On the conclusion of Professor Geddes' address, Hon. D. R. Francis, on the call of the President, spoke briefly on the subject presented by Professor Geddes, expressing a warm interest in the work of the Association, the cooperation of which with the Louisiana Purchase Exposition being planned for St. Louis, a few years hence, is hoped for.

A paper by Dr. G. A. Miller, 'On the primitive substitution groups of degree ten,' was presented by title.

Professor J. L. Van Ornum, late of the United States Engineer Corps, spoke interestingly on 'The sanitary cleaning of a city, as exemplified by Cienfuegos, Cuba,' explaining the conditions found by the United States Army on taking possession of that city, and the thoroughness with which the streets, court yards and cesspools were cleansed by the Engineer Corps, which also charged itself with the betterment of the city water supply. A diagram which the speaker had prepared showed that in addition to a very marked lowering of the death rate which attended the supply of an abundance of wholesome food, on the occupation of Cienfuegos, there had been a decrease of considerably over fifty per cent. in the weekly death rate, directly attributable to the sanitary cleansing of the city; and he further stated that since this work had been done, yellow fever, which before that time had been endemic in Cienfuegos, had been absent from the city.

Five persons were elected to active membership in the Academy.

William Trelease,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

'FLOATING SAND.' 'FLOATING STONES.'

In the *American Geologist* for January, 1896 (Vol. XVII, pp. 29–37) I published an article on 'Floating Sand: an Unusual Mode of River Transportation' in which I gave a detailed account of that phenomenon as seen by me during the preceding August on the Llano river, a tributary of the Colorado, at Bessemer, a station on the Austin and Northwestern Railroad, 94 miles from Austin, Texas. I further gave an account of numerous experiments performed for the purpose of ascertaining how sand may be floated, what sand will float, and why sand will float. No less than fourteen different sands were examined some of which were from widely separated localities, as, for instance, the coast of Long Island and that of Lake Michigan, at Chicago; from the friable sandstone at Alum Bay, Isle of Wight, and the Lower Carboniferous at Pea Ridge, Arkansas. At the time of writing, I may add, the only account of floating sand known to me was in a brief article 'On a Peculiar Method of Sand-Transportation by Rivers' published by Mr. James C. Graham in the *American Journal of Science*, III, Vol. XL, p. 470 (December, 1890) and this I had failed to notice until I had begun my investigations.

Without going into the details of my paper further at this point, I will enumerate the conclusions reached which were as follows:

"1. That sand grains will float in perfectly still water for an indefinite time.

"2. That the grains which float are not necessarily siliceous. That flakes of mica, fragments of marble, bituminous shale, etc., also float and that some of them, the marble and the bituminous shale, for example, are unusually buoyant.

"3. That the property of floating is not confined to the sand of any particular locality, but depends to a considerable extent upon the angularity, *i. e.*, the shape of the grains.

"4. That whether sand will float or not depends, also, upon the mode of launching. Whether it be by ripple waves, as stated by Mr. Graham, or by undermining, it must be gently done, for should the grains be plunged into the water with sufficient force to completely immerse them they will immediately sink.

"5. That the natural conditions necessary to the floating of sand in rivers are somewhat unusual, depending, in the case of the Llano, upon a flood without local rains and, in that of the Connecticut, upon the manner in which certain waves strike a sand-bar. It is quite possible, however, that floating sand is much more common than is ordinarily supposed.

"6. That the physical explanation of the problem is complex rather than simple, and at best unsatisfactory in several important particulars, and that with the advance of molecular physics we may hope for a better understanding of what we now, for convenience, term 'superficial viscosity' and 'capillary attraction.'"

This article attracted considerable attention and was reprinted entire or in part in other journals.

Among the letters received at the time of publication, the following substantiate the last part of the 5th conclusion, viz, that floating sand is much more common than is ordinarily supposed:

Professor William Morris Davis wrote, January 28, 1896: "I have noticed the same thing (floating sand) on the tidal currents of Cape Cod."

Mr. Henry W. Nichols of Field Columbian Museum, Chicago, wrote, February 3, 1896:

"I would like to add another instance. At Cohasset, Mass., a town about twenty-five miles south of Boston, there is a land locked inlet from the sea, known as Little Harbor. There are here and there along its shores, small beaches of angular gravel and sand. When there is no wind, the tide rises gently on these beaches without even a ripple, and gently lifts grains of dry sand which form such patches as you describe a foot or more in diameter. Some days such floating patches are very numerous, and may be seen going out with the tide all the way from the head of the Harbor to the outlet over a mile distant. The rock of the region is granite and the sand is probably derived from it. The grains are very angular. Without thinking much upon the subject, I have always considered that a film of air adhered to the grains and kept them from wetting, and that the floating was due to surface tension as in the case of the familiar experiment with a needle."

In the *American Geologist* for November, 1898, Professor George E. Ladd discussed the 'Geological Phenomena resulting from the Surface Tension of Water.' Under the caption 'Floating Materials' (p. 283) he says:

"It is not uncommon to see materials of a higher specific gravity than water floating upon its surface.

"The principle involved is again that of surface tension, and substances thus float only when the attraction for the water is less than the latter's surface tension.

"The geological results of this principle are chiefly the floating and shifting from place to place of sands. While I have observed such an occurrence on many occasions, in different places, the most important noticed was in Massachusetts, at the mouth of the Merrimac River. Here the northern end of Plum Island, which is a vast accumulation of sand, shuts in the harbor of Newburyport on the southeastern side. The action of the winds, of the waves, in time of storm, and the shifting currents (the position of the harbor's channel varying rapidly) result in the formation of numerous bays or 'basins' in the sandy island, on the protected side, often occupying extensive areas. The largest of these, having a circumference of something over a mile, has endured for the past forty or fifty years. The sand consists mainly of coarse, sharply angular quartz, but much feldspar is present, some mica, and numerous fragments of schistose and gneissic rocks. Whenever, on the retreat of the tide, the beaches and the exposed bars are dried by the sun's heat, the returning water, if not too greatly disturbed by unfavorable winds, lifts, as it creeps up the slope, the whole superficial film of sand, including large thin pebbles of schist, and floats it gently on the surface. The surface of the water, near the shores bearing the sand, commonly moves out towards the main river, even when the tide is rising, the incoming water flowing beneath.

"I have estimated that in the course of a year something like a thousand tons of sand, at a minimum, are lifted and borne away to new resting places by the floating power of surface tension at this locality alone."

During the present year Dr. Erland Nordenskiold's communication to *Nature* (January 18, 1900, p. 278) on 'Floating Stones,' seen by him during his recent visit to southwest Patagonia, has evidently been read with great interest in England and has been the means of calling forth a number of statements concerning floating sand and other mineral matter, such as fragments of shells. Neither Dr. Nordenskiold nor the other correspondents seem to have been aware of the papers published on that subject by Messrs. Graham, Ladd and myself, though printed in journals of wide reputation and extended circulation. Dr. Nordenskiold says:

"Whilst rowing in the long and narrow channel of Ultima Esperansa, to study the plankton, we observed, when the sea was calm or only agitated by a slight swell, small fragments of slate which floated upon the surface packed together in larger or smaller clusters. They drove hither and thither in the neighborhood of the shore, until they were driven away by the strong current which at intervals swept forward in the channel. The quantity was considerable; for instance, 700 of them were obtained at one cast of the net in a few minutes. The stones had evidently drifted out from the beach, which consisted mainly of similiar stone fragments washed off from the cliffs composed of a bituminous mesozoic slate. The

surface of the stones was dry, and they sunk immediately when it became wet by touching or by the movement of the swell.

"The slate fragments collected on the sea surface had a specific gravity of 2.71. The specific gravity of the water in the channel was only 1.0049 at a temperature of 15° C. (59° F.). The largest stone which I obtained from the surface weighed 0.8 gram. Twenty of the smaller fragments had a mean weight of 0.3 gram. The fragments contained no air cavities perceptible to the unaided eye."

These stones, which are pictured in *Nature*, are, it must be confessed, extraordinarily large. The specific gravity of the Llano sand was 2.59 and the largest grains could not approach the stones above mentioned in size.

To quote further from Nordenskiold:

"On examining the floating stones one could discern small gaseous bubbles attached to the under surface of them, and at the shore stones can be seen on the very fringe of the beach which are just beginning to float lightened by gaseous bubbles."

In my paper (p. 31) a possible explanation is offered for the presence of the 'gaseous bubbles': In one of my experiments I dug several holes in the sand forming a bank in the bed of the Llano and when their sides caved in, the dry grains forming the outer coat of the deposit, were gently launched and floated much more abundantly than in a previous experiment when the surface was damp. Furthermore, as each mass of sand slipped into the water, and exclusive of the floating grains, sunk, *the air contained in the interstices between the particles rose to the surface forming a patch of foam or froth.*

Again Dr. Nordenskiold remarks:

"It is probable that the stones were not only provided with gas bubbles, which can be perceived by the eye, but that they were surrounded by an envelope of gas supported by an insignificant coating of algæ, of which the stones are surrounded. At least, traces of diatoms and algæ are discernible on the stones after drying. The greasy surface of the mineral of which the stones consisted also prevented the water from adhering to them, and caused the stones to be surrounded with a concave meniscus, which naturally may have contributed to, and perhaps was the main cause of their floating, which sometimes was further facilitated by a patelliform shape of some of the bigger stones."

The floating sand of the Llano showed upon careful examination no signs of the presence of low forms of vegetable growth, neither was it in the least greasy. That the presence of oil in a bituminous shale may facilitate its floating property can scarcely be doubted.

Nature for February 1, 1900 (p. 318), contains two communications upon 'Floating Stones' by Messrs. Cecil Carus-Wilson and R. C. T. Evans, respectively.

Most of the points made by Mr. Carus-Wilson are covered in the papers of Messrs. Graham, Ladd and myself. It may, however, be of interest here to call attention to the following. He says:

"The grains float as patches composed of fine and coarse material clinging together; the presence of the very fine grains appears to facilitate the flotation of the larger grains and shells."

As bearing on this statement I will quote briefly from my paper:

"As I was sprinkling some sand upon the river for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed, like a funnel, for, say, half an inch before the cause of this unexpected phenomenon broke through its surface and sunk to the bottom" (p. 35).

His statement regarding the formation of 'patches' had also been anticipated in my paper (p. 36).

Mr. Evans writes that he has observed the phenomenon of floating stones at Kimmeridge, where the flaky nature of the beach material renders their appearance very common.

In experimenting with broken roofing slate he found that a small dried piece $1.5 \times .75$ cms. by about 1 cm. floats easily on water when gently placed on the surface.

It will be seen from the above statements that all observers agree that to float, the sand or stones must be lightly launched without complete wetting.

Frederic W. Simonds.
University of Texas.

SEA-BIRDS A SANITARY NECESSITY.

This country is on the verge of losing forever one of the main features of its seacoast charms—the sea-birds themselves. In fact, the Terns, the most exquisite of the Gull family,