the shell of eggs of *Aedes* and *Psorophora* as observed by high power and transmitted light may indicate characters for classification of the eggs of these genera.

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NOTES ON THE INFLUENCE OF SALT-MARSH TOPOGRAPHY ON TIDAL ACTION[1]

W. L. BIDLINGMAYER AND J. W. KLOCK

Field observations of the effect of tidal inundation of several breeding areas of salt-marsh mosquitoes, *Aedes taeniorhynchus* (Wied.) and *Aedes sollicitans* (Walk.) in the Savannah, Georgia, area in 1952 suggested that tidal flooding was not always determinable by terrain elevation *per se* in relation to tidal levels. As a result, detailed observations were made on two salt-marsh areas on Little Tybee Island, Georgia, to observe the influence of a spring tide upon their inundation.

Little Tybee Island is a barrier island 2 miles long and less than 0.5 mile in width that lies about 1.5 miles behind the present coastline and is surrounded by extensive salt marshes. The island consists of a number of parallel sandy ridges which are separated by narrow sloughs, some of which extend the full length of the island. The vegetation of the ridges is composed primarily of pine and scrub palmetto associated with cabbage palms, cedar, and live oak. The lower reaches of the sloughs are dominated by a dense stand of *Spartina alterniflora* Lois, these plants being subjected to the daily ebb and flow of the tides. Farther up the sloughs dense stands of saltgrass, *Distichlis spicata* (L.) Beauv. frequently occur, while in the upper reaches the vegetation consists of fresh-water species (e.g. *Mariscus jamaicensis* Crantz; *Hibiscus* sp.) which can probably tolerate a slight degree of salinity. The areas of the sloughs containing *D. spicata* frequently are good breeding sites for salt-marsh mosquitoes, particularly *A. taeniorhynchus* (Wied.). Two sloughs on this island were selected as sites for the tidal observations. The August spring tide studied was not as high as those that occur at other times of the year and thus may be considered more representative of the general tidal flows than would a spring tide

[1] From the Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

of maximum height (9.3 feet). The maximum predicted height of the August spring tide[2] for Petit Chou Island, the closest subordinate station listed in the Tide Tables, was 8.5 feet above mean low water on August 5, 1952 at 7:46 p.m. By midnight the water had dropped to a predicted height of only two feet above mean low water as determined from Table 3 in the Tide Tables.

Five tidal markers (A, B, C, D, and E, Figure 1) were placed in the ditches or waterways in the lower portions of several of the sloughs; tidal marker A being located in slough A, and tidal marker E located in slough E. A bench mark was established and the elevation of the tidal markers was determined from the bench mark.

One of the sloughs selected for study (E) was narrow with steep sides. At low tide it is dry and mosquito breeding has never been observed in it. In contrast, the second slough (A) was broad and flat and most of it was carpeted with *D. spicata.* Like several of the sloughs on the island, it was ditched many years ago, but the ditches have not been maintained and, at present, they probably are more beneficial than detrimental to mosquito breeding. Large broods of *A. taeniorhynchus* have been observed to emerge from this slough.

In each slough a series of small stakes was placed about 100 yards apart to observe the progress of tidal water (Figure 1). The relation of their heights to each other, or to mean low water, was not determined. As stake number 8 of both series was located where the slough was dry, a hole (approximately 21 inches deep) was dug within 5 feet of stake 8 one week before the test to detect any subterranean movement of the water. This site was numbered 8a.

The data from periodic observations of the tidal markers (A—E) are plotted in figure 2 for comparison with the predicted height of water at the nearby Petit Chou Island. These data show that the crest of the tide is lowered and delayed with increasing distances from Petit Chou Island.

The first observations of the stakes in sloughs E and A were begun at approximately 7:10 p.m. and repeated at 0.5 hour intervals thereafter for 5.5 hours. At slough E the first observations of stakes 1 and 2 showed a water depth of 15 inches and 14 inches respectively, the remaining part of the slough being dry. Slack water occurred during the following one-half hour period and then the tide ran out rapidly, the water dropping to a level of only 1 inch and 2 inches respectively at stakes 1 and 2 by 9:10 p.m. Although the water continued to flow out, its depth began to increase, reaching 9.5 inches by 12:40 a.m. at stake 1, and 8.0 inches at stake 2. Tide water first reached stake 3 at 8:40 p.m., and crested at 10:10 p.m. (10.5 inches). At stake 4 the tide entered at 9:10 p.m. and crested at 10:10 p.m. (7.5 inches). Stake 5 was flooded at 9:40 p.m. and a 6 inch crest recorded at 10:10 p.m. The water flowed to stake 6 at 10:10 p.m. and a 5.5 inch crest was reached at 10:40 p.m. At stakes 7 and 8 the water arrived at 11:10 p.m. and 11:40 p.m. respectively. The highest water levels recorded for these two stations were 6.5 inches and 2 inches respectively, at 12:40 a.m.

Following the tidal crest, the water at stake 3 dropped 7.5 inches by 12:40 a.m. while that at stakes 4, 5 and 6 dropped 3, 3 and 1.5 inches respectively. From the data presented for slough E, it appears that the peak of the tide sends a large mass of water moving up the sloughs. The progress of this mass is not rapid, and, as the height of the water in the Tybee River drops, water will flow simultaneously both forward and backward from a decreasing crest as it penetrates the slough. At stakes 1 and 2 in slough E, the water ran out rapidly after the change in the tide, but as the flood above it began to ebb, the depth of the water again increased. There was

[2] According to Tide Tables, East Coast, North and South America, 1952, U. S. Department of Commerce Coast and Geodetic Survey.

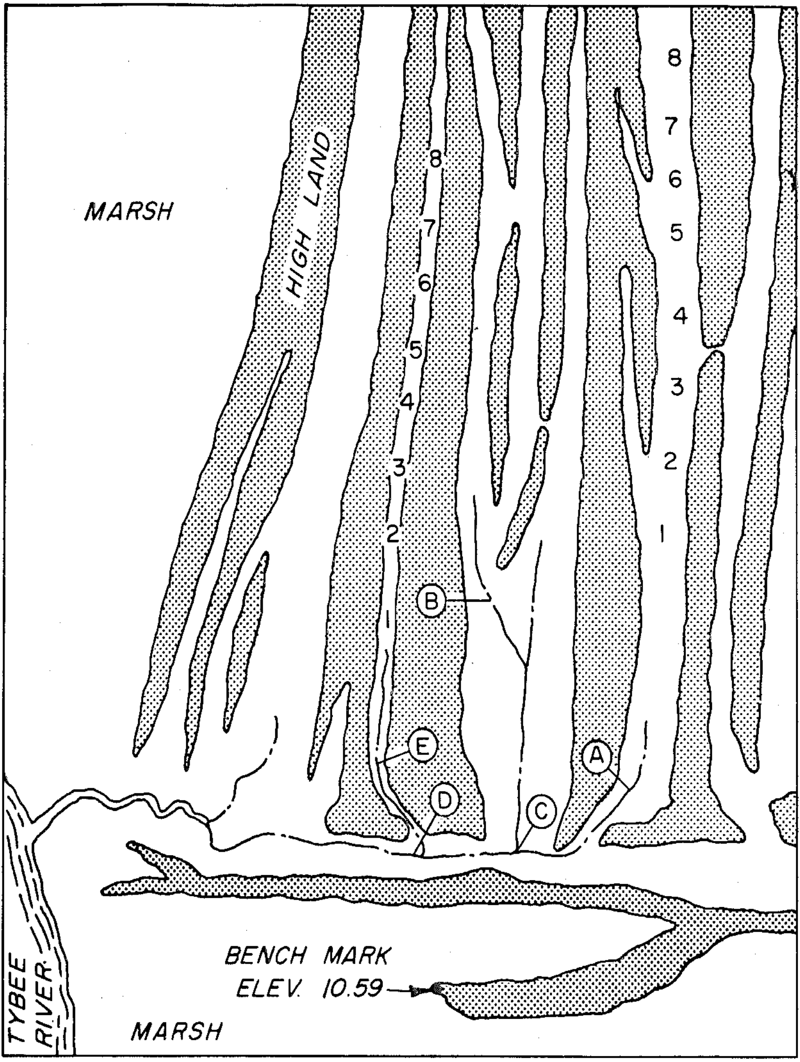

FIGURE I

LOCATION OF TIDAL MARKERS AND ELEVATION STAKES ON LITTLE TYBEE ISLAND, GEORGIA

no fluctuation of the subsurface water level at stake 8a.

Unlike slough E, stakes 1 to 7 inclusive in slough A were in shallow water (2.1–8.0 inches) at the time observations began. The progress of the spring tide up this slough was noted by recording the increase in depth of water at the stakes. At stake 1 the depth began to increase at 8:10 p.m. and the crest occurred at 11:10

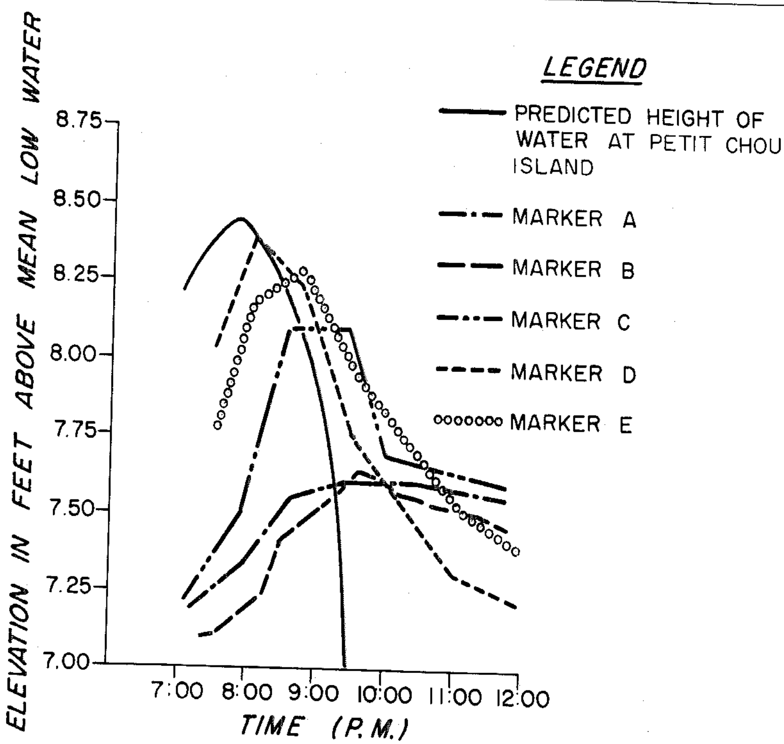

FIGURE 2

HEIGHT OF WATER AT TIDAL MARKERS IN SLOUGHS ON LITTLE TYBEE ISLAND, BETWEEN 7:00 P.M. AND 12:00 P.M. ON AUGUST 5, 1952, COMPARED WITH THE PREDICTED WATER LEVELS AT PETIT CHOU ISLAND

p.m. Stake 2 received tide water at 9:10 p.m. and the crest was recorded at 11:40 p.m. Tide water reached stake 3 at 9:40 p.m. and the crest occurred at 12:10 a.m. At stakes 4, 5, 6, 7 and 8 the tide water entered at 10:10 p.m., 10:40 p.m., 10:40 p.m., 11:40 p.m. and 12:40 a.m. respectively; the water depth continuing to increase at these stakes at the time when the last readings were taken at 12:40 a.m. At stakes 1, 2 and 3 the water level increased 4.1, 3.3 and 3.0 inches respectively. There were slight decreases following the crest probably due to the absorption of the water by the soil. The water level at stake 8a fluctuated slightly and increased 0.5 inches. No surface water reached stake 8a.

Slough A reflected the same delay both in time and height of the tide as did slough E and the 5 tidal markers.

These observations indicate the importance of certain hydraulic factors in investigations on the relationships of marsh flora, salt marsh mosquito production areas, and tidal flooding. Because of hydraulic friction and tidal phenomena, tidal levels in remote areas may be lower than in the main tidal streams under certain conditions. Thus it is possible for vegetation (i.e. *D. spicata*) and mosquito production to occur at lower elevations in these remote areas than it would be in areas which are more accessible to tidal water.

The fact that the evaluation of mosquito production potentialities by use of physical indexes may be complex in character, further emphasizes the value and significance of vegetation as a general indicator of mosquito breeding sources.

SUMMARY. Observation of tidal action in sloughs on Little Tybee Island, Georgia indicate that elevation levels alone are not infallible indicators of the frequency or extent of tidal flooding in an area. Hydraulic action and marsh flora are factors of importance in influencing mosquito production at the same or different elevations.

THE DISCOVERY OF *CULEX ERYTHROTHORAX* DYAR IN TEXAS

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Culex erythrothorax Dyar was found for the first time in Texas during intensive mosquito collecting in the western part of the State in 1953 and 1954. The collecting was done in an irrigated area of the Southern High Plains in connection with encephalitis and irrigation-mosquito studies conducted jointly by the Communicable Disease Center, U. S. Public Health Service, and the Texas State Department of Health. During the two years, approximately 400,000 mosquitoes, representing 6 genera and 18 species, were taken in the light trap and evening biting collections. Among these mosquitoes were specimens of a golden-brown, dark-legged *Culex* which appeared distinct from all the species previously reported from Texas. The male genitalia of these *Culex* were comparable to those of specimens of *C. erythrothorax* Dyar furnished by the Bureau of Vector Control, California State Department of Public Health. Dr. Alan Stone, U. S. National Museum, who examined genitalia slides of the west Texas specimens, also identified the species as *C. erythrothorax*.

C. erythrothorax was represented in the light trap material by a total of 84 adult specimens (Table 1). It was not present in the light trap collections taken at Hale Center, Hereford, and Kress in 1954, but one female was taken in a light trap at Abernathy on September 3 of that year.

In 1953, between August 5 and October 13, 12 *C.erythrothorax* were taken in twelve 15-minute biting collections at Lubbock, and 2 specimens were taken in ten 15-minute biting periods at Plainview. In 1954, only one *C. erythrothorax* was taken in ninety-eight 15-minute biting collections, all made in Plainview and vicinity.

In 1953, 8,000 fourth-instar larvae were identified from collections made in various habitats in the vicinity of Lubbock and Plainview. Among these larvae were 2 of *C. erythrothorax,* both collected on October 21 from permanent seepage pools along Yellow House Creek, near the eastern

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