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DISCOVERY OF TRIPOLI,

—OR,—

POLISHING POWDER, NEAR ST. JOHN.

DR. L. C. ALLISON'S LECTURE BEFORE THE NATURAL HISTORY SOCIETY
OF NEW BRUNSWICK, DESCRIBING THE ORGANISMS
WHICH PRODUCE IT,

AND

MR. G. F. MATTHEWS' REMARKS ON THE USES TO WHICH THIS
SUBSTANCE IS APPLIED IN THE ARTS.

A FEW WORDS ABOUT DIATOMS.

(BEFORE THE NATURAL HISTORY SOCIETY OF N. B., 3rd MAY, 1881.)

LADIES AND GENTLEMEN:—I am glad to be able to use this old familiar form of address to-night, and I hope that the day may soon come when we shall have ladies amongst us not only as guests but also as fellow-members and co-workers. I could have wished to be a little better prepared than I am to do justice to the occasion, but the fact is that the gentleman who was to have addressed you this evening has been unavoidably prevented from doing so, and I have been asked, at somewhat short notice, to supply his place. Under these circumstances I have concluded to call your attention to a few facts in connexion with the minute vegetable organisms known as Diatomaceæ or Diatoms.

Perhaps it will not be altogether superfluous if I begin by telling you what these diatoms are. They are very minute organisms ranging in size perhaps from about 1-200 to 1-3000 of an inch, and composed of a minute jelly-like substance of a yellowish-brown color, enclosed in a self-secreted transparent case of silica. This case is symmetrical and of a regular geometrical figure, variously and often most beautifully marked upon its surface. I have a pleasant personal reminiscence connected with these markings, for it was a sense of their beauty as displayed in one of the commonest marine forms (*Coscinodiscus*), that first turned my attention when a junior student at college,

to diatoms and the microscope, and laid the foundation of an acquaintance with both, which I have cultivated with constantly increasing pleasure ever since. The number, the beauty and the variety of the different forms of diatoms are almost infinite. In the scale of classification they form perhaps the nearest approach that exists to a connecting link between the animal and vegetable kingdoms. When first examined they were almost universally held to be animals and there are a few naturalists who are still inclined to so consider them, though it is not easy to see why, for the power of automatic motion in which lies their sole affinity to the animal kingdom has long been known to exist also in the vegetable. In all other respects (such as their more or less regular geometrical shapes, their living entirely upon inorganic nutriment, as well as their manner of assimilating it by endosmosis and exosmosis instead of by prehension, their lack of any differentiated organs, &c.) their characters are eminently vegetable and refer them to the Protophyta or lowest division of that kingdom. This fact is opposed to that form of the evolution theory which arranges all organised beings in a progressively ascending series from the simplest to the most complex, for if this were really the case we ought to find the vegetable kingdom approximating most nearly to the animal, not through one of its simplest and lowest forms, but through its highest and most elaborate.

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TERMINOLOGY.

The structural plan of a Diatom is not very complicated. In each separate individual or "frustule," the case consists of two symmetrical halves or "valves" joined together by their edges, (sometimes with an intermediate piece or "hoop" interposed) which line of junction is termed the "suture." The circular forms may be likened to a very shallow pill-box of which the upper and lower halves represent the valves, their opposed edges the suture and the body of the box the hoop. If we suppose the shape of the box to be triangular instead of circular we shall have a *Triceratium*, if acutely oval a *Navicula*, and so on. The valves being always more or less concavo-convex, recede from each other so as to enclose a space which is filled by the jelly-like substance called the "endochrome," whose color in the living individual is usually a rich yellowish brown. This color is supposed to be due to the presence of a minute proportion of iron which always enters into the composition of this plant. As the valves vary greatly in the shape and extent of their convexity we cannot get a clear idea of the shape of any particular Diatom until we have obtained at least two different views of it, one by looking at the surface of the valve, and the other by looking at the suture, the former of which is called in description the "side" and the latter the "front" view. These views are never quite similar and they are often so widely different that it would be quite impossible to infer one of them from the other; hence in order to know any one form correctly we must become acquainted with at least two quite dissimilar appearances, a fact which often causes great perplexity and confusion to the beginner. It can readily be believed that when these forms first began to be examined and named, the front and side views of the same Diatom were in more than one instance described as two different species.

SURFACE MARKINGS.

The surfaces of the valves are seldom smooth but are almost always diversified with various kinds of elevations, depressions, lines, dots, etc., which are often arranged in complex and very beautiful patterns. These surface markings have received a good deal of attention from microscopists. Some of them present no difficulties of interpretation to the observer, while long and often angry controversies have been held as to the precise nature of others. It would be a difficult matter to compute how much midnight oil, how many hours of patient labor, how many reams of paper and pints of ink have been expended in attempting to settle such questions as whether certain of these surface marks are really to be considered as transparent knobs or as holes?—whether the valve of a certain species is marked by 100,000 fine striations to the inch or only 75,000?—whether the minute dots into which certain of these lines are resolvable are really elevations or depressions? etc. All these seemingly trivial controversies have not been without great practical usefulness, for to them are largely owing the extensive and important improvements that have been effected within the last twenty or thirty years in the construction and use of high power object glasses and the

application of new and elaborate methods of illumination to objects viewed under the microscope.

"TEST" DIATOMS.

Until quite recently certain of these Diatom-valves were in use as the standard tests of the resolving power of high class objectives, and even the introduction of M. Nöbert's ruled bands has not entirely abolished their use for this purpose. Most microscopists still keep stowed away somewhere in their cabinets a pet valve or two which require the use of high powers combined with elaborate illumination and much manipulative skill to "show the lines" in all their glory. But all this minute refinement of detail belongs more to the province of the optician than to that of the naturalist. I need only say here that the surface-marking of the Diatoms are always pretty and often quite elaborate, and that combined with the geometrical outline and symmetry of the valve they render it a most attractive object to the eye. I have here some rough diagrams to illustrate a few of the forms that are most commonly met with, and under the microscope upon the table you will see other forms which will fully bear out the character that I give them.

AUTOMATIC MOTIONS.

Like some others of the lower forms of vegetable life, the Diatoms possess the power of automatic motion, which, until not very long ago, was thought to be an attribute peculiar to the animal kingdom. The motion that they exhibit is of various kinds. In the discoidal and equilateral forms it is a mere languid roll from side to side and progress is made but very slowly. In the elongated forms the frustule advances for a certain length of time in the direction of one of its extremities, then pauses and moves for a similar period in the direction of the other. If we may judge from the quantity of loose debris and floating particles that the Diatom can drag along with it, these motions appear to be exerted with considerable power. If, however, an obstacle be encountered which is too heavy to be pushed aside or carried along with it, the diatom remains pressing against it until its regular period for advancing in that direction has expired and then backs off in the opposite direction. Sometimes the motion consists of a series of intermittent jerks and sometimes it is a steady and equable progression.

BACILLARIA.

One very curious form, *Bacillaria Paradoxa*, which anybody who wishes to examine it can make tolerably sure of finding in Little River marsh, not far from our city, consists of from about ten to twenty long narrow frustules laid one upon another, and, when massed together, suggesting in appearance the slats of a venetian blind. At intervals these frustules slide over and away from each other until they are almost detached and the rectangular mass or battalion is drawn out into a long chain of rods just touching and overlapping each other by the corners and apparently upon the point of pulling apart from each other altogether. This event, however, never happens, for when the limit has been reached the frustules all slide

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back again in the opposite direction, reproducing, first, the original rectangular mass with all its slats piled one above the other, and then the long chain of rods extended the other way. The singularity of these motions has impressed Dr. Carpenter so strongly that he directs special attention to them in a footnote in his work upon "The Microscope." (Op. cit. ch. vi., p242, ed. 1875.)

NAVICULAE.

Another very pretty and very easily procured spectacle can be obt'r'd by placing under the microscope a minute drop of muddy water from almost any of our fresh water ponds or ditches and observing the little *Naviculae* sailing in twos and threes and sometimes in quite numerous fleets through the bays and channels formed by the sand grains and other debris that have been put upon the slide along with them. Sometimes they seem to be running races. At other times they manoeuvre about and run aboard of each other in a way that almost gives one the notion of an old-fashioned naval battle between wooden men-of-war. Different observers hold different theories as to the way in which these curious motions are effected, but the prevailing opinion is that they are caused by the diatom's imbibing some of the water in which it floats through one set of its apertures and discharging it through another set. It must be noticed that these apertures exist in the siliceous shield only, and are closed at the bottom by the external cell-membrane that encloses the endochrome, hence if such an imbibition does take place it must be by endosmosis and have something to do with the process by which the plant obtains its nutrition. The great majority of observers deny the existence of vibratile cilia or any other special organs of locomotion among the *Diatomacae*. In geological distribution the *Diatoms* are found ranging as far backwards as the Chalk Formation, but their first appearance was probably earlier than this. At the present day their distribution in place is simply ubiquitous. Given the presence of a little water and some organic matter and you will find live *Diatoms* almost anywhere. Fresh, salt, and brackish water all have their peculiar and characteristic forms, and there are other forms which seem to inhabit every kind of water. "There is hardly a roadside ditch, water trough or cistern that will not reward a search and furnish specimens of the tribe" (Rev. W. Smith).

COLLECTION OF DIATOMS.

A few hints on collections may not be out of place here. In the course of a ramble in the country your attention may be caught by a thin, lustrous film, floating upon the surface of some pond or ditch, and looking as if a little oil or tar had been spilt there. If you skim this off and examine it you will probably find it composed largely if not altogether of *Diatoms*. Similar films may be seen sometimes upon the surface of the mud, where little pools have been recently dried up, and these if carefully searched and examined will probably yield a similar result. While walking near the sea shore you may notice upon stones, sea weeds or wooden surfaces that have been submerged by the tide, a red-ochrey looking

incrustation something like a film of iron rust. On scraping off and examining this you will probably find a mixture of *Diatoms* and extremely fine sand. The brown streaks that are sometimes seen in sea froth are also worth examination and will rarely disappoint you. Again, in running streams near the shore and in places where the full force of the current is checked a little, you may see long feathery clouds and filaments attached to the submerged stems of larger plants and wavering about with the current. Strip off and examine these and you will probably get *Diatoms* again. After a little experience in *Diatom* hunting you will acquire a certain sense of intuition that will tell you the moment that you look at them which are the likely spots to search for what you want. Like many other sports this one has a pleasing element of uncertainty connected with it. As all *Diatoms* are pretty much alike to the naked eye you never can tell what your gathering consists of until you have taken it home and examined it. It may contain many rare and choice forms or it may be altogether made up after the most familiar and least interesting kinds, but in any case it is likely to contain a number of pretty and interesting things which are not *Diatoms* at all. Hence it follows that you cannot practically study the *Diatoms* without at the same time incidentally learning a good deal about a number of other minute forms of organic life. Some collectors carry along with them a powerful pocket microscope magnifying up to 100 or 200 diameters and "sample" every gathering as they make it, rejecting all that they don't want to keep, but this is more trouble than most amateurs will care to take and does not perhaps save much time after all.

APPARATUS FOR COLLECTING.

The apparatus required for collection is very simple, and I show you one here which I have used a good deal and can "confidently recommend" as being effective while at the same time it is neither costly, complicated nor cumbersome. You require then a water-tight tin box of a convenient size and shape to be carried in your coat pocket and to contain a bottomless tin cup about three inches in diameter and one inch in depth and having a small side handle; also a number of pieces of muslin or very "open-wave" cotton, each big enough to cover the bottom of the cup and allow a slight margin all around it. The lower edge of the cup had better be "wired" so as to give a grip to the elastic band with which you secure your muslin filter to it. When you want to capture a floating film you take your cup and make a bottom for it of one of your muslin rags secured in its place by an elastic band (of which you had better be provided with several, as these are very apt to get lost), then dip out what you want and strain it. If your arm is not long enough you can attach your cup by means of its handle to a walking stick, if this is still too short you can in most rural localities easily extemporize a longer handle from the nearest convenient bush. Films attached to the surface of stones, mud, posts, &c., may be scraped off (taking care to remove as little extraneous matter as possible along with them) and folded

up in one of your muslin filters. A common pocket knife is the most convenient tool for this purpose but a painter's spatula makes much neater work, and I have often wished that I had one that would shut up in its handle so as to be carried in the pocket. When you have got your gathering upon your filter you fold it up as you would a powder in a paper, place it in the bottom of your box and go on to look for another. By placing each gathering immediately above the preceding one you keep them in their proper order and can tell when you take them out again exactly where each of them came from, thus enabling yourself to dispense with attaching any memorandum tag or label. On getting home you take each filter by itself, wash off the deposit in a separate wide mouthed phial, let it settle and examine it at your leisure.

MICROSCOPES.

Very high-priced microscopes are not a necessity for the study. For \$40 or \$50 you can now buy one that will show you all that anybody but a specialist wants to know about the Diatoms and many another curious little form besides. The Industrial Publication Company of New York manufacture and sell an excellent little instrument of this class for \$35.

FOSSIL DIATOMS.

Diatoms are found in the fossil as well as in the recent condition, and any streaks of light-colored earth exposed in a cutting or about the banks or bed of a drained lake or pond are always worth investigating. If, in addition to its peculiar light grey or bluish grey color, the earth is also very light in weight, the probability of its being Diatomaceous is much increased. These fossil Diatom beds represent what were once the basins of lakes, ponds or seas that have been long dried up. Similar beds are now in process of formation at the bottoms of our own lakes and seas, destined perhaps to be uncovered and studied some centuries hence by some future generation of observers. The little flinty shield or skeletons of these plants are very durable and resist most of the usual agents of disintegration which causes the structures of higher organisms to disappear so rapidly after death. Perfect forms are found in guano which have resisted at least two or three digestions and possibly more. The birds get them from the fish, who probably had them from the mollusks, and after all these digestions we still find them well enough preserved to mount for the microscope. Some of these fossil Diatom beds are very extensive. Hooker speaks of a submarine one not less than 400 miles long and 120 broad, situated upon the banks of Victoria Island, in lat. 78 deg. S., and at a depth of 200 to 400 feet. A stratum 18 feet thick underlies the city of Richmond, Va., and extends over an area whose limits are not known. The strata at Bilin in Bohemia, from which the Polier Schiefer or polishing slate is taken in large quantities, to be used as an article of commerce, average 14 feet thick. The "Turkey-stone," used for sharpening edge tools upon, is composed of an aggregation of Diatoms that have been consolidated and altered by heat,

and the large quantities of flinty (siliceous) matter found in the chalk beds are believed to have had a similar origin. As a single cubic inch of Diatomaceous earth contains some millions of individual forms, we can get some faint idea of the enormous powers of multiplication possessed by these humble little plants. Their remains extend over such areas and reach to such depths as to constitute no inconsiderable part of the crust of the globe.

MR. G. F. Matthews' Address.

Dr. Allison has described to you the Diatoms as they appear to the naturalist, and I propose to say a few words about them from an economical point of view and as witnesses to the past history of this region. The deposits in our lakes and ponds are largely made up of one or the other of two kinds of organisms; one consisting of shells of molluscous animals, chiefly water snails; the other of such diatomaceous structures as the doctor has described. To the former class belong the marl beds of Lawlors' or Torryburn Lake, which have been exposed to view and rendered accessible for examination by the draining of that lake—an operation effected many years ago in connexion with the building of the Intercolonial Railway. To the latter class appertains a deposit recently discovered at

FITZGERALD LAKE,

a pond seven or eight miles from St. John in the direction of Lake Lomond. We may hope that the owner of this lake, Mr. Wm. Murdoch, may make it available for scientific study by draining off the water that now conceals the siliceous earth at the bottom. The study of these lake deposits is of some importance, as they are likely to throw light on the former physical condition of this region and to give information concerning the vicissitudes through which it has passed since its land surface emerged from beneath the waters of the Post-pleiocene Sea. By taking the history of the numerous lake basins which are scattered over the surface of the land in this neighborhood (as shown by a study of the deposits they contain), beginning with those of the greatest elevation, and following downward to those at lower levels, a number of independent records may be obtained, which though synchronous in their latter parts are separated in time in their beginning, and thus will supply a successive chronological history of the later changes which the land surface of the country has undergone. The deeper beds of these lake-deposits are of course the older, and are, therefore, of by far the greater interest in their bearing on the physical history of our land. In this connex-

lon Fitzgerald Lake will give a starting point which will ante-date by very many years the beginning of the deposit in the Torryburn Lake, as the former lake stands on the plateau in the

LOCH LOMOND VALLEY

on which are the Loch Lomond Lakes themselves and a number of smaller lakes nearer St. John. This plateau is at an elevation of 300 feet or more above the present sea level, whereas the Torryburn basin is only about 70 feet above this line. At a future time I hope to bring before this Society the result of the study of deposit in the Torryburn Lakes, but now proceed to say a few words about the economical value of diatomaceous deposits generally.

One of the earliest uses to which diatomaceous earth was applied, was that of polishing metals and other hard substances. It has long been known in commerce under the name of

TRIPOLI, OR ROTTEN STONE,

and Dr. Allison has referred you to a number of localities where it has been found in large quantities. In later years various other uses have been found for this article, besides the original one of grinding or polishing. Silicic acid or Silica, occurs largely in nature, in two conditions—mostly as insoluble silica or ordinary quartz, but also as a hydrate. In the latter condition it is easily attacked by strong acids and caustic alkalis and gelatinous compounds and liquids are produced from it which are useful in the arts. By the use of a strong alkali (soda) silicate of soda is produced from this soluble form of silica. This article is imported into Canada from Great Britain and the United States in considerable quantities. It is largely used in the preparation of silicated soap, as an ingredient in certain paints, as an impervious covering for wood, bricks, etc., and as a cement in

MAKING ARTIFICIAL STONE.

Silica, as it occurs in the exuvia, or skeletons of the diatoms, is in this hydrous, or soluble condition, and therefore can be readily availed of in the production of silicate of soda. Various substances are brought into Canada for the purpose of adulterating soap and improving its appearance, among them a white powder, which, in connexion with the subject before us this evening, I have submitted to microscopic examination. It is not of the nature of a diatomaceous earth, as it is composed of angular, glassy particles, not by any means as fine as the diatomaceous material from Fitzgerald Lake and other localities in New Brunswick. It is either ground quartz or glass, and therefore simply an adulterant; and while it would probably have detergent qualities on account of the sharp, angular condition of the particles which go to make up its substance, its harshness would be apt to have an injurious effect upon textile fabrics. It is claimed however that the substance improves the color and appearance of the soap. Silicate of soda, which is also used for increasing the bulk and weight of soap, has not these harsh qualities which are so objectionable in the ground silix or white powder referred to. The diatomaceous earths of

OUR FRESHWATER LAKES

could be made use of for the production of silicate of soda, which is largely used in the manufacture of silicated soaps, as well as for the production of other articles of commerce, referred to in connexion with the description of certain deposits of this earth which exist in the eastern part of King's County. These were found not long since by Mr. R. W. Ellis, (of the Canadian Geological Survey), at Pollet River Lake, in King's County, and in another lake six miles to the southwest of it. These earths are described at page 26, D, of the Report of Progress of the Geographical Survey, for 1878-9; and at page 4, H, Mr. Christian Hoffman, the chemist of the survey, mentions its qualities and uses. It is just such a material as occurs in the Fitzgerald Lake, and contains similar genera of diatoms. The analysis of the Pollet Lake earth gave:—

Silica.....	80.40
Alumina.....	3.15
Ferrie oxide.....	95
Lime.....	34
Magnesia.....	28
Carbonic acid.....	01
Water combined and hygroscopic and organic matter.....	13.32

98.54

As regards the uses of this substance Mr. Hoffman remarks "that it may be said to constitute an

EXCELLENT POLISHING MATERIAL,

and although no experiments have been made to determine its absorbent power, it may reasonably be expected to prove well adapted for the preparation of dynamite. Again, the extreme facility with which it is dissolved by caustic alkalies (potash or soda) would suggest its advantageous employment for the manufacture of what is commonly known as water glass or soluble glass, a preparation which meets with many important applications in the arts, as for instance as a cement for the manufacture of artificial stone; for the hardening and preserving of building stone; in fixing fresco colors by the process of stereochromy; as an addition to soap in the preparation of the so-called silicated soaps," etc. Mr. Murdock states that Fitzgerald lake has a surface area of about seventy acres in extent, and that he has on sounding found the deposits in all parts of the lake. Around the shores it is thin and the hard bottom below can be easily reached by sounding, but at a short distance out from the shore a ten-foot pole finds

NO BOTTOM IN THE DEPOSIT;

hence he infers that the mass has at least this depth, but he does not yet know whether the whole thickness of the deposit in diatomaceous.

The basin of Fitzgerald lake is divided from the valley of Little River, from which the water supply of the city is drawn, only by gravel banks and ridges, which could easily be cut through, and the water which covers the diatomaceous earth drawn off. Were this done a large mass of this useful material, situated within a few miles of Saint John, and easily accessible, could be made available for commercial purposes.