DISCUSSION

UNDERTOW, RIP TIDE OR "RIP CURRENT"

THE outworn dogmas of science seem to be particularly concentrated in the discussions of the ocean in geology books. In a previous note the writer called attention to several of these fallacies.[1] Among them could have been included the so-called "undertow." The common conception of the undertow, which comes evidently from panicky surf bathers, but has been commonly accepted, is that water is carried in along the surface by the waves or the wind and returns underneath, developing a current which may be strong enough locally to carry people under and out to sea. In 1925 Davis[2] challenged this idea, pointing out quite correctly that a wave causes the water to surge forward at the crest and backward in the trough both at the surface and on the bottom so that a person in the surf is alternately carried forward and backward. He suggested, however, that there must be a subsurface return of the water pushed into a pocket beach by an onshore wind. Davis requested others to write of their experiences which might bear on the subject. The series of short notes which followed must have left readers undecided as to what they should believe. Three writers[3] described currents which they had experienced which carried them seaward faster than they could swim toward land, although the current was largely a surface phenomenon. Another writer on the basis of observations agreed with Davis that the undertow was mythical, while still another gave theoretical support for the old conception. On the other hand, measurement by U. S. Army engineers[4] of the movement of water along the bottom outside the beach showed that the water moves in and out along the bottom in the manner described by Davis. It comes in with a strong, quick surge and goes out with a long, slower movement.

The present writer first obtained some light on the question through conversations with Mr. Cecil Nichols, head of the Los Angeles life-guards. Mr. Nichols told of what he called "rip-tides" along the beach at Venice, California, which he said frequently carried out bathers beyond their depth. Examination of these "rip-tides" showed that they are narrow bands of water moving outward almost at right angles to shore along straight stretches of beach. They are spaced at distances of 200 yards or more and extend out for distances up to half a mile. These currents were observed both under conditions of calm and with an onshore wind. They could be distinguished easily because of the zones of roiled water and foam which were moving out and interfering to some extent with the incoming breakers. These currents proved to be of rather short duration, lasting several minutes as a rule and redeveloping either at the same or in a different location.

By swimming in the "rip-tides" it was found that they have at least some velocity at the bottom as well as that which is so observable at the surface. In one case the bottom was found to contain a depression about a foot in depth along the axis of a persistent "rip-tide." In the outer portion of the current an eddying motion was found. The terminus of the "rip-tide" as well as its marginal boundaries were seen from a row-boat to be very distinct both because of the moving water and because of the suspended sediment in the water.

"Rip current": The name "rip tide" is certainly not appropriate, since the current described has nothing to do with the tide. It may be unwise to suggest another name to replace this one, which has some usage in different parts of the country. Certainly the practice of making new names causes much unnecessary confusion. However, this case seems to merit a change and the name "rip current" is suggested, since it is close to the other name and describes the way in which the current rips through the oncoming breakers.

Since studying the "rip currents" at Venice, California, the writer has seen the same phenomenon in many other places along the west coast as well as in the Hawaiian Islands and along the east coast. Most of these observed cases were off relatively straight beaches and in several cases close to piers. It seems certain that the outward moving currents described by the contributors referred to previously fall into the same category. Also conversations with life-guards from various parts of the coast have shown that the outward moving currents are not unusual. It can scarcely be doubted that some reports of undertow are based on "rip currents," although probably in other cases, as Davis suggested, the suction of the returning wave may have led to the belief in undertow.

Probable cause: The cause of the "rip currents" seems to be essentially that described by Hite,[5] that is, the waves of oscillation changing into waves of translation upon approaching the coast and tending to pile up the water on the shore. Most of this water returns with the outgoing wave, but it appears that some of the water is concentrated into zones and develops an outward current which persists far longer than the return movement of the individual waves. How much this return current is conditioned on the development of an outer bar as described by Hite

[1] SCIENCE, 78: 406–408, 1933.
[2] W. M. Davis, SCIENCE, 61: 206, 1925.
[3] W. C. Jones, SCIENCE, 61: 444, 1925; Wallace Craig, I. Brant, M. P. Hite and W. M. Davis, SCIENCE, 62: 30–33, 1925; T. T. Quirke, SCIENCE, 61: 468, 1925.
[4] Captain L. H. Hewitt, personal communication.
[5] M. P. Hite, *op. cit.*, p. 32.

was not ascertained, but this outer bar probably does play an important part.

Geological importance: The "rip-currents" must be an important factor in the transportation of fine sediment out from the beach, since they are observed to have considerable sediment suspended in them. Probably they are one of several causes for the well-sorted condition of many beach sands.

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A HYPOTHESIS TO EXPLAIN BROWN ROOT-ROT OF HAVANA SEED TOBACCO

Two types of root-rot are known to affect Havana seed tobacco grown in the Connecticut Valley. Black root-rot is caused by the fungus *Thielavia basicola* (Berk. and Br.) Zopf. The conditions under which it develops are understood, and practicable methods for its control in the field are known. On the contrary, little is known about the cause and nature of brown root-rot, the other type. No causal organism has been demonstrated to be associated with it. It has puzzled plant pathologists and agronomists for years. Brown root-rot produces brown lesions on the roots, causes malformation, stunting and decay of the roots, dwarfing of the plant, spindly growth and low yields.

Within the past several years, while at the Massachusetts Agricultural Experiment Station, the writer and his associates conducted researches which bore directly or indirectly on the cause and nature of brown root-rot of tobacco. The results are here briefly summarized and a hypothesis is presented for the possible benefit of those interested in the subject.

(1) In unsterilized water cultures, ammonium compounds, amino acids and certain amides were toxic to tobacco plants and caused symptoms very similar to those of plants affected by brown root-rot in the field. In sterilized media containing these forms of nitrogen growth was slow, but the roots were not injured. These experiments indicated that the browning and rotting of the roots in unsterilized media was a secondary effect caused by common decay organisms. Comparative experiments with several other crop plants showed that tobacco is one of the more sensitive crop plants to toxicity of unoxidized forms of nitrogen.

(2) The most highly oxidized form of nitrogen, namely, nitrate, was most readily and completely assimilated by tobacco, if the plant was grown to maturity. Neither brown nor decaying roots nor other symptoms of brown root-rot resulted from the use of nitrate nitrogen, except in the latter growth stages when ammonium nitrate was used. In the early growth stages ammonium nitrogen from any source caused more rapid growth than did nitrate nitrogen, and there were no apparent ill effects, but in the later stages ammonium nitrogen caused decay of the roots, even when used in low concentrations. When plants with diseased roots were transferred from ammoniacal solutions to nitrate solutions, they recovered, and new, healthy roots were produced.

(3) Chemical analysis of tobacco plants grown in water cultures containing ammonium and nitrate nitrogen, respectively, showed considerably higher percentages of nitrogen in tops and roots of plants supplied with ammonium nitrogen. The tops of field-grown plants which showed symptoms of brown root-rot were found to contain more total nitrogen than did normal field plants, but litle or no difference was found in the nitrogen content of the roots of the same plants. However, it was impossible to get a fair sample of affected roots due to obvious inherent difficulties.

(4) Appreciable quantities of ammonia were found in tobacco field soils in the early part of the growing season. Little difference, however, was found between soils whose crops were affected and those which were not affected by brown root-rot. This may be explained by a possible rapid, preferential absorption of ammonia by the young plants.

(5) Soil amendments which were found in some cases to reduce or eliminate brown root-rot of tobacco grown in infested soil were peat and mono-calcium phosphate, both of which will absorb or inactivate ammonia to some extent. Sodium and calcium nitrates when added to infested soil, did not materially reduce brown root-rot. The tobacco was grown in a soil having a pH of about 5.0, and in a soil of that reaction a preferential absorption of ammonia is to be expected. In such a strongly acid soil nitrate nitrogen would probably be absorbed in only small amounts, even if present in large quantities, so long as ammonium and other basic forms of nitrogen were present. The addition of lime did not reduce brown root-rot infection, except in the latter part of the growing season and its ameliorating action was thought to be due to its enhancement of the nitrification process.

(6) Brown root-rot of field tobacco was observed to be worst in the early part of the growing season. It decreased in the latter part of July, when nitrification was found to be at its peak. Fields with mild or moderate infestation of brown root-rot often improved considerably or entirely recovered during the latter part of the growing season if conditions for nitrification were favorable. The disease was worst in cool, wet seasons, when conditions for nitrification were least favorable.

(7) Brown root-rot could not be transferred from one soil to another by inoculation with small amounts of infested soil, either in the greenhouse or in the field. It was reduced or eliminated by drying infested soil in the air, either at room or higher temperatures.

(8) The disease was observed to be worst following