If the solutions were made faintly acid by adding either organic or mineral acids the heavy orange precipitate persisted in the calcium chloride solution, and a fine orange precipitate appeared in the solutions of sodium and of potassium chloride. There was no change in the color of the mixtures. If the solutions were made alkaline by the addition of sodium or potassium carbonates or hydroxides all the solutions became reddish purple. The fine precipitates in the sodium and potassium chlorides disappeared, the heavy precipitate in the calcium chloride remained and became a deep reddish purple. Thus it is evident that purpurin forms a distinctive reddish purple compound with calcium only in alkaline solutions.

In view of the fact that living protoplasm is approximately neutral it was of interest to determine under what conditions Paramoecia would stain with purpurin. From cultures in which they were abundant, Paramoecia were allowed to rise into glass tubes filled with glass distilled water, and transferred to additional tubes of such water. In this way they could be freed from the culture medium and kept in distilled water for several days or could be transferred to solutions of sodium, potassium, or calcium chloride or saccharose in which they will remain alive for one or more days. Acid or alkali was added to these solutions in some experiments.

The test as devised by Macallum entails the killing of the cells. In this investigation the Paramoecia were either killed in place on cover slips by the fumes of osmic acid, then washed in 70 per cent. alcohol and stained with a saturated alcoholic solution of purpurin; or were killed by transferring them to a small amount of boiling water, then to a slide on which the water was allowed to evaporate somewhat, then fixed and stained with the purpurin solution for ten minutes. All sides were then washed in alcohol, xylol and mounted in balsam.

Paramoecia transferred from an alkaline medium containing calcium and treated with purpurin are stained locally. The pellicle, the nuclear membrane and surfaces of vacuoles become a deep reddish purple. The more concentrated the calcium and the alkali in the solutions or the longer the exposure to the calcium solution the deeper is the color. Those transferred from a medium containing sodium or potassium chlorides or saccharose are diffusely stained. The color in a neutral or acid solution is orange; in an alkaline solution is reddish purple.

Macallum's test is satisfactory if the medium from which the cells are transferred or in which they are killed is alkaline in reaction.

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SPECIAL ARTICLES

THE STEWART BANK IN THE CHINA SEA

DURING a visit to the Hydrographic Office of the Navy Department at Washington last May, opportunity was given me of examining the soundings made by the sonic depth finder on the U. S. Destroyer *Stewart* in the China Sea in March, 1924. It should be here recalled that this vessel was the one on which a line of echo soundings was first carried across the Atlantic from Newport, R. I., to Gibraltar in June, 1922, and that its echo soundings were then continued through the Mediterranean and Red seas, across the Indian Ocean, and into the Pacific; profiles of depths thus determined have been published in a series of charts, numbered for the Mediterranean, H O, misc. 2496–2498, and for the Indian Ocean, H O misc. 2575–2579.

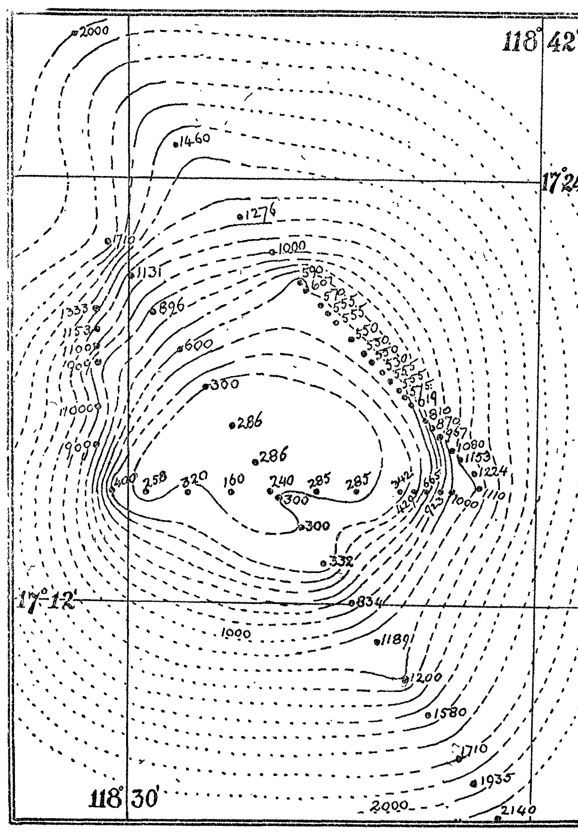
Later soundings by the *Stewart* show that, within the deep, enclosed basin of the China Sea, a bank, measuring about eight miles east–west by five across, with its summit at from 300 to 160 fathoms, rises rather rapidly from depths of 2,000 fathoms, more or less; its center is 83 miles northwest of Cape Bolinao, northwest Luzon, in 17° 16′ N, 188° 34′ E.

This discovery is of merit, for banks of so considerable a depth are seldom charted in the deeper oceans, perhaps less because of their objective rarity than because navigators, after finding "no bottom" at fifty or one hundred fathoms, are generally in the habit of sounding no deeper. The discovery of a deep bank is moreover of special significance in the coral-reef problem, because the lack of charted records of such banks in the coral seas has been taken as indicating their actual absence from the ocean. Yet, according to Darwin's theory of upgrowing reefs on subsiding foundations, some banks of such depths, representing strongly submerged barrier reefs and atolls, ought to be found there; furthermore, if deep banks can be produced in other ways than by the strong submergence of surface reefs, they ought to be doubly numerous; yet they are almost unknown in coral-reef regions. Evidently, if a bank of two hundred-fathom depth has already been found at, as one may say, the very outset of oceanic exploration by echo sounding, and in an oceanic region so frequently traversed as the China Sea, where other banks of smaller depth, like the Tizard and Macclesfield, appear to represent slightly drowned reefs, it is to be presumed that additional examples of deep banks representing strongly drowned reefs, as this one seems to do, will be discovered in the less-explored parts of the broad coral seas in the open Pacific, as echo sounding is more widely extended. On the other hand, if Darwin's theory be correct, such banks should be rarer in the cooler seas; for if volcanic cones usually subside after their eruptive growth ceases, they would after their complete submergence be discovered in those seas only as cones, more or less benched by abrasion, and not as flat-topped banks, ten, twenty or thirty miles across; it would be only in the coral seas, where a subsiding cone becomes reef-crowned while it sinks slowly, that it might later, by subsiding more rapidly with its reef crown around or upon it, form a broad-topped bank of smaller or greater depth.

The manner in which the dimensions of the Stewart bank, as it will be called, were determined is gratifying: The destroyer was steaming on a northwesterly course between Manila and Hong Kong at a rate of fifteen knots an hour over depths of from 1,600 to 2,100 fathoms, and taking soundings at every three or four miles—that is, at intervals of about fifteen minutes of time—when a rapid decrease of depth from 2,140 to 300 fathoms was recorded at five-minute intervals over a distance of nine miles; then a fairly even bank was traversed with depths decreasing from 330 to 250 and increasing to 300 fathoms in the next seven miles, and finally a rapid increase of depth took place from 300 to 1,700 fathoms in the five miles following.

Now in case a rapid change of depth of this kind is detected, "General Orders" authorize the commander of a naval vessel, if a brief delay is not inconsistent with other duties, to zigzag over the bank and thus define its form and size, and especially its minimum depth; for there is small probability that that minimum, which is the most important item in regard to navigation, will be discovered on a predetermined course not chosen with respect to the bank. In view of these orders, the *Stewart*, after passing five miles beyond the bank to a depth of 1,700 fathoms, as above stated, made a sharp turn to a southward course, which was followed for seven miles, with decreasing depths to 400 fathoms on the west side of the bank, and there a square turn to the east was made, so as again to cross the bank, where depths of 258, 160 and 342 fathoms were recorded in a distance of eight miles; after which, on reaching a depth of 1,110 fathoms two miles east of the bank edge, a sharp return was made to the northwest, on a line parallel to but about four miles northeast of the original course; and there, twenty soundings being made at intervals of from one to three minutes, the side slope of the bank was followed for five miles with depths of 600, 550 and 600 fathoms, after which a rapid descent was discovered to depths of 1,000 fathoms in two miles and a slower descent to 2,100 fathoms in thirteen miles; and these great depths then continued as the vessel proceeded on its course. The entire maneuver occupied only four afternoon hours between soundings of 2,140 fathoms at two P. M., and 2,100 fathoms at six P. M. Clearly, a new era of oceanic exploration and discovery is opening, when so admirable a use of a most ingenious instrument may be made by our naval officers. It is to be hoped that, when the results thus gained are more fully published, report will be made not only upon the depths discovered, but also upon their probable error, as affected by the size of the vessel, the recording personnel, the state of the weather, the temperature of the water, and the depth, nature and slant of the ocean bottom.

On the basis of the records furnished by the Hydrographic Office, I have constructed a rough diagram



of Stewart Bank, here presented on reduced scale with submarine contours at one hundred-fathom intervals, drawn in strong lines where well defined, and in dotted lines elsewhere. The contours are presumably open to modification by more precise platting, and still more by the addition of new records. The only soundings previously recorded in this part of the China Sea are, according to H O Chart 798, 2,350 fathoms thirty-one miles to the east; 1,555, eleven miles south; 2,171, thirty-three miles west-southwest; and 2,095, forty-four miles northwest.

The interpretation and origin of the Stewart Bank are of course problematical. It may, however, be observed that the China Sea is, like the other seas enclosed by "festoons" of islands along the border of Asia, generally regarded as occupying a basin of relatively recent down-warping; and that the occurrence of several moderately drowned or imperfectly rimmed atolls in its waters suggest that the down-warping is still in progress; furthermore, these two points taken with the small relief of the summit surface of the Stewart Bank suggest that it is more probably a drowned reef which has been built on a submerged volcano than an upgrowing volcano which has never reached the sea surface. It may also be noted that the smaller depth found at the center of the bank than at its margin suggests that it is a submerged barrier reef, the central island within which had an altitude of about 800 feet over the reef when a more rapid subsidence set in, drowning the reef and eventually submerging its central island also; and hence that it is not a submerged atoll, like the larger, reef-rimmed Tizard and Macclesfield banks, which lie some distance to the southwest in the China Sea, and which have, respectively, diameters of thirty by ten miles with a central depth of forty-eight fathoms, and of seventy by thirty-five miles and sixty fathoms.[1]

On the southeastward return from Hong Kong, the *Stewart* ran 135 miles south-southwest of Stewart Bank, and thus passed by intention close along the southwest side of Scarborough shoal, an imperfect atoll, eight miles in diameter, with a number of discontinuous reefs awash and a central lagoon; here the echo-soundings sufficed to indicate a steep submarine slope for the bank, previously undetermined.

It should be noted that no account is taken in the above records of the departure of the sounding echo from the vertical by reason of its being returned from a sloping bottom as a bank is approached and left behind; for although this refinement is made possible by the full use of the sonic depth finder, its application is seldom necessary, especially in reconnoissance work, because of the prevailing flatness of the ocean bottom. The errors thus introduced on such slopes as those Stewart Bank appears to possess are small, and of such a kind as to shift the contour lines a little outward, but by an amount hardly perceptible on the scale of the diagram here presented. Nevertheless, it would contribute to the scientific glory of the navy if the commander of one of the vessels equipped with a sonic depth finder should, on detecting a marked up-slope of the ocean floor indicative of a submerged cone or bank, thereupon so shape his course as to make a direct ascent of the steepest slope, and after passing over the highest summit of the bank, follow a direct descent down its farther side to full oceanic depth again, thus determining a diametrical profile; and then, turning 135° to one side and running 1.41 times the down-slope distance or semi-diameter from summit to full depth, turn again 135° and thus recross the summit, a fine feat of submarine mountaineering, whereby a second diametral profile would be determined at right angles to the first; thus defining the form of the bank with considerable accuracy. Such a maneuver is precisely what the sonic depth finder makes possible when its devices for determining the azimuth and dip of a returning echo from a slanting bottom are fully utilized. And let it be noted that when a bank is thus defined, the positions of the soundings on its several slopes *with relation to each other* will probably be better placed by dead reckoning from the center of the bank, aided by coincidence of close-placed summit soundings at the intersection of the crossing profiles, than would be possible if a second single line of soundings over the bank were later made independently by the same or by another vessel, the position of which would have to be determined absolutely by observation; for such a determination may depart from the similarly determined position of a first line of soundings by a mile or two; and that distance might be so large a fraction of the bank diameter as to introduce serious errors in the attempt to define its shape.

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[1] W. U. Moore and P. W. Bassett-Smith, "China Sea. . . . Results of an examination . . . of Tizard and Macclesfield banks," Hydrog. Dept., Admiralty, London, 1889. P. W. Bassett-Smith, "Dredgings obtained on the Macclesfield bank," *ibid.*, 1893; also, "Report on the corals from Tizard and Macclesfield banks, China Sea," *Ann. Mag. Nat. Hist.*, vi, 1890, 353–374, 443–458.

ELECTRONATION[1]

The terms oxidation and reduction as applied to chemical reactions have come to mean much more than the simple addition or removal of oxygen or of hydrogen to or from a substance, although many chemists and most text-books of general chemistry still attempt to explain all oxidation-reduction phenomena in terms of these two elements. For example, it is assumed that when potassium dichromate acts as an oxidizing agent it decomposes as follows:

$$K_2Cr_2O_7 = K_2O + Cr_2O_3 + 3\,O$$

The oxygen which is liberated immediately reacts with the substance to be oxidized so that its presence is never actually detectable. Similarly, nitric acid is supposed to yield oxygen when it serves as an oxidizing agent:

$$2\ HNO_3 = H_2O + 2\,NO + 3\,O$$

[1] Read before the fifty-seventh annual meeting of the Kansas Academy of Science, Manhattan, Kansas, April 11, 1925.