Now Lang cites crystals of selenite thrown out of a railroad cut in 1891 near Salt Draw, twenty miles south of Carlsbad, New Mexico. These crystals have bright cleavage faces due to the "lack of tools sufficient to make wind action effective." It should be noted also that these "bright" cleavage faces have persisted for over forty years. Can it be possible that the masses of selenite have been broken and rebroken by casual passersby?

In this region Lang points out that dust is carried in the air, that sand is blown out of the bed of Pecos River and that soil is lifted from cotton fields. All these phenomena occur, and one of the present writers can confirm the observations by personal experience as the result of field work in this area. However, our statements quoted above make no claim that selenite fragments or crystals are criteria bearing on deflation and wind transportation but merely on corrasion by wind-blown sand, *i.e.,* wind scour. All criteria of geomorphological process must be used with caution and applied to the process to which they pertain.

If we consider the area adjacent to Pecos River near Carlsbad and particularly that south towards Pecos City, Texas, the dominant land forms are pediments and terraces produced by stream action, either of Pecos River or of its tributaries. These features record three gradients of Pecos River, 30, 75 and 150 feet above its grade. The broad and recently abandoned flood-plain is actually a terrace 20 feet above river grade. The two higher terraces are described in print[3] and the lower terrace, only 10 feet above the flood-plain or about 30 feet above river grade, is described in a manuscript report.[4]

The sequence of terraces appears to be the same as that so admirably described by Nye[5] for the Roswell area. The recently abandoned flood-plain of the river is Nye's Lakewood terrace, the 30, 75 and 150 terraces correspond to the Orchard Park, Blackdom and Diamond A surfaces.

In addition to stream erosion, ground water solution of salt, gypsum and limestone beds is very active. There are numerous sinkholes joined by the destruction of intervening rises. The solution of caverns and their collapse is also accompanied by deposition of material in the caverns, as pointed out by Lee.[6]

In the area south of Carlsbad, the sinkhole or Karst topography is less developed west of the river than east of it. Nevertheless, near Salt Draw on the west side of the valley close to the locality noted by Lang the generally stream-modeled topography is modified by solution and fill.

East of the river a great mantle of wind-blown sand partly conceals the details of a topography whose major features are dissected pediments modified by sinkholes. The sand has been lifted from the channel of Pecos River and its eastern tributaries by strong westerly and southwesterly winds. This process goes on at present and apparently was characteristic of each of the previous erosional stages. But this movement of sand and its accumulation to form the extensive body shown on Darton's geologic map of New Mexico and referred to by him[7] as the "Mescalero Sands" takes place on the east side of the valley. The existence of these sands and the extensive wind work to which they testify does not, however, indicate wind scour on the west side of the valley. Even within the area of the sands, wind scour is at a minimum, as this area is primarily one of deposition. The more or less continuous rearrangement of the sands by wind leads to wear of sand on sand, not to wear of sand on the underlying bedrock, *i.e.,* true wind scour.

Thus a careful reading of Lang's paper and a consideration of the area to which he refers indicates that he actually uses selenite fragments as criteria for wind scour in the way and to the extent that we indicate, in spite of his somewhat confusing title.

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THE OCCURRENCE AND ACTIVITY OF UREA-SPLITTING BACTERIA IN THE SEA

IT is recognized that microorganisms which ferment urea play an important rôle in the nitrogen cycle and in soil fertility, and they are known to be quite widely distributed in soil, sewage, manure and fresh water. There are fragmentary accounts of the occurrence in the sea of urea-splitting bacteria, but most of the work has been done in bays or near shore. During the past thirty months we have been making observations to ascertain if there are significant numbers of urea-splitting bacteria which are functional in and indigenous to the sea, or if those found in the sea are merely passive terrestrial contaminants.

Numerous samples of water and bottom deposits have been collected at sea from the boat *Scripps* by

[3] O. E. Meinzer, B. C. Renick and Kirk Bryan, *U. S. Geol. Survey Water Supply Paper* 580A, p. 6, 1926.

[4] Kirk Bryan, Geology of Avalon Reservoir, Carlsbad Irrigation Project, New Mexico, with respect to proposed increase in height of the dam, Feb., 1927 (Files of the Ground Water Division, U. S. Geological Survey).

[5] A. Y. Fiedler and S. S. Nye, U. S. Geol. Survey, *Water-Supply Paper* 639, pp. 10–14, 1933.

[6] W. T. Lee, U. S. Geol. Survey, *Bull.* 760, pp. 107–121, 1925.

[7] N. H. Darton, U. S. Geol. Survey, *Bull.* 794, p. 59, 1928.

such rigorous sampling technique[1] as to preclude possibilities of terrestrial contamination. The samples were inoculated into selective media consisting of Mandler filtered sea-water containing 2.0 per cent. urea and 0.2 per cent. each of glycerol, dextrose and calcium lactate. The hydrogen-ion concentration was maintained near pH 8.2 by the addition of magnesium carbonate. Following incubation, growth and ammonium formation were used as the criteria of urea fermentation.

The relative abundance of urea-splitting bacteria was estimated by using inocula consisting of different dilutions of the water or mud samples. The majority of the 1.0 cc inocula of water collected near the surface yielded positive results, nearly half of the 0.1 cc inocula did likewise, and the 0.01 cc inocula did so only infrequently. Obviously, this indicates the presence of from 1 to 10 physiologically active urea-splitting bacteria per cc of sea water. Similar deductive analytical procedures revealed that this is approximately the order of magnitude of the number of urea-splitting bacteria found throughout the euphotic zone to a depth of 50 meters in the Pacific Ocean in the region of Scripps Institution. Occasionally, urea-splitting bacteria are encountered in water 500 meters deep, but, in general, very few are found below depths greater than 100 meters. However, that neither depth nor the accompanying hydrostatic pressure are limiting factors has been shown by the recovery of numerous urea-splitting bacteria at depths exceeding 1,000 meters. Analysis by the dilution method of 16 mud samples collected at depths ranging from 160 to 1,300 meters showed that the surface mud contained from 10 to 1,000 urea-splitting bacteria per gram. From the examination of cores it was found that these bacteria are most abundant in the upper 2 to 3 cm of mud, and decrease progressively with the depth of the cores. Also, urea-splitting bacteria have been demonstrated associated with the integumental slime and intestinal contents of several marine fish.

Twelve pure cultures of urea-splitting bacteria, differing morphologically or physiologically from each other, have been obtained by streaking inocula of the enriched cultures on urea sea-water agar. These have been characterized according to standard methods.[2] Apparently they are new species and will be described elsewhere. Most of these cultures are quite different from the terrestrial urobacteria which have been described.

As further evidence that these urea-splitting bacteria are functional in and indigenous to the sea and probably even foreign to other habitats, it was noted that following primary isolation the majority of them would grow only in sea-water media and not in corresponding media prepared with fresh water. However, by the use of massive inocula, by gradually diluting sea-water media with fresh water, or by prolonged laboratory culture these marine urea-splitting bacteria could be acclimatized to grow in either sea-water or fresh-water media. This is a characteristic which is common to many bacteria isolated from the sea under conditions which preclude chances of contamination and has been discussed previously.[3]

Although the authors are not convinced that bacterial urease is elaborated extracellularly, this enzyme has been demonstrated by the Mandler filtration of 750 cc quantities of substrata which have been acted upon by the bacteria. The optimum temperature for the activity of the urease from one culture was found to be several degrees higher than the optimum temperature for the reproduction of the culture. Also, whereas the activity of the isolated urease was imperceptible after several days' incubation at $+5°$ C., the bacteria from which the urease was extracted multiplied and formed ammonium from urea at $-4°$ C. The explanation of this equivocal observation may be a difference in the quantity of enzyme or it may be the lack of certain co-enzymes in the isolated urease extract which are associated with the intact bacterial cells. Whether or not urea-splitting bacteria are functional at near zero temperatures is especially significant in the sea, inasmuch as over four fifths of the ocean floor is perpetually colder than 3° C. Rubentschik[4] has commented on the activity of *Urobacillus psychrocartericus* at temperatures as low as $-2.5°$ C.

On a basis of their relationship to the substrate three different types of urea-splitting bacteria have been isolated from the sea: (a) Those which grow well in media containing no other source of nitrogen except urea, but liberate no detectable excess of ammonium. We classify these with the urea-splitting bacteria because it is believed that they must cleave the urea molecule before the nitrogen of the latter can supply the metabolic requirements. (b) Those which multiply freely in urea media and produce an excess of ammonium. Some of these produce enough ammonium to make the sea water as alkaline as pH 9.7. These bacteria may play a rôle in the precipitation of calcium carbonate from sea water.[5] (c) Those which do not start to multiply in urea media unless a little ammonium, amino-acid or peptone nitrogen is added to initiate multiplication, after which urea is decom-

[1] C. E. ZoBell and C. B. Feltham, *Bulletin*, Scripps Instit. Oceanog., tech. ser., 3: 279–296, 1934.

[2] Soc. Amer. Bacteriologists, "Pure Culture Study of Bacteria," Geneva, N. Y., 1931.

[3] C. E. ZoBell and C. B. Feltham, Fifth Pac. Sci. Cong., Victoria and Vancouver, *Proc.*, vol. 3, pp. 2097–2100, August, 1934.

[4] L. Rubentschik, *Centralbl. f. Bakt.*, II Abt. 64, pp. 166–174, 1925.

[5] W. Bavendamm, *Archiv. f. Microbiol.*, vol. 3, pp. 205–276, 1932.

posed with the formation of ammonium. We have observed no marine bacteria which require urea for their growth.

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A GROWTH-INHIBITING SUBSTANCE IN LETTUCE SEEDS[1]

LETTUCE seeds which fail to germinate on moist blotters at 25° C. in the light may be germinated at this temperature by placing the seeds on moist absorbent cotton or in water.[2] The increased germination obtained by this method suggests that the promotion of germination may be due to the exit of an inhibiting substance which diffuses from the seed into the aqueous medium. If an inhibiting substance is formed during the process of germination then the repeated placing of seeds in contact with the same substratum should cause a gradual reduction in the percentage of germination. The germination tests that have been made on cotton and in water to test this hypothesis show that lettuce seeds do form a substance of unknown nature which diffuses from the seed, and if present in sufficient quantities prevents germination.

The inhibiting material is formed most readily by freshly harvested seeds of the white-seeded varieties of lettuce which tend to go into dormancy at 25° C. Big Boston lettuce seeds which germinated 3 per cent. on moist blotters at 25° C. in the light germinated 80 per cent. when placed on moist cotton. The percentage of germination upon this same cotton medium was reduced to 5 per cent. after five lots of 100 seeds each had been in contact with the medium over a period of 10 days. In like manner germination in a shallow layer of water was completely inhibited after 600 seeds had been in contact with the medium. When the water from a similar inhibiting medium was used to moisten a freshly prepared cotton substratum the germination of lettuce seeds upon the cotton was reduced from 80 per cent. to 10 per cent. A saturated medium which inhibited the germination of Big Boston seeds at 25° C. failed to prevent the germination of Black Seeded Simpson seeds of the same age, which indicates that the physiological condition of the seed is a factor in determining the response made by seeds to the inhibiting substance.

The increased germination of lettuce seeds in the light indicates that light may promote the diffusion of the substance from the seeds, and although light may accelerate the process, tests have shown that an inhibiting substance passes from the seeds in total darkness. A cotton medium upon which 600 new crop lettuce seeds had been in contact for a period of 10 days in the dark, and then used as a substratum for germination in the light completely inhibited the germination of one-year-old Big Boston seeds. When this cotton medium was washed in water and then used as a substratum a similar lot of seeds germinated 98 per cent.

The age or more specifically the physiological condition of the lettuce seed is a factor influencing the formation of the inhibiting substance, and is also a factor in determining the response made by seeds when placed in contact with a saturated substratum. The inhibiting substance is formed most abundantly by seeds immediately after harvest and in smaller amounts or not at all in old seeds, and appears to be in some way associated with the dormant condition which develops in the seeds when placed at unfavorable temperatures for germination. The marked increase in germination obtained in the light indicates that light may facilitate the passage of the inhibiting material from the seed. The response to light is complicated by the fact that the dormant condition in light-sensitive lettuce seeds can be broken by placing the seeds in an atmosphere that is saturated with water vapor and giving them an exposure to light. The latter response may take place in swollen seeds within a few seconds and without the presence of water in the form of a film surrounding the seed which precludes the possibility of any substance diffusing from the seed. The fact that the material may pass from the seed in total darkness indicates that the function of light is to prevent or break the stable condition of unknown nature which characterizes seeds in secondary dormancy.

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[1] Approved by the director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 53, October 24, 1934.

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