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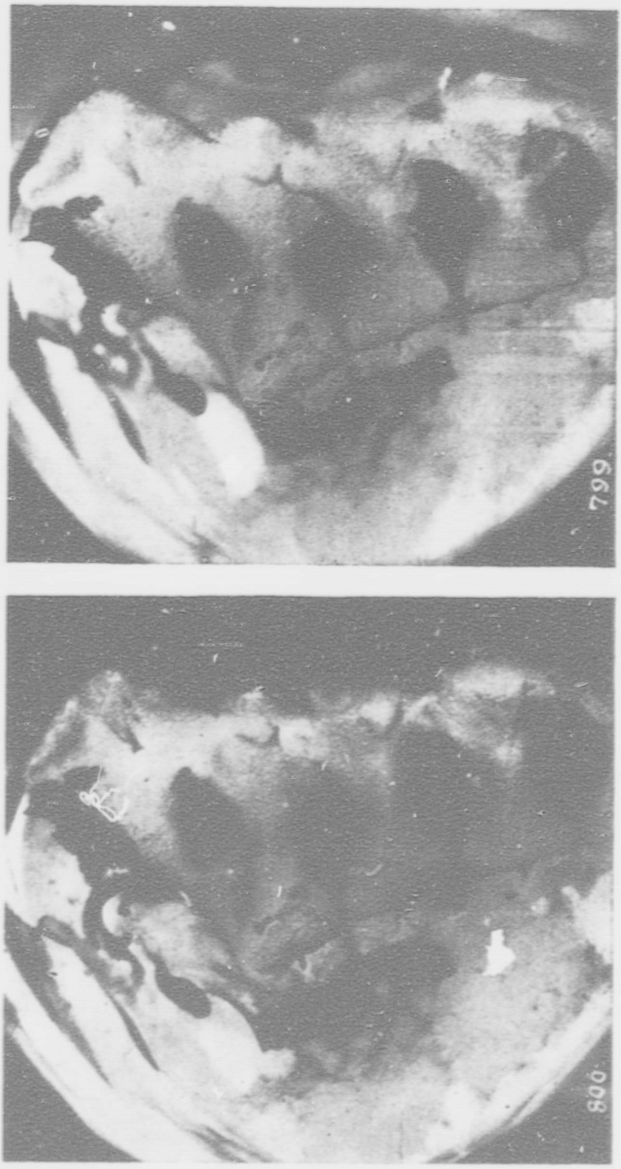

Benthopecten simplex Perrier, inner portion of arm viewed from the side (marginal removed) x 20 dia. mounted under gum. West Indies 1323 fathoms. Specimen from Museum of Comparative Zoology, Cambridge, Mass. To be viewed through a stereoscope.

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THE USE OF GUM DAMAR IN PALEOHISTOLOGY.

(With Notes on the Genus Benthopecten.)

By George H. Hudson, Plattsburgh, N.Y.

In the study of the detail of opaque objects with the simple or compound microscope, there are some very decided advantages to be obtained through covering the object with some transparent medium that may be used to hold a cover glass in position. The writer has long used a solution of gum damar in benzol for this purpose, and whether the mounting was for temporary observation, for drawing under camera lucida or for photomicrographic work, the results were often of surprising value. For instance, he was enabled by this method to obtain a microphotograph which without retouching was used for the production of a figure (1911, plate VI, fig. 1) showing clearly the sutures surrounding the radianal of *Palaeocrinus striatus*, Bill. Billings stated that he could not make out the sutures in this region, and so left it blank in his published analysis. Bather, in Lancaster's "A Treatise on Zoology," Part III, p. 172, gives an analysis that for this region is in error. How great a help this process is in revealing sutures may also be seen by comparing (1911) figures 27 and 28 on page 252. The writer will here give reasons for the character of the results obtained, present other advantages of the method, and give briefly a description of the process as he uses it.

Suppose that we make the attempt to photograph a printed page through a sheet of ground glass placed directly over it. Much of the incident light will be reflected and scattered. Such of these rays as enter the lens will tend to produce a uniform fog over the whole negative. They are from the ground glass surface and not from the covered paper. That portion of the light which reaches the printed surface cannot return without being subjected to both reflection and refraction on account of the many minute angles presented by the ground surface through which it must pass. This tends to give us numerous overlapping images. If now we will wet, oil or varnish the ground surface we shall cut down its reflecting power to a marked degree. The more nearly alike the indices of refraction of the two transparent media the greater will be the amount of light received by the lens from the covered object, and the sharper will be the negative secured.

In the making of photomicrographs of recent or fossil specimens we have to face conditions very similar to those just described. The innumerable elevated microscopic grains on an ordinarily rough surface catch light on their summits and scatter it as do motes in a sunbeam. This light caught on a photographic plate swamps the detail which lies just under these summits. If our specimen is of calcite a thin outer layer is practically transparent, and with the light scattering reduced, we should get some structural detail just under the surface itself. In this way we secured a view of the sutural canals of *Palaeocrinus striatus*, Bill., and their membranous linings in (1911), plate V, fig. 2, while only the canal coverings were visible where the gum was not used, as in fig. 1 of same plate. Compare also figs. 3 and 4 of this plate. In 1913 (*a*) plates 6 and 7, we illustrated the difference in effect secured when this process was used on very recent material. In same reference, in plates 3 and 4, we also showed the value of being able to penetrate thin sheets of calcite adhering to the surface of a mold. Its value in revealing features just underneath the surface was also shown in 1913 (*a*) plate 10. Sometimes we desire just the surface contours or topography,and we may then add to the reflecting points by using the Williams process (holding the specimen in the combining vapors of ammonia and hydrochloric acid). We may thus avoid all stains or detail in colour and get pure form. If, however, we are to do something more than simple species-making, we should desire the detail due to difference in tone or hue. For instance, in the author's work on Blastoidocrinus and Paleocrinus (1911), he found internal organs outlined with black and partially filled, by respiratory and alimentary processes, with mud now yellow with limonite. The contrast between ossicle and decayed soft tissue could have been reproduced almost as pure white and black, or very like the results obtained in 1913 (*a*), plates 7 and 8.

The better to compare these two methods we may suppose that a dweller on the moon desires to photograph the earth. If he could but find the illuminated hemisphere covered with cloud he could eliminate surface stain and get pure but very general form. On the other hand, could he find a hemisphere free from cloud he could get general form plus many differences due to hue and tone. He would have the deeper, truer surface, the detail of mountain and valley, and a very significant difference between sea, mountain top, Sahara and valley of the Amazon.

The ability by means of this process to reduce the amount of reflection from the microscopic facets of granular surfaces

also allows one to quickly view detail on a surface one is grinding down in order to reveal internal structure.

The paleobotanist is well aware that soft parts may be preserved in fossil forms, for he not only recognises different tissues but sometimes individual cells. For him there is a true paleohistology. The paleozoologist, on the other hand, has hitherto been skeptical as to preservation of soft parts in fossil forms. The marvellous finds of Wolcott, his beautifully preserved annelida and delicate medusa-like holthurians—his reproductions of inner organs and discovery of fossil crustacean livers which still show their characteristic microscopic structure on cross section—these things now compel the paleozoologist to also become a believer. Traces of such soft parts should then be looked for, and the gum mounting is peculiarly adapted to reveal them. By this process the author has been enabled (1913 (*b*) plate IX, fig. 1) to show the remains of muscle fibres still adhering to a well-defined muscle field lying between the right hand fifth and sixth marginals of an arm of *Protopaloeaster narrawayi*.

METHOD.

Portions of the crude gum are selected for their clearness and lack of colour, and dissolved in benzol, to form a liquid that will filter easily. The stock solution should be kept in a glass-stoppered bottle, and a very fine bit of wire, or an insect pin, kept between the stopper and neck of bottle. Portions for use should be allowed to evaporate to such a consistency that the fluid will slowly drop from a glass rod. A regular dropping bottle will be found to be a convenient receptacle for the thicker gum.

The specimen to be treated may be attached to a glass slide by means of a few pellets of beeswax. Care should be taken to have the specimen so oriented that when placed on the stage of the microscope it will receive light at the angle which will best emphasize the features to be observed.

A cover glass of appropriate size and shape is then selected and cleaned, the specimen freed from dust, and a drop of benzol placed on it to free the pores or crevices from air. A few drops of gum solution are now added, and a drop also placed on the cover glass, which is then inverted and placed on the specimen. Additional gum may be easily run under the cover glass, and if bubbles are present a slightly inclined position will allow them to pass to one side and escape. Twenty-four hours or more is usually required to so fix the cover glass that it will not creep when placed on a vertical stage.

In case the specimen has a small or convex surface, the cover glass is first placed on a smaller support, such as the screw

cap of a small vial, and the specimen attached to a slide is inverted over it. This slide is supported by a block or bunch of slides at one end, and a weight placed upon it to hold it in position. After making the proper adjustments the slide is removed, specimen and cover glass treated as before, and the specimen then returned to its inverted position. Gum may now be added from time to time until the gummed area is sufficiently large.

Porous specimens, such as colonies of bryozoa, are best treated by slowly lowering them into a very small volume of the thinner gum solution, thus driving out most of the air.

If it is desired subsequently to shift the position or angle of the cover glass, it is only necessary to add a little fresh gum at the edges and slowly push the cover to the new position. Deep Petrie or covered cylindrical glass dishes will be found useful in housing the mounted specimens and keeping them from dust.

To clean: place in benzol until the gum is dissolved. Rinse with a little clear benzol and let dry. The benzol used for dissolving and rinsing may be saved for subsequent operations.

The plate accompanying this article is introduced to show the value of the process where penetration of recent organic material is desired. The remains of muscle fibers here shown are, in appearance, practically as they appear in many fossil forms, when revealed by the gum process. Note that the first (upper) ambulacral (jaw piece) is supported by a process arising from the second. The oral end of each ambulacral is firmly attached to the adambulacral in advance of it. Between the lowest adambulacral in the figure and the ambulacral at the left of it, there is a dark spot revealing a bit of the buried ambulacro-adambulacral muscle. A contraction of this muscle served to draw the following ambulacral orad. The aborad wings on the oral ends of the ambulacra are so shaped as to allow this motion. While the ambulacra themselves are not truly imbricated, the pairs (adambulacral and following ambulacral) are distinctly so placed. The numbers on the lower edge of stereogram are those of the original negatives.

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1913 (*b*).—Hudson, G. H. Does the type of Protopalaeaster narrawayi present an Oral or Aboral Aspect? The OTTAWA NATURALIST, Vol. XXVII (Oct. 1913) plates VIII-IX.

"GLEANINGS IN FERNLAND."

BY FRANK MORRIS, PETERBOROUGH COLLEGIATE.

Readers of the OTTAWA NATURALIST in 1910 who went "Fern-hunting in Ontario" with me, may remember that our treasure-trove amounted to 37 species. In the course of our wanderings, as I seem to remember, we had good store of pleasure, and surprises not a few; the charm of surroundings possessed by the ferns forming a spell of peculiar potency, our sheaf of fronds, in the getting and the gathering, gave us communion with Nature in some of her most enchanting haunts; while in tedding and garnering, these peaceful trophies of ours were still redolent of the woods, and even to-day keep green and fragrant with glad memories of summer days and rambles.

Manifold sights, unseen or unheeded before, taught us to keep eyes open and wits a-stretch for all the observations and reflections we could make. Some of the inferences that we drew might perhaps provoke inquiry; some of our questions never found an answer: moot points, one or two of which have since cleared themselves up; but nothing had happened till quite lately to justify rushing into print. Since last July, however, it has been my good fortune to add no less than six species to our list, and I believe it would be possible for a careful fern-hunter to extend the record to a grand total of 50, without stepping over the border of old Ontario. All, then, who love these most beautiful forms of living foliage, especially in their native haunts of woodland dell and rocky height, are now invited to "follow the gleam" once more, and dream themselves back into summer this Christmas-tide.

One of my first trips for ferns in the neighbourhood of Peterborough was two or three miles south east into Otonabee, my objective being Burnham's wood. The net result of two days' roaming was 15 species of fern: the Oak and the Bracken, the Silvery Spleenwort and the Lady Fern, the Christmas and the Marsh, the Marginal, Crested and Prickly Shield Ferns, the two Bladder Ferns, the two Onocleas, the Adder's Tongue, and the Virginia Grape Fern. A series of tramps west of the city added 10 more to my local check-list of the fern-flora, viz.: Maidenhair, Narrow-leaved Spleenwort and Goldie's Shield Fern, the New York and the Hay-scented, the three Osmundas, and two more Grape-ferns—the Little and the Ternate. This June, in the intervals of a day's trout fishing south of Bethany, I found another station for the Narrow-leaved Spleenwort and its "*fides Achates*," the Goldie's, besides having the exquisite pleasure of

discovering five or six fine clumps (in full bloom) of the Macrae's or Striped Coral Root orchid.

Just before the month ended I paid a flying visit to my old home, 30 miles south of Peterborough. In the few days available I had to choose which of my ancient cronies to gladden my eyes with, and after a tramp north to the ridges, known locally as the "Rocky Mountains," I determined on one long day near Newtonville, in the tamarack swamp with its surrounding fringe of cedars, where ten years ago I made my first rare find among ferns. In order to give some spice of variety to the coming banquet, I chose the new C.P.R. route, which landed me further west by two miles than I had ever been before. Tramping steadily north for a mile, I found myself in full view of the village, and with a very inviting swamp to the east. Shaking the dust of the road from my feet, I swung myself over to the happier side of the fence, and crossing a couple of pastures soon gained the edge of the swamp; distance often lends enchantment, no doubt, but, fortunately, nearness by no means always brings disillusionment; the stretch of swamp had looked promising even from the road, and when I got a nearer view of it, I felt sure the promise spelled fulfilment. Do you know the delightful sense on a field day of being on the verge of mystery, the edge of some discovery, a sense of expectancy like a hush, that sometimes in the shadow of the woods deepens into awe? That feeling came over me now, and I paused a few moments for it to thrill me through, before advancing into the unknown.

All the details of a long eventful morning are fresh in my memory as I write, but space and time forbid more than a summary. I found, in my very incomplete survey of the swamp, hundreds of plants of the Adder's Tongue, and besides the Virginia and Ternate Grape-ferns, I discovered some six stations for the Little Grape-fern and the Matricary; and also (to my huge delight) two colonies of the Narrow-leaved Beech Fern. In the autumn I found another station for this last, north of Colborne, but except for these two finds, I have never seen the plant so near Lake Ontario. In the afternoon I hurried on to the tamarack swamp, intending to make a round of calls and hob-nob an hour or so, but while in the heart of a huckleberry marsh, gathering a posy of *Arethusa* and *Pogonia*, I was overtaken by drenching rain, which threw a wet blanket on all my plans. To get out of the swamp I had to wade over 100 yards through shrubbery almost waist high, and by the time I gained a corduroy road, flanked with Royal Osmunda, and serving (among other things) to cleave in two a most wonderful colony of *Botrychium simplex* —thousands of plants—I was like a drowned rat. Had it been fine, my plan was to go north to the C.N.R. station of Starkville,

for this would have brought me past at least two of my favorite haunts in Fernland: a roadside colony of the Hay-scented Fern, and a series of grassy slopes and low knolls in a willow swamp, on which in the short turf are scores of enormous plants of *Botrychium ramosum* (Matricary Grape-fern). But it was not to be, and this, one of the earliest of my all-day fern-hunts, proved curiously typical of the whole season: a promise of sunshine that ended in rain.

In the first week of July I had to report for duty in Toronto, and mark matriculation papers in the arid waste of a Varsity lecture room, while ever and anon the wizard's wand of imagination transformed the bare space into a leafy grove with ferns and orchids unfurling their crosiers and gay bannerets about my desk. On July 25th, a drudge no more, I hurried down to the Yonge Street wharf, and got the fresh lake breeze from the upper deck of a Niagara boat to blow the dust and grime of city haunts away, clear my head of cobwebs, and sweeten my heart for the reception once more of the fair works of nature.

From headquarters at Queenston village next day, before 5 a.m., I went up to the Heights on foot, and then along the electric railway track towards Niagara Glen. This meant 16 hours—an all-day revel—among woods and thickets near the stupendous gorge, or down in the moist, shady glen, within sight and sound of the rushing cataract. It was a glorious day, and on the New Jersey Tea blossoms by my path I found, among scores of insect visitors, several strange beetles of the *Leptura* and *Strangalia* genera, besides many little chrysomelians busy at their various food plants. The Glen itself is famous for its flora, and I wandered for hours among the giant growth of Goldie's Shield-fern and Narrow-leaved Spleenwort, past huge boulders wreathed with Walking-leaf and crowned with Polypody, or under cliffs studded with the Purple Cliff-brake and Black Spleenwort. Soon after twelve o'clock I left the last fountain and followed the footpath upstream as far as it went; then I made my way on over loose stones and tangled undergrowth to a grove of hemlock and cedar, where I sat down in silent communion with my favorite denizen of this silvan retreat: a tiny colony of the Ebony Spleenwort. This beautiful fern is far from common, the only other colony of my acquaintance being on the north shore of the Upper Rideau, nearly opposite Sand Island.

It was far on in the afternoon when at last I climbed reluctantly out of this fern paradise by the steep flight of wooden stairs. Having absorbed all the beauties of the wayside on my morning's tramp, I had myself flashed back to Brock's Monu-

ment in the electric trolley car, and thus stole a march of over an hour on fleet-foot Time.

From the Monument I walked along a wooded lane on the edge of the Heights till I reached a fine rich open wood, characteristic of the peninsula in the number of chestnut trees among its larger timber,—not *Aesculus*, the Horse Chestnut, but *Castanea*, what in England we term the Spanish Chestnut—characteristic, too, in its rich clumps of Beard Tongue and Oak-leaved Gerardia, both blooming luxuriantly at this latter end of July. The wood was much dryer than our woods further east, and quite open—compact of sunny glades rather than shady groves. Here, to my great delight, I found five or six colonies of a fern till then new to me, the Broad-leaved Beech fern. The living frond is quite distinct in appearance, especially when still young, from that of the Narrow-leaved; exactly where the difference lies is a little difficult to say; sometimes the two are in shape and proportions identical, but as a rule in the Broad-leaved species, the frond is light yellow-green, and smoother, less hirsute. In writing of it five years ago, I was in error when I said it was common near Owen Sound. The Narrow-leaved species is common near Barrie, but the true home of the Broad-leaved is further south, and in south-western Ontario, Welland, Niagara and other districts, it seems to take the place of the Narrow-leaved form. It is recorded from woods near Campbellford, and evidently prefers limestone. In the Algonquin Park, where Huronian and Laurentian granite abound, the Narrow-leaved Beech-fern luxuriates in every moist woodland hollow, and even subsists in dwarfed form on bare crags and the sides of railway cuttings.

The close of July found me established in lodgings at Owen Sound, with a fern press and piles of blotting paper. I had long wanted to visit this famous fern-centre, but till now had never realized my wishes. It is a beautiful neighbourhood, and (to a fern lover) unique in the Province for some of its plants. The city lies in a great hollow delta, flanked on either side by high limestone cliffs that start from Sydenham Falls, a few miles back of the town, and rapidly diverge in the direction of the Sound. The ferns are almost entirely those peculiar to limestone, but within these limitations it is one of the richest localities in North America.

I got there at 1 p.m., and as soon as I had found my quarters and lunched, I hurried out to explore. Making my way west to the nearest flank of limestone, I followed a steep road to the top of the cliff, and looked about. South of me ran another diverging cliff, with signs of an active lime and cement quarry not far off. Making a slight detour round this to a more sequestered part of the cliff, I got my first surprise. In a stony, half-

wooded pasture near the cliff, where limestone strata cropped out of the grass, were several large plants of the Holly Fern! And some of them actually showing signs of having been chewed by that omnivorous ruminant, the domestic cow. You may well imagine what a rude disillusionment and shock it was to me, when I tell you that the only other time I had seen this fern was 3,000 feet up the steep side of lone Ben Lui, in the Perthshire Grampians. It is abundant in the Rockies, and all through this limestone district, from Collingwood west to Tobermory, at the head of the Bruce Peninsula, it fairly runs riot. While slowly moving along at the foot of the cliff, I found in the course of a few hundred yards, plants of Purple Cliff-brake, Slender Cliff-brake, Black Spleenwort, and finally, to grace the triumph, a fine colony of Green Spleenwort. This fern is almost identical with the Black, except that the stalk is brown at the base, and then green from the upper part of the stipe to the tip of the frond. It is abundant on mountain heights in Wales, North England and Scotland, and I have seen it once in Ontario, growing on deeply shaded limestone ledges by the Speed, near Rockwood. Later, I found it growing abundantly on detached limestone boulders in the woods below Sydenham Falls, near the opposite cliff that flanks the east of the city. By this time it was late in the afternoon, and I returned to headquarters.

Next day I went out to Sydenham Falls, and rambled in the wood below, with its rich, swampy hollows filled with Narrow-leaved and Silvery Spleenworts, Goldie's Fern and Maidenhair, and found (along with more Holly Fern) the treasure for which the district is noted, the far-famed Hart's Tongue. This fern is very plentiful in the west of England, and in parts of Somerset and Devon fairly chokes the wayside ditches and hedgerows. But on the American continent it is extremely rare, Woodstock in New Brunswick, Central New York and Tennessee providing the only known stations for it outside of Ontario. It belongs to the talus at the foot of limestone cliffs, or to moist shady situations in limestone districts; at one time it was apparently more generally distributed, and specimens are recorded from Niagara, as well as many widely divergent points of Bruce and Grey counties. Among the ferns of temperate regions, the Hart's Tongue is almost unique in form, the frond being simple and entire—like a long, narrow dock leaf—but the surface, like that of the Holly Fern, is smooth and glossy. Near the Sydenham Falls this rarity proved very abundant, both below the cataract and above, the crevices of the limestone floor throughout the extensive woods being filled with plants of this and the Holly Fern. The growth of the fronds below the falls was very luxuriant, sometimes from 24 to 30 inches. Before

my stay ended I found many other stations for the Hart's Tongue, several miles west of Owen Sound, also on the Rocky Saugeen, near Durham and close to Wiarton. Had this ended my successes I should have been well satisfied. But a delightful surprise was still in store for me. Prof. Macoun's catalogue of 1890 mentions for many of the ferns the name of Mrs. Roy, of Roystone Park, Owen Sound. Among the late Mrs. Roy's recorded finds is the Male Fern, "at the foot of cliffs behind Roystone, and under the same line of cliffs some ten miles up the coast." Finding that Roystone Park was a farm, I called on the tenant, and was directed across hay fields, past the shooting butts, to the cliffs in question. Not five minutes' search—though the record is probably 30 years old—revealed the plant, its identity being all the less questionable because I had so often gathered its fronds in England, Wales and Scotland. But so rare is it in our part of Canada, that I had never seen it at all on this continent, and indeed there is no other station for it known in Ontario. Not only was it abundant at the back of Roystone, but two or three plants were found in sheltered crannies of talus on the adjoining lot. As soon as opportunity served, I made an expedition by buggy up the coast as far as Kemble, and back to the cliffs behind this village. Here the Male Fern was again discovered, both below the cliff and in the woods above, robust, luxuriant and plentiful, occasionally hybridising with its neighbour and congener, the Marginal Shield Fern. But how is one to account for such a limited range in the Province? Two stations about 10 miles apart, with a diameter, the one, of some 50 yards, the other, of perhaps half a mile, in the single county of Grey and nowhere else.

On August the 10th my wife and I had arranged to set up our usual summer tent on Cache Lake, in the Algonquin Park. Shortly before that date I made a trip from Owen Sound to Durham, in the hope of finding *Pellaea densa*, the extremely rare Cliff-brake discovered there by Dr. H. M. Ami some years ago. Unfortunately the date fixed for our trip proved the day of the great gale and rainstorm over Lake Ontario, and the west of the Province. It had already begun to rain when Durham was reached, and conditions grew rapidly worse for the rest of the stay. Bad weather and lack of time combined to make three proposed trips impossible, two from Owen Sound and the third from Utterson, on the way up to the Algonquin Park.

To be continued.

THE CURIOUS EGG OF THE HAGFISH (*MYXINE*).

By PROFESSOR EDWARD E. PRINCE, DOMINION COMMISSIONER OF FISHERIES, OTTAWA.

In classifying fishes, scientific authorities have always placed lowest on the list the hagfishes and lampreys. Indeed, the well-known writer on fishes, William Swainson, in his excellent book, the "Classification of Fishes," London, 1838, goes so far as to claim, regarding the hagfish (*Myxine*), that "all authors agree in placing it near the worms." These fish are, of course, far removed from the worms; but with the exception of the Lancelet (*Branchiostoma* or *Amphioxus*), they are the lowest and most rudimentary of vertebrate animals. The late Dr. Theodore Gill and others concluded that they ought to be separated from the true fishes, and placed in a separate class, owing to their many rudimentary structural features. Thus, they have no paired fins, no scales, no segmented backbone, (the jelly-like notochord persists), no complete skull, no spleen, no pancreas, a very simple brain and nervous system, a peculiar series of gill-pockets instead of typical filamentous gills, and their whole form and structure are in contrast with the true fishes, and higher vertebrates generally. It is still a debated question whether or not, in this peculiar group, the features referred to are original and primitive or degraded and degenerate. In all, the mouth is round and adapted for sucking, not biting. The lamprey attacks fishes, adhering to the outside with its mouth, which it uses like a vacuum sucker, and removes flesh and blood with its rasp-like horny teeth. The hagfish bores its way into fishes, living or dead, and eats out the interior, leaving little more than the skin and bones of its victim. Fishermen find cod and haddock hanging to their hooks which have been destroyed in this way. Moreover, the hagfish has a remarkable device for protecting itself from enemies. The skin is provided with slime glands and pores, which enable it, at will, to pour out a great quantity of tenacious ropy slime, in which it envelops itself. I have seen a specimen, the size of a medium-size eel, fill a bucket with this gummy grey substance, exuded from the slime pores. There are not many species of hagfishes, and they are very local in their occurrence. Thus, *Myxine glutinosa* is well known to abound off St. Abb's Head on the Scottish coast, but is rather rare in other areas. Our Canadian hagfish so closely resembles the British form that both were included in the same species, though our western form is now known as *Myxine limosa*.

Many years ago, when I was the Naturalist at the Scottish Marine Station, St. Andrews, I paid special attention to *Myxine*, for the reason that no one had ever seen a male specimen, and very little was known about its eggs. One egg only was known to scientific men, so far as I am aware, viz., a single specimen in the Bergen Museum, Norway. No doubt it was the study of this unique and valuable specimen which enabled Professor Allen Thomson, of Glasgow, to describe and figure the hagfish's egg in his article "Ovum," in Todd and Bowman's Encyclopædia of Anatomy. I dissected many hundreds of specimens and found plenty of eggs, yellowish brown, very hard to the touch, and about the size of a small bean. Each egg was narrow at the two ends, as Professor Thomson had described, but I never found the bunch of hooks at both apices, which appeared in his description and figure. Carl Claus, in his "Zoology," says that "the deposited egg is recognisable by the filaments attached to both poles, and which probably serve to fix it to sea weeds," while Professor Arthur Thomson, of Aberdeen (Outlines of Zoology, 1892) states that "each has an oval horny case, with knobbed processes at each end. By these they become entangled together." In Dr. Lenn's "Synopsis der Thierkunde," Hanover, 1883, Bd. I., Professor Hubert Ludwig describes the "horny shell as provided at both ends with a long bunch of thread-like hooks." This bunch of threads or filaments is evidently pushed out after the eggs are deposited, for I saw no trace of them in the large number of eggs, many thousands, which I removed from ripe hagfish in Scotland. I may add that I found no males, and this was due to a fact, one of the most astonishing in the whole field of zoology, viz., that only the very small specimens are males, and, as they grow bigger, each changes its sex, and, later in life, produces not sperms but eggs. This sex-transformation, first discovered by Mr. J. T. Cunningham, and by the famous Dr. Nansen, is called "protandry."

It was with very great delight that I found in July last some of these exceedingly rare objects, the ripe eggs of *Myxine*, at the Biological Station, St. Andrews, N.B. Professor Philip Cox, of Fredericton, who was engaged in scientific researches at the station, had placed them in a sea-water tank, under a constant circulation of water, with the hope that they might hatch out. The larval hagfish has never been seen by any zoologist, and a description of it would be of the profoundest scientific interest. After several weeks the eggs died and began to show signs of decay, and before their condition was too advanced I made a study of their external features. In view of my work on *Myxine* in Scotland, I felt a special interest in ex-

amining the structure of these rare specimens. Like the Scottish examples, they were over half an inch in length, oval in shape, and of a whitish yellow colour. The colour is due to the creamy yoke inside the horny shell, for the shell is very transparent, and somewhat thickened at the apices. Each end or apex of the egg rose into a protruding mound, from which projected forty or fifty slender threads, about a fifth of an inch long. At its root each thread was enlarged and outspread, but diminished distally and became slender, until near the free tip, it enlarged again and expanded in the flattened form of a hooked head. They cannot be described simply as "thread-shaped hooks," to use Ludwig's phrase, or as "knobbed processes," according to Professor Thomson's description. They vary so much in shape that hardly two are alike. Most of them may be likened to a bent and half-closed hand, the wrist very slender and the fingers much flattened. Inside each finger tip, a cushion or pad studded with short but very sharp points occurs. Some of the expanded hands or heads possess two fingers only, others have three, but a great many have four, and a few seem to possess five. Usually the fingers are curved over as described, but many are bent in various ways, some turned up, or twisted sideways, just as the fingers of the hand may be variously contorted. The whole of the flattened edge of the "finger tip" may in some cases be studded with minute denticles or teeth; indeed these toothed surfaces are so variously turned that they grasp or cling to anything and everything which comes in contact with them. When once hooked to any object they are as difficult to detach as some of the familiar seeds which cling to one's clothing when walking through the bush. The eggs were entangled with each other when I first examined them, and they could be separated only at the risk of tearing off some of the hooked threads.

These rare and interesting specimens were procured by a Bay of Fundy fisherman, attached to each other, and to the rope or line of a baited trawl set for pollack, between Campbell's Island and the Wolves, New Brunswick, where the depth ranges from 40 to 50 and, in some places, 70 fathoms. The parent fish are said to burrow in the mud or sand at depths of 40 to 300 fathoms, and to protrude the snout only, so that they are rarely procured, excepting when they emerge and swim about in search of prey. As already stated, they bore into hooked cod and haddock, passing eel-like into the abdominal cavity of the fish, or at times they suck in the baited hook set for superior fish, and the hook is swallowed so far down the gullet that the fishermen usually cut off the head of the hagfish, to make them disgorge the hook being practically impossible.

A SUGGESTIVE NOTE AS TO WHAT MIGHT BE BROUGHT TO LIGHT ABOUT THE PADDLEFISH THROUGH DEEP LAKE DREDGING.*

BY ANDREW HALKETT.

One of the most remarkable things in modern biological research concerns what has been brought to light through deep sea dredging. Many new species of fishes, often grotesque in appearance, constructed so as to resist pressure, and many of them furnished with phosphorescent organs enabling them to see in the darkness of the abyss, have through such researches been added to the list. An instance of the kind from our own marine waters relates to the only specimen known of *Raja abyssicola*—a male obtained at a depth to 1,588 fathoms from off the coast of the Queen Charlotte Islands, British Columbia. Upon this fish, in my "Check List of the Fishes of the Dominion of Canada and Newfoundland," I bestowed the vernacular name of Deep Sea Ray; and in a foot note, here quoted from that work, I drew attention to that remarkable find:—

"No ray was ever found at any such a depth as this before. A ray from a depth of 565 fathoms is included in the list of deepsea fishes obtained by the dredgings of the 'Challenger' (Günther), and '*R. mamillidens*', a uniform jet-black species, has been obtained from a depth of 597 fathoms in the Bay of Bengal' (Bridge), but as far as available records show, none have been obtained at a greater depth than some 600 fathoms except this one."

Now, it has occurred to me, for reasons presently to be pointed out, that possibly something concerns the distribution of the Paddlefish ((*Polyodon spathula*), which as yet is unknown. This singular fish still exists in plenty in the Mississippi Valley, and in waters of the southern United States, besides which, at exceedingly rare intervals, it has been found in waters of the Great Lakes system, its records, as again quoted from my "Check List," being these:—

"Exceedingly rare in Canada—the following appearing to be its records: Lake Huron, near Sarnia, Ontario (two specimens); Spanish River, District of Sudbury (one specimen); Lake Helen, Nipigon River (one specimen); Lake Erie (if from the Canadian side of the lake—one specimen): plentiful in the Mississippi valley and southern United States: also recorded from Ohio River (LeSueur, 1817, as *Platirostra eden-*

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tula; and Rafinesque, 1820, as *Acipenser lagenarius*); and from Lake Ontario (Rafinesque, 1820, as *Proceros vittatus*)."

Supplementing its records, a quotation from Dr. Prince, given as a foot note in the Check List, is introduced here:—

"Old fishermen near Point Edward, on the Lambton county shore, vaguely refer to other specimens occurring in Lake Huron."

The form and structure of the paddle-fish determine it to be a species whose habitat is at the bed of the rivers or lakes where ordinarily it occurs. The fusiform body is little compressed. and its long spatulate and somewhat flexible blade, preceding the rest of the head, enables it to scoop among the mud or ooze in the obtaining of its food. It is probably for this reason that it has seldom been found in lakes or rivers tributory to such deep lakes as Lakes Superior and Huron are, and the inference is that it normally remains in the depths; and whilst it is true that individuals of this fish have been found with ripe eggs in Kentucky, in the month of May, and that the paddle-fish was then swimming up stream, so that it has been supposed to spawn in bayous along the river, yet its spawning grounds do not appear to have been located; besides which the fry are entirely unknown, and the young of the paddle-fish, even where it occurs plentifully in the United States, has never been found of a length less than about six inches.

The idea that the paddle-fish normally remains in the depths, or even spawns there, is perhaps strengthened by what is known concerning the structure and habits of its only immediate ally, the fish known as *Psephurus gladius* of great rivers of China, such as the Hoangho and Yang-tse-Kiang. That fish, which is said to attain the great length of twenty feet, has a rostrum of conical shape instead of a spatulate blade like that of the paddle-fish; but this organ also serves the purpose of scooping in the mud; and it may therefore readily be seen how well it is equipped for living at the beds of those great rivers in China, which appear locally to vary in their character from clear and sparkling to turbid and muddy.

This suggestive note claims to be no more than a hypothesis, but the idea seemed to commend itself to Dr. Garman, the ichthyologist of the Cambridge, Mass., University, and to Dr. Hussakof, the palaeontologist of the American Museum of Natural History, New York, to whom I mentioned it; and these gentlemen seemed to share my opinion that there is no saying what deep lake dredging, carried on after the manner of deep sea dredging, which has been so prolific in what it has yielded, might bring to light concerning the paddle-fish which otherwise must remain unknown.

BOOK NOTICE.

A LIST OF CANADIAN MINERAL OCCURENCES. BY R. A. A. JOHNSTON, OTTAWA, 1915, GEOLOGICAL SURVEY OF CANADA.

In view of the great advance of the mineral industry of Canada in recent years, a complete list of its minerals and their localities has been much desired. Such a list now appears among the publications of the Geological Survey, and the compiler, Mr. R. A. A. Johnston, mineralogist of the Geological Survey, is to be congratulated upon the thoroughness of the work.

As is usual in such lists, the work is divided into two parts, the first of which discusses the minerals and indicates the localities where each mineral is found, while the second part contains a list of localities and indicates the minerals to be found in each place.

In view of the rapid development of the country involving changes in the boundaries of districts, it was hardly to be expected that the mineral occurrences should always be listed under the districts as they exist to-day. This difficulty is illustrated by the District of Nipissing, which in recent years has been sub-divided so that portions of the original district are now contained in four districts. In a few instances Mr. Johnston has failed to make the necessary readjustments, particularly in regard to Algoma and Kenora districts. There are some errors as to the chemical composition of minerals, as illustrated by breithauptite, which is an antimonide of nickel rather than of iron.

Unfortunately the localities recorded by Dr. J. J. Bigsby and by Dr. Samuel Robinson have been largely ignored, though some of Bigsby's localities are mentioned. In some cases proper references are given, while in others this has not been done. In the case of beryl from Rainy Lake, the reference is to a Geological Survey Report, but in that publication Dr. Bigsby is given credit for the locality. Interesting omissions are the staurolite on La Croix or Namaycan River, the jasper on Gunflint Lake, celestite from Lake Simcoe, and selenite from Manitoulin Island, which were mentioned by Dr. Bigsby (American Journal of Science, vol. 8, p. 60 et seq.)

In spite of these minor defects, this book is of a character in press work, plan and contents to take its place besides such noted works as Robinson's American Mineral Localities and Dana's Catalogue of American Localities of Minerals.

T. L. WALKER.

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