusion that the valleys are submerged river valleys. The validity of this conclusion will not be discussed as it has already been treated more or less fully in the several papers by Shepard[5] and also by Hess.[6] Professor R. A. Daly has recently advanced the hypothesis that the valleys are the result of submarine scour by muddy salt water produced by the 250 ± foot lowering of sea level during the Pleistocene. Though this hypothesis is well worthy of consideration, the form of the valleys, the fact that they have been deeply cut in some cases through rocks as resistant as granite, and finally that any slight turbulence would cause a mixing of the muddy water with the surrounding water, all lead the writers to favor a subaerial origin. In this note the writers wish briefly to advance a hypothesis accounting for the valleys and point out some of the chief geologic consequences which this hypothesis, if correct, would entail. Explanatory hypotheses have been elsewhere advanced, but none of them fit the facts as now known.

DISTRIBUTION AND DEPTHS

At least forty of these submerged valleys have been noted, and no doubt many more will be found when more soundings are taken on the continental slopes. They are known to occur in many parts of the world; off the coast of North America from Newfoundland south; off the coast of Europe from Ireland south; off Ecuador and Peru on the west coast of South America; off the coast of North America from Vancouver Island south; on the west side of the Pacific off Japan, Formosa and the East Indies; on the east coast of Africa off the Congo, Niger, Cape Verde and Gibraltar Straits; in the Indian Ocean off Ceylon; off the Indus and the Ganges and in the Arabian Gulf; and south of Zanzibar on the east coast of Africa.

Many of the valleys are known to extend to depths

[9] E. Page Painter and Kurt W. Franke, *Jour. Biol. Chem.*, 111: 643, 1935.

[1] J. W. Spencer, *Bull. Geol. Soc. Amer.*, 14: 207–226, 1903.

[2] E. Hull, "The Sub-Oceanic Physiography of the North Atlantic Ocean," London, 1912. Also, *Royal Geog. Jour.*, 13: 285–289, 1899. Also, Victoria Inst., 1898–1908.

[3] W. Upham, *Am. Geol.*, 10: 222–223, 1892.

[4] *Royal Geog. Jour.*, 13: 289–294, 1899.

[5] F. P. Shepard, *Geog. Review*, 23: 77–89, 1933. *Trans. Am. Geophys. Union*, 1933 and 1935.

[6] H. H. Hess, *Trans. Am. Geophys. Union*, 168–170, 1933.

of thousands of feet, but very little information is available as to the maximum depths to which the valleys extend. The valley which may be the seaward extension of the Potomac River, recently surveyed by the U. S. Coast and Geodetic Survey, appears to reach 8,800 feet below sea level (latitude 37°). Several valleys in the Bahamas, investigated by reconnaissance only during the gravity measuring cruise of the U. S. submarine S–48, apparently reach 14,000 feet (latitude 26°). The English Channel valley, on the other hand, probably does not go down to a thousand fathoms (latitude 49°).

Topographic and Geologic Age

The valleys, as far as known, are extremely youthful topographically, thereby indicating a geologically short episode of subaerial erosion.

The data presented by Stetson suggest a younger than Pliocene age for the valleys, while Veatch has evidence that the Congo submarine canyon is post-Mousterian; and Shepard, from several lines of evidence, postulates a Pleistocene age. The suggestion of a pre-Miocene age, originally advanced by Hess, in view of the new data, should now be discarded, though the possibility of valleys of more than one age should be kept in mind.

Deductions

The world-wide distribution and similarity of the valleys indicate a change in relative sea level rather than independent vertical movements of each of the continents. This change must have taken place suddenly; then, after a short interval, sea level must have returned practically to its original level, since it is known that the sea level along the east coast of North America has been near its present level for most of Cretaceous, Tertiary and Pleistocene time, as indicated by sediments of those ages on the Coastal Plain.

Shepard[7] has recently suggested as a working hypothesis that this change of sea level may have been accomplished by locking up water from the seas in ice caps over the Poles. Though this would account for a lowering of sea level and its later return to its original level, it has, we consider, insuperable quantitative difficulties, since the ice would have to have been something like 50,000 feet thick.

Hypothesis

It is proposed that the valley-cutting conditions resulted from a sudden change in the shape of the hydrosphere, depressing sea level in low latitudes, raising it in high latitudes; in other words, a change in the ellipticity of the sea surface.

[7] F. P. Shepard, Talk before the Section of Oceanography, Am. Geophys. Union, April, 1935.

At present we can think of no orthodox cause for this change of ellipticity of sea level. However, a speculation comes to mind; if a sudden decrease in the rate of rotation of the earth took place, the hydrosphere would respond by being drawn into polar latitudes. The solid body of the earth would less rapidly adjust itself into a new spheroid in equilibrium with the slower rotation, which adjustment, when complete, probably would restore sea level to approximately its present position. But during the adjustment, it is postulated that there would have been time enough to allow rivers to cut valleys on the continental slopes. While of course we do not know what could have caused the sudden change in rotation, it is conceivable that a collision with a small extra-terrestrial body would be competent to produce the effect. The grave difficulty of changing the earth's rate of rotation is readily admitted. The authors would welcome any suggestions of other means by which the ellipticity of sea level might be changed.

If the sequence of events thus outlined actually occurred, two major effects should be found: (1) the maximum depths of the valleys should decrease poleward from an equatorial belt, and (2) beyond a particular latitude above and below the equator no valleys should be found, but instead marine phenomena, shore lines, terraces, etc., should occur above present sea level if not completely destroyed by subsequent erosion. The terraces and shore lines should be found at progressively higher altitudes poleward from this same latitude. Evidence of a colder climate flora and fauna might be found in equatorial regions which would have become high plateaus if sea level had been depressed there as much as our hypothesis necessitates.

The few available facts are compatible with the hypothesis here suggested. First, none of the valleys yet found lie above latitude 55° or 60°. The very meager data available do suggest an increase in depths of the valleys from 55° toward the lower latitudes. Marine terraces in latitudes greater than 55° or 60° have not been recognized so far as the writers are aware. It may be noted that the lack of valleys in polar regions and deepening of the valleys progressively toward an equatorial belt, *if true,* is a fatal obstacle to Daly's hypothesis.

We submitted the idea of slowing down the earth's rotation to Professor H. N. Russell for criticism. He points out that it is extremely difficult to change the rate of rotation of an isolated astronomical body, particularly to the extent which this hypothesis would demand. He suggests omitting the hypothesis of change of rotation from this note, and merely suggesting the change in ellipticity of sea level. We feel, however, that it can do no harm and might bring forth some discussion of other possibilities.

GEOLOGIC CONSEQUENCES

If changes in sea level such as herein suggested have taken place, an explanation is available for possible migration of flora and fauna in equatorial belts without the necessity of drifting continents or uplifting land bridges. Such alterations of sea level and ocean masses would also cause large changes in climates with resulting influence on life. It is, also, not beyond the realm of possibility that the internal changes necessitated during the adjustment of the solid earth might produce stresses which would result in orogenesis.

We have hesitated to present this hypothesis for some time because of its radical and highly speculative nature; but we have decided to advance it, though with much doubt in our own minds as to its validity, in order to invite criticism which might ultimately give rise to a satisfactory explanation. Also, we hope that discussion may focus attention on evidence of submergence in high latitudes and new data on submerged valleys.

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DECEMBER 31, 1935

SCIENTIFIC APPARATUS AND LABORATORY METHODS

MEASUREMENT OF THE AREA OF ATTACHED AND DETACHED LEAVES

IN various types of investigations it is often desirable to measure regular or irregular areas quickly and accurately. Especially is this true for attached or detached leaves of plants which differ in size, color and thickness. To facilitate such work a suitable apparatus has been devised. In principle the method consists in the use of a light source capable of producing a small amount of radiant flux, part of which passes through a condensing lens, two plates of glass, a second condensing lens and a diffusion screen, and finally onto a photoelectric cell attached to a meter by means of which a reading is taken. When it is desired to secure the area of any given objects, they are placed between the plates of glass, thus intercepting a portion of light and reducing the amount of radiant energy striking the photoelectric cell. The decrease in the electromotive force generated by the light-sensitive cell is proportional to the light intercepted by the objects, and the reduction indicated by means of a meter.

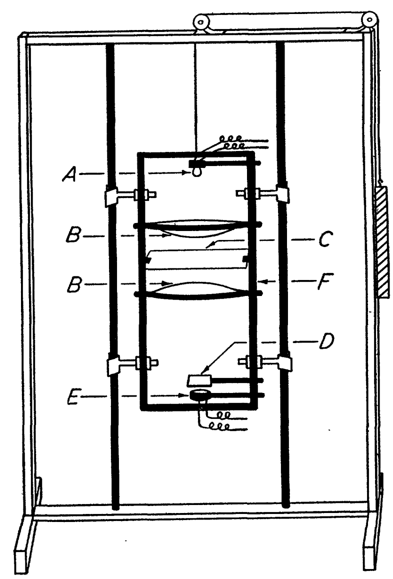

FIG. 1. Diagram of apparatus used to measure attached and detached leaves. A indicates a light source, B lenses, C glass plates, D diffusion screen, E photoelectric cell and F a metal frame.

The various parts of the measuring device were fastened to a metal frame, Fig. 1 F. As a light source a twenty-one candle power automobile lamp was mounted by means of adjustable clamps to the metal frame, A. One condensing lens, twelve inches in diameter, was mounted in a metal ring and attached to the frame at a distance below the light approximately equal to the focal length of the lens, and another lens of the same size was attached at a lower position, B. Below the lower lens at a distance slightly less than its focal length a Weston Photronic cell, E, was attached to the frame with an adjustable clamp. A piece of acid etched glass, slightly larger in area than the photoelectric cell, was fastened about one inch above the cell and served as a diffusion screen, D. Finally, removable clamps supporting two pieces of window glass were fastened between the two lenses, C. The entire frame was then suspended by means of a cable between two vertical metal pipes in a larger wooden frame. It was therefore easily possible to adjust it to any level at which it was desired to secure a measurement.

In actual use, the distance between the upper and lower lenses was sufficient to allow for easy manipulation of the glass plates between which the leaves or other objects were placed in order to keep them flat and hold them in position. The distance between the photoelectric cell and the lower lens was finally adjusted so that the diameter of the light beam from the lenses was slightly less than the diameter of the light-sensitive surface of the cell. The lamp was energized by means of a six-volt storage battery. The photoelectric cell was connected to a microammeter, having an internal resistance of 63.5 ohms, and a sliding resis-