power lens is then focused on the dot and its situation in the field noted. The paper-covered slide is then removed and the situation of the dot in relation to the field is indicated with a small circle around the dot (*o.k.*). The dot illustrated in Fig. 1 was far to the

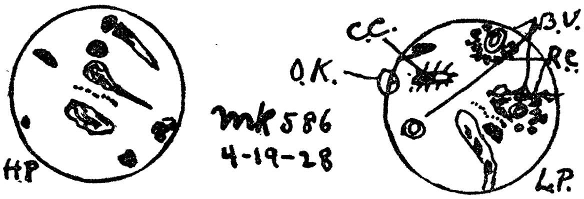

FIG. 1. Paper-covered indicator slide on which the object of interest, the chain of diplococci, is sketched in its relation to conspicuous objects in the high-power and low-power fields.

right of the center of the field. The paper-covered indicator slide is then numbered to correspond to the slide containing the prized field and both are filed away together for future reference. If more than one interesting field is found in the same slide, any number of additional indicator slides may be used.

To find the particular field or fields later, the indicator slide is put in place, and the dot brought to the relative position in the low-power field as indicated by the circle surrounding it. The slide containing the object is then put in its place, the low-power field is oriented, and the object of interest brought to the center of the field, as indicated by the sketch shown in Fig. 1. The high-power or oil-immersion lens is then turned into position and the prized object is almost always within the field, and if not it can readily be located.

It is desirable that the fixed end of the mechanical stage of the microscope used for photography or demonstration be the same as the one used when the field was first found because microscopic slides are usually not of exactly the same length.

EDWARD C. ROSENOW

THE MAYO FOUNDATION,
ROCHESTER, MINNESOTA

SPECIAL ARTICLES

STUDIES OF MEAN SEALEVEL

IN a former issue of this journal[1] there appeared a brief account of sealevel studies undertaken in New York waters to test the theory, advanced by the writer, that along an irregular coast mean sealevel is an irregular surface the precise elevation of which varies with changes in the form of the shore. The studies were carried on under the direction of the division of geology and geography of the National Research Council and have recently been completed. The ultimate success of the undertaking must be credited to several agencies which generously cooperated with the National Research Council to make the study possible, particularly the U. S. Coast and Geodetic Survey, which bore the major burden in the joint effort. A full report will be published in the near future covering (a) the theoretical considerations upon which the whole study was based; (b) the tidal observations, including full field data, prepared by Mr. Paul Schureman, of the Coast and Geodetic Survey, for possible use by those who fifty, a hundred or more years hence may wish to make similar observations for purposes of comparison; and (c) the interpretation of results of the tidal observations, especially in relation to problems of more than local interest.

The outstanding results of the tidal observations to be described in the report are as follows:

(a) The tidal range within Jamaica Bay is greater than at Fort Hamilton near the head of the more open Lower (New York) Bay.

(b) Mean sealevel at all three stations in Jamaica Bay is higher than at Fort Hamilton.

(c) Even within the bay the plane of mean sealevel is not level, but is higher at the northeastern station than at the southern and western stations.

(d) Tidal observations at Fort Hamilton extending over a period of thirty-five years indicate no appreciable change in sealevel at that point during the period of observations.

Let us consider the significance of these points in the order named.

(a) Jamaica Bay was selected as the site of the tidal study here described, in part because it was believed that the breadth and the depth of the inlet would admit tidal waters freely and that the relatively small size of the bay, combined with the fact that much of its area is occupied by marshes and mud flats, would prevent the entering waters from spreading far. Hence it was not expected that this locality would present those extreme conditions encountered where a narrow and shallow inlet into a broad and deep bay or lagoon favors a very small tidal range and at the same time a distinctly higher mean sealevel inside the embayment. The fact that the tidal range in Jamaica Bay exceeds that at Fort Hamilton is sufficient indication that the tidal waters do enter and leave the bay with great freedom and show that the locality was well chosen as an example of moderate rather than extreme conditions favorable to variations in the height of mean sealevel. In this connection it should be noted that not only does high water in the bay rise higher than at Fort Hamilton,

1 "Shoreline Investigations on the Atlantic Coast," SCIENCE, n. s., 65, pp. 4–7, 1927.

but that low water also falls lower, showing that the outflowing waters are not unduly impeded by an exit channel greatly restricted in breadth in its lower levels.

(b) That mean sealevel within Jamaica Bay should at all three tide stations prove to be appreciably higher than at Fort Hamilton, despite the relatively free ingress and egress of tidal waters, and other conditions generally unfavorable to the development of sealevel differences, is most significant. The shape of the inlet channel may account for part of the observed difference in sealevel height, and there might thus be a higher mean sealevel in the bay if no other factor than the tidal régime as affected by the shore form entered into the picture. But other factors are doubtless involved. Some fresh water from the surrounding land enters the bay, although the locality was selected in part because the quantity of this water was believed to be small. Partial impounding of this water, and its lower density as compared with the sea water, would both tend to raise sealevel slightly within the bay. Winds from a westerly direction have in this region a greater average intensity than those from an easterly direction, and due to the form and position of the mouth of Jamaica Bay westerly winds should be more effective in blowing water into the bay and holding it there than would be the case at Fort Hamilton. Just as the shape of the entrance channel may distort the position of mean sealevel, so also the form of channels, shoals and bordering island and mainland shores within the bay may have their effect. None of these factors should produce a great effect in the Jamaica Bay region but each may play a minor rôle. The observed differences in mean sealevel are thus presumably the resultants of a combination of causes, each producing a very limited effect because of the physiographic conditions of the locality.

The quantitative values of the observed differences in mean sealevel are quite as great as, if not greater than, were anticipated. From the physiography of Jamaica Bay and its surroundings it was predicted that the differences found would be "very small, at most a very few inches and possibly only fractions of an inch." It was thus considered quite possible that the maximum values might not amount to an inch. In fact, the difference at one station in the bay amounted to 2.04 inches, at the other two stations to .72 and .84 inches, respectively, as compared with mean sealevel at Fort Hamilton. That the predicted values should be equaled or exceeded by the observed values gives one added confidence that distortions of the mean sealevel plane may safely be inferred from a consideration of the physiography of a given shoreline. In the light of these results it seems reasonable to believe that much greater distortions of the mean sealevel plane must exist at many points along our coast, while smaller but appreciable distortions may be expected in some of our bays and harbors widely open to the sea.

(c) It is not surprising to find that mean sealevel within Jamaica Bay itself varies more than an inch in altitude. The greater altitude at the northeastern station (North Channel Bridge) may reflect a slope of sealevel due to distortion by westerly winds. It may also be in part due to the shoal character of the water in this locality, or to the form of neighboring tidal channels. The same principles which apply to distortion of mean sealevel by larger features of the shore apply in appropriate measure to distortions caused by lesser features within a bay.

(d) Special interest attaches to the long series of tidal observations at Fort Hamilton. These cover a period of thirty-five years (1893 to 1927, inclusive).

The tabulated data afford no proof of any progressive change in the general level of land or sea. The annual variations, the four-year variations and the nine-year variations are all within the limits of variations normally due to astronomical and meteorological causes. A more or less steady rise of sealevel from 1912 to 1919 was followed by a more or less steady fall from 1919 to 1926. The average position of mean sealevel for the first five years of the 30-year period 1898–1927 differed from that of the last five years by only 0.01 foot or little more than one tenth of an inch. Obviously there is nothing thus far revealed in the Fort Hamilton record which can be taken to indicate a progressive rise of the general sealevel, or a progressive subsidence of the land.

Should future years show that in the long run local sealevel continues, on the average, to rise, it would then be necessary, before assuming a general rise of sealevel or subsidence of the land, to eliminate the possibility that the change was merely local and due to changing conditions within the harbor or on adjacent shores. In this connection it would be necessary to study past and future changes in Coney Island, Rockaway Beach and Sandy Hook and perhaps along other parts of the coast of the Lower Bay; the effects of artificial changes in the Lower and Upper Bays and in neighboring waters, including the dredging of channels, building of jetties, obstruction of currents by wharves and piers, filling in of harbor areas, etc.; possible changes in the volume of fresh water brought by the Hudson and other streams, and all other factors which might locally affect the position of the sealevel plane. It will be an appropriate time to make this study after we have first found in the tidal records indications of sealevel changes which are not readily explained as normal and expectable fluctuations due to astronomical and meteorological causes.

DOUGLAS W. JOHNSON

COLUMBIA UNIVERSITY

SEGREGATIONS OBSERVED IN BREEDING THE MONILIA BREAD MOLDS

IN the heterothallic species of Neurospora, two nuclei bearing factors of inheritance from both parents come together in an ascus and fuse. After a short resting period the fusion nucleus undergoes three successive divisions. Each of the resulting nuclei is then included in a spore. Eight uninucleate unisexual ascospores are thus formed from a single mother cell. The asci are long and slender and the nuclear spindles are very definitely oriented so that the relationship of the different spores is readily determined. The results obtained in crossing different strains as well as species of the Monilia bread molds have been such as to suggest the desirability of knowing in each case just where segregation of the various factors of inheritance takes place.

Neurospora crassa is a species commonly found on sugar-cane bagasse and elsewhere in the south. The eight spores from each of several asci have been isolated one by one and germinated. The eight haplonts, each from a single spore and all from a single mother cell in each case, were grown in pairs in all possible combinations. The results prove conclusively that segregation of the sex factors occurs in the first nuclear division in the ascus. The four spores in one end of the ascus are all alike as to sex, and the four in the other end of the ascus are of the opposite sex.

Neurospora sitophila, the common pink mold of the bakery, resembles *N. crassa* in many respects, but it has been reported[1] that in this species segregation of the sex factors must occur in the second division because the spores alternate in pairs as to sex. That this is not always the case is evident from results recently obtained by the writer. The strains mated were originally obtained at the Arlington Experimental Farm in Virginia. Eight haplonts were obtained by germinating the spores from one ascus. After the cultures had developed a few days very striking differences could be seen. The cultures had been numbered 1 to 8 corresponding to the location of the spores in the ascus. There was a very definite alternation in pairs as to the color of the aerial hyphae and the amounts of the salmon-pink conidia produced. Mycelia Nos. 1, 2 and 5, 6 produce pale or albinistic aerial hyphae with few, if any, conidia. Mycelia Nos. 3, 4 and 7, 8 produce masses of brightly colored salmon-pink to orange conidia. By growing the eight haplonts in pairs in all possible combinations, however, it was proved that this alternation in pairs was independent of sex. The haplonts alternate four and four as to their sex, so that as in *N. crassa* segregation of the sex factors must occur in the first division, even though the factors for conidia segregate in the second division. By mating haplonts Nos. 2 and 7 a new generation of perithecia was obtained. The same alternation in pairs as to production of conidia, and alternation four and four as to sex, was proved to obtain in asci of these perithecia also.

Quite otherwise is the situation when two albinistic races such as Nos. 2 and 6 are mated, or when two strains such as Nos. 4 and 8, which produce an abundance of conidia, are grown together. For example, when haplonts Nos. 2 and 6 are mated a new albinistic race is established which produces few, if any, conidia even when grown on bread, its natural medium. Such a race would be less obnoxious to the baker, since it must rely on sexual reproduction for its perpetuation. The spores from the different asci were tested out as to their sexuality. While the eight haplonts from an ascus are all alike in being albinistic, and practically sterile as to production of conidia, it was found that as to sex the spores alternate in pairs. When haplonts Nos. 4 and 8 referred to above were mated, asci were developed in which all eight spores were alike as to production of conidia by their mycelia, but again the spores alternate in pairs as to their sex.

Neurospora tetrasperma is a homothallic species. The mechanism by which a spore is provided with a nucleus of each sex is rather remarkable. Segregation of the sex factors could occur in any one of the three divisions, yet each ascospore would ordinarily be bisexual.

The three species of Neurospora furnish very desirable material for studies on inheritance in the fungi. Perhaps in no other place in the plant or animal kingdoms so far known can the progeny from a single mother cell be studied so readily and to such an advantage. Just why, in a mating of strains of *Neurospora crassa* which appear to be homozygous as to factors for production of conidia, segregation of the sex factors should occur in the first division in the ascus, while in similar races of *N. sitophila* these factors are segregated in the second division, is not altogether clear. Further study proves that segregation of various factors of inheritance in *N. sitophila* may occur at different points, depending on certain conditions not yet clearly understood.

B. O. DODGE

THE NEW YORK BOTANICAL GARDEN

[1] Marguerite S. Wilcox, "The Sexuality and Arrangement of the Spores in the Ascus of *Neurospora sitophila*," *Mycologia*, 20: 3–17. 1928.