ART. XLIII.—*On a Champlain (?) deposit of Diatomaceæ belonging to the Littoral Plain;* by ARTHUR M. EDWARDS, M.D.

ON the 30th of March, 1859, F. C. S. Roper read a paper by me before the meeting of the Microscopical Society of London, and which was published in volume vii of the Transactions, "On Diatomaceæ collected in the United States." In it there is spoken of a gathering made at Hoboken, N. J., in which eighty-six species of Diatomaceæ, from fresh, brackish and salt water are mentioned as coming from that locality. This gathering, or rather these gatherings, for there were more than one hundred made at that time, were mostly from a large brook, the mud of which yielded the shells of the dead Diatomaceæ. At that time I did not try to work out the geology of the deposit, only pointing out that the mixture of marine, brackish and fresh water forms in the deposit was curious. Since that time I have kept the matter in view and am now prepared to assert what I believe to be the geology of the deposit. I shall show that the Diatomaceæ in it, and by which its geology is determined, are widely spread.

It is the first time that Diatomaceæ are found at all in the geological scale and referred to the brackish, although they are indicated by Ehrenberg in the *Mikrogeologie*, 1854, as coming from Norwich, Conn. This I will show is the same as those.

They are known to be marine and are referred to the Eocene, Oligocene or Miocene Tertiary. These are from Paita, Peru; San Pedro (or farther south in Southern California) to Sub Little Mines, Del Norte Co., in California; Petersburg, Virginia, to Atlantic City, New Jersey; Oran, in Africa; Mors, in Denmark; Simbirsk, in Russia; Sentz Peter, in Hungary; Moron, in Spain; Nicobar Island, in the Bay of Bengal; Cuba, Trinidad and Barbadoes, in the West India Islands; Sandai, Kobe and Netanai, in Japan; the Island of Sicily and Omaru, in New Zealand.

On the 18th of December, 1871, I read a paper before the Lyceum of Natural History, New York, "On a deposit of marsh-mud upheaval by superincumbent pressure and containing the remains of shells of Mollusca and microscopic organisms," which was not then published, but is now for the first time in the microscopic notes for January 1, 1893. As this records the instance of the shells of marine and brackish Diatomaceæ in this deposit also, it now sees the light. The third instance of marine, brackish and fresh-water Diatomaceæ mixed I have now to publish. This deposit I have studied for over three years past. Besides the many spots on the

Newark meadows, N. J., where I have collected the Champlain (?) deposits, I will mention the following as typical, and from which I have gathered the clay, blue, gray or white, and made slides: Harrison, near the bridge; opposite Athar's factory; opposite Lister's factory; by Hillingsworth's factory; between Hillingsworth's factory and the P. R. R. bridge; Frank Creek, half way across the meadows; near the P. R. R. No. 1 and No. 2; near the bridge over the Passaic River; on the extension of the P. R. R.; raised meadows on the P. R. R.; Woodruff's Creek, near Elizabeth; near Linden Park No. 1 and No. 2, Elizabeth; back of Jersey City; in Jersey City, at the third street from New York Bay; Elizabethport; Bay Way, Elizabethport; Kingsland; Seward; Kearney; Peddie Street Ditch; Signal post on the L. V. R. R., Bound Creek; and Arrowchar, S. I., N. Y. Besides these I have the same clay from near New Haven, collected by myself, and also sent to me by Mr. W. A. Terry, of Bristol, Conn.; near Boston, Mass., from Mr. F. F. Forbes and Mrs. S. A. Fuller; also from Mr. L. Woolman, as clay, water works, Absecon, N. J.; Bingham House, No. 1 and 2, Philadelphia, Penn.; 11th and Market streets, Philadelphia; Spreckel's Refinery, Reed Street Wharf, Philadelphia; abutment Walnut Street Bridge, Philadelphia; Gray's Ferry, B. & O. R. R., and he records in the *Microscopical Bulletin* for October, 1892, "Fossil Diatoms in Philadelphia beneath the girls' new Normal School buildings." And I am also indebted to Mr. C. L. Peticolas for a slide from Cornfield Point, St. Mary Co., Md. I have also to record that Professor J. W. Bailey discovered in the earth of the rice fields at Savannah, Ga., Diatomaceæ. This I received at the same time, about forty years ago, from Dr. W. C. Daniels, Savannah, Ga. Bailey records it in his *Microscopical Observations* made in South Carolina, Georgia and Florida, and published in 1850 in the *Smithsonian Contributions to Knowledge*, Vol. II, page 5. Dr. F. W. Lewis records the finding of Diatomaceæ in the blue clay of the Delaware River, Philadelphia, Penn., in his *Notes on new and rarer species of Diatomaceæ of the United States seaboard*, 1861.

We now come to mention the species of Diatomaceæ found in the Champlain (?) deposits of the Littoral Plain. They include the following:

- ACHNANTHES hirta, O. F. M., lanceolata, A. de B.
- ACTINOCYCLUS ternarius, C. G. E.
- ACTINOPTYCHUS biternarius, C. G. E.
- AMPHIPRORA alata, C. G. E., lepidoptera, W. G., pulchra, J. W. B.
- AMPHORA cymbifera, W. S., lanceolata, P. T. C., pellucida, W. G., robusta, W. G., undata, H. L. S.
- AMPHITETRAS antediluviana, C. G. E.
- BREISSONIA lanceolata, C. A. A.

BIDDULPHIA aurita, A. de B., lævis, C. G. E., pulchella, S., radiata, F. C. S. R., rhombus, C. G. E., turgida, C. G. E.

CAMPYLODISCUS clypeus, C. G. E., echeneis, C. G. E.

COCCONEIS diaphana, W. S., distans, W. G., limbata, W. G., major, W. G., oceanica, C. G. E., placentula, C. G. E., scutellum, C. G. E., undulata, C. G. E.

COCCONEMA cistula, H., lanceolatum, C. G. E.

COLETONEMA eximium, F. T. K., vulgare, T.

COSCINODISCUS asteromphalus, C. G. E., excentricus, C. G. E., lacustris, A. G., nitidus, W. G., radiatus, C. G. E., sol, G. C. W., subtilis, C. G. E.

CYCLOTELLA carconensis, S. G., operculata, F. T. K., kütz-
ingiana, T.

CYMBELLA stomatophora, H. G., truncata, W. G.

CYMATOPLEURA elliptica, A. de B., quinquepunctata, F. T. K.

DIPLONEIS apsis, C. G. E., elliptica, F. T. K.

DENTICULA minor, A. G.

DORIPHORA amphiceros, F. T. K.

ENCYONEMA paradoxum, F. T. K., prostratum, J. R.

EPITHEMIA Jurgensii, C. A. A., gibba, F. T. K., gibbula, F. T. K.

EUNOTIA arcus, C. G. E., gracilis, C. G. E., incisa, W. G.,
lunaris, A. de B., pectinalis, S. R.

FRAGILARIA Pacifica, A. G., virescens, S. R.

GOMPHONEMA acuminatum, C. G. E., cupitatum, C. G. E., con-
strictum, C. G. E., ? curvatum, F. T. K., cristatum, S. R., mamilla,
C. G. E., marinum, W. S.

HYALODISCUS scoticus, F. T. K., stelliger, S. W. B.

LYRADISCUS ovalis, R. K. G.

MASTOGLOTA lanceolata, W. S., Smithii, T.

MERIDION circulare, C. A. A.

MELOSIRA crenulata, F. T. K., grandis, M. P., granulata, C. G. E.,
Jurgensii, C. A. A., nummunoides, C. A. A., punctata, A. G.,
sulcata, C. G. E., undulata, F. T. K., varians, C. A. A.

NAVICULA Americana, C. G. E., bacillum, C. G. E., borealis,
C. G. E., cancellata, A. S. D., Couperi, T. W. S., cruciformis var.
brevior, P. T. C., cuspidata, F. T. K., dactylus, C. G. E., Dariana,
A. G., elegans, F. T. K., esox, C. G. E., firma, F. T. K., gigas,
C. G. E., gibberula, F. T. K., gracilis, C. G. E., granulata,
A. de B., Henedyii, W. S., interrupta, F. T. K., Lewisiana,
R. K. G., lyra, C. G. E., major, F. T. K., maxima, W. G., min-
utula, W. S., Mexicana, C. G. E., nobilis, C. G. E., oblonga,
F. T. K., peregrina, C. G. E., radiosa, F. T. K., spherophora,
C. G. E., stauroneiformis, W. S., (tenuis Grey var. ?) sublineais,
W. G., trinodis, W. S., viridis, F. T. K., viridula, C. G. E.

NITZSCHIA, acicularis, F. T. K., amphioxys, C. G. E., Bright-
wellii, F. K., bilobata, W. S., constricta, F. T. K., compressa,
J. W. B., fasciculata, A. G., obtusa, W. G., Peruviana, C. G. E.,
paradoxa, G., reversa, W. S., scalaris, C. G. E., sigma, F. T. K.,
sigma, var. major, A. G., sigmoidea, C. G. E., subrecta var. rigida,
A. G., tryblionella, H., (tryblionella var. ?) littoratis, A. G.

PLAGIOGRAMMA Gregorianum, R. K. G.

PLEUROSIGMA angularis, W. S., Balticum, C. G. E., delicatulum, W. S., oximium, F., elongatum, W. S., fasciola, F. T. K., hippocampus, C. G., obscurum, W. S.

PODOSIRA moniliformis, C. G. E., Montagnei, F. T. K.

PYXILLA ? Baltica, A. G.

RHABDONEMA Adriaticum, L., arcuatuum, F. T. K.

SYNEDRA affinis, F. T. K., lunaris, C. G. E., pulchella, F. T. K., salina, W. S., tabulata, F. T. K., ulna, F. T. K.

STICTODISCUS craticula.

STEPHANODISCUS corona, C. G. E., Niagaræ, C. G. E.

STAURONEIS acuta, W. S., anceps, C. G. E., aspera, W. S., salina, W. S., legumen, C. G. E., maculata, J. W. B., phœnicenteron, C. G. E., pterodea, C. G. E., gracilis, C. G. E., fenestra, C. G. E.

SURIPELLA acuta, C. G. E., Brightwellii, W. S., crumena, A. de B. cardinalis, F. K., Davidsonii, A. S., Fastuosa, C. G. E., gemma, C. G. S., gracilis, A. G., linearis, W. S., Molleriana, A. S., ovalis, A. de B., Ratayii, A. S., recedens, A. S., robusta, C. G. E., splendida, C. G. E., salina, W. S., Suevica, Z.

SCHIZONEMA cruciger, W. S., divergens, W. S., hyalina, W. S., Smithii, C. A. A.

TETRAGRAMMA Americana, T. W. B.

TABELLARIA fenestrata, F. T. K., flocculosa, F. T. K.

TRICERATIUM alternans, T. W. B., favus, C. G. E., reticulum, C. G. E.

VAN HEURKIA rhomboides, A. de B.

We now come to the geology of the Newark Champlain (?) deposit. I understand the Champlain deposit to be formed when the melting of the glacier which succeeded the Tertiary age. The first were glaciers forming the glacial period and then they melted and formed the Champlain period. When the glaciers were nearly melted, the Diatomaceæ lived in the fresh water, and their shells were deposited when the stream of the Champlain period rushed down from the North. The deposit was mostly clay and covered the states where it is now found. From New Brunswick to Pennsylvania on the Atlantic coast of North America it is formed covering the whole country. The clay was of course fresh water, and the Diatomaceæ were also fresh water. By and by salt water flowed in and formed brackish pools on the coast. As this was raised a brackish clay was formed, and this I call the raised or sunken beach. Dr. J. S. Newberry calls it the Littoral Plain. He describes it in the geological history of New York Island and harbor in the Popular Science Monthly, vol. xiii. The fresh-water deposits are innumerable, but really are one and form the clay at the bottom. Upon this is the raised coast. The raised coast forms two deposits in the Newark meadows. Upon this is a clay of fresh water Diatomaceæ, and lastly comes the recent clay now forming.