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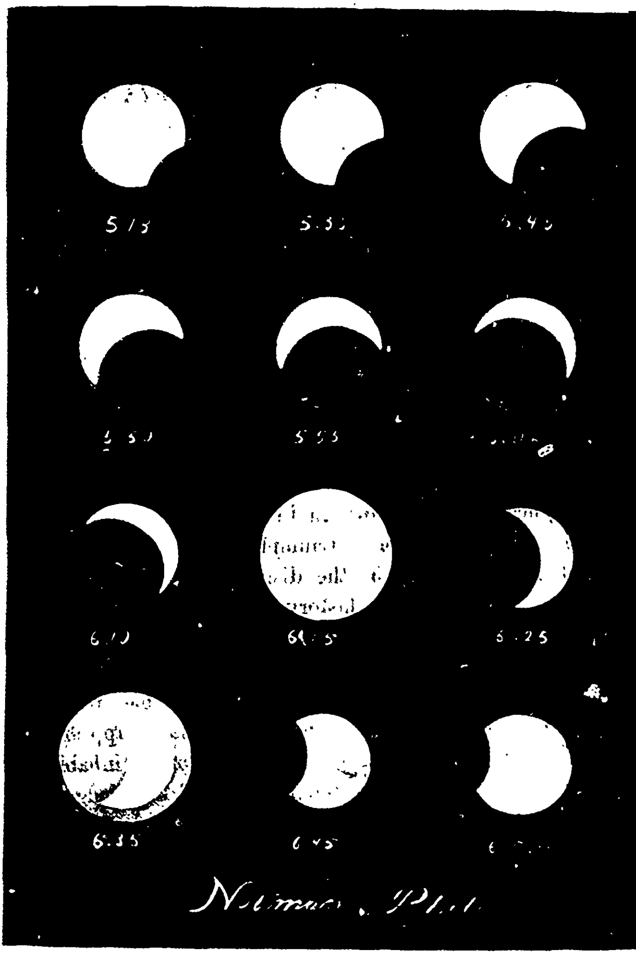
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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

ON THE PARTIAL ECLIPSE OF THE SUN, AUGUST 7TH, 1869.

By C. SMALLWOOD, M.D., LL.D., D.C.L.

The varied and beautiful phenomena presented in an Eclipse of the Sun, form an important era in the life and study of the astronomer. They form a sort of triumph of his science, a winning-post, planted, as it were, in the distant confines of space—a point of time graven on the history of the past—a land-mark placed as a beacon for the future—and a song of praise to Him, whose power and might are so manifest in the "Heavens that declare His glory, and in the moon and stars that He has ordained."

The occurrence of a total eclipse gives rise to appearances which have excited the admiration and wonder of the inhabitants of the earth in all ages; but the increase of knowledge, and a more definite theory of the properties of light, and the various improved and modern appliances of science for the investigation of these phenomena, have shed a bright lustre around these observations of a character at once sublime and of intense interest.

No experiments since the days of Newton, but the discovery by Fraunhofer of the dark lines in the solar spectrum, with the more recent invention of the spectroscope, could have led to those results which the total eclipse of last year, 1868, so fully determined, and which would seem to afford such positive proofs of the composition and nature of those protuberances, which, up to that time, had caused so much speculation among men of science.

We are not aware to what point of investigation these several objects have been brought during the past month by our American scientific brethren, or by the two or three Canadian observers who have been enabled by the liberality of the Dominion Government to witness and record, in a more favorable locality, those interesting phenomena which may justly be deemed physical and astronomical, apart from those which may be termed photographic, which, indeed, are only of a secondary and less important character.

The recent investigations of Huggins and Lockyer on the sun's envelope, show that it is not necessary that an Eclipse should take place for the observation of these peculiar and hitherto mysterious prominences, the spiral form or rotary motion of which remind us of those similar forms of nebulæ, which Lord Ross has so well delineated from actual observation in his six-feet reflector.

As far back as the Eclipse which occurred on the 24th June, 1778, and was observed at sea by the Spanish Admiral Don Antonio Ulloa, these prominences were seen, and by him described as possessing rotary motion.

The observations here recorded were carried out at the Magnetic and Meteorological Observatory at this place, (Montreal,) latitude 45°31' N., and longitude 4 hours 54 m. 17 sec. West of Greenwich, and 182 feet above the mean sea level. Mr. Black kindly consented to act as assistant and time-keeper, an office he very faithfully and vigilantly fulfilled. Mr. Balch, one of the students in Arts, received some instructions, which he carried out at Tadousac, while on a visit to that place.

The Observatory possesses no telescope which could be used with advantage: a 42 in. Dollond, 3 in. aperture, with a power of 40, was the only one which was available. A small comet-seeker, of about the same power, possessing a large field, was also brought into requisition. The screen glasses used in both cases during the whole time were red.

The first contact took place at 5 hours 7 min. 41.5 sec., Montreal mean time. The position at the telescope was taken at 5 o'clock, and my assistant was very exact, and marked well the calls and signals previously fixed upon. There was a slight agitation of the sun's limbs a second or two before the first contact occurred: it seemed as though the edge of the sun became suddenly lighted up as it were with rose-coloured prominences, shooting out coruscations of the same rose-coloured light towards the sun's bright disc, which display instinctively led to the strict observance of the position of the first point of contact. The contrast between the sun's bright disc and these rose-coloured protuberances was very distinct and well marked. The colour (as seen through the red screen) reminded me much of the *Strontian* light in a display of fireworks. These prominences increased, seeming to precede the moon's dark edge as a narrow band during the whole time, and preserving the same distinct rose colour.

The magnitude of the obscuration was 9½ digits, and was on the south side of the sun. The greatest obscuration occurred at 6 hours 6 min. 41 sec. The final contact, which occurred at 6 hours 58 min. 41 sec., was, from its position, hid from view.

Mr. Notman, the photographic artist, made, at my suggestion, (as he kindly did in 1860,) some photographs of these appearances, which are appended to this paper. He likewise exposed a collodion plate to the sun, moving it forward every five minutes, to show the effect of the sunlight on the sensitive surface. A like exposure of sensitive paper was made at the Observatory, with remarkably similar results. A piece of chromotype paper was there also exposed in a similar way, and formed a complete photometer scale, showing the action of the sunlight in the production of photographic effects.

On the Thursday previous, two large dark and prominent spots were observed on the sun, among others less conspicuous, but on Saturday (the day of the Eclipse) only one of these was visible on the N. W. aspect, and the progress of the moon across this spot was hid from view, owing to the passage of a somewhat dense *Cumulus* cloud, which obstructed distinct vision.

No distortion of the cusps was apparent. They appeared at all times sharp and well defined, and no flashes nor coruscations were seen on the moon, which presented the same apparently dark appearance and somewhat serrated edge throughout. The border of the moon before contact could not be observed by the small instruments employed.

Two polariscopes were used, one placed in a position due North and the other South. There was an absence of sky polarization in the one placed South during part of the time of the Eclipse, but that placed North showed the usual appearances. The change in the aspect of surrounding objects, and of the landscape generally, was very apparent, giving to the buildings (mostly of grey lime-stone) a peculiar lurid yellow hue, quite unlike the grey dawn of twilight. The leaves of the maple trees, close to the Observatory, were noticed to droop, and the petals of some flowers (the *Petunia Phœnicœa*) were observed to be partially closed. The effects, if any, on animals, domestic poultry, or birds, were not perceived. This may be owing to the late hour at which the obscuration occurred, being but a short time earlier than the usual hour of retirement.

Table 1.—*Showing the Gaseous and Hygrometric State of the Atmosphere.*

Montreal Mean Time, August 7th, 1869.	Gaseous pressure of the Atmosphere, in inches.	Temperature of the Dew Point.	Elastic force of Aqueous Vapour.	Weight of Vapour.		Degree of Humidity.	Weight, in grains, of a cubic foot of Air.	Remarks.
				In a cubic foot of Air.	Required for Saturation of a cubic foot of Air.			
P.M.								
4*h*. 0*m*.	29.486	59.7	0.524	5.44	3.27	0.624	514.5	
5 "	....	60.5	0 532	5.81	3.23	0.643	514.4	
10 "	....	58.0	0.489	5.31	4.29	0.553	512.7	
15 "	29.545	56.5	0.465	5 06	4.54	0.527	512.8	
20 "	.....	57.2	0.467	5.11	3.62	0.595	514.7	
25 "	....	56.0	0.428	4.68	3.82	0.551	517.0	
30 "	29.566	54.4	0.434	4.77	3.46	0.578	518.0	
35 "	....	57.5	0.481	5 28	2.91	0.640	517.7	
40 "	....	56.5	0.464	5.14	3.02	0.609	517.8	
45 "	29.451	58 0	0.489	5.38	2.62	0.672	518.7	
50 "	.... ..	56.0	0.458	5.03	3.22	0.609	517.8	
55 "	....	55.8	0.456	5.01	3.20	0.607	517.6	
5*h*. 0 "	29.508	55.0	0.442	4.87	3.13	0.609	518 9	
5 "	......	54.6	0.437	4.82	2.94	0.621	519.9	
10 "	....	54.9	0.438	4 83	2.95	0.624	520.0	*First contact,*
15 "	29.463	54.6	0.437	4.82	2.94	0.621	519.9	5*h*. 7*m*. 41.5*s*
20 "	....	55.0	0.414	4.37	3.19	0.598	520.1	
25 "	....	55.2	0.445	4.93	2.60	0.685	521.0	
30 "	29.455	55.2	0.445	4.93	2.60	0.655	521.0	
35 "	....	54.7	0.438	4 82	2.48	0.649	522.1	
40 "	....	54.2	0.431	4.77	2.33	0.651	522.0	
45 "	29.505	54.6	0.442	4.87	2.21	0.690	523.0	
50 "	....	55.1	0.443	4.76	2.42	0.687	522.1	
55 "	....	54.8	0.440	4.88	2.20	0.689	523.0	
6*h*. 0 "	29.500	53.8	0.425	4.72	2.15	0.687	524.2	
5 "	....	53.7	0.424	4.73	2.10	0 700	524.1	
10 "	....	53.6	0.424	4.74	1.93	0.710	527 4	
15 "	29.500	53.8	0.425	4.73	1.92	0.711	525.1	Greatest obs-
20 "	....	54.2	0.431	4.81	1.67	0.724	527.1	curation, 6*h*.
25 "	... .	54.8	0.435	4.86	1.59	0.731	531.4	6*m*. 41*s*.
30 "	29.483	53.7	0.427	4.89	1.51	0.754	534.7	
35 "	....	54.5	0.430	4.86	1.59	0.734	526.9	
40 "	....	54.1	0.434	4.83	1.57	0.741	526.7	
45 "	29.479	53.7	0.431	4.80	1.56	0.751	527.1	
50 "	....	54.5	0.435	4.86	1.59	0.753	526.0	
55 "	....	55.5	0.421	4.70	1.55	0.753	527.1	
7*h*. 0 "	29 455	53 2	0.445	4.99	1.26	0.789	527.4	End of Eclipse 6*h*. 58*m*. 41*s*.

No dew was observ:d appreciable on a prepared paper exposed for that purpose, although a very sensible increase of the moisture in the atmosphere was distiuctly felt.

Ozone was much in excess. The ozonometer, placed at 4 P.M, and removed at 7 P.M., showed a tint corresponding to 3 of the scale, while the usual measure, exposed from 4 P.M. till 7 P.M., showed somewhat less than 2.

The observations of the sky spectrum, by the spectroscope, were not carried out so well as was desirable. The only difference observable was a dulness in the colour of the red ray.

Peltier's Electrometer indicated but a very slight disturbance in the electric state of the atmosphere. The temperature of the air was observed every five minutes, as also the temperature of evaporation. The Barometer was read every fifteen minutes. From these combined observations the gaseous and hygrometric state of the atmosphere have been reduced.—(See Table 1.)

Table 2.—Showing the Height of the Barometer, the Temperature, Solar Radiation, Clouds and Wind.

Montreal Mean Time, August 7th, 1869.	Barometer corrected and reduced to 32° F. in inches.	Temperature of the Air—F.	Intensity of the Sun Rays.	Clouds.			Wind.	
				Name.	Direction.	Extent.	Direction.	Velocity, in miles.
P.M.		°	°					
4*h*. 0*m*.	30.010	74.1	83.6	Cirr. C. Str.	N.E.	4	W.S.W.	Calm.
5 "	......	74.7	....	....	......	....	....	....
10 "	......	76.0	....	....	......	....	....	....
15 "	30.010	76.1	90.5	Cirrus.	N.E.	1	N.E.	1.0
20 "	......	74.0	....	....	......	....	....	....
25 "	......	72.0	....	....	......	....	....	....
30 "	30.000	71.0	85.0	Light Cirri.	N.E.	2	W. by N.	Calm.
35 "	......	70.7	....	....	......	....	....	....
40 "	......	70.9	....	....	......	....	....	....
45 "	29 956	70.2	82.9	Light Cirri.	N.E.	4	W. by N.	Calm.
50 "	......	70.7	....	....	......	....	....	....
55 "	......	70.7	....	....	......	....	....	....
5*h*. 0 "	29.950	70.0	87.7	Cirrus.	N.E.	1	N. E.	1.0
5 "	......	69.0	....	....	......	....	....	....
10 "	......	68.7	....	....	......	....	....	....
15 "	29.904	69.0	81.5	Cirrus.	N.E.	3	N. E.	Calm.
20 "	......	69.1	....	....	......	....	....	....
25 "	......	68.0	....	....	......	....	....	....
30 "	29.900	68.0	71.0	Cum.	N.E.	2	N. E.	Calm.
35 "	......	67.8	....	....	......	....	....	....
40 "	......	67.1	....	....	......	....	....	....
45 "	29.917	66.9	65.6	Cum. Str.	N.E.	2	W. by N.	Calm.
50 "	......	66.9	....	....	......	....	....	....
55 "	......	66.0	....	....	......	....	....	....
6*h*. 0 "	29.925	65.0	65.7	Clear.	......	....	N. E.	Calm.
5 "	......	64.5	....	....	......	....	....	....
10 "	......	64.1	....	....	......	....	....	....
15 "	29.925	64.0	62.0	Clear.	......	....	N. E.	Calm.
20 "	......	63.5	....	....	......	....	....	....
25 "	......	63.0	....	....	......	....	....	....
30 "	29.914	63.9	61.5	Clear.	......	....	N. E.	Calm.
35 "	......	63.0	....	....	......	....	....	....
40 "	......	62.9	....	....	......	....	....	....
45 "	29.911	62.5	....	....	......	....	....	....
50 "	......	63.0	....	....	......	....	....	....
55 "	......	62.1	....	Clear.	......	....	N. E.	Calm.
7*h*. 0 "	29.900	60.2	....	....	......	....	....	....

The intensity of the Sun's rays was also taken every fifteen minutes—see Table 2—which also shows the reading of the Barometer, and the temperature of the air, with the amount of wind and clouds, as bearing more especially on the meteorological effects of the Eclipse.

The wind was from the N. E., and veered occasionally to the W. For the most part it was calm. The clouds moved, during the whole time, from the N. E.

The weather, for some days previous to the 7th, was, for the most part, cloudy, accompanied by showers of rain, with wind from the S. W., and moderate, varying from five to ten miles per hour. Rain fell on the fifth and sixth days.

The Barometer, at 7 A. M. on the fifth day, stood at 29.811 inches; it rose steadily until 7 A. M. on the morning of the eighth day, and then stood at 30.141 inches: at 2 P. M. of the seventh day it stood at 30.034 inches, and at 4 P. M. the reading was 30.010; from fifteen minutes after 4 until 7 P. M. there was a continuous fall; it reached, at that hour, 29.900, and at 9 P. M. it again attained 30.110 inches. This fall of the Barometer accords with the observations made on the partial eclipse of 1860, at the St. Martin's Observatory.

The temperature of the air, at 7 A. M. of the seventh day, was 53°9; at 2 P. M., 75°0, and at 9 P. M., 63°0. These were the usual tri-daily observations. These observations, reduced as a standard, from which the departure in decrease of temperature is reduced, are given in Table 3, which shows the mean daily curve, and the depression caused by the withdrawal of the Solar heat. The Thermometer marked a constant and almost uniform depression (which was, in a slight manner, interrupted by the presence of clouds) from 5 P. M., when it stood at 70°0, and at 7 P. M., when it stood at 60°2, from whence it rose to 63°0 at 9 P. M. The decrease in the intensity of the Sun's rays showed a like uniformity.

The greatest degree of humidity occurred at thirty minutes past 6, or about twenty-four seconds after the greatest obscuration; in like manner the increase of aqueous vapour, and the other hygrometric states of the atmosphere, culminated at or near that time.

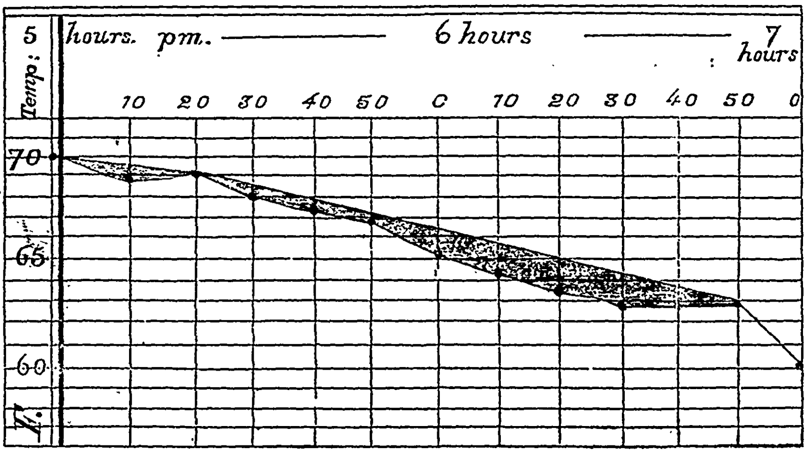
The wind, during the night of the fifth day, and up to noon of the sixth, was from the N. by W.: mean velocity, 8.33 miles; maximum velocity, 13 miles per hour. There were three hours of calm. From noon of the sixth day till noon of the seventh the wind was variable. It was due North, and calm, for forty-six minutes. It then veered by the West to W. N. W. At 9.45 P. M. it was N.N.W., and, from 11 to 12, it attained a velocity of 19 miles: mean velocity, 11.11 miles per hour. There was one hour calm from 12 noon to 1 P. M. At noon on the seventh day the wind veered to the N. by E., and, from that time, to the N. W. and N. E. by N. From 3 to 4 P. M. it was W. by S., 18 miles. During the Eclipse it was variable, from N. E. to W. S. W.; and it continued in that point until 11 P. M., when it veered to N. by W. until daylight. It was calm from 12 to 1; from 1 to 2 also calm; from 2 to 3, 2 miles; from 3 to 4, 18 miles; from 4 to 5, 2 miles, and was calm during the rest of the night.

No flurries or gusts of wind occurred during the eclipse, and no Aurora Borealis was seen.

Observations on the Magnetic Elements were attended to. The experiments on Vibration indicated nothing differing from the usual appearances. The vibrations did not seem at all affected by the Eclipse.

The Declination Magnet indicated a considerable variation in Eastern declination, and this continued increasing up to the seventeenth day. The Inclination Magnet showed a very slight variation in the dip, but one of very small amount.

Table 3.—Curve shewing the mean daily mean range of Temperature, and its departure below, during the partial Eclipse of the Sun, Aug. 7, 1869. —Montreal Observatory.



No stars were visible to the naked eye, and no telescopic search was made, although some of the first magnitude were well placed for observation, as were also some of the planets

From the time of the Eclipse, and for the next succeeding eight days, the weather assumed a warm and genial character, in contrast to the unfavourable state of the previous month, and was a source of welcome and delight to the husbandman who so much required it to enable him to reap and secure a prolific harvest.

In reference to the observations of Mr. Balch, at Tadousac, the weather seems to have been very unfavourable. High wind, with rain and cloudy weather, impeded the view. The amount of Ozone would seem to have been somewhat in excess, and there was considerable variation in the Magnetic declination.

In reference to the twelve photographs made by Mr. Notman, there is an error in time of three minutes compared with Montreal mean time, at the Observatory. Thus for 5h. 18m. read 5 hours 15 minutes, and so on, making a deduction in every case of three minutes from the time noted in the accompanying photographs; in other respects they are a most faithful and reliable delineation of the various phases of the eclipse.

[In the accompanying photographs, the light part represents the sun, the dark projections upon its disk the portion of the moon showing the amount of eclipse at the time marked underneath each.]

MONTREAL OBSERVATORY,
August 20, 1869.

THE PLANTS OF THE WEST COAST OF NEWFOUNDLAND.

BY JOHN BELL, A.M., M D.

During the months of June and July, 1867, I had the pleasure of visiting the west coast of Newfoundland, in company with a party of two or three. The section of coast visited extended from the mouth of the Great Codroy River to the Bay of Islands.

A schooner was chartered at Quebec, and suitably fitted up for the voyage, also to serve as our abode when not camping-out during the expedition. A skiff and a couple of bark canoes for ascending the rivers completed our means of transit; and on the afternoon of the 12th June, *La Providence* set sail, and carried us quietly down past the Falls of Montmorenci and the Island of Orleans. After a sail of three days, with varying breezes, we anchored in Gaspé Basin after meeting large fleets of inward bound vessels and several schools of porpoises, seeing diverse whales spouting in the distance, admiring the scenery on the south shore, feeling a few qualms of sea-sickness and experiencing the other pleasures of a voyage down the Gulf. At Gaspé Basin the services of an excellent canoe-man, well known to tourists and explorers, were secured, and the schooner again headed out, in the direction of the Magdalen Islands. In thirty-six hours we were sailing between the main island of the Magdalen group and Isle Byron, and shortly after, with a stiff S.E. wind and heavy sea, passed the small red-sandstone islands known as the "Bird Rocks," on account of the immense numbers of sea-fowl which continually float like a snow-storm in the air around them, and whiten their tops and craggy sides. The sea now becoming very rough, the captain put back, and, with reefed foresail, lay-to for the following day under the lee of the Magdalen Islands. The next day, however, we came in sight of Cape Ray to the S.E., and in a short time Cape Anguille, spotted with patches of snow, rose above the horizon. Having soon after passed between the high headland of Cape Anguille and the lower level land of Cape St. George, we sailed, with alternate breeze and calm, up the long tapering bay, or rather gulf, of the latter name, which, at its head and along the southern side, receives numerous streams and rivers. The water of the bay was covered with a coating of yellow pollen from the fir-trees, which, being often blown from the flowers in great quantities and washed down by the rain, is popularly believed to be sulphur. Porpoises played around the schooner, and numbers of gulls winged their way over-head, or rested like white specks on the dark blue surface of the water, while the slanting rays of the setting sun, reflected from the painted or iron-stained cliffs of part of the southern shore, added to the beauty of the scene.

A long, low tongue of land runs out at the south side of the head of the Bay, forming an excellent harbour. In the morning of the following day, a fair wind having sprung up, we ran merrily up to anchorage in this harbour; and it being high tide, we, happily, passed over some shoals, where, in our ignorance of the channel, we might otherwise have stranded. On the south side of the harbour, a long stretch of the bank appeared, quite black, which I afterwards found to be a section of one of the peat bogs, so numerous in the island, cut away by the action of the water.

In the evening I landed on the sandy point on which Flat Bay village is situated, and, wandering along the shore, collected the Sea-side Crowfoot (*Ranunculus Cymbalaria*), *Mœhringia lateriflora*, and the delicate *Primula Mistussinica*, growing a little above the waves that rolled in quantities of Eel grass (*Valisneria spiralis*), *Laminaria*, and *Fucus vesiculosus*, in tangled masses on the beach. Among the stunted spruces (*Abies nigra*) and Balsams (*Abies balsamea*), in the middle of the point, the Star-flower (*Trientalis Americana*), Strawberry, a species of Gentian, and the shrubby stems of the Cowberry (*Vaccinium Vitis-Idæ*), found a grateful shelter,—the common blue and sweet white Violets (*Viola cucullata et blanda*) flourishing in the more moist and shaded places; while the Shepherd's-purse (*Capsella bursa-pastoris*), Sorrel (*Rumex acetosella*), Goose-grass (*Polygonum aviculare*), and Lamb's-Quarters (*Chenopodium album*,) found themselves more at home in the gardens and around the houses of the village.

Flat Bay extends in a south-westerly direction, and at its head receives the waters of a brook of the same name, which runs in a N.W. course through the mountains that lie along the south side of St. George's Bay. About ten miles up this brook, Cairn Mountain rises in a cone somewhat higher than its fellows, and is surmounted by a large pile of lichen-covered stones, which were no doubt placed there by Captain Cook as a point from which to take observations during his survey of the neighbouring coasts, and from which the mountain takes its name.

On stepping ashore on the south side of the harbour I observed the Silver-Weed (*Potentilla anserina*), with its bright yellow flower trailing over the gravelly ridge that separated the harbour from a marshy depression inside, in which the Marsh-Marigold (*Caltha palustris*) grew in luxuriant bunches. Here, too, the stately Cinnamon Fern (*Osmunda cinnamomea*) shot its light-brown fertile fronds up through the centre of elegant green vases, and the less ostentatious *Asplenium thelypteroides* spread its delicate foliage around. The Wild Mint (*Mentha Canadensis*) reared its formal spikes of pink flowers in tufts beside the pools, the mud around which, in many places, seemed as if iron-stained from the profusion of the low-lying clammy brown leaves of the Sun-dew (*Drosera rotundifolia*).

The small Cranberry (*Vaccinium oxycoccus*), Dwarf Raspberry (*Rubus triflorus*), and Creeping Snowberry (*Chiogenes hispidula*) wreathed the moss-covered stumps and fallen logs among the clumps of Alder (*Alnus incana*), Labrador Tea (*Ledum latifolium*), Sheep and Pale Laurel (*Kalmia angustifolic et glauca*), in which the little Smilacinas (*S. bifolia et trifolia*) found a quiet retreat, leaving the Polypodiums (*P. Dryopteris et Phegopteris*) and Bunch-berry (*Cornus Canadensis*), to mount guard on the hillocks outside. A striking feature of this place was the great quantity of the Pink Rhodora (*R. Canadensis*), which was now in full bloom, and reminded one of a fine greenhouse display of Azaleas. It was found growing in all the swampy ground on the way up to Cairn Mountain, near the summit of which I obtained a pure white specimen. A species of Willow and Wild Rose grew along the fence of a field, in which the Canadian Burnet (*Sanguisorba Canadensis*), and early Meadow-Rue (*Thalictrum dioicum*) found a suitable *habitat*.

After passing the swampy 'intervale' south of Flat Bay Harbour, the land rose considerably, became much dryer, and produced a different class of plants. The Rowan tree (*Pyrus Americana*), Shad bush (*Amelanchier Canadensis*) and Maples (*Acer rubrum et Spicatum*) with tangles of the Wild Red Raspberry (*Rubus strigosus*, Michx), Great Willow Herb (*Epilobium angustifolium*), and Bracken (*Pteris aquilina*), now appeared. The little Mitrewort (*Mitella nuda*, L.), Clintonia (*C. borealis*, Raf.) and Linnæus' favourite Twin flower (*Linnæa borealis*, Gronov.), were also found. The pathway, leading through a light wood and among Blueberry bushes (*Vaccinium Pennsylvanicum*, Lam.), brought us to the edge of one of those open areas or barrens which form such a peculiar feature in the scenery of Newfoundland. Mr. Comack, in the narrative of his journey across the southern part of the island, describes several which were many miles in extent; but this one was not more than two miles across. Its level surface was almost entirely covered with deep wet sphagnum moss, and relieved only here and there by a stunted spruce, or broken by deep circular ponds of brown water, in some of which I got the Buckbean (*Menyanthes trifoliata*, and around them *Andromeda polifolia*, a small Honeysuckle (*Lonicera*), and the tubular leaves of the Pitcher plant (*Sarracenia purpurea*). The little Cloud-berry (*Rubus chamæmorus*) dotted the cold boggy moss with its large white blossoms, and various sedges tufted the level surface. The dark level bushes of the Sweet Gale (*Myrica Gale*), in places bordered the barren, and in its dryer areas the Black Cowberry (*Empetrum nigrum*) matted its low woody stems together. Small Tamarac trees (*Larix Americana*), and the rank Cow-parsnip (*Heracleum lanatum*), with its large umbels of white flowers, bounded the barren on the opposite side.

From this point the road conducted us over higher land, among bushes of common Juniper (*Juniperus communis*), Ground Hemlock (*Taxus baccata* var. *Canadensis*), and Leather-leaf (*Cassandra calyculata*, Don), to a forest of Fir trees and Paper Birch (*Betula papyracea*), in which the following woodland plants were collected;—the Rosy Twisted Stalk (*Streptopus roseus*, Michx), Nodding Trillium (*T. recurvatum*, Beck), Bane-berry (*Actæa spicata*, L.), Twayblade (*Listera Convallarioides*, Hook), Goldthread (*Coptis trifolia*), Rattlesnake Plantain (*Goodyera pubescens*), Star Lily (*Smilacina stellata*), Wild Sarsaparilla (*Aralia nudicaulis*), common Wood Fern (*Aspidium spinulosum*, Swartz), and on a rocky escarpment, *Woodsia Ilvensis*. The Pigeon Cherry (*Prunus Pennsylvanica*), and Mountain Holly (*Nemopanthes Canadensis*), were met with in the woods just before we reached Flat Bay Brook, which was here bordered by bushes of Green Alder (*Alnus viridis*), Sweet Viburnum (*V. Lantago*), and Maple-leaved Arrowwood (*V. acerifolium*). Nearer the shore ragged bushes of the Shrubby Cinque-foil (*Potentilla fruticosa*,) gave evidence of having been washed by many a spring flood, and the long runners of the Creeping Crowfoot (*Ranunculus*) timidly felt their way over the well-worn shingle, which formed a pleasing background to the glaucous leaves and rose-coloured petals of the *Epilobium latifolium*.

Next morning, having paddled up the brook to where it bends round the base of the mountain, we landed, and after a toilsome climb over its northern spur, reached the summit, from which a magnificent view of the hills and valleys in all directions was obtained. A mountain tarn, calm as a mirror, lay nestling below among the dark green woods of a depression, some hundreds of feet above the river, which wound along in the curving valley beneath, and from the opposite side of which the hills sloped away up to the south-west, verdant with the White Pine (*Pinus Strobus*), and various hard-wood trees. In the ascent from the river, near which a swamp afforded specimens of Meadow Rue (*Thalictrum Cornuti*), Flowering, Interrupted and Sensitive Ferns (*Osmunda regalis O. Claytoniana*. and *Onoclea sensibilis*), we first passed a thicket of Beaked Hazel (*Corylus rostrata*), and Red-berried Elder (*Sambucus pubens*); then up a wooded steep, the trees of which shaded the creeping vines of the Partridge Berry (*Mitchella repens*), and beautiful May-flower, or Trailing Arbutus (*Epigæa repens*), the floral emblem of Nova Scotia. From the edge of the forest, low Red Cedar (*Juniperus Virginiana* Var. *humilis*), and Bearberry bushes (*Arctostaphylos Uva-ursi*), carried vegetation a little further up the rocks, until, at the summit of the ridge referred to, almost the only plants to be obtained were the Bog Bilberry (*Vaccinium uliginosum*), Alpine Azalea (*Loiseleuria procumbens*, Desv.), and Mountain Cinque-foil (*Potentilla tridentata*.) Along the top of the rocks, quantities of crisp Reindeer, Iceland and Hedwig's Hoary Moss (*Cladonia rangiferina*, *Cetraria Islandica* and *Hedwigia ciliata*) crunched beneath the feet, while budding tufts of the graceful Harebell (*Campanula rotundifolia*), waved from the fissures in the cliffs below. A solitary bunch of the pretty Fragrant Fern (*Aspidium fragrans*, Swartz) was procured from the cleft of a shaded rock on the north side of the mountain, near its summit.

At a bend in the river below the mountain, I observed the broad leaves of the Pond Lily (*Nuphar advena*) floating on the surface of the deep quiet pool, overshadowed by the spreading branches of a Black Birch (*Betula lenta*.) Several miles above this, the Butterwort (*Pinguicula vulgaris*), dotted the cracks in the damp rocks along the shore, and on the moist banks I gathered the Enchanter's Nightshade (*Circæa alpina*), with its pellucid stems, the Twisted-stalk (*Streptopus amplexifolius*), Blue-eyed Grass (*Sisyrinchium Bermudiana*), Purple Avens (*Geum rivale*), and the *Potentilla Norvegica*, which in the woods always looks as if it had strayed from some more civilized regions. The thicket beyond was bordered by

Alternate-leaved Cornel bushes (*Cornus alternifolia*) and brushwood, over which the fetid Currant (*Ribes prostratum*) and Bramble (*Rubus villosus*) climbed in an impenetrable tangle.

Returning from Cairn Mountain to the harbour, the party passed over nearly the same ground as in going, and collected several species which had not been noticed on the way up. In an upland wood, several Yellow Birch trees (*Betula excelsa*) were observed, and over the rich shaded ground, beneath them, the Round-leaved and Lesser Pyrolas (*P. rotundifolia, et minor*), and the waxen white Indian Pipe (*Monotropa uniflora*), bashfully hung down their snowy blossoms. The Ground-Pine (*Lycopodium dendroideum*) and other species of Club Mosses (*L. lucidulum, S. clavatum, complanatum* and *alpinum*,) sent up evergreen tufts among the rustling leaves. The Petioled Willow (*Salix petiolaris*), the Pearlwort (*Sagina procumbens*), and, strange to say, the common Groundsel (*Senecio vulgaris*), in flower, were discovered on the sloping sandy shore of Flat Bay Brook. In one part of its course, the toilsome path led through a wet sedgy bog of Sphagnum, whose uneven surface here and there bore waving tufts of Cotton grass (*Eriophorum vaginatum, Virginicum et polystachyon*), angular bushes of the Dwarf and Alpine Birch, and white flowering branches of the neat little Chokeberry (*Pyrus arbutifolia.*) A few scapes of Arethusa (*A bulbosa*), which needs no foliage to "set off" its large rose-purple and sweet-scented flowers, stood alone among the bluish-green moss of the barren.

Another ramble along the Bay shore secured for me the Sea Sandwort (*Arenaria peploides*), and Lungwort (*Mertensia maritima*), the Sea Rocket (*Cakile Americana*), and the Glasswort (*Salicornia herbacea.*)

Beyond the spring-tide mark the Beach Pea (*Lathyrus maritimus*), and Orache (*Atriplex hastata*), spread themselves over the sand, while a large and small variety of the Blue Flag (*Iris versicolor*), alike in every particular, except size, mingled together in luxuriant bunches.

A large variety (?) of the Sea-side Plantain (*P. maritima*), with broad leaves and long tapering root, was found near the extremity of Flat Bay Point.

We sailed on the 4th July to the low gravelly Isthmus separating Port-à-Port from St. George's Bay. Eastward from this place, a high gravelly bank rises above the sea shore. On the oozy spots of this bank, the Yellow Mountain Saxafrage (*Saxafraga aizoides*) lay matted together in heavy masses, where also grew straggling bushes of the Shepherdia (*S. Canadensis*), whose rusty scales were noticed in the last number of this journal. The Yellow Evening-Primrose (*Œnothera biennis*) took a firm hold in the loose gravelly slopes, bordered above by the Low Bush Willow (*Salix humilis*). Among the grass, on the top and shelves, grew the Pasture Thistle (*Cirsium pumilum*), Pearly Everlasting (*Antennaria margaritacea*), Yellow Rattle (*Rhinanthus Crista-galli*), Mouse-ear Chickweed (*Cerastium viscosum*), Yarrow (*Achillea millefolium*), and in the moister places the Northern Green Orchis (*Platanthera hyperborea*) and *Epilobium coloratum*, besides many others whose names have been already mentioned The variety *juncides*, of *Plantago maritima*, the Birds-eye Primrose (*Primula farinosa*), and the delicate *Carex aurea* of Nuttall, grew from crevices in the rocks, occasionally wet by the salt spray from the breakers. The rich fronds of *Aspidium aculeatum*, variety *Braunii*, were collected in a wood immediately above the 'Gravel' or Isthmus, where I found the common English Garden Snail (*Helix hortensis*), which, from having been found extensively in Gaspé and in the islands of the St. Lawrence by Prof. Bell in 1858, I judge to be indigenous here, and in those parts of Canada bordering the Gulf.

During the night the schooner sailed across the mouth of the harbour, and next morning we found ourselves passing by Cape Anguille, *en route* to Cod Roy Island. The shore all along was apparently formed of red sandstone, on edges sloping at a very high angle, and indented with large clefts and chasms. The waves washed the bases of the rocks, which were fringed above with graceful shrubbery, and the dark green mountains, dotted with the light foliage of the deciduous-leaved trees, rose gradually to their heathy summits, which were divided from one another by deep and winding valleys which lodge huge masses of almost perpetual snow, and give rise to streams that wear away the gullies and dash in foaming torrents to the sea. As the sea-breeze blew over the land, the moisture in the air became condensed by the cold of the mountain tops, and soon formed clouds which hid the summits from our view.

NOTES ON TADOUSAC PLANTS.

By A. T. Drummond, B.A., L.L.B.

The hilly environs of Tadousac, and its position on the high northern coasts of the Lower St. Lawrence, along which sweeps the cold current which flows through the Straits of Belle Isle, are very favourable to the existence of a boreal flora. The hills on either side of the Saguenay here vary in elevation, but in some cases rise to heights of about one thousand feet. Their summits were some years since almost denuded of vegetation by destructive fires. Standing upon the top of the highest hill in the rear of Tadousac, and looking northwards, the nearly treeless surface of the Laurentian rocks extending, hill beyond hill, as far as the eye can reach, convey an idea of the desolation caused by the ravages of the fires. Still, even here, the botanist is delighted to find a few semi-alpine and boreal forms. The rocks are beautifully time-stained by *Buellia geographica*, Schaer, and *Parmelia centrifuga*, Ach.; by *P. stygia*, Ach., and *P. Fahlunensis*, Ach., the yellow hues of the former two presenting a striking contrast to the black appearance of the latter. Other boreal, but less conspicuous Lichens here, are *Cetraria pinastri*, Sommerf. a beautiful species sometimes found in a dwarfed condition in milder localities in Canada, *Peltigera malacea*, Ach. and *Stereocaulon paschale*, Laur.

On the bared surface of the gneiss are the blackish leathery Tripe de Roche (*Umbilicaria hyperborea*, Hoffm., *U. erosa*, Hoffm. and *U. Muhlenbergii* Ach.,) which, from the exposure to the rays of the sun, are very brittle to the touch. Among the higher forms of plant life here, as well as in the mossy depressions of the rocks near the sea shore, the Crowberry, (*Empetrum nigrum*, Linn.,) and the Cowberry, (*Vaccinium Vitis-Idææ*, Linn.,) thrive in great abundance. On the precipitous sides of these hills, and in the deep gorges between, the little Scrub Pine (*Pinus Banksiana*, Lambert.) is sometimes met with, but the prominent feature which fixes the attention of the rambler on these and other hills of the Saguenay district, is the vast abundance of bunchberries and blueberries. The latter, during August, form an important item in the exports from the river.

At a considerable distance above the level of the sea, and hemmed in on all sides by the Laurentian hills, is a charming little sheet of water, known as Tadousac Lake. Here occurs a number of very interesting aquatic and other plants. Near the beach, rearing their flowers above the surrounding water, are the water lobelia, *Lobelia Dortmanna*, Linn., the bog rush, *Juncus Canadensis*, Gay, Water Milfoil, *Myriophyllum tenellum*, Bigelow, and the little *Eriocaulon septangulare*, Withering, all of them plants of Eastern range. *Nephroma arcticum*, Fr., and *Sticta scrobiculata*, Ach., spread themselves on the neighbouring rocks, and long delicate trails of *Usnea longissima*, Ach., and *Bryopogon jubatus* Fr. var. *setacea*, Ach.

When strolling among the rocks on the shore at Cap Rouge, at the entrance of the Saguenay, the botanist meets with the Hemlock Parsley, *Conioselinum Canadense*, Torr and Gray, the sea side Plantain, *Plantago Maritima*, Linn., squirrel tail grass *Hordeum jubatum*, Linn., Tripe de Roche, *Umbilicaria hirsuta*, Ach., and *Stereocaulon Corallinum*, Fr.; and in his rambles to the different surrounding places of interest, in addition to numerous other forms, the equally familiar denizens of the forests and hills of more southern portions of the Dominion, he sometimes lights upon *Carex Houghtonii*, *Sphagnum acutifolium*, Ehrh., *Polytrichum piliferum*, Schreb., *P. juniperinum*, Hedw., *Bartramia fontana*, Brid., and *Mnium punctatum*, Hedw.

ON HYPONOME SARSI, A RECENT CYSTIDEAN.

By S. LOVEN.

(Reprinted from the "Annals and Magazine of Natural History," September, 1869.)

The general appearance of this very remarkable Echinoderm is that of a small starfish or a Euryalid. It has a disk, convex on the ventral surface, flattened on the dorsal, and five short and broad rays; each of these is divided into two short dichotomous branches, terminating in four very short rounded lobes. As in the recent genera *Antedon* and *Pentacrinus*, a large, conical, proboscis-like funnel rises in one of the interradial spaces of the ventral surface of the disk; and from a point situated a little before the centre of the same surface five narrow channels, protected by marginal scales, radiate and defurcating thrice, run out on the rays and their branches, giving off short branchlets to certain sacculate protuberances placed at regular distances. No pinnulæ. On the protuberances and on the rays the channels are open; but upon the disk, between their first bifurcation and their common starting-point, their marginal scales close over them, forming a vault, so that the five channels are converted into covered ducts, converging into a common subcentral aperture, concealed beneath the integument, and not visible from the outside. In the covered parts of the channels I found masses, consisting of miscroscopic Crustacea, larval bivalves, and other remains of the food of the animal, apparently taken through the ends and open parts of the channels, and on its way, through their covered parts, to the concealed mouth. On the rays, near their tips, are seen some few pores, perhaps indicating the existence of retractile organs. The ventral surface is clothed with rather small, thick-set, irregular whitish scales, among which, in certain places, some six or seven larger ones are seen forming a rosette. Between the rays and their bifurcations this scaly covering of the ventral surface extends back pn to the dorsal surface, ending there with great regularity in triangular spaces pointing to the centre of the disk. The remainder of the dorsal surface of the disk end the rays, which, by this arrangement, assumes the form of a regular star with five broad dichotomous rays, is clothed with a soft and smooth brownish skin. There is no trace of a calyx. In the centre of the even dorsal face of the disk is seen a somewhat pentagonal space studded with minute pores.

To have the channels on the disk converted into tunnel-like passages leading to a mouth concealed beneath the integument is a peculiarity hitherto not observed in any recent Crinoid; but it is, as shown by Professor Huxley and Mr. Billings, a characteristic of the palæozoic Crinoids and Cystideans. The absence of any indication of a calyx at once excludes *Hyponome* from the former. Among the Cystideans it recalls the genus *Agelacrinites*, of Vanuxem, by the depressed form of the body, the scaly covering, and the flatness of the dorsal surface, devoid of anything like a stem or peduncle, as also by the absence of pectinated rhombs and of pinnulæ. Branchlets running from the channels to sacculate protuberances are found also in the genus *Glyptocystites* of

Billings and *Glyptosphærites* of Johannes Müller; and bifurcations of the channels are met with in *Sphærocystites* and *Callocystites* of Hall. Lastly, the genus *Hyponome* shares with the surviving type of the Crinoidea the radiated form of the body and the simply conical unprotected funnel. The specimen described is from Cape York, Torres Strait.

Dr. Lutken has sent us the following note on the above:—

Hyponome Sarsi, a recent Australian Echinoderm, closely allied to the palæozoic *Cystidea*, described by Professor LOVÉN, with some remarks on the mouth and anus in the *Crinoidea* and *Cystidea*, as a reply to the note of Mr. BILLINGS, in the December number for 1868; by Dr. LUTKEN, of Copenhagen.

Certainly I was not, as Mr. Billings believes, "mistaken" in stating that, before the appearance of Professor Loven's paper on *Leskia*, it was merely "a hypothetical supposition," that the "pyramid" in *Cystidea* was the mouth. I have allowed that this theory has been *very ingeniously advocated* by Mr. Billings, but I cannot allow that it was ever proved "according to the ordinary rules of comparative anatomy,"—the less so, as Mr. Billings himself confesses its being at variance with that capital fact in comparative anatomy, that in all other Echinoderms the mouth is situated in the very centre of the ambulacral system. This fact cannot be invalidated by the analogy furnished by the *supposed* combination of mouth and vent in palæozoic Crinoids. This supposition still remains to be proved, or rather it is, as I think I shall be able to point out, completely *disproved*. It is unnatural, as I have shown elsewhere years ago. We have instances enough of the mouth becoming a vent, but none of the vent becoming the mouth; and that would be the case if the proboscis (the anal tube) of recent Crinoids were also the mouth of the palæozoic. But we now know well where the mouth lies in these old sea lilies, and Mr. Billings has himself first shown the way that leads towards its discovery; but of this more afterwards. The first *apparently* (but only apparently, I believe) true analogy from recent nature, brought forward to corroborate the view of the *oral* character of the "pyramid" in Cystidea, is really that of *Leskia*. I therefore regret that I cannot recall my expressions as incorrect, though I am sorry that Mr. Billings (whose labours in this field I, of course, highly value and admire) should have thought them improperly used. I may add, that I do not conceive how "a simple inspection" can decide on the interpretation of facts, that can only be well understood through inference from analogy. "Reasoning" is here indispensable, and the only logical one is that which starts from a clear perception of the morphology, evolution, and comparative anatomy of the nearest *recent* representatives of the extinct types.

As bearing highly on the present question, I shall lay before the reader of the "Canadian Naturalist and Geologist" a translation of Professor Lovén's description of his newly-discovered recent remarkable representative of the palæozoic *Agelacrini* and *Cystidea*.

"Professor Lovén laid before the zoological section of the Scandinavian Association of Naturalists, at Christiania, in 1868, the figures of an Echinoderm hitherto unknown, viz., *Hyponome Sarsi*, Lovén,* and explained shortly its structure. Exteriorly it resembles an Asterid, with five short and thick dichotomously branching arms, but in other respects it differs from all other recent Echinoderms hitherto known; while in its most essential parts it agrees with the *Cystidea*, which were hitherto regarded as extinct during the palæozoic epoch. Among these it most nearly approaches, through the want of a stem and other characters, to *Agelacrinites* (Vanuxem), and in other respects to *Glyptocystites* (Billings.) As in *Antedon* and *Pentacrinus*, a conical proboscis arises from one of the interradial areas of the ventral surface. The ambulacral furrows, which distally branch dichotomously, also give off short branches to several small club-like swellings of the perisome. These parts of the furrows (the distal extremities and the branches) are open; *but in the ventral disk itself, in the vicinity of the point where they meet, the limiting plates are seen to unite so densely from both sides as to form a vault, converting the furrows into covered-up galleries, which open into the visceral cavity through a common orifice, situated near the centre, but invisible exteriorly.* Small heaps of microscopical Crustacea and other marine animalculæ found in these galleries, intimate that the food is picked up in the open parts of the furrows, and, through these means, conveyed to the hidden mouth. The covering of the ventral surface consists of

* At the risk of some slight repetition we give both Dr. Lovén and Dr. Lutken's description of this interesting addition to our knowledge of the Echinodermata.

small irregular calcareous plates and is continued between the arms, and there branches towards the dorsal surface, where it ends with a triangular limitation. The rest of the dorsal surface is covered with a smooth skin of a darker colour, and has in its centre a roundish spot, with many small pores."

Owing to the specimen described being unique, no account of the anatomy of this remarkable animal is yet given, and its bearing on the obscure and disputed points in the morphology of Echinodermata generally, and Cystidea especially, cannot be fully made out, though we may expect valuable suggestions from the pen of the distinguished author. Nevertheless, the evidence given by this astonishing discovery is clearly—

1. That the "proboscis" in palæozoic *Crinoidea* (and, I conclude, by analogy, that the valvulate "pyramid" in *Cystidea, Caryocrinus, Agelacrinus*, etc.,) is, as in recent *Pentacrini, Antedon, Rhizocrinus*, only an *anal* tube, as maintained by Prof. Wyville Thompson and myself, and has nothing to do with the mouth.

2. That the mouth can, where it *apparently* fails altogether, as in most palæozoic Crinoids, though present, be completely concealed through the converting of the ambulacral furrows into vaulted galleries. This will give the clue to the understanding of the true character of many palæozoic Crinoids. We now understand that these subteguminal galleries described by Mr. Billings, and by a contributor to the "Geological Magazine," did not only contain the continuation of the "water-vessels," but are the very ambulacral furrows of Crinoids, Asterids, etc., closed up and converted into vaulted corridors.

This correct theory of the mouth and anus of palœozoic Crinoids was, however, as I now learn, given already by Dr. Schultze, of Bonn, in the introduction to his excellent monograph of the Echinoderms of the Eifel limestone, published by the Imperial Academy of Vienna, and bearing the date of 1866. As this book is indispensable to all engaged in the study of palæozoic Echinodermata, it will not be necessary to give here an extract of his arguments. Happily, this controversy will now be at an end, but the details of the question may yet have to be worked up in many extinct types.

NOTE.—In my former paper on *Leskia*, reprinted in this magazine, several "errata" have crept in, obscuring the meaning in several instances. I will here only state that "clausur" means "clausus,"—quinqueralis" "quinquevalvis,"—"lissit" "lis sit," etc.

With the highest respect for Dr. Lutken, I do not entirely agree with him. I think that the rule on which he relies can only be accepted as having the value of an ordinary generalization, to which an exception may any day start up. The mouth in all the *known* species of existing Echinoderms, and also in a vast number of the extinct forms, does, unquestionably, lie in the very centre of the ambulacral system. But it does not inevitably follow, from this fact, that all Echinoderms, whether known, unknown, recent or extinct, must have it in precisely the same relative position. In proof of this we have only to refer to the instance of *Hyponome Sarsi.* A few months ago we could, with equal confidence, have declared it to be a general rule that "*no existing species of the Echinodermata has the mouth internal.*" If such a rule had been laid down by any one there would have been no way of disproving it by mere "inference" or "reasoning." Nothing but the production of a specimen in which it could be actually seen that the mouth was internal could be sufficient. Such a specimen has now been produced by Prof. Lovén. By his truly wonderful discovery the non-universality of the rule has been demonstrated by "simple inspection," or more properly speaking, "by actual observation." I believe that the function of the so-called "pyramid," of the *Cystidea,* can be determined by this latter method of proof. It is evident that the process of reasoning relied upon by Dr. Lutken, and by several others, all of them naturalists whose works I highly appreciate, is not perfectly conclusive.

E. BILLINGS.

ON SOME RESULTS OBTAINED BY DREDGING IN GASPÉ, AND OFF MURRAY BAY.

By J. F. WHITEAVES.

During the past summer dredging operations have been carried on in Gaspé Bay and other localities in the Lower St. Lawrence by Principal Dawson and myself.

My own investigations were confined to Gaspé Bay, on both sides, from Little Gaspé and Douglastown to Ship Head, and from the latter place to the village of Cap Rosier.

Principal Dawson dredged at two or three localities in Gaspé Bay, also in the River St. Lawrence opposite Murray Bay, at which latter place curious and somewhat unexpected results were obtained. The greatest depth at which the dredge was successfully used, was a little over 50 fathoms. A large number of marine invertebrata were procured, of which it is proposed to give a general and preliminary account, as at present the species have not been sufficiently studied to enable an accurate detailed description of them to be given. In the division Protozoa a number of species of Foraminifera and of sponges were procured. Of the Foraminifera upwards of forty species, and varietal forms, known to inhabit the Gulf of St. Lawrence, are in Dr. Dawson's M.S. lists, of many of which examples were taken. Of these *Truncatulina lobulata* was by far the most abundant, and *Miliolina seminulum* and *Lituola Canariensis* most conspicuous from their large size. Among the other species recognized are *Lagena vulgaris*, *Entosolenia globosa*, *costata*, and *squamosa*, *Polystomella crispa*, *Rotalia Beccarii*, *Polymorphina lactea*, and *Nonionina scapha*. Almost nothing is known with any certainty respecting the Canadian marine sponges, but if the external form is any criterion, it is probable that we have at least as many as from six to eight species in our waters. One curious form occurred,—a small species between two and three inches high, with a root of radiating siliceous fibres. Specimens of most of these are in the hands of Dr. Bowerbank, of the British Museum, for examination. Many fine hydroid polyps were procured, but these are at present undetermined. No example of a true coral has as yet been taken in the Canadian area, in our seas they seem to be represented by Polyzoans with stony cells, such as Myriozoum subgracile and species of Eschara. Alcyonium rubiforme was frequent; it is one of the nearest Canadian allies to the true corals, and our two common sea Anemones, *Metridium marginatum*, and *Actinia (Urticaria) crassicornis* were obtained in abundance. The latter is certainly identical with the European species, and presents the same series of varieties.

Among the Echinoderms a large sea cucumber new to our fauna, was taken, but no other species of special interest except Sars' brittle star, which occurs not unfrequently in Gaspé Bay. Many species of marine worms and crustacea were observed.

Wood bored by a species of Limnoria (?) was dredged off St. George's cove, and a large parasite isopod crustacean was found attached to cod-fishes. Special attention was paid to the smaller crustacea, of which about twelve species were taken. Among these were four species of shrimp, which appear to be *Crangon vulgaris*, (the common English shrimp,) and another species, also *Hippolyte Fabricii* and *Gaimardii*. In addition to these, specimens of *Gammarus locusta*, *Alauna Goodsiri*, and *Caprella septentrionalis* were collected; also several undetermined Amphipods, and two species of Entomostraca, one of which is probably the *Cypridina excisa* of Stimpson. Fine examples of many species of Polyzoa and tunicates were dredged; these are in the hands of Principal Dawson for study and determination. Among the latter *Didemnium roseum*, *Boltenia Bolteni*, and two species of *Cynthia* have been recognized. In a previous paper published in this journal (vol. 4 p.p. 48–57), a list was given of all the marine mollusca then known to inhabit Lower Canada.

In addition to the 103 species there enumerated, the following have since been met with:—

Macoma inflata, Stimpson. Gaspé Bay.

Cochlodesma Leanum, Con. Near Douglastown. This is the most northerly locality yet recorded for this species.

Thracia Conradi, Couthuoy. Near Grande Grève.

Teredo dilatata ? Stimps. Gaspé Bay.

Philine lineolata, Couth. Gaspé Bay. Principal Dawson.

Utriculus ——?

Diaphana debilis? Gould.

Margarita argentata? Gould.

Rissoa, an additional strongly marked species, at present undetermined.

Mamma immaculata, Totten. Gaspé Bay.

" nana, Moller. " "

Amaura candida, Moller. " "

Bela. Two additional species, undetermined.

Besides these 14 additional species, the following new localities were observed for scarce shells:

Leda minuta, Mull. Plentiful off Cap Rosier village.

Crenella pectinula, Gould. Off Grande Grève.

Astarte lactea, Brod and Sow. Alive, between Ship Head and Cape Bon Ami, four miles from shore. This is the shell catalogued in my list as A. borealis, Chemn, on Mr. J. G. Jeffreys' authority.

Tellina (Angulus) tenera, Say. Off Douglastown.

Amicula Emersonii, Couth. A living specimen of this species more than an inch long was taken by Principal Dawson off Murray Bay.

Molleria costulata, Moll., sp. Frequent in Gaspé Bay.

Rissoa castanea, Moll. Gaspé Bay.

Scalaria Groenlandica, Perry. One living off St. George's Cove.

Astyris Holbollii, Beck. Several specimens were taken in Gaspé Bay.

Chrysodomus tornatus, Gould, sp. One fine adult specimen was taken alive in 10-15 fathoms off St. George's Cove.

By dredging in the St. Lawrence opposite Murray Bay, 60 species of marine mollusca, identical with well-known Ladrador shells, were obtained by Principal Dawson. It was not previously known that such strictly marine species lived so far up the river. Among the most interesting of these shells is an Astarte which will go far to prove that the A. Laurentiana of Lyell, a well-known Canadian post pliocene fossil, is a local variety of the recent A. Banksii of Leach. Not only, too, are these Murray Bay shells of a very marine type, but in many cases they are of an unusually large size. The force of the tide in the River St. Lawrence is such that it is often difficult and almost impossible to dredge except in sheltered situations, but the results obtained are very encouraging, and should stimulate to renewed exploration. The observations recently made have shewn that the range in depth of the Canadian marine mollusca is very variable, the same species having been taken living in from 10 up to 50 fathoms. We are still, however, profoundly ignorant as to what creatures live at great depths in the Gulf of the St. Lawrence, and there is little doubt that, were the dredge used in the deeper parts of the Gulf and River, most interesting and valuable results would be obtained. My thanks are due to Mr. J Gwyn Jeffreys for the loan of a dredge of improved construction; and I am again much indebted to my friends Messrs. John Luce and P. De Carteret, of Grand Grève, for their kindness and assistance, without which these investigations could not have been carried out.

ON MICROSCOPIC ACCESSORIES.

By J. BAKER EDWARDS, Ph.D., F.C.S.,

Hon. Sec'y Montreal Microscopic Club, and Cor. Mem. Liverpool Micro. Club and New York Microscopic Society.

Next to the possession of a good, solid, smoothly-working stand, with good powers and good illumination, is the desire for the acquisition of those useful accessories which the zealous microscopist soon finds are essentials to his progress in practical study. Of these I shall first notice simplifications which amount to permanent improvements. Thus the shutter or graduating diaphragm is an improvement likely to supersede the rotating diaphragm beneath the stage; and the adjusting side-light as a parabolic reflector is a useful substitute both for the bull's-eye condenser and the various Lieberkuhns. The orthoscopic eye-piece, in its double service as an achromatic condenser, is also a valuable and economical accessory. I have already stated that the binocular prism is an essential to the best form of stand, and is entitled to a higher place in the estimation of the working student than a mere accessory.

The new rotating glass stages of either Messrs. Crouch or Collins certainly accessions to the instrument and can be recommended to those who do not care about the expensive mechanical stage. The movement is smooth and true, and the fingers may soon become educated so as work the object with all the precision desired.

A rotating diaphram, furnished by Crouch or Collins, also gives all the effects of the dark well and oblique illuminations.

The parabolic condenser of Wenham is an invaluable illuminator for foraminifera, polycystina, and transparent injections.

The camera lucida, lever compressorium and object glass reflectors may, I think, be considered as luxuries, not at all essential to the student. So also the "Erecting Eye-piece," although invaluable under exceptional circumstances, may be generally dispensed with, as, for ordinary dissections, the binocular folding stand, called the "Collins' Lawson Dissector," holds the preference.

Every real student should procure at least a stage micrometer, and he will probably not regret the possession of a "cobweb ditto" for the eye-piece. Accuracy in the expression of the size of objects described is often of the greatest importance in original investigation.

Must I call the "Brook's nose-piece" an accessory? I suppose I must; yet I am accustomed to regard it as one of the most essential parts of my instrument. So valuable is the ready exchange of two object glasses, that it is almost essential where high powers are often used. I may here state incidentally that I have tried the multiplication of this rotatory movement to the extent of three and five object glasses, but have found that the strain and leverage upon the fine adjustment is too great, and therefore prefer the double nose-piece.

The polariscope is an essential part of a good microscope. It cannot be dispensed with, and should therefore not be deemed a mere accessory. Still it often is so called, and various contrivances have been suggested to reduce its cost. I should recommend, however, large prisms and thin selenites, and would by no means advise any experiments with tourmalines or Herapathites. I have tried them, and find no polariscope is so satisfactory as the Nichol's prism, with a good selenite below the object; the analyser being placed immediately behind the object glass. In the Harley Collins' microscope, the arrangement is excellent; the same slide carries the analyser and the binocular prism into the body, thus saving a great amount of screwing and unscrewing.

I would urge upon the microscopist the importance of this mode of illumination, as it frequently gives valuable delineations when least expected. Objects required for investigation, such as parasites and tissues, are often obscure and unsatisfactory by ordinary modes of illumination, owing to their great transparency. In these cases polarized light is of the greatest assistance in the delineation of structure.

Some confusion exits in the popular mind as to the comparative value of the polariscope and a mode of illumination introduced by Mr. Heys, of Machester, of a very different character, called the kalescope. By passing the rays of light through the bull's-eye, obscured by a coloured glass, and through the condenser below the stage, through a diaphragm of various coloured glasses, Mr. Heys obtained brilliant fields. Opaque objects are thus illuminated with bright lights of different colours, and are tinted with fringes of considerable beauty and delicacy. But such an illumination affords no information as to the real nature of the object, for these tints are as artificial as those which fall upon the faces of people in church from an oriel window; the colours may be beautiful, but they certainly do not improve the complexions of the worshippers; and as a microscopic accessory, the kalescope is a mockery, a delusion, and a snare.

The Sorby micro-spectroscope is a specialty which appeals only to the chemist or toxicologist. The live box and the Zoophyte trough are necessary accessories to the naturalist, and will afford ample return from the employment of several forms of them.

I do not think it necessary to enter into the merits of those contrivances which are invented for the mounting and preservation of objects; but, in the above short sketch, have endeavoured to give my experience as to the necessary desiderata for the working student.

The most complete working instrument that I have yet seen is the Harley Collins' binocular, with its appurtenances, and I doubt whether anything can be obtained of greater working value for the moderate price of $100. I shall therefore conclude with a detailed description of it:—

A compound binocular body, with two sets of eye-pieces and eye-shades; neutral tint reflector for camera lucida; rotatory glass stage, with lever movements; shutter to body to carry polarizing and binocular prisms; Brook's double nose-piece; 1 inch and $\frac{1}{4}$ inch object glasses (good); a wheel of side-light diaphragms, stops and adjusting shutter diaphragm; achromatic condenser, polariscope and double mirror; side-light reflector, and bull's-eye; together with a good mahogany box, and packing for the apparatus.

In conclusion, I would recommend a good selection of "accessories" in preference to a long series of "object glasses;" but I am satisfied that the ingenious student will contrive many of these without the aid of the optician. I have endeavoured herein to indicate the most profitable investments, leaving many excellent inventions unnoticed; for a description of such in detail, let the reader consult the last edition of "Carpenter on the Microscope."

NOTES ON THE STRUCTURE OF THE CRINOIDA, CYSTIDEA AND BLASTOIDEA.

By E. BILLINGS, F.G.S., Palæontologist of the Geological Survey of Canada.*

1. POSITION OF THE MOUTH IN RELATION TO THE AMBULACRAL SYSTEM.

The earlier Paleontologists, Gyllenhal, Wahlenberg, Pander, Hisinger, and others, described the large lateral aperture in the Cystidea as the mouth, apparently on account of its resemblance to the five-jawed oral apparatus of the sea-urchins. In his famous Monograph "Uber Cystideen," 1845, Leopold von Buch advocated the view, that it was not the mouth but an ovarian aperture; and that the smaller orifice usually situated in the apex, from which the ambulacral grooves radiate, was the true oral orifice. These opinions were adopted by Prof. E. Forbes, in his Memoir on the British Cystidea, by Prof. J. Hall, in the Paleontology of New York, and by most others who have described these fossils, including myself, in my first paper on the Cystidea of Canada, published in the *Canadian Journal* in 1854. In 1858 I re-investigated the subject while preparing my Decade No. 3, and came to the conclusions that the lateral aperture was the mouth, in those species which were provided with a separate anus; and in all others it was both mouth and anus. The small apical orifice I described as an ambulacral aperture. According to these views, the mouth of a Cystidean does not stand in the

* This paper was prepared for the press last December, but, as my collection of the Blastoidea was small, I thought it best to delay publication until I could examine a greater number of specimens. In January I applied to S. S. Lyon, Esq., of Jeffersonville, Indiana, and he replied that, if I would let him know what points I wished to investigate, he would supply me with the materials. On my giving him the desired information, he, in the most liberal manner, sent me a large collection—much larger than I expected to receive—consisting of numerous specimens of several genera, many of them in the state of preservation best adapted for investigation—some of them empty and others silicified in a matrix of limestone. Prof. E. J. Chapman (Prof of Geology and Mineralogy, Univ. Coll., Toronto) also kindly supplied me with several Russian Cystideans. To both of these gentlemen I here tender my thanks.

centre of the radial system, as it does in all the existing Echinodermata. On this point Prof. Wyville Thompson has the following observations:

"I can see no probability whatever in the opinion lately advocated by Mr. Billings, and which has received some vague support from the writings of De Koninck, and others, that the 'pyramid' in the Cystideans is the mouth, and that the aperture whence the ambulacra radiate is simply an 'ambulacral orifice.' Such an idea appears to me to be contrary to every analogy in the class. There can be no doubt of the existence of distinct openings for the passage of the ambulacral nerves and vessels from the calyx of many of the paleozoic crinoids; but I think we must certainly assume that in this, as in all other known instances, these vessels had their origin in an annular vessel surrounding the mouth. In the whole class the æsophageal circular canal seems to be the origin and centre of the ambulacral system. It is the first part which makes its appearance in the embryo, and is so permanent and universal that one could scarcely imagine a radiating ambulacral vessel rising from any other source. The early origin of this important vascular centre, in this annular form and in this position, evidently depends upon, and is closely connected with, the origin of the nervous system in the æsophageal nerve ring, constant in the whole invertebrate series."*

With all due deference I cannot admit that we must assume that, in the Cystidea, the ambulacral tubes had their origin in "an annular vessel surrounding the mouth." It is true that such a vessel does surround the mouth of existing Echinodermata, but there is no essential or direct physiological connection between the two organs. Their functions are exercised independently of each other. There is no organ issuing out of the alimentary canal that communicates with the annular vessel. This latter might be situated in any other part of the body and still perform its functions, provided there were a connection between it and the ambulacra. In this class, the position of the various organs, in relation to each other, and also to the general mass of the body, is subject to very great fluctuations. Thus, the mouth and vent are separated in some of the groups, but united in others, while either, or both, may open out to the surface directly upward, or downward, or at any lateral point. The ovaries may be either dorsal or ventral,

* Edinburgh N. Phil. Jour., vol. xiii., p. 112, 1861.

internal or external, and associated with either the mouth, the anus, or with neither. The ambulacral skeleton may be imbedded into and form a portion of the general covering of the body, or lie upon the surface, or borne upon free moving arms. In genera belonging to the same family these relations are constant, or nearly so, but are found to be extremely variable when different orders, or when remotely allied families are compared.

While preparing my Decade No. 3, I investigated this subject, and satisfied myself that in, at least, a large proportion of the paleozoic Crinoids the mouth was disconnected altogether from the radial system. A great many species might be referred to in which we can see both the centre, from which the ambulacra proceed, and the mouth; and at the same time see that they are not in the same place. A long train of reasoning is not necessary—only simple inspection. It will be quite sufficient to notice a few of these species to prove that the rule laid down by Prof. Wyville Thompson is not a general rule.

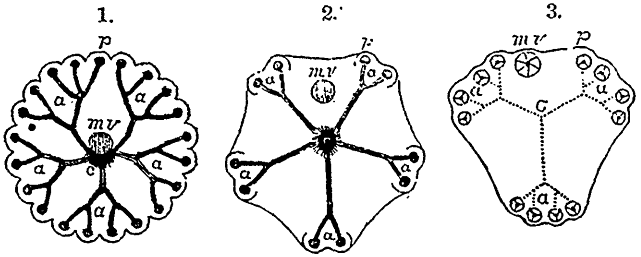


Fig. 1.—This figure is a diagram of the interior of the vault of a Crinoid, which appears to be *Batocrinus icasodactylus* (Cassiday,) a fossil that occurs in the Carboniferous rocks of Kentucky. It was sent to me by Mr. S. S. Lyon, of Jeffersonville, Indiana, several years ago. The test is in a beautiful state of preservation, and perfectly empty, so that all of the markings on the inner surface can be distinctly seen. There are twenty-one arms, arranged in five groups (*a*,) and the same number of ambulacral openings (*p*,) each just large enough to admit of the entrance of a slender pin. The mouth (*mv*) is nearly central, and close to it, on the posterior side, there is a small rudely pentagonal space (c) with no markings, except several small tubercles. The grooves are scarcely at all impressed, and, indeed, I think they never are so in any Crinoid, except in those which have a thick test. In this specimen their course is clearly indicated by

the remains of the thin partitions which either separated them or to which the vessels were attached. They do not run directly toward the mouth, as they would do if that organ were the centre of the ambulacral system, but to the small space (*c*) behind it, where there appears to have been situated a vesicle or some other apparatus, to which all of them were united. Whatever may have been the structure of this central organ, from which the five main grooves radiate, it no doubt represented the annular vessel of the recent Echinodermata, to which Prof. Thompson alludes.

Fig. 2—represents the structure of an *Amphoracrinus*, from the Carboniferous rocks of Ireland,—precise locality and species not determined. There are ten arms; the test is very thick; the ambulacral channels converge to the central point (*c*,) but do not quite reach it; the mouth (*mv*) is about half-way between the centre and the margin. In this Crinoid it is perfectly impossible that the mouth can be the centre of the radial system, because the two anterior passages, between which it is situated, are for their whole length tunnelled, as it were, through the substance of the plates, and only penetrate downward into the interior at the central space (*c*.)

Fig. 3—is a plan of the summit of the widely known and remarkable fossil, *Caryocrinus ornatus*, (Say.) In this species there are only three, instead of five, groups of arms. In large individuals there are from twelve to twenty free arms (but always arranged in the three groups) with a small pore at the base of each. This pore is about the size of the ovarian pore of an *Echinus*, and can only be seen in well preserved and clean specimens. The ambulacral grooves have not yet been observed, but their course is indicated by three low rounded ridges, which may be seen, in some specimens, radiating from a large heptagonal plate situated at (*c*). The mouth (*mv*) is valvular, composed of from five to eight or ten plates, and is always situated near the margin betwen the two anterior groups of arms. With the exception of the ambulacral pores there is positively no other aperture in the summit of *Caryocrinus*. If it be true that the mouth of an Echinoderm must be always situated in the radial centre, then *Caryocrinus*, and also nearly all the paleozoic genera were destitute of that aperture.

Caryocrinus is a genus which seems to form a connecting link between the Crinoidea and the Cystidea. By examining numerous well polished sections, I find that the structure of the respiratory areas is the same (in general plan) as that of the genera *Glyptocystites, Pleurocystites* and *Echinoencrinites*, as will be shown further on. The arms are also arranged in three groups, as in *Sphæronites* and *Hemicosmites*, while the mouth is valvular. On the other hand, the long cylindrical column, and the arrangement of the arms around the margin, with the ambulacral pores at their bases, are crinoidal characters.

In addition to the above, the following species may be referred to, as examples of Crinoids, with the mouth separate from the centre of the radial system.

Amphoracrinus tesselatus (Phillips).—Figured by J. Rofe, Esq., Geol. Mag., vol. ii, p. 8, f. 3. The figure represents a cast of the interior of the vault, showing the five ambulacral grooves in relief. The mouth is situated in the angle between the two anterior grooves.

Strotocrinus perumbrosus (Hall, sp.).—Figured by Meek and Worthen, in the Geology of Illinois, vol. ii, p. 188, f. 5. The specimen is 13 lines in diameter, the ambulacral centre 13 lines from the anterior margin, and the mouth 11 lines.*

Glyptocrinus armosus (McChesney sp.).—This extraordinary Crinoid is figured by McChesney in his "New Pal. Foss.," pl. 7, f. 6, and also by Prof. Hall, in the 20th Reg. Rep., N.Y., pl. 10, f. 11. The specimens are between 2 and 3 inches in length. There are ten arms, the anterior side is much inflated, the proboscis appears to be large at its base, and eccentric in its position; but instead of standing erect, it bends down to the surface of the vault, and lies upon it, crossing over to the posterior margin. Judging from the figures, the centre of the base of this organ must be distant from the radial centre at least one-fourth of the

* In April last I received from Messrs. Meek and Worthen a paper entitled, "Notes on some points in the structure and habits of the Palæozoic Crinoidea." Of all the papers relating to this subject yet published on this continent, this one, at least, so it appears to me, is the most interesting and important. It is written with a clearness and particu larity rarely to be seen in palæontological memoirs. In some respects it confirms the opinions advocated in these notes, but bears directly against my views on the question here under discussion, *i.e.*—"the position of the mouth with relation to the radial centre." As I wish to give the remarkable observations of the authors full consideration, I shall not discuss them now, but delay until the September No. of this Journal. I shall only state here, that I believe that the grooves on the ventral disc of *Cyathocrinus*, and also the internal "*convoluted plate*" of

whole width of the vault. *G. siphonatus* (Hall), figured on the same plate, shows, that the anterior grooves curve round to the posterior side of the proboscis, as they do in *B. icosadactylus* above cited.

I should also state here, that two or three years ago, Mr. Meek, to whom I had written for information on this subject, wrote me that, in all cases, where he had observed the grooves on the interior of the vault, they radiated, not from the mouth, but from a point " in front of it." (This would be not in front of, but behind the mouth, according to the terminology used in these notes. I think that the side in which the mouth is situated should be called " anterior " or " oral," even although both the mouth and anus should be included in it.)

In all the species above cited, the figures (with the exception of *C. ornatus*) exhibit the relative position of the mouth and radial centre, as it has been actually seen in casts of the interior of the vault. But besides these, numerous examples may be found in the works of Miller, Austin, De Koninck, Phillips, Meek, Worthen, Shumard, Hall, Lyon, Cassaday, and others, of Crinoids whose external characters show that, in them, the mouth cannot be in the central point, from which the grooves radiate.

With respect to Prof. Thompson's theory, I freely admit that if it is true that in all the echinodermata, fossil and recent, the mouth is the radial centre, then, that aperture must be the one which I call the ambulacral orifice in the Cystidea. The views, however, advocated by me in my Decade No. 3, appear to be gradually gaining ground. As these fossils are rare, few have occasion to study them, and consequently the subject has not been much discussed since 1858, the date of the publication of

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the Palæozoic Crinoids, with the tubes radiating therefrom, belong to the respiratory and, perhaps, in part, to the circulatory systems—not to the digestive system, as is supposed by the authors. The convoluted plate, with its thickened border, seems to foreshadow the " æsophageal circular canal," with a pendant madreporic apparatus, is in the Holothuridea. To me the final determination of this question is of much importance, for, if Meek and Worthen are right, then I must be wrong so far as regards nearly all that I have published with reference to the functions of the apertures of the Palæozoic Echinodermata. It is fortunate that the solution of this curious problem is now undertaken by men who have access to the magnificent cabinets of the geologists of the Western States, and by men who habitually discuss scientific subjects with the sole object in view of arriving at the truth.

that work. The following are the only authors, so far as I have ascertained, who have given their opinions on this vexed question during the last eleven years:—

Prof. Wyville Thompson, op. cit., p. 111 (1861), agrees with me that the lateral aperture is not an ovarian orifice, but, as we have seen, is strongly opposed to the view that it is the mouth. He calls it the anus.

Prof. Dana (Man. Geol., p. 162, 1863) recognizes it as the homologue of the simple aperture (oral and anal) in the summit of those Crinoids which have but one. This is exactly my view. [J. W. Salter agrees with Prof. Thompson, that it is the anus, not the ovarian aperture. (Mem. Geol. Sur. G. B., vol. iii., p. 286, 1866.) Prof. S. Lovén, of Stockholm, has described, in the "Proceedings of the Royal Swedish Academy," 1867, the remarkable sea Urchin, *Leskia mirabilis* (Gray), which has the mouth constructed on the same plan as that of the Cystidea, that is to say, with five triangular valve-like plates, which are immeattached to the interambulacral plates, without the intervention of a buccal membrane. After comparing this structure with the valvular orifice of *Sphæronites pomum* (Gyll.) he says, "that the 'pyramid,' which in *Leskia* is the armature and covering of the mouth, is the same thing in the *Cystidea* is now quite certain; in the last-named group it was, doubtless, also the vent. The mouth does not lie where J. Müller and Volborth sought for it, viz.: in the centre of the ambulacral furrows; and the organ, interpreted as the vent by Volborth and von Buch, is more correctly regarded as an external sexual organ." Geol. Mag., vol. v., p. 181, Dr. Lütken's trans.]

2. *On the pectinated rhombs and calycine pores of the Cystidea.*

None of the organs of the Echinodermata have been the subject of so much speculation as the calycine pores and the so-called "pectinated rhombs" of the Cystidea. Their relations and function long remained in doubt, but there seems to be now sufficient data to shew that they are respiratory organs, and also, that they are the homologues of the tubular apparatus which underlies the ambulacra of the Blastoidea. J. Müller suggested a comparison between these peculiar organs and the respiratory pores of the *Asteridæ*. (Uber den bau der Echinodermen, p. 63, 1854.) Prof. Huxley has placed them in the same relation.

(*Medical Times*, Dec., 1856.) Eichwald calls them respiratory pores. (Lethaea Rossica, vol. 1, p. 614, 1860.) Prof. Dana says, "they are probably connected with an aquiferous system and respiration." (Man. Geol., p. 162, 1863.) Mr. Rofe, after showing that their structure is the same as that of the striated surfaces between the rays of *Codaster*, says, "From the construction of these striations on the face of *Codaster*, and on the '*pectinated rhombs' of the cystidea, may we without assumption* suggest the possibility of their being respiratory sacs, lined with cilia, and constructed of a porous test, through which air from the water could pass by diffusion." (Geol. Mag., vol. ii., 251, 1865.) As for myself, when I prepared my decade on the cystidea, I gave this subject a great deal of consideration, and studied a large number of specimens, but could arrive at no conclusion satisfactory to myself. *I am now convinced that the* view of the above named distinguished authors is the correct one. These are respiratory organs. In all the species in which they occur, they seem to be constructed on the same general plan, *i.e.*, the interposition of an exceedingly thin partition, between the circumambient water, and the fluid within the general cavity of the body. They are usually of a rhomboidal shape—each rhomb being divided into two triangles by the suture (*c c*, figs. 4, 5,) between two of the plates. In several of the genera, the two halves of the hydrospires are reniform, ovate or lunate, and either internal or external.

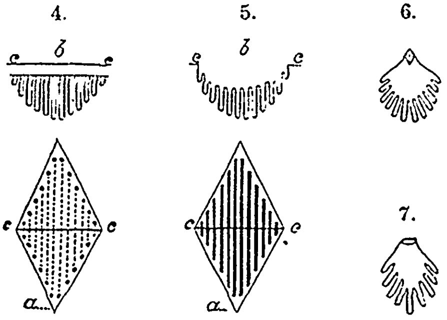


Fig. 4 Hydrospire of *Caryocrinus ornatus*. *a*, surface view; the dots around the margin are the spiracles, the small dotted lines represent the course of the flat internal canals; *c,c*, suture between the two plates; *b*, transverse section. 5. Hydrospire of *pleurocystites*. *a*, surface view: *c,c*, suture; *b*, transverse section. 6. The same with the points, *c,c*, drawn together. 7. Internal gill of a spider.

In order to avoid the use of double terms, I propose to call them "*hydrospires*," and their apertures, "*pores*," "*fissures*," or "*spiracles*," according to their form.

In *Caryocrinus ornatus* the hydrospires (fig. 4,) are of a rhomboidal form, and have each of the four sides bordered by a single row of small tubercles. Some of these tubercles have a single pore in the summit, while others are perforated with a variable number,—from two to twenty, or perhaps more,—thus becoming vesicular or spongy. It is only the apex of the tubercle, however, that has this structure, for, when this is worn off, there is only a single pore to be seen. The pores penetrate through the plates, but do not communicate directly with the general cavity of the body. Internally each hydrospire consists of a number of flat tubes arranged parallel to each other and lying side by side, in the direction of the dotted lines in fig. 4, *a*. Each tube receives two of the pores seen on the exterior—one pore at each end. These tubes are composed of a very thin shelly membrane, which, although possessed of sufficient rigidity to maintain its form, was no doubt of such a minutely porous texture as to admit of the transfusion of fluids in both directions, outward and inward. In a large hydrospire there are about twenty of those tubes. Their greatest breadth is at their mid-length, where they are crossed by the suture *c c*; and as they become narrower accordingly as their length decreases, the one in the middle projects the deepest into the perivisceral cavity. In consequence of this arrangement, when a section is made across the hydrospire at the suture c c fig. 4 *a*, the form *b* is obtained where c c is the surface of the shell, while the comb-like structure below represents the tubes.

Specimens of *C. ornatus* almost entirely empty are often found, and in some of these the internal form of the hydrospires is sometimes preserved. Those that I have seen have the form of small rhomboidal pyramids, with four slightly convex sloping faces, and composed of a number of vertical parallel plates—the casts of the interior of the tubes—the substance of the tube itself not being preserved. I have, however, several polished transverse sections, in which I think the thin walls can be seen.

The structure of the hydrospires is such, that there can scarcely be any doubt that they are respiratory organs. The sea-water entered through the pores, and ærated the chylaqueous fluid, contained in the perivisceral cavity, by transfusion through the exceedingly thin membranous shell that composed the walls of the tubes. The number of pores varies with the size of the individual. In large specimens these are from 800 to 1000.

It has been stated by some authors that the pores were passages for the protrusion of internal organs connected with the vitality of the animal. The fact, however, that the pores do not penetrate into the general cavity of the body, disproves this theory; and, moreover, through many of the tubercles—those with a vesicular and spongy summit, such protrusion would be utterly impossible.

In *Caryocrinus ornatus* there are thirty hydrospires arranged as follows:

1. Ten at the base—half of each on a basal plate, and the other half on one of the subradials, their longer diagonal vertical.

2. A zone of six around the fossil at the mid height—their longer diagonals horizontal. These seem to be imperfectly developed, for, on the inside, the tubes occupy only a small space in the centre.

3. A third band of fourteen—two of them with their longer diagonals vertical, and the others arranged in six pairs, the diagonals of each pair inclining toward each other, upward, at an angle of about 30°. There are only three interradii in *Caryocrinus:* the mouth is placed in one of them, and the two hydrospires with vertical diagonals in the other two.

In *Pleurocystites* the hydrospires are also of a rhomboidal form, but instead of having the tubular structure of *Caryocrinus*, they consist of a number of parallel inward folds of an exceedingly thin part of the shell. These folds no doubt represent the tubes of *Caryocrinus.* If we grind down a hydrospire of this latter, so as to remove all the shell, and expose the edges of the tubes, it then exhibits precisely the same form as fig. 5 *a*, *i.e.*, the form of a rhomb, longitudinally striated at right angles to the suture, and with no pores. The tranverse section in *Pleurocystites* only differs from that in *Caryocrinus* in having no shell between the points *c c*. In the hydrospire of *Pleurocystites robustus*, of the Trenton limestone, we have the commencement of the formation of an internal gill with a single spiracle. The surface is not flat, as it is in many species, but concave, as shown in the section; and it is evident that if the concavity should be carried further, and, at the same time, the points c c made to approach each other, the effect would be to produce an elongated sack, deeply folded on one side, and with a fissure extending the whole length on the other side. The transverse section of such a sack would be fig. 6, the same as in *Pentremites*. Again, if we contract the four sides, gradually curving them outward at the same time, but not diminishing the superficial extent of the walls of the folds, although altering the form to correspond with the decreasing aperture, the result would be a deeply folded, flask-shaped sack, with a small round orifice like fig. 7, which is the internal gill of a spider.

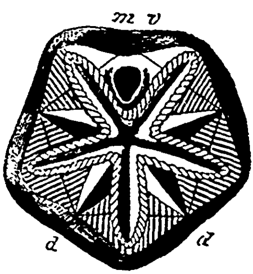
In *Palæocystites tenuiradiatus*, a species very characteristic of the Chazy limestone, the whole surface (in the condition in which the fossil is usually found) is covered with deeply striated rhombs, the fissures being deepest where they cross the suture, and growing gradually shallower as they approach the centre of the plates, where they die out altogether. Detached plates occur in vast abundance, but no perfect specimens have ever been found. I discovered, however, several fragments of the body sufficient to give the general form, and to show that, when the surface is perfect, all these fissures are completely covered over by a very thin shell, and that, when they cross the suture, there is a small pore in the bottom of each, which penetrates to the interior. The rhombs of this species are thus external hydrospires. The fissures seen in the ordinary weathered specimens are the remains of flat tubes, like those of *Caryocrinus*, situated on the outer instead of the inner surface of the test. The chylaqueous fluid passed outward through the pores and filled the tubes, to be ærated through the thin external covering by the surrounding water. In *Caryocrinus* the water passed inward, through the pores, into the tubes, and ærated the fluid within the general cavity of the body.

The discovery that the fissures and pores of the Cystidea, do not communicate directly with the general cavity of the body is entirely due to Mr. Rofe. After reading his highly important paper, I re-examined a great number of specimens, and found sufficient to confirm his observations.

3. *On the genus Codaster.*

Every author who has described a species of this genus, has remarked the peculiar striated areas in the interradial spaces. Prof. McCoy, the founder of the genus, pointed out their resemblance to the hydrospires of the Cystidea; but it was Mr. Rofe who first showed that they were also identical in structure therewith. On comparing one of those with that of the cystidean *Pleurocystites*, fig. 5, we at once perceive that they are the same in the external form, while Mr. Rofe's figures show that the section at *d d* has the structure of fig. 9, which only differs from fig. 5 *b* in being straight above instead of concave, and in being divided into two parts. This division is the result of the position of the arm which cuts the hydrospire in two, in a direction parellel to the fissures. By drawing the points *d a* and *a d* together, we get fig. 10, which is, in general plan, a section across one of the ambulacra of a Pentremite. On examining nearly all the published figures of species of this genus, I find that there is a series of forms which exhibit a gradual passage from those with the hydrospires, almost entirely exposed, as in fig. 8, through others in which they are crowded more and more under the arms, until at length they become altogether internal.

8.



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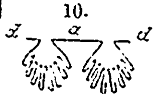

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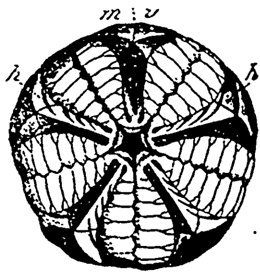

Fig. 8. Summit of *C. acutus* McCoy, *m v* mouth and vent; *d d* suture across the posterior hydrospire. 9. Section across the hydrospire from *d* to *d*, at *a* is the place of the arm. 10. The section contracted, as in fig. 6. 11. Summit of *Pentremites caryophyllatus* De Koninck.

In *C. acutus*, fig. 8, only a small portion of the hydrospire is concealed under the arm. In *C. Canadensis*, a new species, lately discovered in the shales of the Hamilton group in Canada West, each of the four interradial spaces, in which the hydrospires are placed, is excavated in such a manner as to form *a small triangular pyramid*, with two of its faces sloping down toward the sides of the two adjacent arms. On these two slopes are placed the hydrospires, which appear to have one fissure entirely under, and another partly under the arm, five others being fully exposed. S. S. Lyon has described a species under the name of *C. alternatus* in the "Geology of Kentucky," vol. iii., p. 494, from the Devonian rocks of that State. which closely resembles *C. Canadensis*, but is still distinct therefrom. Speaking of the structure of the summit, he says: "the depressed triangular intervening spaces are filled with seven, or more, thin pieces, lying parallel to the pseudambulacral fields, articulating with the summit of the second radial, and the prominent ridge lying between the pseudambulacræ. These pieces were evidently capable of being compressed or depressed; the "*point*" at the lateral junction of the second radials is in some specimens folded over toward the mouth, so as to entirely obscure these triangular spaces by covering them." This important observation proves that, even in the same species, the hydrospires may be either partly or wholly concealed under the arm. The "*point*" to which Mr. Lyon alludes is seen above, in fig. 11, just below the letter *b*. It is the same as the "*small triangular pyramid*" in *C. Canadensis*. It is evident that (supposing the shell to be flexible) if these points were to be drawn inward, the movement would gradually cause what remains exposed of the hydrospire to be covered, until at length it would be entirely concealed under the arm. The five points would then be situated in the angles between the five ambulacra, as they are in the genus *Pentremites*, fig. 15. The concealment of the hydrospires may also be the result of the widening of the arm. This is well known in *P. caryophyllitus* DeKoninck (*P. Orbignyanus* according to Roemer), *P. Schultzii* De Ver., and several other species. In these the apices of the pyramids remain near the margin, but the hydrospires are nearly covered by the wide arms. This is shown in fig. 11, where the ends of the fissures of the hydrospires are seen along the sides of the angular ridges which extend from the apices of the pyramids to the angles between the arms. I do not think that such species can be referred to *Pentremites*, and if I had specimens before me, instead of figures only, I would most probably institute a new genus for their reception.

Our specimens of *C. Canadensis* are well preserved, and show the characters of the arms perfectly. After many careful examinations under the microscope, I can state positively that in this species the so-called "pseudambulacral fields" have no pores.

The markings that have hitherto been mistaken for ambulacral pores in *Codaster* are not pores, but the small pits or sockets which received the bases of the pinnulæ. The rays therefore in this genus are not "pseudambulacral fields" in the sense in which that term is used in descriptions of species of *Pentremites*, but simply recumbent arms, identical in structure with those of the cystidean genera *Glyptocystites*, *Callocystites*, *Apiocystites*, and others. They lie upon the surface of the plates which constitute the shell of the animals—not imbedded into them, as in *Pentremites*. The large lateral aperture is both mouth and vent, and the central opening, heretofore called the mouth, is the ambulacral, or, more properly, the ovarian orifice. As, therefore, *Codaster* has the arms of *Apiocystites*, the hydrospires of *Pleurocystites*, and the confluent mouth and vent, common to all *Cystideans*, I propose to remove it from the *Blastoidea*, and place it in the order *Cystidea*.

4. *On the genus Pentremites.*

In *Pentremites* the hydrospire is an elongated, internal sack, one side of which is attached to the inside of the shell, while the side opposite, or toward the central axis of the visceral cavity, is more or less deeply folded longitudinally. There are two of these to each ambulacrum, attached along the two lines of pores. There appears to be a fissure extending nearly the whole length, in the direction of the dotted line *f*. One edge of this fissure is attached to the lancet plate along one side of the line of pores; the other to the shell, on the other side of the row. The pores all enter the hydrospire through this fissure. There are ten hydrospires, connected together in pairs, each pair communicating with the exterior through a single spiracle. The arrangement of the folds varies according to the species. In *P. Godoni* there are five folds, the outer sides of which are close up to the inner side of the lancet plate, fig. 13. In a specimen of *P. obesus* Lyon, nearly two inches in diameter at the mid-height, the hydrospires extend inward about three lines, the main body being about one line from the lancet plate. There are five folds, each two lines deep; and thus, if the thin shelly membrane, which constitutes the wall of the hydrospire, were spread out, it would have a width of 22 lines,—and the ten together would form a riband, about 18 inches in length, and nearly two inches wide. The object of the folding is, of course, to confine this large amount of surface to a small space, an arrangement which at once proves the function to be respiratory. Of those figured by

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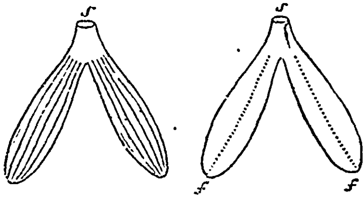

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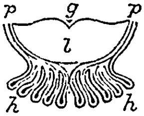

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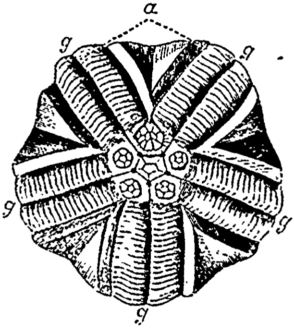

Fig. 12.—Diagrams of one pair of the hydrospires of a *Pentremite*,—*a* the inner side; *b* the outer, or side attached to the shell; *f* the fissure. 13. Section across an ambulacrum of a specimen of *P. Godoni*, enlarged 3 diameters.—*l* lancet plate; *g* ambulacral groove; *p p* pores leading into the hydrospires; *h h* the two hydrospires, in transverse section. 14. Ideal figures of a transverse section through an entire specimen, showing the ten hydrospires.—*l* one of the five lancet plates; *p p* pores; *r r* the two branches of one of the radial plates. 15. Summit of *P. conoideus*,—*a* anterior side; *g* ambulacral grooves (copied from Dr Shumard, but with the ovarian pores added).

Mr. Rofe, *P. ellipticus* Sowerby appears to have only one fold, *P. inflatus*, id., shows eight folds in one, and eleven in the other hydrospire of the same ambulacrum. Another specimen, figured by Mr. Rofe, under the name of *P. florealis* Say, has five folds, situated at a distance from the inner surface of the lancet plate, as in *P. obesus*. From the form of the organ, I think that Mr. Rofe's specimen cannot be the species called *P. florealis* by Say.

If it be granted that these organs are respiratory in their function, then their five apertures should be called *spiracles*,—

not "ovarian orifices." The large anterior aperture would thus be the *oro-anal spiracle*. Applying this system of terminology to other groups,—the so-called ovarian orifice of the Cystidea, the homologous aperture of *Nucleocrinus*, *Codaster*, *Granatocrinus* and of the Paleozoic Crinoidea generally (but not of the recent forms), should be styled the *oro-anal orifice*.

I think that the side of an Echinoderm in which the mouth is situated should be called "anterior" even although the anus and the mouth be confluent in one orifice. Most star fishes have but one aperture for mouth and vent, and yet it is called the mouth by naturalists generally. Why not call the under-side of a star-fish "the anal or posterior side," and the central aperture the "anus?"

Dr. B. F. Shumard has shown (Trans. Acad. Nat. Sci. St. Louis, vol. 1, p. 243, pl. 9, fig. 4,) that in perfect specimens of *P. conoideus* Hall, the six summit apertures are closed by several small plates. In a specimen of the same species sent me by Mr. Lyon, in which those plates are partly preserved, I find that there is a small pore in each of the five angles of the central apertures. The five ambulacral grooves enter the interior through these pores. I have copied his figure, but modified it by adding the pores, fig. 15. He also found that the summit of *P. sulcatus* Roemer, was covered with an integument of small plates, arranged in the form of a pyramid. From these facts he infers that in all the pentremites the summit apertures will be found in perfect specimens, to be closed in a similar manner.

Dr. C. A. White, at present State Geologist of Iowa, in a paper on the same subject, (Bost. Jour. N. H., vol. 8, p.p. 481—488,) describes *P. Norwoodii* Owen and Shumard and *P. stelliformis*, id., as having a similar structure—but he goes further,—he considers the central orifice "*not to be the mouth*," and I believe that he is the first naturalist who ever published such an opinion. His idea of its function is thus expressed: "It seems more probable that, as the ova were germinated within the body, they found their exit through the central aperture, and were conveyed along the small central grooves of the pseudambulacral fields before mentioned, beneath the plated integument, to the bases of the tentacula, where they were developed and discharged, as in the true crinoids." I perfectly agree with Dr. White in this view. The central aperture is not the mouth; in fact, it is not a natural orifice, but a breach in the summit, caused by the destruction of a portion of the vault. The true natural orifices of this part are those that I have discovered in *P. conoideus* as above mentioned. They are the homologues of the *ovarian pores* at the bases of the arms of *Caryocrinus* and in part, as I shall show in another part of these notes, of the ambulacral orifices of the true crinoids.

With regard to the structure of the calyx of *Pentremites*, it is generally supposed that there are only three series of plates—the basal, radial and interradial. Mr. Lyon has advanced the opinion that there are three small plates below those now called the basals (Geol. Ky., vol. iii., p. 468, pl. II, fig. 1c). I have examined a number of specimens with reference to this point, and I think he is right. There are three small pentagonal basals, the two upper sides of each are excavated to receive the sub-radials, *i.e.*, those at present designated "the basals." They are, in general, anchylosed to the subradials, but in one of Mr. Lyon's specimens that I have seen, they are distinctly separate.*

(*To be continued.*)

NOTES ON THE SMALL CABBAGE BUTTERFLY, PIERIS RAPÆ.

By A. S. Ritchie.

The effects produced by insects, either beneficial or injurious to man, have not been studied by the people as the subject deserves. Their benefits are taken as a matter of course, whether in their capacity as scavengers, fertilizers of plants, or as producers of silk, dyes, wax, honey, &c.; but when injuries, which affect either our persons or our property, directly or indirectly, are caused by the presence of insects, the "hue and cry" begins.

More natural history ought to be taught in schools, so that the habits of the many creatures composing this world of ours might be better known and understood by the youth of the country.

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Kirby says, in connection with the injuries caused by insects: "You will be disposed to admit, however, the empire of insects over the works of creation, and to own that our prosperity, comfort, and happiness are intimately connected with them, and consequently that the knowledge and study of them may be extremely useful and necessary to promote these desirable ends, since the knowledge of the cause of any evil is always a principal, if not an indispensable, step towards its remedy."

The object of the following few notes is to give some account of an injurious insect, which has made its appearance in Canada within the last nine or ten years, namely, *Pieris Rapæ, Linn.*, or the small cabbage butterfly of England. As a colonist, it thrives; and to all appearances there is no fear of the race dying out. This country, for some reason or other, is peculiarly fitted for the development of certain introduced insects, which do not thrive so well in Europe. For instance, another butterfly, *Vanessa Antiopa*, or the Camberwell Beauty, of England, is one of our most common insects, while there it is rare. *Pieris Rapæ* threatens also to become very common here.

"This insect was first introduced from Europe into Quebec about 1859 or 1860. It soon became abundant within a circle of forty miles round that city, and has even spread into Maine and Vermont, along the line of railway leading from Quebec."*

The first notice of its appearance in Canada was by Mr. Couper, in a paper on "The Genera and Orders of Insects," read by him before the Literary and Historical Society of Quebec, on the 20th April, 1864.

He says:—"Another species, supposed to be the *Pieris Rapæ* of Europe, is one of the most common butterflies of this neighborhood. Four years ago (1860) I captured the first specimen of this species in Quebec, and then looked on it as a great rarity, but, unfortunately, I cannot do so now. In England it is called the Turnip Butterfly, where it appears at the end of April or middle of May, and the beginning of July or middle of August; therefore the species is double brooded in England, and, as far as I have studied the introduced butterfly, it is the same with us. Here it appears to have discarded its British food plant and taken to our cabbages. The chrysalides can be found now on any garden fence where cabbages were grown. It would be very

* Packard's "Guide to Insects."

interesting to ascertain how far this butterfly has penetrated the country. Westwardly it has not reached Montreal, and it has not been traced south of Point Levis; eastward it has not been taken at St. Anne's, where a collector of Lepidoptera resided at the time of its occurrence here; north-west it appears to have made the greatest inroad, for it has been noticed at a distance of thirty miles in that direction. I am safe in stating that five years have not elapsed since this butterfly was introduced into Lower Canada, and it is now brought before the public as an unprofitable addition to our insect fauna."

The first paper on *Pieris Rapœ* was read by S. J. Bowles, Secretary of the Quebec branch of the Entomological Society of Canada, on the 7th July, 1864, wherein he describes the species as first captured by him in the vicinity of Quebec in 1863.

"Its identity with the English species was established by Mr. Saunders, of London, Ont., and Mr. S. H. Scudder, of Boston, Mass."—(See Bowles on *Pieris Rapœ, Canadian Naturalist*, Vol. 1, New Series, 1864, p. 258.)

I first noticed the insect in Montreal about the 26th May, 1867, and again in August of the same year. In 1868 the increase was very visible,—they could be seen flying in numbers about the streets, alighting on any weeds growing by the footpaths.

The appearance of the insect was the subject of much discussion among a few of my entomological friends at the time. On comparing it with Stainton's description in his "British Lepidoptera," I found it to be sometimes smaller, although resembling in all particulars his description, which I will give: "Expanse of wings, 1" 10''' to 2" 2'''; wings white; fore-wings faintly blackish at tip, and bare; male spotless, or with one blackish spot; female, with two black spots and a clouded dash on inner margin; hind wings; a black spot on costa. Larvæ green, irrorated with black; a row of yellow spots on each side in a line with the spiracles." Mr. Stainton adds: "This insect in its larva state feeds on cabbage, mignonette, tropæolum, also on various cruciferæ." The insect may be easily known from the Canadian species of *Pieris*, *P. oleracea* (the "grey veined white"), and *P. protodice*, by the blackish tips of its wings and the spots; by these characters it may be told from the genus *Colias* of the same family. The first are called the "whites," the latter the "yellows."

The fecundity of insects makes them formidable as enemies to man when they attack his crops. I shall quote a few illustrations of this fact from entomological records: The loss sustained in the turnip crop, in Devonshire, in 1886, was not less than £100,000. This was caused by individuals of the genus *Haltica*, or turnip flea, belonging to the Beetles.

The loss sustained by the hop growers in England, when the *Aphides*, or plant lice, prevail, is great, the difference to the revenue in the amount of duty on hops being often as much as £200,000 per annum.

The editor of the *American Entomologist* writes:—"Taking one year with another, the United States suffers from the depredations of insects to the annual amount of three hundred millions of dollars."

The *Canada Farmer* says, to take one single instance:—"We are all familiar with the frightful losses occasioned by the wheat insect in past years, which, for a time, almost prevented the sowing of fall wheat throughout the most fertile portion of Canada. How many thousands, may we not say millions of dollars, were thus lost to the country? Take, again, the apple crop, which is rapidly becoming one of great importance to the Province; this very year (1868) about one-half of the apples grown in Ontario have a worm in the core,—the larva of the codling moth."

And now another insect, in the shape of *Pieris Rapæ*, threatens destruction to our cabbages and other vegetables. I have heard of its ravages as far west as Chateauguay, so that it is now spreading westward, on the opposite side of the St. Lawrence, as well as this. The question to be answered is,—Can we do anything to stop the ravages of destructive insects? Most assuredly we can, to a great extent.

The following extracts will serve to illustrate what has been done and is doing in the neighboring States with regard to injurious insects.

The *Canada Farmer* says:—"During the last year or two State Entomologists have been appointed in Illinois and Missouri. For many years skilled Entomologists have been employed, at the public expense, in New Jersey, in Massachusetts, and at Washington. For twenty years Dr. Fitch has been hard at work, as State Entomologist in New York, with what success the following statement will show:—"At a meeting of the New York Agricultural Society, Senator A. B. Dickinson gave it as his deliberate opinion that the writings of Dr. Fitch had saved, annually, to the single State of New York, the large sum of fifty thousand dollars; and, so far as appears from the record, not a single dissentient voice was raised against this most remarkable assertion." The article concludes thus:—"Surely Canada, with her world-renowned Geological Survey, cannot long afford to neglect the encouragement of this most utilitarian pursuit."

As all farmers and agriculturists are not likely to become Entomologists, it is the duty of Natural History Societies to spread such knowledge as they possess regarding insects and their habits, their benefits or injuries, direct or indirect, so that the benefits from insects may be reaped, and the injuries averted.

The following means are suggested for keeping in check the cabbage butterfly:—As has been shown, the insect produces two broods a year, which appears, first, as eggs; secondly, as larvæ, or caterpillars; then as chrysalides; and, lastly, appears the imago, or butterfly. In the egg state of these insects little can be done to eradicate them. The larval state of most butterflies consists of four or five periods, or ages. When they come out of the egg they immediately commence eating till the first skin is too small for the body. They cast this skin, a new one having been formed underneath the old one. This takes place during the other periods, until they arrive at full growth. The caterpillar state affords opportunities for thinning them out by what is called hand-picking. It would not be a hard matter to pick them off cabbages in a small garden, but, when fields containing acres are to be taken into account, the task becomes very different, although hand-picking has been very beneficial, as the following instance will show.

In the transactions of the Entomological Society of London appears the following:—"A striking instance of the use of hand-picking (in most cases by far the most effective mode of getting rid of insects) appeared in the *West Briton*, a Provincial paper, in 1838, stating that Mr. G. Pearce, of Penmare Goran, had saved an acre and a half of turnips, sown to replace wheat destroyed by the wire worm, and attacked by hosts of their larvæ, by setting boys to collect them, who, at the rate of three halfpence per hundred, gathered 18,000, as many as fifty having been taken from one turnip."

Thus, at an expense of only twenty-two shillings and sixpence, an acre and a half of turnips, worth from £5 to £7 sterling, or more, was saved; while, as the boys could each collect 600 per day, thirty days' employment was given to them, at 9d. per day, which they would not otherwise have had.

When the caterpillar has attained its full growth it changes into a chrysalis, which may be found attached to fences and hothouses in the immediate neighborhood of the fields where the cabbages are grown. In my opinion this is one of the best times for their destruction. Half a dozen boys could gather and destroy thousands in a day for a small remuneration. A friend of mine, in the city, has gathered handfuls of them in this stage, and destroyed them.

A great deal may be done by netting them in the perfect or butterfly state, which, no doubt, is the best and surest method. Bring the boys into the field with nets, and, by capturing all they see, they prevent the depositing of the egg, and thus cut off the supply. When the larvæ have once got among the plants, to any extent, the destruction commences. When they appear in great numbers the best plan would be to plough up, and plant neither cabbages nor turnips on the farm, for a time, in the infested localities. This, of course, would be only in extreme cases.

Encourage the small birds on the farms: abstain from their destruction: they are undoubted benefactors of the agriculturist. It would also be a wise plan to turn fowls into the fields, and allow them full scope: they will give a good account of themselves. Nature will also help, no doubt. The innumerable ichneumons will soon find out the larvæ of the cabbage butterfly; in fact, they have already found them this summer. Their operations, on our behalf, will be felt a few seasons hence.

Insects, when first introduced into new countries, may find this food more juicy or better suited to their tastes than in the countries they left, and, therefore, commit greater havoc; besides, there are what are termed "insect years,"—that is, a certain species will be noticed in greater abundance one year than another. This may be accounted for by the mildness or severity of the season; or it may be influenced, to a very considerable extent, by "parasitic attacks," which latter is one of the many ways which nature takes to keep in check the many varieties of insects. We believe firmly that all insects, as well as other animals, have their peculiar parasite, and, in the majority of cases, are preyed upon by those creatures internally and externally. The most beneficial parasites to us, in connection with insect pests, are the ichneumons.

One of the reasons that *Pieris Rapœ* does not commit such ravages in England, is, no doubt, owing to the fact—one well attested by Entomologists—of the powerful check kept on this species in Europe by ichneumons.

Reaumur writes as follows:—"Out of thirty individuals of this common cabbage caterpillar, put into a glass to feed, *twenty-five* were fatally pierced by an ichneumon (*Microgaster globatus*)." Such a percentage of mortality must tell on a colony of caterpillars.

The question may here be asked, after the recommendation of hand-picking, netting, &c., is nature doing anything to help us in the matter of the cabbage butterfly in Canada? We answer in the affirmative. Any observer of the larvæ on cabbages will have noticed a small four-winged fly very actively running over the plants, looking as if it had lost something, running down this rib, then up that, under one leaf, then flying to another. By close attention you will see the cause of this uneasiness on the part of this little *hymenopter*, for so we call her, as she belongs to the Hymenoptera, or membranous winged order of insects. She is hunting the caterpillars of the cabbage butterfly, for the purpose of depositing her egg or eggs in their bodies. This she does by means of her ovipositor, piercing the body of the creature—but not in a vital part—so that her young may have a nidus where food will greet them immediately on their coming out of the egg. They then live on the juices of the caterpillar until they (the parasites) undergo their metamorphosis and attain the imago or winged state, when they eat their way out of the caterpillars' bodies and fly away. This is given as an illustration of one of Nature's methods of keeping in check noxious caterpillars. We noticed this circumstance last summer in connection with the cabbage butterfly. In all probability the preponderance of ichneumons will so affect the prospects of this insect that in a year or two they will become good colonists, and instead of producing want and famine they will ornament our Canadian landscape by their airy gambols and spare the cabbages.

Still farmers and gardeners should not leave all to nature, but would do well to use all precautions, those recommended here, or any other, which will be beneficial in keeping them in check.

There is no one particular remedy. The combined experience of all interested is necessary for the removal of the evil, by watching the habits, and thus learning more of the natural history of these creatures.

In conclusion, we would say that in a new country like this, where immigration is going on among *insects* as well as among *men*, it should be part of the duty of the Minister of Agriculture to know what insect emigrants may be taking up their abode with us to the injuries of our crops. And to this end it would be a wise step to appoint competent Entomologists throughout the Dominion (an appointment which has been so beneficial in the neighboring States) to warn the Agriculturist of his many enemies among insects and the best mode of getting rid of them.

In the last number of the *Naturalist* appeared a paper, by Dr. Sterry Hunt, on "The Probable Seat of Volcanic Action," which was reprinted from the *Geological Magazine* for June, and should have been credited to that journal, to which it was originally communicated. This explanation is rendered the more necessary from the fact that the paper in question is reprinted in *Scientific Opinion* for October 20, and there credited to the *Canadian Naturalist* as having been read before the Natural History Society of Montreal,—a very natural though incorrect inference, from the fact that the paper, by an oversight, appeared in our pages as an original communication.

MEETING OF THE BRITISH ASSOCIATION AT EXETER.

Want of space forbids our giving a detailed account of the proceedings at this interesting meeting. We have thought it advisable to give summaries only of some of the papers in the departments of Geology, Zoology and Botany. The next meeting will be held at Liverpool, with Prof. Huxley as President:—

GEOLOGY AND PALÆONTOLOGY.

THE DEVONIAN GROUP CONSIDERED GEOLOGICALLY AND GEOGRAPHICALLY, BY PROFESSOR GODWIN-AUSTEN.

This paper dealt with the probable distribution of land and water during the Devonian period, its fossil Zoology and Botany, and the physical changes which have taken place subsequently. Mr. Godwin-Austen briefly and popularly sketched the order of successive sea-beds, and showed that these represented geological periods. Of these the Devonian group was amongst the earlier. Our rocks, sandstone or otherwise, were simply sea-bottoms, and the geologist only referred them to their original condition in order that he might deduce their physical and zoological history. The Devonian rocks had a wide geographical extent in Europe, Asia, and America. In the latter country there was a broad band of old Silurian rocks which existed as dry land during the Devonian epoch. In Great Britain the Devonian rocks had a general direction from north-east to south-west. From the nature of the fossil fishes of these rocks, Mr. Austen came to the conclusion that the Old Red Sandstone was of fresh-water origin, as of all the existing fishes only six genera were related to the Ganoid family, and all of these were essentially of fresh-water habits. The dry land was covered with a series of great fresh-water lakes, like those of North America. Besides the strata deposited along the bottoms of these lakes there was a series of vast marine deposits, which are termed Devonian. The Old Red Sandstone group was a very perplexing one, and passed down into the Silurian at its base, and into the Carboniferous towards its upper portion. The most northern portion of Devonshire where rocks containing true Devonian fossils came up was Lynton. The author then traced the easterly direction of the Devonian group, showing how they cropped up beyond the chalk of Boulogne, and thence across Belgium and Prussia, into Bohemia and Russia. Prof. Phillips said the division of Old Red Sandstone as fresh-water, and Devonian as marine, made by Mr. Godwin-Austen, was very distinct. The former extended towards the north, and the latter towards the south. He expressed himself, however, as opposed to the fresh-water origin of red sandstones, simply because few fossils were found in them. Mr. Pengelly said he had found 300 specimens of Pteraspidian fishes in the Devonian rocks, as well as Cephalopoda. Mr. Edward Hull, F.R.S., expressed his hope that geologists would withhold their decision on Mr. Godwin-Austen's separation of the Old Red Sandstone and Devonian, and pointed out the three subdivisions of these formations in various places. He thought the evidence of fossil fish was not sufficient to establish the fresh-water origin of the Old Red Sandstone.

THE GRANITE OF THE NORTHERNLY AND EASTERNLY SIDES OF DARTMOOR, BY G. W. ORMEROD, F.R.S., &c.

This short paper was intended to serve as a guide to geologists visiting Dartmoor. Schorl and tourmaline are of frequent occurrence in the granites. South of Torquay are rock basins, of various shapes and sizes. Throughout the whole of Dartmoor the granite is much jointed, and sudden changes in the joints and stratification frequently occur. On the north of Dartmoor, near Belston, the granite bends under schistose rocks, and the present contour of the country may be attributed to this phenomenon. It was an uncertain point whether the Dartmoor granite was all of one age, but the "elvans," or veins crossing the mass, were of undoubtedly later age. A vein of fine porphyry may be seen on the road from Okehampton to Exeter. Mr. Ormerod said geologists visiting Dartmoor could not help asking what had become of the overlying rock masses, and what had been the agents which had cut the granite down to its present form. Mr. Pengelly had stated that some of the beds in the Isle of Wight had been formed out of the wear and tear of the granites of Dartmoor. The author had not found any glacial scratchings, but last year Professor Otto Jorell had visited with him the gravels near Hunt's Tor, and that geologist had declared it as his firm opinion that these were remains of *moraines*.

SOURCE OF THE MIOCENE CLAYS OF BOVEY TRACEY.

W. Pengelly, F.R.S., F.G.S., read a few notes on the above subject. All the beds of clay and sand at Bovey thin out towards Dartmoor. Most of these were formed of disintegrated granite. The clays are interstratified with the lignite, or coal beds, and the author thought that Mr. Maw and himself had referred to two different beds.

NOTES ON THE BRACHIOPODA HITHERTO OBTAINED FROM THE "PEBBLE-BED" OF BUDLEIGH SALTERTON, BY T. DAVIDSON, F.R.S., F.G.S.

The author had examined the specimens forwarded to him by Mr. Vicary and others. None of the rocks known to occur in England presented such a fauna, although in Normandy we have a bed of Silurian rock extant containing the same. Mr. Davidson could not account for the extraordinary mixture of Devonian and Silurian forms, except by supposing that some old land had been broken up. There were ten Silurian, ten Devonian, and fifteen undescribed species of brachiopoda. Mr. Winwood, Mr. Vicary, and Mr. Godwin-Austen afterwards spoke on the subject, the latter gentleman entering into a popular detail of the occurrence of these fossils. Mr. Salter was of opinion that when these "pebble-beds" were formed there was no break between England and Normandy. The fossils were derived from rocks which occur nowhere else than in Normandy. Mr. Davidson thought that at least one-half of the fossils found in the pebbles had been derived from local sources. Mr. Austen said that Lower Silurian fossils were found on the south coast of Cornwall. Mr. Pattison thought that the remarks which had been made only bore out the theory of Mr. Godwin-Austen, that a reef of palæozoic rocks had formerly stretched across what is now the English Channel. Mr. Etheridge pointed out that the Budleigh pebble-bed lay on the trias of Teignmouth, and thought that the pebbles had come from Normandy.

THE SOURCE OF THE QUARTZOSE CONGLOMERATES OF THE NEW RED SANDSTONE OF CENTRAL ENGLAND, BY EDWARD HULL, F.R.S., F.G.S.

The author referred to a supposed statement of Dr. Buckland, that the quartzite pebbles of the New Red Sandstone had come from the rocks of the Lickey, in Worcestershire. That geologist, however, only said they were very similar to them. Mr. Hull then proceeded to trace the probable origin of these pebbles. In South Lancashire and Cheshire these conglomerates attained a thickness of six and seven hundred feet. They were thicker as we proceeded northerly, and the author therefore thought we ought to look in the latter direction for their source. He produced pebbles from various counties, all of them liver-colored.

quartzites. One peculiarity about them was their well-rounded, water-worn form, never sub-angular. The author thought that these pebbles had gone through at least two periods of trituration, and he had some time ago come to the conclusion that all were originally derived from the Old Red Sandstone formation. This idea was verified when he went to study the old red conglomerates near Loch Lomond; and he thought the question of the origin of the new red conglomerates of Central England might now be regarded as settled. Mr. Maw, Mr. Pengelly, Mr. Godwin-Austen, and Prof. Huxley then continued the discussion of the subject, Mr. Austen objecting to the idea that a great amount of time is required to produce well-rounded shingle. Professor Huxley objected to the idea that a shingle bed could thicken seawards.

FRESH-WATER DEPOSITS OF THE VALLEY OF THE RIVER LEA, IN ESSEX, BY MR. HENRY WOODWARD, F.G.S., F.Z.S., OF THE BRITISH MUSEUM.

Certain excavations made by the East London Water Works Company had revealed the presence of shell marl, on the Walthamstow Marshes. The marl was accompanied by vegetable remains, and bog iron ore. All the shells are recent, and the most notable fact connected with the bed was the presence of bronze spear-heads, arrow-heads, knives, &c. These were accompanied by bones of man, wolf, fox, beaver, wild boar, red-deer, roebuck, fallow-deer, *rein-deer*, &c., as well as of the sea-eagle, and fishes. As late as the year 1700 the entire tract was forest-land. In 1154 the same country is described as abounding in wolves, wild boar, wild bulls, &c. Mr. Woodward thought that the maintenance of a Royal Forest had been the means of preserving this bed. In the deep cutting of the bed remains of the Mammoth were met with. The author thought much of the deposit might fairly be ascribed to the beaver working and making dams in the old valley of the Lea. Mr. Pattison said the implements were found in the upper, or historical portions of the beds mentioned. Mr. Woodward, in reply, said the discovery of the beaver, red-deer and rein-deer, within seven miles of London, was something astonishing.

EXPLORATION OF KENT'S CAVERN.

Mr. Pengelly, the Secretary of the section, read the fifth report of the Committee on the Exploration of Kent's Cavern, with notes on the Mammalian remains, and described the locality and the position of the different portions or apartments of the cavern. In that part of the cavern known as the vestibule is a layer of black soil from two to six inches thick, known as the Black Band. In that Black Band were found 326 flint implements, chips, bone tools, &c., and bones of extinct animals, some of which were partially charred. The theory was that this formed a portion of the residence of an ancient British family. To test the disputed question whether it could be used as a cooking place without suffocating the animals, half-a-dozen fagots were lighted, and five persons who acted as the judges decided that the objection on that score was not tenable. All the bones which had been collected had been separately packed and labelled, showing their original position. Over 50,000 bones were collected, and all separately marked. When they came to be examined there was found among them a bone needle with an eye capable of receiving small twine. It was broken, but was supposed to have been originally two-and-a-half inches in length. It had been exhumed on the 4th December, 1866, and belonged to the Black Band beneath the stalagmitic floor. A bone harpoon, or fish-spear, was also found beneath the Black Band. The report next gave an account of the researches made during the present year. Mr. Pengelly mentioned that there was a perennial spring which a mercantile company had proposed to utilize for the purposes of a brewery, using the cavern as their store for "the beverage" which they brewed. He described the narrow passage leading from certain portions of the cave to other portions. These were, in some cases, so small as to require explorers to progress in a recumbent position and by a vermicular motion. In the cavern were found initials of individuals, and names and dates. One remarkable one was "Robert Hedges, of Ireland, February 20, 1688," and it was believed that the date was genuine. It was inscribed on the stalagmite, and proved that the drip of two-and-a-half centuries had not been enough to obliterate the inscription. Mr. Pengelly caused some amusement by exhibiting a collection of modern articles found in the lake, which had been emptied, consisting of such things as a ginger beer bottle, a mutton bone, an oyster shell, a hammer, a chain, candle, and candle sconce. An elephant's tooth was also found. They had also, this year, made a most important advance in their researches by the discovery of evidence of the existence of man at a point in the remote portion of the cavern—" the lower cellarage," as Mr. Pengelly called it. On the 5th of March last a flint flake was found, which there could be no doubt had been produced by human agency. The flake has been laid before Mr. Evans, F.R.S., who had examined and reported upon it. He said it was undoubtedly of human workmanship, and carried on it evidence of its having been used as a tool, the edge being slightly worn away and jagged. The hill was tunnelled by burrows of foxes and other animals. A small bell had been found—such as was used to tie on a terrier when sent into a burrow. The depth of the lake was mentioned as an average of 5ft.

Professor Dawkins added some remarks on the "dry bones" of the animals found in the cavern. The various strata of the cavern, he said, contained remains of animals of different epochs from the post-glacial upward. During the time the Black Band was being formed it would appear from the remains found in it that the cavern was inhabited by a race of men, who not only lived on the other animals, but on their own race. The older deposits contained undisputable traces of the glutton, a species of hare, known to the French palæontologists, and rather larger than our own. He concluded with remarks on the antiquity of the human race as indicated by the facts mentioned in the report.

ON THE "ENTRANCE OF THE MAMMOTH" BY MR. H. H. HOWORTH.

He reviewed the various historical notices in old authors of the mammoth remains in Siberia and elsewhere. The common idea once was that the mammoth was a sort of huge mole which burrowed beneath the surface of the earth, and whose motions could be traced by the upheaving of the soil as the creature traversed its cave below. This was one way by which they accounted for the vast remains found, and another that at the deluge, the bodies, after floating about were washed into caverns. Mr. Howorth did not think the extinction of the *mammoth* ought to be ascribed to the men of the early stone age. He believed the extinction of the mammoth was simultaneous with the disappearance of a specific and distinct race of men from the same region.

Professor Phillips offered some remarks on the history of the mammoth generally. He dwelt at some length on the more popular geological notions of the former condition of northern geography. The great points received, he observed, were—the mammoth being contemporaneous with man—"When did it cease to live?" and "Where did it appear for the last time?" They would never understand Kent's Hole completely until they had solved these points.

Professor Boyd Dawkins in reply to a portion of Mr. Howorth's remarks, said he had been misunderstood. He had never said that the extinction of the mammoth in Siberia was owing to its been hunted down, but he had stated that in England and Western Europe generally there was no doubt that the mammoth had become extinct by the hand of man. He also shewed that the mammoth had lived when arctic animals existed.

Mr. Howorth, in reply, still differed from Professor Dawkins as to the cause of the extinction of the mammoth. The race of men existing at the time in the regions where the mammoth was found was not able to cope with so gigantic a creature. With regard to the second question put by Professor Phillips, he fixed the north-east corner of Siberia as the spot where the last mammoth lived.

"ON THE TRAPPEAN CONGLOMERATES OF MIDDLETON HILL, MONTGOMERYSHIRE," BY M. G. MAW.

This was a description of the contemporaneous traps of Lower Silurian age in the ridge known as Middleton Hill, running parallel with the Breiddens, on the borders of Shropshire and Montgomeryshire. Especial reference was made to the great beds of bouldered trap, consisting of boulders of compact felstone imbedded in a softer matrix of felspathic tuff. The nodules occupy about half the mass of the conglomerate, and are unaccompanied by pebbles of any other rock. They vary from the size of a walnut to rounded masses of more than a hundred weight. Sir R. Murchison's description of these beds was referred to, and the author took exception to the term "concretionary traps" employed in the Silurian system, as he considered that the rounded outline of the boulders was unquestionably due to mechanical causes. The interbedded traps, bounded on either side by Lower Llandeilo Flags, are of a collective thickness of about 780 feet, including two beds of the bouldered felstone 115 to 140 feet thick, alternating with two beds of whitish-green felspathic breccia, 210 to 315 feet thick. The line of separation between the breccia beds and the beds of boulder trap is remarkably sudden and no gradation of character occurs between them. The breccia is worked for hard felspar used for pottery purposes, and contains small nests of steatite. The bouldered condition of the felstone beds was considered due to their partial breaking up on being erupted under water, the soft matrix of felspathic tuff being the portion more intimately divided, and the compact boulders, fragments that had resisted disintegration. The sudden alternation in Middleton Hill of eruptive beds of very dissimilar character was noticed; they seem all to have been emitted in immediate succession, as although overlain and underlain by sedimentary deposits. There is no evidence of interstratification of sedimentary beds. The author, in conclusion, pointed out the close geographical association with these bedded traps, of the much later porphyritic greenstone of the Breidden Hills, which it was suggested might have been emitted from the same points of eruption; and the local association of the intrusive greenstones with the lower silurian interbedded felstones was noticed as being very general in N. Wales.

Professor Dawkins said he had by accident very recently explored the same district as had been described by Mr. Maw, and he could corroborate his statements. There could be no doubt that the boulder track was due to the attrition of waves. He asked for some further information as to the appearance of the great mass of freestone after the close of the triassic era.

Mr. Maw replied to Mr. Dawkins by citing the authority of Sir R. Murchison.

ZOOLOGY AND BOTANY.

COLOUR IN BIRDS.

(From the President's Address.)

The Turaco, or plantain-eater, of the Cape of Good Hope is celebrated for its beautiful plumage. A portion of the wings is of a fine red colour. This red colouring matter has been investigated by Professor Church, who finds it to contain nearly six per cent. of copper, which cannot be distinguished by the ordinary tests, nor removed from the colouring matter without distroying it. The colouring matter is in fact a natural organic compound of which copper is one of the essential constituents. Traces of this metal had previously been found in animals—for example, in oysters, to the cost of those who partook of them. But in these cases the presence of the copper was merely accidental; thus oysters that live near the mouths of streams which came down from copper-mines, assimilated a portion of the copper salt, without apparently its doing them either good or harm. But in the Turaco the existence of the red colouring matter which belongs to their normal plumage is dependent upon copper, which, obtained in minute quantities with the food, is stored up in this strange manner in the system of the animal. Thus in the very same feather, partly red and partly black, copper was found in abundance in the red parts, but none or only the merest trace in the black.

This example warns us against taking too utilitarian a view of the plan of creation. Here we have a chemical substance elaborated which is perfectly unique in its nature, and contains a metal the salts of which are ordinarily regarded as poisonous to animals; and the sole purpose to which, so far as we know, it is subservient in the animal economy is one of pure decoration. Thus a pair of the birds which were kept in captivity lost their fine red colour in the course of a few days, in consequence of washing in the water which was left them to drink, the red colouring matter, which is soluble in water, being thus washed out; but except as to the loss of their beauty it does not appear that the birds were the worse for it.

REPORT OF THE "CLOSE TIME" COMMITTEE.

On behalf of the Committee, Mr. Dresser advocated a close time being secured for various birds in the same manner as is secured in foreign countries. The discussion was principally remarkable for the remarks of Professor Huxley against having a close time at all, and against the Preservation of Animals, &c., Act, particularly in its application to the deep-sea fisheries. Professor Huxley contended that that Act was useless, mischievous and meddling; and stated that the gulls, which had been protected by recent legislation, were of no further use, and could be put to no higher service, than when they furnished their plumage to surmount the bonnets of the interesting sex. He generally ridiculed the idea of having a legislative "close time" for such birds. Opposite views were advocated by the Rev. H. B. Tristram, Mr. Wallis, Professor Newton and Miss Becker. Some very interesting examples were given by Mr. Smith of the effect of the preservation of birds in the Scilly Isles. He had preserved birds there for many years, and found that while some would increase, others would decrease, being pushed out by stronger and more rapacious kinds of birds. The Rev. H. B. Tristram read a paper on the "Effect of Legislation on the Extinction of Animals," strongly advocating legislative means being used to prevent the extinction of wild animals, and particularly birds. In the discussion which ensued, the opinions generally expressed were in favour of this view.

DEEP SEA DREDGING.

The Rev. A. Norman, F.G.S., read a letter from Professor W. Thomson on the successful dredging of H.M.S. *Porcupine* in 2,435 fathoms. He said—in a few words of introduction—there could be no great progress in the work of sea dredging without the aid—first, of the Royal Society, and secondly, of the Government. They would remember that Professor Forbes had laid it down as an axiom that life did not exist in the sea below 300 fathoms in depth, to which conclusion he was led by his investigations in the Ægean and Mediterranean Seas. The results was a warning to them not to theorise on individual facts. Subsequently living forms were obtained from the Atlantic at greater depths. But since the last meeting of the British Association at Norwich, an enormous stride had been made in these investigations. At that meeting Professor Huxley read a paper on a form of life drawn up from the Atlantic. Since then great efforts have been made in several parts of the world by deep sea dredgers, amongst whom was Dr. Percival Wright, who had made investigations off the Spanish coast. Professor Sars had made a communication on the distribution of animal life in the depths of the sea, and enumerated 427 species. The work had been assisted by the Royal Society and the Government. The late Government had sent the *Lightning* to dredge in the sea between the Hebrides and the Faroe Islands, and an account of that expedition was given by Dr. Collins in the Transactions of the Royal Society. That expedition showed that there were currents of different temperature running side by side. In one place the temperature at the surface was 54°, and at the bottom 47°; and in the other the surface was 54° and the bottom 32°. He considered that one was the back current of the water that had coursed from the tropics to the poles. Mr. Norman then read the following letter from the Professsor:

"BELFAST, Aug. 7, 1869.

"My dear Norman,—You are already aware that, during the first cruise of this year, Mr. Jeffreys and his party dredged and took most important thermometrical and other observations to a depth of 1,476 fathoms. When I took Mr. Jeffrey's place for the second cruise, it was the intention to proceed northwards, and to work up a part of the north-west passage, north of Rockall. I found, however, on joining the vessel, the gear in such perfect order, all the arrangements so excellent, the weather so promising, and the confidence of our excellent commander so high, that, after consulting with Capt. Calver, I suggested to the hydrographer that we should turn southwards, and explore the very deep water off the Bay of Biscay. I was anxious that, if possible, the great questions of the distribution of temperature, &c., and of the conditions suitable to the existence of animal life, should be finally settled, and the circumstances seemed singularly favourable. No thoroughly reliable soundings have been taken beyond 2,800 fathoms, and I felt that if we could approach 2,500, all the grand problems would be virtually solved, and the investigation of any greater depths would be a mere matter of detail and curiosity. The hydrographer at once consented to this change of plan; and on the 17th of July we left Belfast and steered round to Cork, where we coaled, and then stood out towards some soundings, about a couple of hundred miles south-west of Ushant, marked on the Admiralty charts 2,000 fathoms and upwards. On the 20th and 21st we took a few hauls of the dredge on the slope of the great plateau, in the mouth of the Channel, in depths from 75 to 725 fathoms, and on the 22nd we sounded with the 'Hydra' sounding-apparatus, the depth 2,435 fathoms, with a bottom of fine Atlantic chalk-mud, and a temperature registered by two standard Miller-Six's thermometers of 35·5° Fahrenheit. A heavy dredge was put over in the afternoon, and slowly the great coils of rope melted from the 'Aunt Sallies,'—as we call a long line of iron-bars with round wooden heads, on which the coils are hung. In about an hour the dredge reached the bottom, upwards of three miles off. The dredge remained down about three hours, the Captain moving the ship slowly up to it from time to time, and anxiously watching the pulsations of the accumulator, ready to meet and ease any undue strain. At nine o'clock P. M., the drums of the donkey-engine began to turn, and gradually and steadily the 'Aunt Sallies' filled up again, at the average rate of about 2 ft. of rope per second. A few minutes before one o'clock in the morning 2 cwt. of iron—the weights fixed 500 fathoms from the dredge—came up, and at one o'clock precisely a cheer from a breathless little band of watchers intimated that the dredge had returned in safety from its wonderful and perilous journey of more than six statute miles. A slight accident had occured. In going down the rope had taken a loop round the dredge-bag, so that the bag was not full. It contained, however, enough for our purpose—1½ cwt. of 'Atlantic ooze'; and so the feat was accomplished. Some of us tossed ourselves down upon the sofas, without taking off our clothes, to wait till daylight to see what was in the dredge. The next day we dredged again in 2,098 fathoms, practically the same depth, and brought up 2 cwt. of ooze—the bottom temperature being 36·4°; and we spent the rest of the day in making what will, I am sure, prove a most valuable series of temperature observations at every 250 fathom-point from the bottom to the surface. These enormously deep dredgings could not be continued. Each operation required too much time, and the strain was too great both upon the tackle and upon the nervous systems of all concerned, especially of Capt. Calver and his officers, who certainly did all that could be compassed by human care, skill and enthusiasm, to ensure success. We crept home, dredging in easier depths. We start again to-morrow, and, as you may suppose, I have enough to do. I can, therefore, only give you the slightest possible sketch of our results, anticipating fuller information when I have time to collate the diaries and to look over the specimens. First, as to the temperature. The super-heating of the sun extends only to the depth of about 20 fathoms. Another cause of super-heating, probably the gulf-stream, extends to the depth of from 500 to 700 fathoms. After that the temperature gradually sinks at the rate of about 0·2° for every 200 fathoms. This is probably the normal rate of decrease, any deviation being produced by some special cause—a warm or a cold current. Secondly, the aeration of the water. Mr. Hunter, who accompanied me as physicist, found the water from great depths to contain a large excess of carbonic acid, and he found the water from all depths to contain a considerable proportion of dissolved organic matter; thus in every way bearing out the observations of Mr. W. L. Carpenter during the first cruise. Thirdly, distribution of life. Life extends to the *greatest* depths, and is represented by all the marine invertebrate groups. At 2,435 fathoms we got a handsome dentalium, one or two crustaceans, several annelids and zephyrea, a very remarkable new crinoid, with a stem 4 inches long,—I am not prepared to say whether a mature form or a *Pentacrinoid*,—several star-fishes, two hydroid zoophytes, and many Foraminifera. Still the Fauna has a *dwarfed* and Arctic look. This is, doubtless, from the cold. At 800 to 900 fathoms, temperature 40° Fahr. and upwards, the Fauna is rich, and is specially characterized by the great abundance of vitreous sponges, which seem to be nearly related to, if not identical with, the ventriculites of the chalk. This year's work has produced many forms new to science and many new to the British Fauna. Among the most remarkable in the groups I have been working at I may mention a very singular Echinoderm, representing a *totally new group* of the sub-kingdom,—a splendid new Ophiurid,—many specimens of Sars's Rhizocrinus Loffotensis,—many vitreous sponges, including specimens of Aphrocallistes, Holtenia and Hyalonema,—a fine Solarium from the coast of Kerry, and many other things. As I am only writing in the interval of scaling the boiler, with no opportunity of going over the collections, you must accept this sketch. I trust to your contributing the Crustacea, which will be sent to you as soon as possible. I will write again from Lerwick.—Ever truly yours,

WYVILLE THOMSON."

Professor Huxley hoped that the meeting would not go away with the idea that scientific men had coincided with the views of the late Mr. Forbes as to the depth at which life could not exist in the ocean. These views had never been accepted by scientific men, and for the real conclusions of science they must not be content with consulting "text books," which the Professor styled a sort of literary *chiffonier*. The results obtained by deep sea dredging were of the greatest moment to science. They showed that the cretaceous formation was continued till the present day. The history of chalk extended back to millions of years beyond the recorded history of man. That was established in science, and could not be upset. Suppose that in Central Africa we found a colony of the ancient Egyptians still living, with their physique, dress, and appearance exactly as they were of old—that would not be one-tenth so marvellous and important as the facts which showed that the creatures that lived in the old chalk age had their posterity and exact counterparts still living. The Professor observed that the discoveries made showed that there was a gigantic network of a jelly-like life encircling the globe.

Dr. Hooker also stated that Professor Forbes's hypothesis had never been accepted by scientific men. Dr. Percival Wright made some observations on soundings. Mr. Norman wished to guard the Association against supposing that deep sea soundings were recent. It was the dredging only which was recent.

ON THE LAW OF DEVELOPEMENT OF CEREALS: BY MR. F. F. HALLET, OF BRIGHTON.

Mr. Hallet's experience showed him several years ago that corn, and especially wheat, was injured by being planted too closely. He found a wheat plant would increase above the ground in proportion as its roots had room to develope, and that the roots might be hindered by being in contact with the roots of another plant. Mr. Hallet continued a series of experiments, planting one grain of wheat only, and succeeded so well in improving the method of cultivation as to raise wheat, whose ears contained 123 grains, or more than 60 on each side. In the course of his investigations, Mr. Hallet made other discoveries with regard to the growth of cereals which he sums up as follows:—" 1. Every fully developed plant, whether of wheat, oats, or barley, presents *an ear superior in productive power* to any of the rest on that plant. 2. Every such plant contains one grain, which, upon trial, proves more productive than any other. 3. The best grain in a given plant is found in its best ear. 4. The superior vigour of this grain is transmissible in different degrees to its progeny. 5. By repeated careful 'selection' the superiority is accumulated. 6. The improvement which is first raised gradually, after a long series of years is diminished in amount, and eventually so far arrested that, practically speaking, a limit to improvement in the desired quality is reached. 7. By still continuing to select, the improvement *is maintained*, and practically a fixed type is the result." In the discussion which ensued, Mr. Hallet was warmly complimented upon the results he had attained, and the gigantic ears of wheat which he exhibited were examined with the greatest interest by those in the room.

INAUGURATION OF THE PEABODY ACADEMY OF SCIENCES AT SALEM, MASSACHUSETTS.

"The various alterations and improvements in the East India Marine Hall at Salem, which were necessary to accommodate the large and valuable collections intrusted to the care of the Peabody Academy of Science by the Essex Institute and the East India Marine Society, having been completed, the occasion of the visit of the American Association for the Advancement of Science was taken advantage of to dedicate the Academy to the uses for which it was designed by its founder."

The inauguration took place on the morning of the 18th of August, 1869.*

It will be probably remembered that Mr. George Peabody, in the year 1867, established a trust, and liberally endowed it with the sum of $140,000, for, to use his own words, "the promotion among the inhabitants of my native county" (Essex Co., Mass.) "of the study and knowledge of the natural and physical sciences, and their application to the useful arts." The following extract from the address of Mr. W. C. Endicott at the dedication of the building will give some idea of the way in which the trustees have endeavoured to carry out the wishes of the far-seeing and enlightened founder of the institution:—

"It would be impossible, and by no means desirable, to recite what the museum contains, or the particulars of its arrangement. Three general objects were steadily kept in view.

First. The formation of a complete collection of the fauna, flora, geology and mineralogy of the county of Essex, so that all can have the means of becoming acquainted with the various objects of nature to be found on every hand. Great progress had already been made in this direction by the Essex Institution, and the western gallery is now devoted to all the specimens now in possession of the academy founded in the county of Essex.

Second. To complete, as far as practicable, the noble beginning already made by the East India Marine Society, of a collection illustrative of the habits and customs of the various

* The greater part of this article is taken from the columns of the *Boston Daily Advertiser.*

tribes and natives living beyond the Cape of Good Hope and Cape Horn, with whom the founders of that society carried on so large a trade, and also to preserve as far as possible the remembrance of that trade, and of the society itself, by models of the vessels employed and by a collection of portraits of those who, either as owners or navigators, were its pioneers. To these collections the eastern side of the hall is devoted, and large additions have also been made to them by the Academy, relating to the Indians of North America, especially those who lived in the neighbourhood.

Third. The arrangement of the general collection upon the simplest possible plan, that of bringing together the different divisions according to their structural affinities. This arrangement is intended to be limited, for the present certainly, to the wants of the public and the general student, in other words to be such a display of typical specimens, that every intelligent visitor may find the means of investigating the more general laws which govern the natural affinities of animals, plants and minerals. In the accomplishment of this purpose it was thought proper to suppress all useless details. Information in regard to the minor points of structure, which can only be conveyed by a large number of closely allied forms, is of no value to the general observer. On the contrary, it tends to confuse and distract attention from general principles, and concentrate it on questions of limited application, of no practical importance, except to the special student. We are aware that the difficulties in the way of this arrangement are by no means confined to the selection of suitable specimens or their disposal in regular order. When placed in their most perfect condition, classified and labelled according to their different relations to each other, or to the circumstances of their geographical or geological distribution, they still are but dumb illustrations of the laws of nature. They are indeed the best possible illustrations, and rank next to the living facts in exactitude and truthfulness, but still they are only the illustrations of the book of nature, of which the text book is still unwritten. To complete the plan therefore, and make the museum all that it should be, catalogues are needed, which shall be to some extent abbreviated text-books. And it is believed by the gentlemen in charge of the museum that they can be so made, that any desirous of information in regard to any of the groups of the three kingdoms, may find not only a statement of the laws of their classification, but objects so prepared and arranged that he can readily obtain the information desired. Such is the plan upon which the museum has been arranged. We cannot say it is yet fully completed, but we trust it may in some degree meet the requirements for which it is intended. While the completion of the museum has been the main object thus far, the trustees were of opinion it would be wise to begin at once upon a small scale what at some time we hope to do on a large and extended scale. Provision was therefore made in our by-laws for lectures and also for the publication of papers strictly scientific, to be called the "*Memoirs of the Peabody Academy of Science.*" One paper has already been published, which we trust will be the first of a continuous series. One course of lectures has been given by Messrs. Putnam, Morse, and Hyatt, and it is hoped that we may commence another season with a course of lectures to be delivered by the above named gentlemen, assisted by some of the trustees from various portions of the county. These may be regarded as the commencement of a series of lectures, regular and systematic, which will be one of the chief instrumentalities for the diffusion of that knowledge which Mr. Peabody intended to afford to the county of Essex.

The lectures must be given chiefly in the rooms and the halls of the academy, when finished, but at stated periods they should be delivered in the several cities and towns of the county, and before various local societies, schools, and classes.

And here it may be remarked that lectures affording solid instruction in an agreeable and interesting way, are much needed in this community. The persons who for the most part supply the popular lecture platforms are either professional lecturers, given to sensational declamatory fine writing, gentlemen of some general reputation obtained in other fields, or the advocates of some particular hobby or reform. Lectures are given and attended, not for instruction and improvement, but to gratify curiosity, or to afford amusement or excitement to audience.

The results is that the lecture now seldom instructs. Aiming at other ends, the modest rewards of the scholar and man of science are no longer the measure of payment, and the prices have risen to an exorbitant rate. Lecturers swell their incomes by a winter's tour at one or two hundred dollars a night. They are paid as opera singers are paid. The lecture platform is thus forced to pay a heavy tribute, and in the smaller towns and communities the performance is beyond the reach of the people. It would be idle, even if it were desirable, to attempt a change in this condition of things, or to enter into a crusade against the present system, bnt it would seem that much might be done in this county by an institution like this coöperating with local societies, to furnish that which Lyceums no longer supply.

But the formation of a museum, which is the first and most definite object named in the instrument of trust, yet constitutes but a part of Mr. Peabody's scheme. After it is finished and such buildings as may be required are completed, the income is to be devoted in certain proportions to the departments of the physical and natural sciences. In what way this shall be done the instrument of trust does not state. This is left in the fullest manner to the discretion of the trustees.

In the early stages of an institution, it is somewhat difficult to lay down a definite plan of operations; certainly it would be unwise to encumber ourselves with any inflexible formula of action or management. Circumstances may change, or our means may be insufficient. In stating, therefore, the purposes of the trustees, I state that which now seems to them most desirable, and the best method, in connnection with the museum, of promoting, to use the precise words of the trust, "among the inhabitants of the county of Essex, the study and knowledge of the natural and physical sciences, and their application to the useful arts.

These words clearly define three distinct objects. The aid to be afforded to the student of the sciences. The aid to all in the pursuit of a knowledge of the sciences. The advancement of the material prosperity of the county by the application of science to practical purposes. Having these objects in view, the following plan is proposed:—

1. "To promote the study of the natural and physical sciences," it is proposed to offer inducements to teachers and scholars to enter upon the special study of the sciences.

The practical execution of this would be as follows:—To give courses of lectures to the Normal School as often as practicable; to give courses of lectures of a strictly educational character to teachers, persons interested in science, and select classes of students combined in different parts of the county; to distribute collections properly named, labelled and mounted, to the schools, suitable for the practical illustration of text books and lectures, provided the school committee or others receiving them will agree to preserve and use the same for the benefit of students, or return them without unnecessary delay to the academy: to afford to all special students who manifest an earnest desire to study science, the opportunity of doing so free of charge for tuition.

2. "To promote a knowledge of the sciences among the people," it is proposed to give courses of lectures to public audiences; to give practical discourses of a conversational and informal character, at certain hours, in the halls of the academy, illustrating them with the collections; to print catalogues of the collections, which shall be abbreviated text-books of the different departments, and convey to the visitor lessons upon the principles which have governed their arrangement: to print one general catalogue on the same plan, which shall be compiled from the others, but illustrated by a separate collection in the museum; to sell these catalogues at as low a price as possible: to encourage the formation of scientific associations for the promotion of knowledge, by giving collections, properly labelled and arranged, provided the recipients agree to furnish proper cases, make them the nuclei of local collections, and use them for the benefit of the public, or return them without unnecessary delay to the academy; to provide inexpensive means of communication for investigators in distant parts of this country, and in Europe, for the transportation, exchange, and purchase of books and instruments of a scientific character: to encourage any worthy publication of a scientific character which may be issued within the limits of the county.

3. To promote the "application of the natural and physical sciences to the useful arts," it is proposed to organize a systematic survey of the county, and that the means of accomplishing it may be provided, it is recommended that every salaried officer and special student of the academy be required to study some scientific subject of local application, and contribute his knowledge in a written communication for the use of the survey, that these communications be published, whenever practicable, by the academy, under the general title of "The Annals of the Scientific Survey of Essex County;" that all explorations and investigations upon local subjects of a worthy character be encouraged, and, if of sufficient importance, published in the "Annals."

In addition it is proposed to obtain a full set of works which would facilitate the arrangement and use of the collections, by exchange with other societies and institutions issuing works of a scientific character; to purchase, when the funds justify the expenditure, such books and pamphlets as may be from time to time needed by the officers of the museum in the arrangement of the collections. The geographical position of the academy and its natural advantages, impose upon its officers certain duties to science. These are, to supply institutions and individuals situated in the interior with typical collections of native products, especially the marine animals and plants, properly named and labelled, to regard these collections as exchanges, and a means of completing and increasing the museum, but to give them freely as donations, whenever it may be for the benefit of science to make the exception.

Such is the museum we to-day dedicate, such the general plans and views of those intrusted with its management. That such a plan is practicable, and would result in promoting in this vicinity the study and knowledge of the sciences, and their application to the useful arts, we have no question. How far we shall be able to carry it out, and whether we can with our present means accomplish more than a part (of that there is no doubt), the future must determine."

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Eighteenth Meeting, held at Salem, Mass.

From among the numerous papers of interest read at the above meeting, we give abstracts of the following: *

ON TWO NEW GENERA OF EXTINCT CETACEA.

By Prof. Cope.

In this paper a description was given of the characters of a very large representative of the Dugong of the modern East Indian seas, which was found in a bed, either Miocene, or Eocene, in New Jersey. It was double the size of the existing Dugong, and was interesting as adding to the series of Asiatic and African forms characteristic of American Miocenes. Another type was

* These extracts are selected and adapted from the columns of the *Boston Daily Advertiser*.

regarded as remotely allied to Squalodon, but it was edentulous, and furnished with a broad shallow alveolus, either that left after shedding a tooth, or that adapted to a broad obtuse tooth. It constituted a remarkable new genus which was called *Anopolonassa forcipata.* It was found in postpliocene beds near Savannah. He also exhibited teeth of two gigantic species of Chinchilla which had been discovered in the small West India island of Anguilla, which has an area of but about thirty square miles. The specimens were taken from caves, and were thought to indicate postpliocene age. With them was discovered an implement of human manufacture, a chisel made from the lips of the shell *Strombus gigas.* The contemporaneity of the fossils and human implements was supposed, but not ascertained. Its interest and connection with human migrations was mentioned; also the supposition of Pomel, that the submergence of the West India islands took place since the postpliocene period.

ON THE EARLY STAGES OF BRACHIOPODS.

By Prof. E. S. Morse.

Mr. Morse said he made a visit to Eastport, Maine, early in the summer, for the purpose of discovering the early stages of a species of Brachiopod (*Terebratulina septentrionalis*, Couth), so abundant in those waters. As little had been known regarding the early stages of this class of animals, the facts presented were of interest, as settling, beyond a doubt, their intimate relations with the Polyzoa. We can only give a few of the more important features mentioned. In a few individuals the ovaries were found partially filled with eggs. The eggs were kidney-shaped, and resembled the statoblasts of Fredericella. No intermediate stages were seen between the eggs and the form represented, which he proved on the blackboard. This stage recalled in the general proportions Megerlia or Argiope, in being transversely oval, in having the hinge-margin wide and straight, and in the large foramen. Between this stage and the next the shell elongates until we have a form remarkably like Lingula, having, like Lingula, a peduncle longer than the shell, by which it holds fast to the rock. It suggests also in its movements the nervously acting Pedicellina.

In this and the several succeeding stages, the mouth points directly backward (forward of authors), or, away from the penduncular end, is surrounded by a few ciliated cirri, which forcibly recall certain Polyzoa. The stomach and intestine form a simple chamber, alternating in their contractions, and forcing the particles of food from one portion to the other. At this time, also, the brownish appearance of the walls of the stomach resembles the hepatic folds of the Polyzoa. In another figure he showed a more advanced stage, where a fold was seen on each side of the stomach; from this fold the complicated liver of the adult is developed, first, by a few diverticular appendages.

When the animal is about one-eighth of an inch in length, the lophophore begins to assume the horseshoe-shaped form of Pectinatella and other high Polyzoa. The mouth at another stage begins to turn towards the dorsal valve (ventral of authors), and as the central lobes of the lophophore begin to develope, the lateral arms are deflected. In these stages an epistome is very marked, and it was noticed that the end of the intestine was held to the mantle by attachment, as in the adult, reminding one of the *funiculus* in the *Phylactolæmata*.

Prof. AGASSIZ rose at the termination of the reading of Mr. Morse's paper, and said that it had been many a year since he had listened to a paper more important to the progess of science. That now, after many years and many failures, they had at length a foundation for the homologies of the Brachiopods. He also recommended that this paper should be published, not with the usual meagre illustrations, but with a fullness worthy of the subject. He regretted that Mr. Morse had not given them more of the details of his investigations.

VERTEBRATE REMAINS IN NEBRASKA.

By Prof. O. C. Marsh.

The locality described by Prof. MARSH was the Antelope Station, on the Pacific Railroad, in south-western Nebraska. While engaged in sinking a well at that place, in June, 1868, a layer of bones was found by the workmen at a depth of sixty-eight feet below the surface, which were at first pronounced to be human, but during a trip to the Rocky Mountains, Professor Marsh examined the locality and bones, and found that the latter were remains of tertiary animals, some of which were of great interest. The well was subsequently sunk about ten feet deeper, and the bones obtained were secured by the professor. An examination proved that there were four kinds of fossil-horses, one of which he described in November last as *Equus Parvulus.* Although it was a full grown animal, it was not more than two and one-half feet high. It was by far the smallest horse ever discovered. Of the other kind of fossil horses one was a three-toed horse of the Hipparion type. Including the above the number of species of fossil horses discovered in this country was seventeen, although the horse was supposed to be a native only of the old world, and was first introduced here by the Spaniards. Of the other remains there were two carnivorous animals, one about the size of a lynx and the other considerably larger than a lion—the last twice as large as any extinct carnivore yet discovered in this country. Among the ruminants found in this locality was one with a double metatarsal bone, a peculiar type, only seen in the living aquatic musk deer and in the extinct Anoplotherium. There were also the remains of an animal like the hog, a large rhinoceros, and two kinds of turtles. These, together forming fifteen species of animals, and representing eleven genera, were all found in a space ten feet in diameter and six or eight feet in depth. It is supposed that the locality was once the margin of a great lake, and that the animals sunk in the mire when they went down to the water to drink.

At the close of Professor Marsh's address, Professor AGASSIZ made a few interesting remarks on the possibility of determining genuine affinities from fragmentary fossil remains, after which he read a paper on the Homologies of the Palæchinidæ, partially prepared by his son, ALEXANDER E. R. AGASSIZ.

ON THE GEOLOGY OF THE COAST OF MAINE.

BY PROF. S. W. JOHNSON.

In this paper an account was given of the geology of that part of the coast of the State of Maine between the mouths of the Kennebec and Penobscot rivers. The coast of Maine, the author stated, may be called a coast of denudation, and takes its present conformation from the rocks underlying the soil, the waves of the Atlantic having long since removed everything that is movable. The rocks of this region are metamorphic, and lie in immense folds, nearly parallel with each of the rivers, Kennebec, Sheepscot, and others further east, occupying the synclinal axes between the folds. Most of the islands lying off this coast are only continuations of the promontories constituting these folds. Monhegan is an exception to this, being, as the professor believes, a part of an immense trap uplift of the same age as the trap dike at White Head Island, and other places further north.

He spoke also of the markings on a rock on Monomah Island, which lies by the side of Monhegan. These markings, he was disposed to consider not artificial characters, but as produced by the action of the atmosphere upon the partially crystalline rock.

Prof. AGASSIZ made a few remarks at the close of Prof. Johnson's paper, after which an essay "on Norite or Labradorite Rocks," was read by Dr. T. STERRY HUNT, F.R.S.

SOME NOTES ON THE CHEMISTRY OF COPPER.

By T. STERRY HUNT, L.L.D., F.R.S.

Copper in its cupreous form presents some relations to silver which were pointed out. Cupreous oxyd, like oxyd of silver, decomposes many protochlorids, as those of magnesium, zinc, manganese, cobalt, and iron, forming cupreous chlorid. This, though insoluble in water, is readily soluble in solutions of chlorids, as of sodium and magnesium, especially if hot and concentrated, but is in large part separated by cooling, and by dilution. From solutions of chlorids of zinc and manganese the red oxyd of copper precipitates insoluble oxychlorids of these metals. From chlorid of magnesium pure hydrated magnesia separates. With ferrous chlorid the reaction is more complex, since ferrous oxyd reduces cupreous chlorid, giving metallic copper, so that the iron separates as ferric oxyd, together with one-third of the copper in the metallic state. In presence of an excess of ferrous oxyd the whole of the copper is reduced to the metallic state. Cupric oxyd, in like manner, decomposes ferrous chlorid with production of ferric oxyd, while two-thirds of the copper are obtained as cupreous, and one-third as cupric chlorid. These results are best obtained in presence of strong hot solutions of chlorid of sodium, which dissolve the cupreous chlorid. The relations, both geological and economical, of these reactions, were then alluded to.

TRICHINA SPIRALIS.

Dr. J. BAKER EDWARDS read a paper with the above title, which appeared in the last number of this journal.

COAL AND IRON IN CHINA.

By Prof. A. S. Bickmore.

The object of the paper was to show that, although China is and has been for many ages the most densely peopled area on the suface of our earth, yet her natural resources remain to be developed, and that these resources are so ample that there is a bright future for China now that the enterprise of Europe and America is to join hands with the untiring industry of her people. Professor Bickmore, who has travelled very extensively in China, gave a full list of the localities where all the above minerals are found, and some statements tending to indicate a great yield in all these mines. Coal was used for fuel ages before its properties were known to Europeans. Marco Polo, the great Venetian traveller, who visited Pekin more than six hundred years ago, found it in common use. The only mode of transporting this mineral in the northern parts of China is on the backs of camels, mules and donkeys. Professor B. described a mine near Pekin, which he descended for a mile, being obliged to crawl on his hands and knees, as the height of the adit or tube was only four or five feet. The coal is drawn up in baskets on sleds, each basket holding from a peck to half a bushel. The only covering of those who drag it up is a thick layer of coal dust. This slow and laborious mode of taking the coal to the surface was the only one seen in all mines visited; neither are there any adits or tunnels for the admission of pure air. Accidents from the explosion of fire-damp rarely or never occur, however, probably because the Chinese are unable to dig lower than the water level for want of proper pumping apparatus. For the same reason the best coal in China remains as yet undisturbed, and awaits the enterprise and improved apparatus of western nations. Coal appears from place to place over the whole empire. It is overlaid with a red sandstone, and the Chinese commence their operations when the strata chance to outcrop, and follow them down at whatever angle they chance to lead.

Prof. Bickmore showed by extracts from ancient works that petroleum was not only known but used for lamps more than one hundred and sixty years ago. The Chinese name for it is "Oil of Stone," which is identical with our name petroleum.

Iron, the next most important mineral to coal, is found in the immediate vicinity of coal over most of the northern part of

China. The best ore, from which is made the steel used in manufacture of razors and other cutlery, is found in the province of Shursi.

The abundance and wide distribution of these invaluable minerals offer the best facilities for the construction of machinery of all kinds, and render railroads practicable as soon as there is a government stable and strong enough to protect such property.

Copper is found in many places in the north of China, and large quantities have undoubtedly been taken out, and it is probable that larger quantities yet remain.

Tin is said to be found among most of the mountains of China, though Prof. Bickmore had not seen a specimen *in situ.* If this metal should prove to be as abundant as it is asserted on what may be regarded as good authority, then Prof. B. thinks it will be found that China, on account of the early age of her civilization, has been the chief source whence came the tin that was used by the Lake Dwellers in Switzerland in manufacturing their bronze implements. Silver exists in the province of Shansi, probably in great quantities. Gold is found in the beds of nearly all the rivers in China, so long as they flow through the mountainous regions. Prof. B. concluded his paper with these words:—"In review, we see that China is well supplied with coal and iron, the two minerals especially necessary for her future development; that these minerals are widely distributed over almost her whole area, and that she has thus the requisite materials for manufacturing her own cotton without being dependent on the looms of England. Again, China possesses her share of the precious metals, and yet nearly all her ample material resources remain to be developed, though she has been the most civilized nation in all the east, and the most populous empire the world has ever seen."

THE METAMORPHIC ROCKS OF NEW BRUNSWICK AND MAINE.

Prof. L. W. Bailey read a paper written by himself and Mr. G. F. Matthew "On the Age and Relations of the Metamorphic Rocks of New Brunswick and Maine."

The sediments to which the paper referred related chiefly to those embraced in the most southerly of three spurs projecting to the northeast from that extensive tract of altered and often highly crystalline rocks which occupy the greater part of New

England, and lie between the unaltered Silurian of New York on the one hand and the New Brunswick coal-field on the other.

Dr. GESNER, who made a geological survey between 1838 and 1842, recognized granitic ridges on two of these spurs, and spoke of the slates in the central part of the province as Cambrian, and described others near the bay of Fundy as Silurian. Dr. James Robb adopted substantially these views. The classification was based upon the highly altered character of the rocks and the paucity or entire absence of organic remains. About the year 1858, Mr. G. F. Matthew, from certain further examinations, pronounced some of the deposits near the city of St. John to be of Upper Devonian age.

At the beginning of the present decade, a geological survey of the State of Maine, under Prof. C. H. Hitchcock, was undertaken, by which a knowledge of some of the metamorphic rocks adjoining New Brunswick was obtained. In the following year the characters of the metamorphic belt eastward of St. John, by a reconnoissance made for the government of New Brunswick by the authors of this paper, in connection with Prof. C. F. Hartt, were discovered.

The paper described in some details the formations recognized in New Brunswick, and showed how the same formations extended into the State of Maine, which tended to throw much light on the geology of eastern New England, so long involved in obscurity.

The formations thus recognized are the Lower and Upper Laurentian, the Huronian, the Primordial, the Upper Silurian, the Upper Devonian, the Lower Carboniferous, Carboniferous, and New Red Sandstone, all except the first two and the last containing characteristic fossils. Most of these formations may be looked for in New England, especially the Laurentian (now known in the Laurentides of Canada, the Adirondacks of New York, and the Highlands of the Hudson), which probably form portions of the coast in the vicinity of Portland, and the Silurian and Devonian, altered beds of which may constitute much of the crystalline rocks of New England. In connection with this subject, one of the principal points of this paper was to show the intimate relation in New Brunswick between certain of the granites of that region and fossiliferous strata, probably of Upper Silurian age, the former passing by regular gradation into the latter. If such highly altered strata, which have long been regarded as eruptive, are thus shown to be of comparatively recent origin, many of the similar rocks now so abundant in Maine and Massachussetts, and of which the White Mountains are composed, may prove to be of similar age—a conclusion long since suspected by some geologists.

Prof. HITCHCOCK said he had examined the rocks on the Maine border, and it appeared to him that the results agreed generally with the conclusions arrived at by Prof. Bailey. Some of the generalizations, however, as yet made, must be received with some reservation until confirmed by more minute examination. He regarded the paper as a valuable contribution.

ON THE GEOLOGY OF NORTH EASTERN AMERICA.

Prof. T. STERRY HUNT, the eminent Canadian geologist, next made some remarks on the above subject, illustrating his observations by means of a splendidly colored geological map of Canada, New England, and of the northern and western portions of the United States.

He complimented the authors of the previous paper on the fidelity with which they had discharged their task, and entered into some detail in regard to the geological history and composition of many of the rocks of northeastern America.

ON SURFACE CHANGES IN MAINE.

BY DR. N. T. TRUE.

The paper began by stating that the almost infinity of time since the earth was brought into existence was now generally accepted, not only by geologists, but by non-scientific men. This had led some writers to give loose reins to their imagination and to attribute an immense period of time since the close of the last great geological changes on the surface of the earth without duly examining the condition of things within their reach which, by their accumulating evidence might lead to different results. The paper then specified the various geological, surface, and other changes that were now going on in New England, and from observations within the range of human experience and record attempted to show how materially a few thousand years might alter the character of a country. From these data the paper inferred that there was no necessity for throwing back the history of the present geological era to a period much if any before the time when man was in the infancy of his race,—not very long before the historic period. Geology had suffered too much from loose conclusions, and the present state of science demanded the most rigid investigation of facts. In conclusion, it was pretty evident that if the present epoch had claims to a very high antiquity, the evidence had not yet been seen in New England, especially in the State of Maine, and that the present results might more logically be traced back to a period from five thousand to ten thousand years ago than fifty thousand.

A somewhat animated discussion ensued, in which Prof. Agassiz and other gentlemen took part.

EVIDENCES OF HIGH ANTIQUITY IN THE KJŒKKENMŒDDEN DEPOSITS OF NEW ENGLAND.

Prof. E. S. MORSE made some remarks on this subject. He said that all along our shore we have a deposit of clam shells, sometimes forming large piles, which were probably thrown out by ancient inhabitants who fed on their meat. The traces of stone fire-places are found near these deposits in Denmark, as well as in this region; also, arrow-heads and other implements; though stone implements are remarkably scarce in our shell heaps. Bone instruments, however, are remarkably plentiful, with sharp cutting edges, made from the antlers of deer. The age of these heaps is a matter for consideration, and possibly those of New England belong to an earlier period than those of North Carolina, where stone implements are found similar to those of Denmark. They are of varied thickness, from two to three feet, and the shore end is abruptly cut off by the wash of the sea. There are evidences of a great change in vegetation since the deposits were made. Quahogs and oysters, which are comparatively rare on the New England coast now, evidently existed at that period in great abundance. The bones of the elk and the great auk (now extinct) are frequently found under the heaps, and are suggestive of their high antiquity. The want of the stone implements Mr. Morse considered as additional evidence of his view of their age.

ON THE ROCKY MOUNTAIN ALPINE REGION.

BY PROF. C. C. PARRY.

The lecturer began by stating that the Rocky Mountain Alpine Region was of special interest on account of its extensiveness as compared with anything which they had in the east. Hitherto it had been mostly inaccessible, but now that railways were making it accessible, further exploration would reveal its flora and thus it could be compared with the Alpine flora of Europe. The woody belt of coniferous trees began at an average elevation of six thousand feet. Its densest growth was at between seven and nine thousand feet elevation, and its termination was at an average height of eleven thousand three hundred feet. The growth was most dense and varied where there was the greatest and most regular amount of aqueous precipitation. At still higher elevations the actual limit of tree growth was determined by conditions of temperature which satisfactorily explained the peculiar features of vegetation there met with. This belt of trees terminated with singular abruptness. The probable explanation was that this timber line marked the extreme point of minimum winter temperature below which no phœnogamous vegetation could exist. After alluding to the meteorological conditions of the region, the paper went on to point out the peculiar dwarfed tree growth scattered occasionally above the timber line. It was on the most open exposures above that the Alpine flora was most diversified and attractive, presenting from June to September a succession of colors most attractive to the eye of the naturalist. Out of one hundred and forty-two species, fifty-six were exclusively confined to these Alpine exposures. The usual characteristics of Alpine plants were a dwarfed habit of growth, late period of flowering, and early seeding, the forms being exclusively perennial. Of the thirty-four natural orders in the Alpine flora, thirty-one belong to the Phœnogamous plants, the remaining three were of the higher order of Cryptogams. Of the latter, ferns were represented by a single species not exclusively Alpine (*Cryptogramma acrostichoides*). Mosses were more numerously represented, but were still comparatively rare. Lichens were most abundant and afforded the greatest number of species. The superficial extent of these bare Alpine exposures in Colorado Territory had been roughly estimated at from twelve hundred to fifteen hundred square miles. After a brief allusion to the fauna of the region, the paper stated that, when accessible, it would doubtless afford a good site for summer pasturage, and eventually yield choice dairy products, equalling those of the Swiss Alps, and produce delicate fibrous tissues rivalling those of the looms of Cashmere. As a summer resort it was unexcelled in the purity of its atmosphere, the clearness of its streams, and its picturesque and extended views. The paper concluded with some topographical details and with a list of Alpine plants.

ON SOME NEW MOSOSAUROID REPTILES FROM THE GREENSAND OF NEW JERSEY.

By Prof. O. C. Marsh.

The striking difference between the reptilian fauna of the cretaceous period of Europe and the same period in America was that in the former there were great numbers of remains of ichthyosauri and plesiosauri, while hardly a tooth or vertebra of the mososauroids was to be found. In America the two former kinds of reptiles appeared to be almost entirely wanting. One or two specimens found here had been alleged to be icthyosauri or plesiosauri, but further examination threw strong doubts on the matter. To replace these forms, however, the mososauroids were found in abundance. The affinities of the mososauroids were chiefly 'i the serpents rather than with other reptiles, although they had certain other affinities with swarming reptiles. Prof. Marsh produced some fossil remains of different specimens of Mososauroids, showing the peculiar formation of the skull. These reptiles appeared to have no hind limbs, although Cuvier thought he had detected them. The specimens found in this country, however, afforded no evidence of this. He called attention to two new forms of the family—the *Macrosaurus platyspondylus* and the *Mosasaurus Copeanus*—in which the articulation of the lower jaw was one of the most interesting features. The larger specimens of these animals showed that they must have been the monarchs of the seas of those periods, and in appearance and size not unlike the popular notion of the sea serpent, being sometimes seventy-five feet long.

Prof. Agassiz said that the examination of the Mososauroid remains revealed much that was new to descriptive palæontology. He was not quite satisfied that the remains showed real serpent-like affinities. The resemblances of the Mososauroids to serpents, he thought, were rather of the synthetic type than of affinity. The articulation of the lower jaw, he thought, in no way corresponded to that of serpents.

REVIEWS AND NOTICES OF BOOKS.

THE ENTOMOLOGICAL CORRESPONDENCE OF THADDEUS W. HARRIS, M.D. EDITED BY SAMUEL H. SCUDDER.

The volume before us contains and shadows forth part of the life works of an indefatigable and conscientious naturalist. The review of such a volume becomes a pleasure to any lover of natural history—particularly to the entomologist—illustrating as it does the studies of such men as Hentz, Doubleday, Le Conte, Melsheimer, and others.

The book contains 437 pages, together with an excellent portrait on steel of Dr. Harris. It has four steel plates of beetles and their larvæ, also of moths and their caterpillars (coloured) while numerous woodcuts appear in the text.

The volume commences with a memoir of Dr. Harris, by Col. T. W. Higginson, which treats of his early life and collegiate careers. It also introduces to the reader the naturalists forming the circle of his acquaintance and correspondence, including such men as Curtis, Newman, Doubleday, Hentz, Herrick, Say, Kirby, Melsheimer, Le Conte, and others well known to entomologists.

Col. Higginson, speaking of Dr. Harris as a Professor at Harvard College in 1842, says: "I was fortunate to be among his pupils. There were exercises twice a week, which included recitations in "Smellie's Philosophy of Natural History," with occasional elucidations and lectures by Dr. Harris. There were also special lectures on Botany. Dr. Harris formed in addition a private class in Entomology, to which I also belonged. It included about a dozen young men from different college classes, who met one evening of every week at the room where our teacher kept his Cabinet in Massachusetts Hall. These were very delightful exercises according to my recollection, though we never got beyond the *Coleoptera*. Dr. Harris was so simple and eager; his tall, spare form and thin face took on such a glow and freshness as he dwelt so lovingly on Antennæ and Tarsi, and he handled so fondly his little insect martyrs that it was enough to make us love the study for life beyond all branches of natural science, and I am sure that it had that effect on me."

Dr. Harris, in speaking of his Entomological Cabinet, says: "My object in making a collection, and for this purpose asking the aid of friends, has not been merely personal gratification,—it has been my desire to add something to the cause of science in this country. Even should death surprise me before the results of my labours are before the public, I shall leave an extensive, well arranged, and named collection, which from the care bestowed on it, will be in a condition of good preservation, and will remain as a standard of comparison when I am gone."

"Dr. Harris is principally known to the people of America by his 'Report on Insects injurious to Vegetation' first published for the State in 1841, in his capacity as one of the Scientific commissioners of a Geological and Botanical Survey.

This was reprinted by himself under the name of 'Treatise' instead of Report, in 1842—and it was again revised in 1852. After his death it was reprinted by the State in an admirable form, with engravings, and it is upon this that his scientific reputation will mainly rest.

It is admitted by all who read this treatise that it is a model combination of the strictly scientific spirit with the clearest popular statement.

Dr. Harris also combined the use of the pencil with the study of entomology—an accomplishment of great importance and benefit. After learning to classify butterflies by studying the nervures of the wings, he fixed by copying each successive stage of their developement."

His excursions too, though rare, were effectual; he had the quick step, the observant eye, and the prompt fingers of a born naturalist; he could convert his umbrella into a net and his hat into a collecting box; he prolonged his quest into the night with a lantern, and into November by searching beneath the bark of trees.

Col. Higginson in speaking of the correspondence of Dr. Harris, says—

"In this destitution of books and cabinets there was anot' r compensation which gave to Dr. Harris a more practical satisfaction.

The conditions of a new country implying these drawbacks, imply also a great wealth of material. In older countries it is rare to discover a new species; it is something even to detect a new habitat. But these lonely American entomologists seem, as one reads their correspondence, like so many scientific Robinson Crusoes, each with the insect-wealth of a new island at his disposal, they are monarchs of all they survey. With what affluence they exhibit their dozen undescribed species; with what autocratic power they divide and re-combine genera! How ardently writes Hentz to Harris, 'Oh! why must we live at such a distance from each other? What pleasures we might enjoy together; or, mourn no longer for the singleness or solitude of your *Amphicoma Vulpina!* I have found another.' Yet they were richer for their loneliness, and perhaps it was better that Massachussetts and Carolina even in scientific jurisdiction should remain at a reasonable distance. Had these students shared one entomological region they would have had less wealth of material for exchange."

Col. Higginson concludes the memoir thus: "The steady growth of Dr. Harris' reputation is not due alone to his position as one of the pioneers in American Science during its barest period. It has grown because he proves to have united qualities that are rare at any period. He combined a fidelity that never shrank from the most laborious details, with an intellectual activity that always looked beyond details to principles. No series of observations made by him needed revision or verification by another; and yet his mind always looked instinctively towards classification and generalization. He had also those scientific qualities which are moral qualities as well; he had the modesty and unselfishness of science, and he had what may be called its chivalry. He would give golden days of his scanty summer vacations to arrange and label the collections of younger entomologists, and it roused all the wrath of which his soul was capable, when even a rival was wronged, as when Dejéan ignored Say's descriptions, because he had not learned English enough to read them." So much for the man. We shall now look for a short time at some of his correspondence. The foregoing we have drawn altogether from the memoir by Col. Higginson, considering it the best description we could give of the man—and would earnestly recommend all interested in entomology to purchase the work and study it for themselves, believing that they will be fully compensated by its perusal.

We shall merely glance at a very few points mentioned in this correspondence, which have been corroborated by succeeding entomologists. In a letter to Hentz, dated Nov. 28th, 1825, he says:—"The unarmed *Onthophagus*, (*Copris*,) I have always taken to be the female of *Latebrosus*. Individuals of the male sex vary considerably in the size and projection of the thoracic protuberance." This has been well established since by entomologists. Processes such as antennae, mandibles, thoracic projections, clypeal developments are more prominent in the males of nearly all insects. We have also taken this particular insect *in coitu*. Again, in a letter dated Feb'y 26th, 1828, we quote what most coleopterists will agree with. "Say's genus *Harpalus* is a kind of magazine for doubtful species, several of which have the apex of the elytra *sinuato-emarginate*, as you observe in that common and very beautiful species, *H. Viridis*, Say, or as Prof. Peck more judiciously named it (from its great variation of hues)—*Proteus*. I am not sure but this species may prove to be the *viridi-æneus* of Beauvois, whose figure and description correspond very well with our insect." This species we have been puzzled with not a little on account of its variety of colours. Some in our cabinet are of a bright metallic green hue, while others have a cupreous appearance. The difference in colour we believe to be mainly a sexual distinction. In reference to Say's genus, *Feronia*, he says, "It is nevertheless a heterogeneous mixture, a complete *p t pourri*, out of which several natural genera may be rescued." We have found some of the genera of the *Carabidæ* to have been our *Pons asinorum* in Coleoptera. Species of this group closely resemble each other, and are very difficult to determine. Modern entomologists, however, have done much to clear up this difficulty; among the foremost is Le Conte.

The correspondence of this indefatigable worker (Harris) is invaluable to the entomologist, as many an idea discovered by himself is here made known for the first time. In a letter bearing date July 28th, 1829, he says, "An excellent natural character by which you may distinguish *Colymbetes* from *Dytiscus* (if you have not the males) is that there is a projection of the anterior part of the orbit over the eye in *Colymbetes*, and not in *Dytiscus*. This character had not been noticed by other entomologists. You will see it very distinctly in *C. sculptilis*." We have an acknowledgement of this discovery in a letter of Hentz, Aug. 13th, 1829, thus: "I thank you for mentioning your discovery for distinguishing between *Colymbetes* and *Dytiscus*. It is of the highest value where we must in the state of the science know the sexes to ascertain genera."

The above gives some general idea of his correspondence with Hentz, Melsheimer, Doubleday, Herrick, Say, Le Conte, and others. Through all his writings there is traceable that perseverance and clearness of decision, which marks the true naturalist. The familiar, popular, yet truly scientific style of its reasoning will recommend the "Correspondence of Thaddeus William Harris" to all lovers of Natural History.

The volume contains, also, descriptions of larvæ, their metamorphoses, habits, &c.; selected descriptions of insects; re-published papers, and contributions to entomology heretofore scattered in different works, and not easily obtained. A. S. R.

GEOLOGY AND MINERALOGY.

Fossil Bivalved Entomostraca.—No one has done more than Prof. T. Rupert Jones to illustrate these numerous and curious fossils, often microscopic, sometimes liable to be mistaken for Bivalved Mollusca, which abound in stratified rocks of all geological ages, and sometimes contribute not a little to the mass of strata of some thickness. In the following paper, from the *Quarterly Journal of Microscopical Science*, he clearly describes their characters, affinities, and geological relations:—

"On this occasion I have to explain the nature of the microscopic Bivalved Crustaceans, to allude to their ways of life, and to draw attention to some of the facts connected with their being found fossilized in clays and stones.

The common Crab and Lobster are important members of the Crustacean group of Animals; so also are Shrimps, Prawns, Sandhoppers, Woodlice, the King-crab of the Moluccas, and many others, which are only noticed by the naturalist and seen in museums.

A characteristic feature of the Crustaceans is their jointed structure (placing them among the *Articulata* or *Arthropoda*), and their being for the most part coated with a hard, tough armour—the part that covers the front of the body being usually formed of a large plate or buckler (called the Carapace or Cephalothorax), and the rest consisting of ring-like segments.

The Shell (or Test) of the Lobster well illustrates this. In the Crab, however, the body is more shrunk up, as it were, beneath the Carapace, which is widened and enlarged, whilst the jointed tail-piece is very small and folded neatly underneath. The organs in the Crab are, as it is said, concentrated; and the traces of the many ring-joints (or "somites") of which the Crustacean Animal is typically or theoretically constructed are nearly lost to sight. Indeed, if we trace the modifications of structure from one Crustacean to another—from the many-segmented Brine-shrimp to the more definitely jointed Woodlouse and Sandhopper, almost equally ringed throughout the length of their bodies—and through Squills and Shrimps with their carapace in front and their armoured tail behind, and the *Anomoura* or short-tailed members of the Lobster Tribe, until we get to the Crabs, with scarcely any tail at all, we follow, as it were, the footsteps of Nature in her advance from the lower and simpler structures, with their many times repeated parts and organs, to the higher, more concentrated, more complicated, more specialised, and, in one sense, more perfect type of animal structure.

We see the carapace flat in the Crab; in the Lobster it is folded down on either side, and so we have it in many other species; but this folding is carried a step further in some groups; the two halves being quite separate at the back, along the central line that is well marked in the Lobster, and becoming the two valves of a two-sided carapace, resembling that of a common Bivalved Mollusc.

This bivalved structure is not met with among the larger Crustacea, but only in the smaller and frequently microscopic forms. These are members of the group known by the general term "Water-fleas," or *Entomostraca* ("shelled insects)." Some live in the sea, some in ponds and rivers. They exist in countless numbers. Like the Sandhoppers, Shrimps, Lobsters, &c., they assist in the health-economy of the watery world; they are scavengers, using up all dead matters.

The Crustaceans have been termed "the Insects of the Sea," and well they may, for they not only take the place of Insects, Centipedes, and Spiders in the ocean, on every shore and at nearly every depth, but they emulate the Insect-tribe in the extremes of grace and ugliness. Though they can scarcely be said to resemble the Insects in their flight, yet in their flittings to and fro they are not unlike; and in their ceaseless, unwearying crawlings the likeness holds good;—as scavengers, too, they claim brotherhood with a world of Beetles and other Insects. In this, however, as well as in the less amount of concentration of their organs, they differ from Insects—namely, the changes which the latter undergo are from one distinct stage to another, such as caterpillar, chrysalis, butterfly; but in the Crustacea we have successive moultings of the crust, with some alteration in the body, corresponding with the growth of the individual; and though these changes are often striking (in the young state of Crabs, for instance), yet there is no break in the line of life, no dormant period, no transition from one mode of living to another, as there is in Insects.

However diversified the forms of the different kinds of Crustacea may be—however varied the number and disposition of their limbs, yet this great group have, with few exceptions, their articulated framework as a feature in common; and if that be wanting, still (according to Huxley) the uniformly similar, six-limbed, and Nauplius-like form in which so many members of the lower groups of Crustacea begin their existence, furnishes a strong connecting link among them.

The diversity of organs among the Crustacea is almost endless; what serves as jaws in one division are legs in another; the antennæ in one may be organs of sense, in another of locomotion or of prehension: then there are thoracic branchiæ in some (Decapods), sac-like branchial appendages in others (Tetradecapods); whilst the Entomostraca rarely have any true branchiæ, the surface of either some part or of the whole of the body serving for aëration.

In the Crabs, which present the condition of highest centralisation for the Crustacea, the three front segmental elements are coalesced and modified as the organs of feeling, sight, and hearing; the next six supply the mandibles, maxillæ, and palpi for the mouth; five are devoted to the organs of locomotion and prehension; and the remainder are lost in the abbreviated abdomen or tail-piece. In the other Decapoda (with ten limbs) also, such as Lobsters, &c., *nine* segments and their pairs of appendages are thus concentrated into the organs of sense and the mouth. In the Tetradecapoda (with fourteen limbs), such as the Woodlouse, &c., only *seven* segments are concentrated for these cephalic organs, In the Entomostraca, only *six* thus coalesce for the senses and mouth in the *Cyclops* group, only *five* in the *Daphnia* and *Caligus*, and only *four* in *Limulus*.

The essential points in the framework of the body of an Entomostracan of low organization, and in the arrangement of the organs, are well seen in the Brine-shrimp (*Artemia.*) Here the body has numerous articulations or segmented portions. The head-part takes up four or five coalesced somites, bearing the antennæ, eyes, and masticatory organs; eleven pairs of natatory and branchial limbs follow on eleven segments; the next two joints or rings have their own modified appendages; seven segments succeed, without appendages, except that the last ends with the caudal-flaps (post-abdomen or telson.)

Others also of these lower Crustacea, or Phyllopoda (whether bivalved or not), have more than twenty segmented parts in their body; but of the twenty theoretical typical somites or segments (twenty-one,* including the telson) characteristic of a well-developed Crustacean, several of the hindmost are absent in most of the Bivalved Entomostraca; and this curtailed form is wholly enveloped in the two more or less closely-fitting carapace-valves of the cephalothorax.

Thus in the Phyllopodous *Limnadia*, after the front part of the body, bearing the antennæ, eyes, and mandibles, succeed twenty-two pairs of branchial limbs, more or less developed, followed by the post-abdomen. Locomotion is here effected by the antennæ and post-abdomen. In the Cladocerous (Daphnioid) and Ostracodous (Cyproid) groups, however, of the Entomostraca, the antennæ, eyes, mandibles, and maxillæ, two to six pairs of feet (with branchial appendages attached to some of them), a short abdomen, and a strong hooked post-abdomen, are the chief features; so in these Bivalved forms, instead of the numerous branchial laminæ of the Phyllopods, we have a few pairs of locomotive organs with their branchial appendages.

The disposition of the organs in various orders, families, and genera, may be studied in detail in the works of Baird, Dana, Zenker, Lilljeborg, Fischer, Grube, Sars, Norman, Brady, and others. For the family and generic characters of the *Ostracodæ*,

* The twenty-one theoretical somites are thus allocated by some naturalists:—seven to the head or cephalon, seven to the thorax or pereion, and seven to the abdomen or pleon.

see G. S. Brady's memoir in the 'Intellectual Observer' for September, 1867; and for the specific characters of many of the *Cladocera*, see Norman and Brady's memoir on the *Bosminidæ*, &c., in the 'Nat. Hist. Trans. Northumberland and Durham,' 1867.

The Bivalved Entomostraca differ among themselves not only with respect to the arrangement and characters of the organs of sense, mastication, locomotion, and aëration, but also very markedly in the shape and structure of their carapace-valves.

In *Apus*, one of the Phyllopods, the carapace (or shell covering the cephalothorax) is nearly flat and shield-like, but ridged along the middle. In *Nebalia*, another Phyllopod, the carapace is folded down, as it were, on either side of the animal; the abdomen extends beyond it behind, the legs below, and the antennæ in front, with a small, arched, movable projection above the eyes. In the *Cladocera* (*Daphnia*, &c.) the carapace is still more flatly folded down, with a bend along the dorsal line; and the whole of the body is included within it, except that the antennæ (as swimming limbs) protrude at the head from lateral notches, which give to the front of the carapace a hood-like or quaintly beaked shape.

In other Bivalved Entomostraca the two sides of the folded carapace are quite distinct, forming separate valves, but united in life along their dorsal margins by either a simple membranous attachment (as in *Estheria*, &c.), or by a more complex system of ridge and furrow, or teeth and sockets (as in the *Cyproidea*).

In outline the carapaces of *Cladocera* range from orbicular to oblong, with varying contours. They are horny or chitinous, thin, usually transparent, and ornamented often with some reticulate pattern, having reference to the hexagonal cell-system of the typical crustacean test, or the network resolves itself into the delicate bands and furrows by the greater development of one set of mesh-lines than another. This carapace is periodically moulted and renewed; but occasionally it is retained, and one layer succeeds on the inside and at the outer edge of another until the valve is marked with several concentric boundary-lines of the periodic stages of growth. Mr. Norman points out that this feature, normal in *Menosphilus tenuirostris*, is occasional in *Lynceus elongatus*; see 'Nat. His. Trans. Northumberland and Durham,' 1867, p. 53. It is also normal in the *Limnadiadæ*, which retain their valves, whilst they cast only a chitinous skeleton or framework of the body.

Fossil carapaces of *Cladocera* have not been recognised, their extreme tenuity probably being neither favorable for their preservation nor, if preserved, to their detection in the fossil state.

The Bivalved Phyllopods, such as *Limnadia*, *Estheria*, and *Limnetis*, are larger than the *Cladocera*, and their valves are usually thicker and stronger. In shape round, oval, or oblong, they often resemble the shells of Conchifera or Bivalved Molluscs, and have been mistaken for them when living, and much more frequently in the fossil condition. The presence of a straight hinge-line, of umbones, and of concentric lines of growth, are special features in which they more or less imitate the Conchifera, such as *Avicula*, *Tellina*, *Pisidium*, &c. *Estheria donaciformis* came to the British Museum as a *Nucula;* but Dr. Baird recognised its crustacean characters, disguised as they are by the molluscan shape. *Estheria minuta* long passed as a little shell among geologists until Prof. Quekett's microscope detected the hexagonal cell-tissue of the Crustacean in fragments of the fossil: see my 'Monograph of the Fossil Estheriæ' (Palæontographical Society), 1862, pages 3, 11, &c.

Very different kinds of carapace-valves belong to the *Ostracoda*. A synopsis of the recent British forms of this great group, carefully drawn up and illustrated by Mr. G. S. Brady in the 'Intellectual Observer' for September, 1867, gives us a good general view of these very interesting Bivalved Entomonstraca, amongst which are (excepting some of the Copepoda and Cladocera) the most common of the marine and freshwater forms, both recent and fossil. Thus—

CYPRIDÆ.—*Cypris; Cypridopsis; Paracypris; Notodromas; Candona; Pontocypris; Bairdia; Macrocypris.*

CYTHERIDÆ.—*Cythere* (and *Cythereis*); *Limnocythere; Cytheridea* (and *Cyprideis*); *Cytheropsis* (to be changed to "*Eucythere*") *Hyobates; Loxoconcha* (=*Normania*); *Xestoleberis; Cytherura; Cytheropteron; Bythocythere; Pseudocythere; Cytherideis; Sclerochilus: Paradoxostoma.*

CYPRIDINIDÆ.—(*Cypridina*,) *Philomedes; Cylindoleberis; Bradycinctus.*

CONCHŒCIADÆ.—*Conchœcia.*

POLYCOPIDÆ.—*Polycope.*

CYTHERELLIDÆ.—*Cytherella.*

The valves of the *Cypridæ* (Brady) are small, usually either kidney-shaped, oblong, or boat-shaped, smooth or bearing only faint punctation and delicate setæ, and rarely thickened on the hinge-margins. The *Cytheridæ*, on the other hand, though often smooth, have frequently thick and highly ornamented valves, coarsely or neatly pitted, sculptured with fret-work (more or less reticulate), or bristling with spines and spikes. Either ovate or oblong in many shapes, they have usually thick hinge-margins, with furrows and sockets for bars and teeth. The other families mentioned have smooth valves; those of *Cypridina* are large, thick, and convex, mostly round or oval, and are marked with an antero-ventral notch. *Conchœcia* has an oblong, and *Polycope* a subspherical shell; both thin. *Cytherella* has oblong, compressed, thick valves, usually smooth, one fitting into the other, somewhat like the lid of a wooden snuff-box.

Of the *Ostracoda* very many are found fossil, such as belonged to fresh waters, to brackish waters, and to the sea, in great variety. Münster, Roemer, Reuss, De Koninck, Bosquet, Bornemann, and others, have described many species from the strata of Germany, France, Belgium, &c.; and at home McCoy, Salter, Kirby, Holl, G. S. Brady, and myself, are among those who have treated of such as have been met with in the British Isles; but a large number still remained undescribed.

Amongst the fossil specimens are several that cannot be readily co-ordinated with the groupings made out of the existing forms, as may be expected both by the naturalists who are accustomed to look on the existing races as successional representatives of older forms, and by those who may regard successive faunæ as creational replacements.

Among such fossil forms are many from the older ("Palæozoic") strata; but even for these existing representatives occasionally turn up, such as Brady's *Heterodesmus*, lately brought from the Japanese seas, which has apparently a close affinity with M'Coy's *Entomoconchus* of the Mountain-limestone. Some, indeed, of the old forms are scarcely distinguishable, as far as the valves are concerned, from their modern representatives; for instance, *Cypridina primæva* (M'Coy, sp.) of the same old limestone, and its associates *Cyprella* and *Cypridella*, present in the various valves of their multiform species gradations among themselves, and an easy passage into *Cypridina* itself. Others among the ancient faunæ possess two or more of the characteristics that are now divided amongst the several members of a group; thus the carapace of the *Leperditia* of the Silurian period has resemblances in outline to members of the Limnadiadæ, Cypridininæ, and Cypridæ; in muscle-spot to the first two; in vascular markings to the first and to the Apodidæ; in the place of the eyes to the second and fourth; and in the eye-tubercles to the third and fourth. Altogether *Leperdit* ·, and its palæozoic congeners *Isochilina*, *Entomis*, *Primitia*, *Beyrichia*, and *Kirkbya*, seem to be more nearly within the alliance of the *Limnadiadæ* than of the others. Nevertheless, in these, as well as in other groups of Bivalved Entomostraca, we have always to be careful in assigning special value to differences of outline, ornament, and structure, because it is not unusual, among these little Crustacea, to find that similar shells may belong to different genera, when we examine them alive, and on the other hand very closely allied species may have dissimilar valves.

As a general rule the fossil Entomostraca of freshwater, brackish, and marine strata, respectively, correspond in family and generic characters to species found in such waters at the present day; and therefore the geologist often finds his supposition as to the origin of a set of strata confirmed by the presence of this or that kind of Entomostraca; and in some instances thin intercalated bands of freshwater or of estuarine deposits, amongst marine strata, can be indicated by the presence of *Estheriæ*, which in past, as in present, times appear to have avoided sea-water, though living abundantly in salt-marshes and lagoons. See the 'Monograph of Fossil Estheria,' 1862.

Thus, also, Mr. G. S. Brady observes ('Intellectual Observer,' 1867, p. 111), in noticing the geological interest of Entomostraca, "My belief is, therefore, that those strata which exhibit such very abundant and closely packed remains of the smaller *Cypridæ* and *Cytheridæ* have most likely been formed in shallow, brackish lagoons, or at the mouths and deltas of rivers. The species of Ostracoda which I have found in these situations are *Cytheridea torosa* (Jones), *Cythere pellucida*, Baird, and *Loxoconcha elliptica*, Brady; while in water a little further from the saline influence, but still slightly partaking of it, it is not uncommon to meet with *Cypris salina*, Brady, and *Cypridopsis aculeata*, Lilljeborg, as well as Entomostraca belonging to other orders."

The Entomostraca act pre-eminently as scavengers in both salt and fresh waters. Most of the groups (as Copepods, Ostracods, and Phyllopods) comprise both marine and fresh-water species; but the *Cladocera* are confined to fresh water. The excessive swarming of the pink *Daphnia* or Water-flea has occasionally reddened pond-water so strongly as to have seemed supernatural to our ancestors, and to have produced terror, as an evil omen, among the ignorant. Amongst the British *Ostracoda*, *Cypris*, *Cypridopsis*, *Notodromas*, *Candona*, are inhabitants of lakes, ponds, ditches, streams, and rivers; and they can be readily obtained and conveniently kept and studied in the aquarium. *Paracypris*, *Pontocypris*, *Bairdia*, and *Macrocypris*, are marine members of Mr. Brady's group "Cypridæ." Excepting the fresh-water *Limnocythere*, all the *Cytheridæ* are marine, *Cytheridea* and *Loxoconcha* having also a taste for brackish water. These salt-water species of the Bivalved Entomostraca are distributed in deep and shallow seas, in pools on the beach between tides, in lagoons and back-waters, and in the brackish water of estuaries and salt-marshes. The 'Trans. Zoolog. Soc., 1867, contains a memoir, by Mr. G. S. Brady, descriptive of some new forms of Ostracoda, in which we find some "habitats" referred to as being in "shallow water," and others at 14, 17, 30, 43, 60–70, 223, 360, 470, and even 2050 fathoms.

The *Cypridæ*, having plumose "antennæ," or natatory limbs, possess a greater or less power of swimming, *Candona* being a marked exception. On the other hand, the anterior locomotive limbs of the *Cytheridæ* have usually short setæ and hook-like spines, instead of bunches of long, delicate filaments; and consequently these animals crawl about on the weeds, shells, and mud, and few among them can swim at all.

The *Cypridinidæ* are mostly free-swimming, oceanic forms. Mr. Brady observes that "some of the members of this family have very slight swimming powers, and live chiefly amongst mud; others are very agile swimmers, and are often taken in the towing-net—more especially at night—near the surface of the sea. They seem, indeed, to contribute very materially to the production of the wonderful phosphorescence of the tropical seas" ('Intellectual Observer,' 1867, p. 115.)

The removal of dead animal matter is easily accomplished by Entomostraca and other small Crustacea; and, as the Emmets and their little fellow-labourers pick bare the bones of large land animals, so these minute creatures of the water use up the dead bodies of the animals in the ocean, the lakes, and rivers, foraging for the dead zoophyte, and swarming over the lifeless mass of mollusc, annelid, and star-fish, and taking their share of the dead fish that had lived by eating their fellows, * and of the dead whale that had strained from the water myriads of their congeners for his daily food. When the sailors, in one of Parry's voyages, hung their salt beef over the ship's side in the water for a while, it soon disappeared under the combined attack of these little devourers; and if a fish be put in a perforated canister in a suitable stream or pond for a couple of days, its skeleton will be prepared by the tiny Crustaceans. Just as Mr. Charles Moore has found in the Lias of Somersetshire, the fossil reptiles overlain by a swarm of Ammonites, buried with the half-eaten carcase in the mud, so the fossil remains of the fishes (as noticed by Phillips, Binfield, myself, and others) are often and often found imbedded with innumerable carapace-valves of the Entomostracous scavengers in mud-beds of all ages, especially the Carboniferous, Wealden, and Tertiary clays); nor are Entomostraca wanting among the bones of fish and reptile in the Lias above alluded to.

Thus also we have seen a crowd of *Cyprides* and *Candonæ* cleaning out the shell of a *Paludina* or a *Limnæus* in an aquarium; and in the fossil state we know that valves of Entomostraca are sometimes associated in the shells of Molluscs. Thus Mr. J. W. Kirkby says ('Trans. Tyneside Nat. Field-Club,' vol. iv. 1859,) "The convex valve of a Conchifer appears to have been a popular place of resort with the *Bairdiæ*, for out of one I procured some dozens of individuals."

The rapid increase of some kinds of Entomostraca, and the tenacity of life possessed by the eggs, are circumstances that have attracted the attention of naturalists. The almost sudden appearance of *Apus* and of *Estheria* in great numbers in ditches, and even in cart-ruts, after heavy summer rains, in Germany and France, has been particularly noted. Here allusion need be made to these facts only to remind the reader that the dried mud of ponds will nearly always be found to contain the still vital eggs of various species of Entomostraca; and if small portions be sent home from abroad, and placed in pure water, the species belonging to the original pond may be produced under the eye of the naturalist and properly recorded. Thus, Mr. Henry Denny and Dr. Baird had the pleasure of raising in England, from dried mud sent by Dr. Atkinson from Jerusalem,

* See Dr. Baird's "Notes on the Food of some Fresh-water Fishes more particularly the Vandace and Trout." 1857.

several species of Entomostraca new to science. (See 'Ann. Nat. Hist.' for 1859 and September, 1861.)

Flourishing, then, in every water-area, fresh or salt, deep or shallow, running or still,—possessing strong powers of vitality and reproduction, and furnished with relatively hard or tough coverings, calcareous or corneo-calcareous in substance, these minute but innumerable Entomostraca have left their valves, either as the exuvia of periodical castings, or as the lasting remains of hosts of animalcules buried in the tide-shifted silt or the mud and sand of the freshet, to be fossilized in laminated clays, hardened mud-stones, and solid rocks of limestone.

In the extremely old "Silurian" strata we find abundant specimens of *Primitia*, *Beyrichia*, *Leperditia*, and *Entomis*, apparently related to the Phyllopods, and always associated with marine fossils. In the "Devonian" beds of marine origin we find *Entomis*, &c.; and in the fresh-water beds of the same period there is an *Estheria*, both in Scotland and Russia. The "Carboniferous" formations next succeed, and contain a host of Bivalved Entomostraca, many of them not yet described. *Cypridina* is well represented in these old strata with *Entomoconchus* (before alluded to); *Leperditia* lived on, with *Beyrichia*; and *Kirkbya* flourished with *Cythere* and *Bairdia*. In the fresh-water or estuarine bands *Estheria* occurs in several species, and *Cypris* or *Candona* is present also. The persistence of these genera from so old a time to the present is what is expected of such relatively low forms of life; wide geographical extension and long continuance belonging to such creatures as have not been highly specialised. In the "Permian" formations ("Magnesian Limestone" of Durham and other strata) *Bairdia*, *Cythere* and *Kirkbya* play an important part. In the "Trias" or "New Red Sandstone" we find *Estheria*, where marine conditions failed and fresh water had an influence, not only in Europe, but in India and America. (See my 'Monograph on Fossil Estheriæ,' 1862.) The Entomostraca of the "Lias" and the "Oolites" are not few, though not well known. In the "Purbeck" and "Wealden" beds they are better known. Masses of Purbeck building stone are wholly composed of the valves, and some of the Weald clays split like paper along the layers of shed valves of *Cypridea*: nor are *Estheriæ* wanting in these old fresh-water beds. The "Gault" and "Chalk" are full of *Cythere*, *Bairdia*, and other allied genera, all marine. The

"London Clay," the "Bracklesham Beds," and "Barton Clay," swarm in some places with similar forms, whilst the "Woolwich Beds" below them, and the "Hampstead" and "Osborne" formations of the Isle of Wight, above, are characterised by *Candona*, *Cytheridea*, &c., such as love estuaries, lakes and rivers. Lastly, for England, the "Crag" of Suffolk, and that of Bridlington, abound in marine forms.

If we had only these little fossils whereby to form an opinion of the probable conditions under which the clays, sandstones and limestones were formed in the long past eras of this planet, we should have, in nearly every case, ample evidence of the history of each bed of mud, silt, and shell-sand, in which these minute Entomostraca can be found.

The seas of the Silurian period had their thick-shelled *Leperditiæ* and *Beyrichiæ* very distinct from their now living congeners, but linked to them by close affinities readily discoverable by the Naturalist. When land was increased, in the Devonian period, the sea-coasts still abounded with marine Crustacea, and the lakes and rivers abounded with *Estheriæ*, like those of the present day. The coral-seas, which gave birth to the Derbyshire limestone, abounded with strange forms of Entomostraca. Land still extended, and miles and miles of swampy coasts and lowlands crowded with the dense vegetation of the Coal period, and, intersected with black, muddy lagoons, offered a home for endless tribes of Entomostraca, feeding on animal and vegetable refuse—the rotting plants and shoals of fish, poisoned by the black mud of the peaty rivers. These muds and silts, and all their buried shells, and plants, and fish, and crustaceans, sank down, and were covered up and hardened—petrified, often baked by heat, and then, pushed up again by subterranean force, re-appearing at the surface as the hard, rocky base of many a new country, and forming the bed of new seas, were eaten into by the ever-working waves, worn down by periodic rains, aided by the scorching sunbeams, the splitting frost, and the incessant agency of the atmospheric gases chemically affecting the surfaces of the rock.

The sea, now occupying fresh areas, continued its great work of destruction and reparation—wearing down the shores to make up the sea-beds; and it continued to be the abode of life in its myriad forms; but they were mostly new forms. In the new deposits laid down on the upturned edges of the old strata we find Entomostraca again, similar to those of to-day, and in the lagoons and lakes of the Triassic period *Estheriæ* abounded. The varying seas, the estuaries, bays, gulfs, and oceans of the Oolitic period, when land was rising here and sinking there—the sea ever rolling under its tidal laws, and coming and going amongst the ever-shifting land—these seas, we know, swarmed with Entomostraca, amongst the world of marine creatures, and the rivers and lakes were swarming too. The land that bore the great Iguanodon and Megalosaurus—gigantic lizards wandering on the marshy grounds, just as the amphibious Hippopotami of to-day wallow along the African swamps—had its great rivers; and their deltas like those of the Ganges and Mississippi, consisted of mud-banks and muddy lagoons, full of *Uniones*, *Paludinæ*, *Cyrenæ*, and other shell-fish, and above all, with *Cypridæ* and *Estheriæ*, feeding on the dead molluscs and fish.

The Sussex marble is mainly composed of these sometimes; some beds of freestone at Swanage are wholly made up of them, and flake after flake of black clay, once mud, may easily be picked by the hand, in the Isle of Wight, in cliffs some miles in extent, from beds of shale nearly two hundred feet thick, every surface being thickly coated with the shells or carapaces of these minute creatures. What durable witnesses of a long-past age!

The "Age of Reptiles" passed away, the land and its rivers went down, the sea-bed and the estuaries were coated over with new sands and clays, derived from new cliffs and new lands, washed by the untiring, enduring sea. Some parts of what is now the European area sank several hundred feet, and was covered by a deep sea, and in this were formed successively the Greensand, Gault and Chalk. The shores were thus gradually changed, and the new land elsewhere raised up, or remaining as islands here and there, bore new plants, new trees, and new animals; the sea also brought forth new Entomostraca, which may be easily obtained by washing the Gault clay into mud, drying and sifting it, and by washing the Chalk into powder, and examining it with a glass.*

Another great change occurred over half the world, at least; the strata that had been accumulating in gradually deepening seas, and on sinking sea-beds, were hoisted up again by subterranean force, and a new era was inaugurated—recognized by geologists in the sands, clays, and limestones which they denomi-

* See some notes on the preparation of clays, sands, and chalk, for microscopical purposes, in the "Geologist" 858, vol. i., p. 249.

nate "Tertiary." The land was diversified more than before;—more islands, more bays, more rivers, more seas; hence a greater variety of life in every shape, animal and vegetable, and not least in *Entomostraca.*

From some beds of sand and clays we get *Cytheridea Muelleri,* such as now covers the estuarine muds not far from mouths of rivers; in other beds we get *Bairdia subdeltoidea,* such as is chiefly found in deep seas and warm climates: in another stratum we get the carapaces of *Cytheres,* such as we find in the shallow water of our own coasts. Here we have evidences of the existence of different conditions of sea-bottoms, contemporaneous or successive, as the case may be, in a series of deposits now converted into clay or stone.

Elsewhere we have layers of clay or stone filled and covered with the shells of *Cyprides,* as thickly strewn as in the mud of any river now running.

Tracing these river-deposits and these sea-deposits, the geologist traces out the ancient outlines of land and sea in the long past periods of the earth's history, of which we have no other record. But this is a record sufficient; and it teaches us, also, that not only to great things but to small, not only to monster beasts—Iguanodons, Elephants, Whales—but to microscopic Entomostraca, is our attention to be turned if we wish to learn aright what has passed on this earth's surface, if we wish to carefully study God's creation, and to see all the evidences of perfect design and perfect adaptation that the history of successive forms of life, with their successive modifications of structure and habits, can supply.

Boulder Clay.—Is Boulder Clay a marine or land deposit. formed by glaciers or by icebergs, or is it of both or of several origins? These questions, in so far as they relate to the Till or Boulder Clay of Scotland, are ably discussed as follows by Mr. Crosskey, in the transactions of the Glasgow Geological Society:

Under the general term, boulder clay, many deposits produced at various periods during the great glacial epoch, and by different causes have been loosely included. It is necessary to distinguish between these various 'Boulder Clays," before observers in separate localities will be able to understand each other's language, and before any satisfactory theories can be established regarding the methods of their formation.

The old motto for statesmen dealing with barbarous tribes on the frontiers of an empire was, "Divide and command;" and this must also be the motto for students of the apparently confused accumulations of glacial deposits. We must divide to command.

I. The oldest boulder clay I at present believe to be represented by that which underlies the shell clay of the West of Scotland.

It is only in the lower districts, however, that the shell clay rests upon it, while it reaches to a height in Scotland (1,500 feet or more) far beyond that at which any shells have yet been discovered. Its thickness extends from a mere covering of the rock, to the depth of even 300 feet, and is excessively variable.

It is closely compact, as though subjected to immense pressure and difficult to work even with the pick-axe.

Although occasionally containing patches of sand, of greater or less extent, it has no stratification. The included stones are in large numbers, polished and striated, and have not been broken by the process through which they have passed. Even thin and brittle pieces of shell are found finely striated.

These polished and striated surfaces are so freshly preserved that the stones could not have been rolled on a beach subsequently to their production. Any trituration would at once destroy the fineness of the glaciated surfaces.

The included stones are chiefly traceable to the heights nearest the locality in which the special bed is found, although a certain proportion have travelled from distances in the direction along which a glacier would naturally have moved, according to the general conformation of the country.

This boulder clay, we suggest, belongs to the period when the cold of the glacial epoch reached its intensest point.

It preceded the development of the arctic fauna, now fossil in our glacial clays, since the shell beds again and again most decisively rest upon it.

The highest point at which arctic shells are found in Scotland is 510 feet (Airdrie); from that point downwards at various levels to half-tide mark and beneath the sea.

The boulder clay, however, is found destitute of shells to the height of at least 1,600 feet, in every hollow and nook, on mountain flanks, through Scotland.

The only cases of fossiliferous boulder clays are those which I shall presently describe under the second type of boulder clay, and which form cliffs upon the shore, and never extend to any dis'ance inland.

It is difficult to explain these facts in connection with the marine origin of the older b ulder clay.

Upon the higher grounds it occupies frequently large hollows; these hollows might possibly have existed beneath an ice sheet and the clay have been accumulated within them, and subjected to great pressure.

At lower levels the boulder clay is largely developed, both in the plains themselves, and on the flanks of the hills bordering wide valleys, and may thus have been formed beneath the glacier near its termination at the sea.

Whatever explanation of its origin, however, may be given, there seems, so far as present investigations extend (and I admit that all present investigations are more or less tentative), to be evidence for the existence of a boulder clay. (1) Older than the fossiliferous glacial deposits. (2) Extending to greater heights than those to which the proof of any *recent* elevation in Scotland yet extends. (3) Unsubjected to any action of the tidal wave upon the shore. (4) And connected with the more remote and extreme arctic conditions.

II. There is a boulder clay very similar in physical composition to the one just described, but containing fragments of broken shells and many Entomostraca and Foraminifera.

I have examined this along the Irish coast, at the base of the Hill of Howth, and many other localities; on the Scotch coast; on the English coast near Sunderland; in Yorkshire, and along the banks of the Mersey.

The shells this boulder clay contains are essentially arctic in character; but they are very fragmentary, and even single valves are seldom found whole. This feature is in strange contrast with the state in which fossils are found in the great shell beds, resting upon the boulder clay in the Clyde districts. In these shell beds specimens are characteristically found with united valves, and in their natural position.

I have not yet observed this clay in any other situation than within easy reach of the shore, and I am inclined to regard this fossiliferous boulder clay as peculiar to the seaward terminations of the general deposit.

This fact (if as a fact it is finally established by further researches) may throw considerable light upon its origin.

This fossiliferous boulder clay may represent the *debris* accumulated on its progress downwards from the mountain by the descending glacier, and deposited by it, as it pushed itself beneath the sea on reaching the shore.

While this boulder clay possesses the general physical characteristics of the boulder clay first described—containing the usual striated and polished stones, and being compact and unworkable—these characteristics may, perhaps, fairly be described as not quite so intense in their development in many cases, although often its only distinguishing mark is the presence of shell fragments.

Its peculiar position in cliffs near the shore, the occurrence of fossils, and its general composition, seem to sustain the theory that it marks the point where the *debris* of great glaciers was pressed to the bottom of the sea at the final point of their descent.

Without reference, however, to the method of its formation, as a matter of fact there exists a boulder clay. (1) Fossiliferous—the included shells being arctic in character, but fragmentary. (2) Chiefly developed in the neighbourhood of the shore in the form of sea cliffs. (3) Physically the same as that which underlies the shell clay of the Clyde district, although sometimes distinguishable by a diminution in the intensity of its characteristics.

III. The type of a third clay, which may in its extreme form be termed a boulder clay, may be seen near Lag, Arran, overlying the older boulder clay. It is very hard and compact; the shells are better preserved than in the second boulder clay; but the embedded stones are not so well striated, and have been more or less worn since their first glaciation. Patches of sand and sandy clay are common.

This clay I am disposed to regard as the wash of the last described boulder clay upon a somewhat exposed coast. The angular blocks have been jumbled together, and their striations half obliterated, and their polish somewhat worn off, while the clay has been washed and rewashed around them, and a rude and rough habitat formed for the scanty development of some forms of molluscan life.

IV. An upper boulder clay, belonging to the period of retreating glaciers, and an ameliorated climate, is very distinguishable. (1) It is far less compact than any clay yet described.

(2) The included stones have very feeble polish, and only faint reminiscences survive of their former striations. They have evidently been much worn in many cases, and in others have not been subjected to any extreme glaciating force. (3) It is not fossiliferous.

The older boulder clay, and this younger boulder clay may sometimes be seen resting upon each other. At Chapel Hall, Airdrie, a good example of this occurs. The line of separation in a well dug by Mr. Russell in his garden, might even be detected by the eye, and it was in a deposit occurring between the two that fossils were found.

Sometimes a shell bed may been seen in sections intervening between the older and the newer boulder clay. This may be admirably studied in the beds before alluded to near Lag, Arran.*

In regular and ascending order may be seen the older boulder clay—1 of this paper; unfossiliferous and typical.

The fossiliferous clay—3 of this paper; with a scattering of striated stones; a wash from an older bed, indicating depression.

Younger boulder clay—4 of this paper; unfossiliferous, loose and sandy, with feebly striated stones; the most recent bed which can be attributed to ice action.

If there be any truth whatever in these divisions of "boulder clay," it is evident that to speak of a fossil as found in boulder clay, or under boulder clay, is a most vague and indefinite phrase.

A shell may be said to occur *in* the boulder clay, and may have been found in the second, third, or fourth, of the beds discriminated in this paper; or a shell may be said to occur *under* the boulder clay, and may have been found under the first or the fourth.

A fossil really belonging to the age of the Paisley clay may thus be ascribed to a more remote or a more recent era, to the great confusion of any attempt to understand either variations of climate or distribution of species during the glacial epoch.

The classification of boulder clays in this paper is given as a suggestion rather than in any way as an established arrangement, with the view of urging upon the members of the Society the necessity for more extended investigations.

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* *See* a joint account of these beds by Dr. Bryce and the writer, 'Geology of Arran."—P. 166, 2nd edition.

PREHISTORIC HORSES.—Much interest attaches to the remains of horses in the more modern deposits both in the Old World and in America; which latter Continent, though destitute of wild horses when discovered, exhibits the remains of several extinct species; but much difficulty has been felt from the time of Cuvier to that of Leidy in distinguishing one species or variety from another.

Professor Owen has recently examined some interesting specimens from a pre-historic cave at Bruniquel in France where bones of horses occur with those of rein-deer, and in such circumstances as to show that both animals afforded food to some aboriginal tribe. He has described these remains in a paper read before the Royal Society, and has in a subsequent communication compared them with equine remains from South and Central America. The following abstracts are from the Proceedings of the Royal Society.

"Referring to the want of figures of the natural size, or of any figures of the characteristic surface of the teeth of the molar series in the known species of the existing Equines, the author gives a description thereof in the Horse (*Equus caballus*), Ass (*E asinus*), Kiang (*E. hemiconus*), Quagga (*E. quogga*), Dauw (*E. Burchelli*), and Zebra (*E. Zebra*), indicating by comparison their respective characteristics. These descriptions are accompanied with drawings (of the natural size) of the working-surface of the dentition of each species, with lettered details of such surface in the teeth of both upper and under jaws.

"The Equine fossils from the Cave of Bruniquel are then described and compared with each other, with the above-named existing species of *Equus*, and with previously defined fossil species of *Equidæ*. Two varieties in respect of size and some minor characters are pointed out in the Bruniquel series, of one of which figures (of the natural size) of the grinding-surface of the upper and lower molar series, and of the second variety, figures of the same surface of the upper molar series are given.

"The author, remarking that such evidences of mature and full-grown animals are rare from the Bruniquel Cave-deposits, selects evidence of certain phases of dentition in the Cave Equines which lend aid in determining their affinities; these phases being illustrated by four drawings of the natural size, "Of the various fossil teeth of *Equidæ* with which those from Bruniquel have been compared, the author finds the closest resemblance, approaching to identity, in certain fossils from fresh-water sedimentary deposits of Postpliocene or "Quaternary" age in the Department of the Puy-de-Dôme, France. Of these, descriptions are given of the teeth of the upper and lower jaws from such deposits at a locality traversed by the river Allier, near the "Tour de Juvillac." A figure of the working-surface of the teeth of the lower jaw from this locality is given (of the natural size), showing the characters of the canine and proportions of the diastema. The close conformity in the characters of the upper grinders of the Puy-de-Dôme fossils of deposit with those of the Bruniquel cavern enables the author to dispense with figures of them.

"The sum of the several comparisons is to refer the above Equine fossils from sedimentary deposits and both varieties from the Bruniquel cave to one and the same species or well-marked race belonging to the true Horses, or restricted genus *Equus* of modern mammalogists; the individuals of which race, with a small range of size, probably due to sex, were less than the average-sized horse of the present period, but larger than known existing striped or unstriped species of *Asinus*, Gray.

"Interesting testimony, confirmatory of the conclusion from the palæontological comparisons, is adduced from outlines of the heads of different individuals of the Cape Equine when alive, neatly cut on the smooth surface of a rib of the same species, discovered by the Vicomte de Lastic St. Jal in 1863, in his cavern at Bruniquel, under circumstances which indisputably showed the work to have been done by one of the tribe of men inhabiting the cavern and slaying the wild horses of that locality and period for food.

"The author remarks that every bone of the Horse's skeleton (and such evidence had been obtained from about a hundred individuals that had been exhumed at the period of his second visit to Bruniquel, in February, 1864) had been split or fractured to gain access to the marrow. The dental canal and roots of the teeth had been similarly exposed in every specimen of the jaw.

"Then, referring to his previous paper on the Equine fossil remains from the cavern of Bruniquel, he finds, in the preliminary illustrations of the dental characters of existing species of the Horse-kind, the requisite and much-needed basis of comparison for the determination of other fossils of the Solidungulate group, and he devotes the present paper to the elucidation of those which have reached him from Central and South America.

"In a subsequent paper he commences by referring to the type-specimens of teeth, from two localities in South America, on which he founded the species *E. curvidens*, describing it (in 1840) 'as one co-existing with the Megatherium, Toxodon, &c., in that continent, and which had become extinct at a pre-historic period.'

"He then proceeds to describe more complete evidences of the dentition of an allied extinct Horse discovered by Don Antonio del Castillo, mining engineer, in newer Tertiary deposits of the Valley of Mexico. Besides repeating the originally described characters of the curvature of the grinder with a certain resemblance of enamel-pattern to the grinding-surface of the *E. curvidens*, they show a greater degree of curvature of the alveolar series of the upper jaw, with corresponding greater convergence of the right and left molar series toward the fore part of the palate, than in any previously described species of *Equus*.

"Deciduous teeth of the *Equus conversidens* from the same deposits of the Valley of Mexico are described. Having determined these corroborative and distinctive characters of aboriginal and now extinct American horses, the author remarks, 'It is unlikely, seeing the avidity with which the Indians of the Pampas have seized and subjugated the stray descendants of the European horses introduced by the Spanish 'Conquistadors' of South America, and the able use the nomad natives make of the multitudinous progeny of those war-horses at the present day, that any such tameable Equine should have been killed off or extirpated by the ancestors of the South-American aborigines.' If, therefore, the fossil Equine teeth do belong, as the author deems that he has proved, to a species distinct from *Equus caballus*, Linn., the circumstances of their discovery, and the fact of the extinction of such (curvident and conversident) species of Horse would point to some other cause than that of man's hostility to so useful an animal, and such doubt as to extinction by human means may then be extended to the contemporaries of the *Equus curvidens* and *E. conversidens*, viz., *Megatherium*, *Mylodon*, *Toxodon*, *Nesodon*, *Macrauchenia*, *Glyptodon*, *Mastodon*, &c.'

"The author next proceeds to describe fossil teeth from the upper and lower jaw, discovered by Don A. del Castillo in the same deposits of the Valley of Mexico, and referable to a third species of *Equus*, viz., *Equus tau*, Ow. Finally the author proceeds to the description of some fossil upper molar teeth from Pampas deposit, in the bed of a brook falling into the "Arroyo Negro' near Paysandi, Monte Video, showing characters more decisively distinct from any other known species of *Equus* than have hitherto been described.

"The degree of curvature of the upper molar teeth exceeds that in *Equus curvidens*, and equals that in *Toxodon*; and the specific name "arcidens" is accordingly proposed for this aboriginal American species of Horse. It is compared with so much of the characters as have been given by Dr. Lund of his *Equus neogæus* and *E. principalis* from Brazilian caverns; and the differences from all other Equines which these species and the *E. arcidens* agree in presenting lead the author to view them as having, like the *Hippotherium* of Kaup, formed a generic group in the *Equidæ*, for which he proposes the name *Hippidion*.

The fossil teeth of *H. arcidens* were found associated with remains of *Megatherium* and *Glyptodon* in the above-named locality; the specimens were transmitted and presented to the British Museum (in 1867) by the Hon W. G. Lettsom, Her Britannic Majesty's Minister at Monte Video.

BOTANY AND ZOOLOGY.

PLANTS NEW TO CANADA.—Mr. Macoun, of Belleville, a corresponding member of the Society, in a letter to one of the Editors, gives a list of the species which he collected, for the first time, during the summer of 1868. The following are some of the more interesting:—

Cakile Americana *Nuttall*,	Physalis grandiflora *Hooker*,
Myriophyllum tenellum *Bigelow*,	Limnanthemum lacunosum *Griseb.*
Aster azureus *Lindley*,	Polygonum ramossissimum *Michx.*
Lobelia Dortmanna *Linn.*	Potamogeton natans *Linn.*
Littorella lacustris *Linn.*	—— Oakesianus *Robbins*,
Utricularia cornuta *Michx.*	—— Claytonii *Tuckerman*.

Potamogeton Vaseyi *Robbins*,
—— spirillus *Tuckerman*,
—— rufescens *Schrader*,
—— amplifolius *Tuckerman*,
—— gramineus *Linn.* and
var. ? myriophyllus *Robbins*,
—— lucens *Linn.*—the
var. minor *Nolte*,
—— perfoliatus *Linn.* and
var. lanceolatus *Robbins*,
—— compressus *Linn.* (ex *Fries*),
—— obtusifolias *Mertens* et *Koch*,
Potamogeton paciflorus *Pursh*,
—— pusillus *Linn.*—the
var. vulgaris *Fries*,
—— pectinatus *Linn.*
—— Robbinsii *Oakes*,
Saggitaria heterophylla *Pursh*,
Habenaria virescens *Sprengel*,
Juncus pelocarpus *E. Meyer*,
Scirpus subterminalis *Torrey*,
Carex adusta *Boott*,
—— livida *Willd.*
Triticum violaceum *Hornemann*.

Littorella lacustris—abundant in the north of Scotland, and widely distributed throughout Europe, chiefly among the mountainous regions and extending into the arctic circle —is now, for the first time, recorded as American. The remoteness of the locality in which it was found ('on an island in Gull Lake') gives it an undoubted claim to be a true native.

Two interesting ferns have been added to the flora of Canada during the past summer, viz.:—

Cystea montana (Lam.)

Polypodium montanum *Lamarck* Flore Francaise, vol. i. p. 23; Cyathea *Smith* Turin Memoirs, vol. v. p. 417; Aspidium *Swartz* Synopsis Filicum, p. 61; Cystopteris *of Authors*: Polypodium myrrhidifolium *Villars* Histoire des Plantes des Dauphine, vol. i. p. 262; etc., etc. (Filices Canadensis, No. 30 b.)

It is well figured by Schkuhr (table 63) and in Hooker's British Ferns (table 25). In Europe it is generally distributed from Lapland to the Apennines and Pyrenees; in Asia it is said to occur in East Siberia; of America Sir Wm. Hooker says, "We possess five specimens from the east side of the Rocky Mts. "gathered by Drummond." It was found in some abundance by Mr. Macoun on one of the most northerly bays of Lake Superior, "in low woods, July 19, 1869," and may be looked for near the same latitude throughout Canada East.

Polystichum Filix-mas (Linn.)

Polypodium filix-mas *Linnæus* Species Plantarum, p. 1551; Polystichum *Roth* Flora Germanica, vol. iii. p. 82; Nephrodium *Rickard* in Desvaux's Annals, vol. vi. p. 260; Aspidium *Swartz* Synopsis Filicum, p. 55; Dryopteris *Schott* Genera Filicum; Lastrea *Presl* Tentamen Pteriodographiæ, p. 76; etc., etc. (Filices Canadensis, No. 23 b.)

Throughout Europe this is one of the commonest and most abundant of ferns; in Asia its range extends from Siberia to Asia Minor, the Himalayas and Japan; it occurs in North Africa; and one of its forms (the *Aspidium paleaceum* of Don) is common throughout America from Mexico to Peru. Its range in temperate North America is not well understood; Mr. Baker unites with it *Polystichum elongatum* (Aiton) which, he says (probably in error), occurs in the Southern States; Sir Wm. Hooker unites with it his own *Polystichum Floridanum*, which is found throughout the Gulf States, but Mr. Eaton has correctly shown that the affinity of this plant is with *P. cristatum*. Several fronds of its normal form were found among some specimens of *P. Goldieanum*, obligingly sent to me by Mrs. Roy, of Royston Park, Owen Sound, who afterwards recognized one of them as belonging to a large and stately plant which grew close to her residence. Mrs. R. hopes to collect an abundance of specimens next year. Her neighbourhood is very rich in ferns, perhaps richer than any other equally circumscribed locality in Canada. *Filix-mas* doubtless occurs throughout the continent from the Great Lakes to the Pacific, and perhaps southward to Mexico along the Rocky Mountains.

D. A. W.

MOSSES NEW TO CANADA.—Since the publication of my catalogue of Canadian Cryptogams, Mr. Macoun has detected the following species of Musci in the neighborhood of Belleville, which were not then known as Canadian :—

Sphagnum Wulfianum *Girgensohn*,
(=*S. pycnocladum* Angst.)
—— Girgensohnii *Russow*,
—— Austinii *Sull.*
—— laricinum *Spruce*,
—— recurvum *Beauv.*
—— subsecundum *Nees*,
Gymnostomum calcareum *Nees* et *Horns*.
Anodus Donianus *Bry. Eur.*
Campylopus viridis *Sull.* et *Lesq.*
Dicranum spurum *Hedw.*
—— Schreberi *Hedw.*
Fissidens minutulus *Sull.*
Barbula cæspitosa *Schwægr.*
Encalypta vulgaris *Hedw.*
Orthotrichum Lescurii *Austin*,
Bryum cernuum *Hedw.*
—— cyclophyllum *Bry. Eur.*
—— intermedium *Brid.*
Mnium spinosum *Bry. Eur.*
—— cinclidioides *Blytt*,
—— lycopodioides *Hook.*
Fontinalis novæ-Angliæ *Sull.*
—— Dalecarlica *Bry. Eur.*
Myurella Careyana *Sull.*
—— julacea *Bry Eur.*
Pterigynandrum filiforme *Hedw.*
Hypnum lutescens *Hudson*,
—— plumosum *Swartz.*
—— rivulare *Bry. Eur.*
—— hispidulum *Brid.*
—— stellatum *Schreber*,
and var. protensum *Schim.*
—— minutissimum *Sull.* et *Lesq.*
—— cariosum *Sull.*
—— compactum *Sull.*
—— Sullivantiæ *Schim.*
—— turfaceum *Lindberg*,

Specimens of these mosses will be presented by Mr. Macoun to the Society's herbarium.

Rev. James Fowler of New Brunswick recently sent a set of his Sphagnaceæ to Mr. Austin of New Jersey, who has given me the following large list of species as forming the collection :—

Sphagnum acutifolium *Ehrh.*	Sphagnum molluscum *Bruch,*
—— Austinii *Sull.*	—— recurvum *Beauv.*
—— cuspidatum *Ehrh.*	—— rigidum *Schimper,*
—— cymbifolium *Ehrh.*	—— rubellum *Wilson,*
—— fimbriatum *Wilson,*	—— squarrosum *Persoon,*
—— Girgensohnii *Russow,*	—— subsecundum *Nees,*
—— laricinum *Spruce,*	—— Wulfianum *Girg.*

D. A. W.

Dr. Rabenhorst, of Dresden, has for many years been engaged in the publication of European Cryptogams, a priced list of which he has recently sent to me, as follows :—

1.	Herbarium Mycologicum, Centuries i.—viii., at 6	48	Thalers
2.	Fungi Europæi exsiccati, Centuries i.—xiii., at 6	78	do.
3.	Lichenes Europæi exsiccati, Fasc. i.—xxxi., (Nos. 1 to 850) at 2½	78	do.
4.	Cladoniæ Europææ	30	do.
5a.	Desmidiaceæ, Century i	12	do.
5b.	Diatomaceæ, Century i	15	do.
6.	Algen Europa's, Decades 1 to 12, (Nos. 1 to 2120, at 20 s. g	141	do.
7.	Characeæ Europææ exsiccatæ, Fasc. i. to iii. (Nos. 1 to 75) at 3	9	do.
8.	Hepaticæ Europææ, Decades 1 to 44, at 20 s. g	29	do.
9.	Bryotheca Europæa, Fasc. i. to xxi. (Nos. 1 to 1050) at 3	63	do.
10.	Cryptogamæ Vasculares Europææ, Fasc. i. to iv. (Nos. 1 to 100) at 3.	12	do.
11.	Cryptogamia—"a collection for school and home, containing examples of all Orders and Tribes, and in the Fungi the diseases of cultivated plants ;"—500 species in folio	12	do.

(The Thaler is equal to about seventy-five cents, being exactly three shillings sterling).

I have lately had an opportunity of examining the collection of the vascular cryptogamia (no. 10 above), and of comparing his specimens with our Canadian forms, and append a few notes on some of the species which are common to both continents. I copy Dr. R's nomenclature exactly ; it is near enough to that of Gray's Manual to enable any one to recognise the plants. As a rule the specimens are well preserved and mounted, and are amply sufficient to illustrate the species. The four fasciculi contain in all about one hundred species, many of which are illustrated by several examples from various localities.

No. 8. Botrychium simplex *Hitchc.* The specimens are small, but they agree exactly with ours.

No. 9. Botrychium Lunaria (*Linn.*) *Kaulf.*
No. 14. Cystopteris fragilis (*Linn.*) *Bernh.* } We have forms similar to these; both species are very variable.

No. 15. Woodsia ilvensis (*Swartz*) *R. Brown.* A small specimen, but identical with ours.

No. 16. Aspidium Thelypteris *Swartz.* Exactly our plant.

No. 17. Aspidium cristatum *Swartz.* We have forms agreeing with these, but this species is much more variable in America than it is in Europe,—verging with us as well towards *Filix-mas* and *Goldieanum* as towards *spinulosum.*

No. 18. Aspidium spinulosum *Swartz.* The broadly-ovate frond and dark-centered scales of this specimen are usually considered to be characteristic of the var. *dilatatum* (Hook. Br. Ferns, t, 19) rather than of the normal *spinulosum;* we have this form, but that named var. *intermedium* by Eaton, is much more common with us.

No. 19. Aspidium spinulosum-cristatum *Lasch in litt.* This is exactly the *A. Boottii* of Tuckerman, whose name has undoubted priority. Gray and Eaton consider it to be a form of *spinulosum*; my specimens are more *cristatum*-like; Milde considers it a hybrid of these two species. Its proper name, according to my views, would have been *A. cristatum* var. *Boottii.*

No. 20. Aspidium Braunii *Spenner.* This is exactly our North American plant, my specimens from Tadousac, Temiscouata, the Green Mountains and the White Mountains being all identical with it. Dr. Gray should have written it as *A. aculeatum* var. *Braunii* Doll's Rheinische Flora (1843) p. 21.

No. 23. Aspidium Filix-mas (*Linn.*) *Swartz.* Agrees well enough with Mrs. Roy's specimens to be considered identical. Prof. Eaton has it from the Rocky Mountains of Colorado, from Lake Superior, and from Greenland; Sir Wm. Hooker has it ("the normal form,") from California; and Kunze says he has "seen it from Newfoundland."

No. 25. Asplenium Trichomanes *Hudson.* Exactly ours.

No. 29. Botrychium matricariæfolium *Al. Braun.* Identical with our forms. I have this species from Temiscouata (Dr. Thomas), Belleville and Lake Superior (Mr. Macoun), White Mountains (Horace Mann), and Pennsylvania (per Prof. Porter as *B. neglectum* A. Wood, leg. A. P. Garber).

No. 30. Botrychium rutæfolium *Al. Braun.* Evidently conspecific with our *B. lunarioides;* and Dr. Milde has very properly united both with the older *B. ternatum* of Thunberg and Swartz.

No. 31. Scolopendrium officinarum *Sw.* NewYork plants are nearer to these specimens than ours, but the species is a variable one.

No. 34. Asplenium viride *Huds.*
No. 37. Asplenium Ruta muraria *L.* } Are all identical with our North American plants.
No. 38. Aspidium Lonchitis *Sw.*

No. 40. Aspidium spinulosum *var.* dilatatum (*Sm.*) I have specimens like this from the Saguenay, but our usual form is a much large and more compound plant; *dilatatum* is with us less variable and nearer to a type-plant than is *spinulosum,* and should therefore, I think, be taken as our species.

No. 55. Polypodium vulgare (*C. Brauh.*) *Linn.*
No. 56. Phegopteris polypodioides *Fee.* } Are our forms exactly.
No. 57. Phegopteris Dryopteris *Fee.*

No. 58. Phegopteris calcarea (*Sm.*) *Fee.* Not certainly known as North American, but hardly more than a variety of No. 57.

No. 59. Struthiopteris germanica *Willd.*
No. 61. Acropteris septentrionalis (*Linn.*)*Link.* } Are identical with our North American forms.
No. 62. Cystopteris montana (*Roth*) *Bernh.*

No. 82. Woodsia hyperborea *R. Brown.* Clearly identical with our plant, but the specimen is very small (less than two inches high) and *ilvensis*-looking. Scarcely distinct as a species from No. 15.

No. 83. Woodsia glabella *R. Brown.* Having seen numerous European specimens of this species, chiefly from Scandinavia, which were invariably named *W. hyperborea,* I had formed the opinion that the *Acrostichum hyperboreum* of Liljeblad (Stockholm Transactions, 1793, p. 201), must be different from the *W. hyperborea* of R. Brown (Linn. Trans., vol. xi. p. 173); be that as it may, it is now manifest that European botanists have long time had *W. glabella* without recognizing it. The specimen here is from the Alps of the Tyrol, and is contributed by Dr. Milde, who appends a note, stating that the species had been collected in that district as long ago as 1848, but had been called *W. hyperborea,* until in 1855, when it first came under his notice, he found it to be the true *W. glabella.* He says the present specimen grew on a dolomite block, in company with *Potentilla nitida, Phyteuma Sieberi, Euphrasia minima, Silene quadrifida, Asplenium viride, Cystea fragilis,* etc., etc., and adds that in Tyrol, "this plant, like *Asplenium Seelosii,* is confined to the dolomite."

No. 84. Asplenium alpestre (*Hoppe*) *Metten.* Identical with some Californian specimens in my herbarium.

No. 92 *a.* Allosurus crispus (*L.*) *Bernh.* These specimens appear sufficiently distinct from our *Cryptogramme acrostichoides* to give the latter the rank of a variety, though I have in my herbarium a specimen from California which is identical with one from Scotland. It is singular that some European botanists should insist on the identity of our *Pellæa gracilis* with this species.

The Lycopodiaceæ and Equisetaceæ of Europe are also very fully illustrated, there being seven species of Lycopodium (including *L. inundatum*, *L. alpinum*, *L. selaginoides* and *L. Helveticum*), seven of Isoëtes, and no less than twenty-two species and varieties of Equisetum. Any of Dr. Rabenhorst's works can be obtained through the publishers of this journal.

D. A. W.

THE ACROGENS OF LAKE SUPERIOR.—Mr. Macoun, of Belleville, has lately returned from a somewhat extended botanical tour around the north shore of Lake Superior, which occupied him during July and part of August. By dint of excessive work he has made a large collection, many of his specimens being of great rarity and interest. A catalogue of all the plants noticed and collected by him is in progress, and will probably be published by instalments in this journal. The Acrogens, being worked up, are here given as a beginning; and the opportunity to include the species obtained by other collectors, in the same locality, is availed of. I am indebted to Prof. T. C. Porter for a list of the species collected by a party, consisting of himself, Dr. Robbins, and Mr. Smith of Philadelphia, who botanized around the south shore in 1865—these are marked Port.; also to Prof. Eaton, for such as are authentically known to him as occurring on the shores and islands of the Lake—his being marked Eat. The mark Gr. is for Dr. Gray, referring to his Manual; and Ag. is for Prof. Agassiz's work, 'Lake Superior,' (Boston, 1850). Mr. Macoun's own species are marked Mac. His most interesting ferns are *Cystea montana*, *Woodsia hyperborea*, *W. glabella*, *Botrychium matricariæfolium* and *B. simplex*; while it is remarkable that he did not find *Cryptogramme crispa*, *Polystichum Filix-mas* or *Woodsia Oregana*, which occur on the south shores of the Lake, the first-named being also abundant on Ile Royale. The personal-name attached to each species (and variety) is that of the author who first gave the specific name here adopted; when it is placed within brackets, that author put the plant in a different genus (or in the same genus differently named) from that to which it is here assigned.

ACROGENÆ LACUS SUPERIORIS.

FILICES.

1. POLYPODIUM Linn.

1. P. vulgare *Linn.*
Port. Mac.

2. CRYPTOGRAMME R. Br.

2. C. acrostichoides *R. Br.*
Port. Eat. (not distinct from *C. crispa*).

3. PELLÆA Link:

3. P. gracilis (*Michx.*)
Ag. Mac.

4. P. atropurpurea (*Linn.*)
Mr. Barnston.

4. PTERIS Linn.

5. P. aquilina *Linn.*
Ag. Port. Mac.

6. ——— var. lanuginosa *Hook.*
Eaton.

5. ADIANTUM Linn.

7. A. pedatum *Linn.*
Macoun.

6. ASPLENIUM Linn.

8. A. Trichomanes *Linn.*
Port. Mac.

7. ATHYRIUM (Roth) Milde:

9. A. thelypteroides (*Michx.*)
Port. Mac.

10. A. Filix-fœmina (*Linn.*)
Eat. Port. Mac.

8. PHEGOPTERIS Fee:

11. P. connectile (*Michx.*)
(=*Polyp. Phegopteris* Linn.)
Port. Eat. Mac.

12. P. Dryopteris (*Linn.*)
Ag. Port. Eat. Mac.

9. POLYSTICHUM Roth, Tentamen vol. iii. p. 69:

13. P. Lonchitis (*Linn.*)
Gray, Eat.

14. P. acrostichoides (*Michx.*)
Macoun.

15. P. aculeatum var. Braunii (*Doll*)
(=*Aspidium Braunii* Spenner).
W. D. Whitney fide Eaton.

16. P. Thelypteris (*Linn.*)
Macoun.

17. P. Noveboracense (*Linn.*)
Porter.

18. P. fragrans (*Linn.*)
Port. Eat. Mac.

19. P. Multiflorum (*Roth*),
Port. Mac.

20. ——— var. spinosum (*Roth*),
Eaton, Mac. (the var. *intermedium* of Eaton).

21. P. cristatum (*Linn.*)
Eat. Mac.

22. P. Filix-mas (*Linn.*)
Port. Eat.

23. P. marginale (*Linn.*)
Macoun.

10. ONOCLEA (Linn.) Swartz,

24. O. Struthiopteris (*Linn.*)
Ag. Port. Eat. Mac.

25. O. sensibilis (*Linn.*)
Port. Mac.

11. CYSTEA J. E. Smith, Eng. Flora vol. iv. p. 284:

26. C. fragilis (*Linn.*)
Port. Mac.

27. C. bulbifera (*Linn.*)
Agassiz (?)

28. C. montana (*Lamarck*)
Macoun—"near Current River."

12. WOODSIA R. Brown:

29. W. Ilvensis *R. Br.*
Ag. Port. Mac.

30. W hyperborea *R. Br.*
Macoun—"near Fort William."

31. W. glabella *R. Br.*
Macoun — Michipicoten and elsewhere.

I follow Robert Brown's nomenclature, though I consider 30 to be a variety of 29; some of Mr. Macoun's specimens of 31 are, however, remarkably near 30.

32. W. Oregana *Eaton*,
Dr. Robbins fide Port.

13. OSMUNDA Linn.

33. O. regalis *Linn.*
Port. Mac.

34. O. Claytoniana *Linn.*
Port. Mac.

14. BOTRYCHIUM Swartz:

I follow Dr. Milde (Monographia Botrychiorum) both as to species and nomenclature.

35. B. Lunaria (*Linn.*)
Ag. Macoun—"near Pic River."

36. B. matricariæfolium *A. Braun*, (=*B. rutaceum* Schkuhr t. 155, fig. b: Rabenhorst, No. 29).
Macoun—"near Neepegon."

37. B. simplex *Hitchc.*
Macoun—"near Fort William."

38. B. ternatum var. Americanum *Milde*, (=*Botrypus lunarioides* Michx.)
Macoun—"near Fort William" some curious forms.

39. B. Virginianum (*Linn.*)
Ag. Port. Eat. Mac.

EQUISETACEÆ.

1. EQUISETUM Linn.

1. E. arvense *Linn.*
Ag. Port. Eat. Mac. —Eu. As. Af.

2. E. Telmateia *Ehrh.*
"Shore of Upper Great Lakes"—Gray. —Eu. As. Af.

3. E. pratense *Ehrh.*
Macoun. —Eu. As.

4. E. sylvaticum *Linn.*
Ag. Port. Mac. —Eu. As.

5. E. palustre *Linn.*
Porter. —Eu. As.

6. E. limosum *Linn.*
Ag. Port. Mac. —Eu. As.

7. E. litorale *Kuhlew.?*
I refer some of Macoun's specimens to this species. —Eu.

8. E. lævigatum *A. Braun*,
Dr. Robbins fide Eat.—N. Am. only.

9. E. hiemale *Linn.*
Port. Mac. —Eu As.

10. E. variegatum *Schleicher*,
Eat. Mac. —Eu. As.

11. E. scirpoides *Michx.*
Port. Mac. —Eu. As.

LYCOPODIACEÆ.

1. LYCOPODIUM Linn.

1. L. lucidulum *Michx.*
Ag. Port. —Asia.

2. L. Selago *Linn.*
Gr. Eat. Mac. —Eu. As. Af. Aus. S.Am.

3. L. annotinum *Linn.*
Ag. Port. Mac. —Eu. As.

4. L. dendroideum. *Mickx.*
Ag. Port. Mac. —Asia.

5. L. clavatum. *Linn.*
Ag. Port. Mac. —Eu. As. Af.

6. L. inundatum *Linn.*
Agassiz. —Europe.

7. L. complanatum *Linn.*
Ag Port. Mac. —Eu. As.

8. L. alpinum *Linn.*
Newfoundland, Canada, Hudson Bay Territories, and Rocky Mountains, *vide* Hook. Br. Ferns. —Eu. As.

2. SELAGINELLA (Beauv.) Spring:

9. S. selaginoides (*Linn.*)
Link, Fil. Hort. Berol. p. 158; *S. spinosa* Beauv. Prodr. 112, Spring Monogr. ii. p. 59; *S. spinulosa* A. Braun in Doll's Rheinische Flora, p. 38.
Ag. Port. Mac. Europe.

10. S. rupestris (*Linn.*)
Spring l. c. p. 55; *Stachygynandrum* Beauv.
Ag. Port. Mac. —Eu. As. Af. S.Am.

3. ISOETES Linn.

11. I. lacustris *Linn.*
Porter. —Eu.

12. I. echinospora *Durieu?*
Macoun—Michipicoten; his specimens are too immature for accurate determination, but they are not 11.

The following species are not, so far as I am aware, recorded as occuring in this region, but are more or less likely to be found :—

Cheilanthes gracilis (*Fee*) *Mett.* (=*Ch. lanuginosa* Nuttall),
Blechnum Spicant,
Scolopendrium vulgare,
——— rhizophyllum,
Asplenium ebeneum,

Asplenium viride,	Dicksonia punctilobula,
—— Ruta-muraria,	Osmunda cinnamomea,
—— septentrionale,	Botrychium boreale,
Athyrium rhæticum,	—— lanceolatum,
(=*Asplenium alpestre* Mett.)	Ophioglossum vulgatum,
Polystichum Goldieanum,	Selaginella apus.

Two species of North Europe may also possibly occur there, or in some other part of northern North America, viz. *Athyrium crenatum* and *Cystea sudetica*, the latter of which, a somewhat recent discovery, is closely allied to *C. montana*.

The northern shores of the lake would appear to be more prolific in Filices than the southern, inasmuch as Mr. Macoun has thirteen species which are absent from Prof. Porter's list, while the latter has but four species not collected by the former: these four are—

2. Cryptogramme crispa (not Canadian as yet),
19. Polystichum Noveboracense,
22. —— Filix-mas,
32. Woodsia Oregana (not Canadian as yet).

Other collectors have contributed only four species, viz:—

4. Pellæa atropurpurea,	15. Polystichum aculeatum,
13. Polystichum Lonchitis,	27. Cystea bulbifera.

The last named is inserted on the authority of Prof Agassiz's catalogue, and may be a mistake for *C. fragilis*, which, though abundant on the north shore, where his party botanized, is not noted by him; should the species not occur, its absence would however be remarkable.

Of the thirty-nine numbers enumerated, two (6 and 20) are deemed varieties, leaving thirty-seven species; of these

29 species are also Asiatic;
25 do. are also European;
12 do. are common to Europe and Asia;
11 do. are common to Europe, Asia and Africa;
6 do. are common to Asia only;
6 do. are peculiarly American; and
2 do. are (apparently) common to Europe only.

The two lasted noted species (*Botrychium simplex* and *B. matricariæfolium*) are probably also Asiatic, while the six non-European species are not likely to be found there; these six (common to Asia) are—

3. Pellæa gracilis,	18. Polystichum fragrans,
7. Adiantum pedatum,	25. Onoclea sensibilis, and
9. Athyrium thelypteroides,	34. Osmunda Claytoniana.

The affinity is thus nearer to the fern flora of Asia than to that of Europe, which will probably become more apparent when the former continent is more thoroughly explored.

The six peculiarly American species are:—

2. Pellæa atropurpurea throughout N.A. from south Mexico northward).
14. Polystichum acrostichoides (Louisiana eastward and northward).
17. ——— Noveboracense (North Carolina eastward and northward).
23. ——— marginale (same range as 17).
27 Cystea bulbifera (same range as 12).
32. Woodsia Oregana (Lake Superior to British Columbia, and southward, along the mountains, to California).

As regards their distribution throughout the world,—

18 species enter the Arctic circle;
13 do. extend into the Tropics; and
11 do. into the Southern Hemisphere.
8 do. are common to the Arctic circle, Tropics, and S. H.;
3 do. are common to the Tropics and S. H.; and
2 do. are common to the Tropics only.

The eight widely spread species are:—

1. Polypodium vulgare,
5. Pteris aquilina,
10. Athyrium Filix-fœmina,
15. Polystichum aculeatum (the most ubiquitous of all the ferns),
19. ——— multiflorum,
22. ——— Filix-mas,
26. Cystea fragilis (perhaps next to no. 15 in ubiquity), and
38. Botrychium ternatum.

The other five tropical species are:—

Tropics and S. H.	Tropics only.
8. Asplenium Trichomanes,	4. Pellæa atropurpurea,
16. Polystichum Thelypteris,	39. Botrychium virginianum.
33. Osmunda regalis.	

In addition to the eight above noted, the following ten species enter the Arctic circle:

2. Cryptogramma crispa,	28. Cystea montana,
11. Phegopteris connectile,	29. Woodsia Ilvensis,
12. ——— Dryopteris,	30. ——— hyperborea,
13. Polystichum Lonchitis,	31. ——— glabella,
18. ——— fragrans,	35. Botrychium Lunaria;

and probably also the two species of Pellæa, *P. gracilis* being known from Siberia, and *P. atropurpurea* being said to be in Dr. Richardson's collections from "the wooded country, latitude 54° to 64° north" of British America, and more definitely localized by Sir Wm. Hooker as "Bear Lake."

The indications of geographical distributions which are appended to the species of Equisetaceæ and Lycopodiaceæ have been omitted from the Ferns, it being the writer's intention to treat them separately.

D. A. WATT.

NOTE ON THE NAME ASPIDIUM SPINULOSUM VAR. DILATATUM.—Botanists are at variance as to the personal name which ought to be attached to the scientific name of a plant. The British Association rule is that the author of a species is entitled to have his name always attached to it, no matter in what genus it may thereafter be placed, than which nothing could be fairer or more correct. Linné named a Siberian plant *Polypodium fragrans*. Roth, finding the Linnean genus Polypodium to be susceptible of division, separated from it a number of species under the name Polystichum, but, inasmuch as he treated of the plants of Germany only, *P. fragrans* is not named in his work. Swartz followed Roth; naming the genus Aspidium, he included the plant in question, calling it *Aspidium fragrans*. Still later Richard named the same genus Nephrodium, without having occasion to include *P. fragrans*, it being unknown to him as an American plant when he wrote "Michaux's Flora." We thus have what is practically one genus under three different names, and one well understood species, in defining which, by either generic name, we must, under this rule, if we adopt Roth's genus, write thus—*Polystichum fragrans* (Linn.); or, if we desire to be more precise, Polystichum *Roth* Tentamen Fl. Germ. vol. iii. p. 69—*P. fragrans* (Linn. Sp. Pl. p. 1550).

Many botanists, however, prefer to attach the name of the author by means of whose works the plants referred to have been by them determined, or whose works are generally accessible. Thus Robert Brown, in contributing to "Richardson's Appendix to Franklin's Journal," refers almost exclusively to the Species Plantarum of Willdenow, and writes the names of common and well-known Linnean plants thus,—"*Polypodium vulgare* Willd;" "*Lycopodium Selago* Willd."—He even goes so far as to write "*Woodsia Ilvensis* Pursh," though he himself established the genus Woodsia, and correctly defined by the old Linnean name of Ilvensis, what had hitherto been a doubtful species. By this rule it would be equally correct for us, when determining our plants by means of Dr. Gray's excellent Manual, to write "*Woodsia Ilvensis* Gray, Manl. ed. 2nd. p. 596."

Either of these modes is simple and easily understood, and neither of them involves much confusion in nomenclature. But of late years many botanists have adopted a rule different from both, and have attempted to give to it the force of law, whereby any author who first removes a well described species of another author into a different and previously described genus, or even into the same genus under a different name, is thereby entitled to connect his own name with it to the exclusion of that of the original author both of the genus and of the species. Thus Robert Brown, in the catalogue cited above, having occasion to include *P. fragrans,* wrote one line thus, "440. *Nephrodium fragrans,* Aspidium fragrans *Willd.,* v., p. 253," and thereby became entitled to have his name associated with this plant when any subsequent writer called it a Nephrodium, to the exclusion of both Linné and Richard.* A more absurd instance is furnished by another well-known North American fern, the *Nephrodium punctilobulum* of Michaux (anno 1803). In 1788 L'Heritier founded the well-characterized genus Dicksonia before Michaux's species was known; about 1809 Schkuhr figured and described the plant, under its proper genus, as *Dicksonia pubescens,* a characteristic name; in 1846 Sir Wm. Hooker re-described it in Species Filicum as "*D. punctiloba* Hook." restoring but misspelling Michaux's name; in 1848 Prof. Kunzé contributed to *Silliman's Journal,* a paper "on some Ferns of the United States," in which he says, in correction, "I refer, with Hooker, this plant again to Dicksonia, and name it *D. punctilobula,*"—in reward for which intellectual effort most United States botanists now write D. punctilobula *Kunzé !*

Nor is it always easy to find out who was the first author to do such signal service to botanical science as to move a plant from one established genus to another, to restore an older specific name, or to correct a lapsus pennæ. Even the careful Gray makes slips, and writes his own name after some species in violation of his own "law." A remarkable instance of this occurs in the case of Aspidium spinulosum var. dilatatum *Gray,* the

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* It is true that several years before this author wrote some able papers on Fern Genera, but that circumstance does not affect the case as now put. It is somewhat singular too that this credit is generally denied to Brown; Sir Wm. Hooker, Mr. Baker, and other authors, always write Nephrodium fragrans *Richardson,* although the latter gave full credit to Brown for his share of their joint work.

synonymy of which I had occasion lately to investigate, with the following result:

Anno.	Author.	Work.	Spinulosum.	Dilatatum.
1767	Muller	Flora Friedrichsdalina, Nos. 841, 884	Polypodium spinulosum, t. 707	Polypodium Dryopteris, t. 759.
1770	do	Flora Danica, tt. 707 et 759		
1770	Weiss	Plantæ Cryptogamicæ, pp. 316-7	Polyp. Filix-fœmina var. spinosa..... ...	P. Filix-fœmina var. cristata.
1795	Hoffman	Deutchlands Flora, vol. ii. pp. 7-8	Polypodium cristatum............... .	P. dilatatum et P. tanacetifolium.
1797	Roth	Catalecta Botanica, pp. 135-7	Polyp multiflorum var. spinosum	Polypodium multiflorum.
1800	do	Flora Germanica, vol. iii. pp. 87-91	Polystichum spinosum	Polystichum multiflorum.
1801	Swartz	in Schrader's Journal (for 1800), p. 38	Aspidium spinulosum	Aspidium spinulosum.
1804	Smith	Flora Britannica, pp. 1124-25	do do	Aspidium dilatatum.
1805	De Candolle	Flore Francaise, vol. ii. pp. 561-2.....	Polystichum spinulosum	Polystichum tanacetifolium.
1806	Swartz	Synopsis Filicum in add., p. 420	Aspidium spinulosum	Aspidium dilatatum.
1812	Wahlenberg.....	Flora Lapponica, No. 503	A dilatatum var spinulosum	do do
'20?	Hartmann ..	Handbok i Skandinaviens Flora, p. 398	Polystichum spinulosum	P. spinulosum var. dilatatum.
1827	Desvaux	" Mém. Soc. Linn. vol. vi. p. 261"	Nephrod. spinulosum et N. intermedium..	Nephrodium dilatatum.
1827	Hornemann.....	Nomenclatura Floræ Danicæ, p. 33. [editions)	Aspidium spinulosum	A. spinulosum var. dilatatum.
1830	Hooker	British Flora, ed. 1st, p. 444 (and subsequent	do do	do do
1836	Presl	Tentamen Pteridographiæ, pp. 26-27	Lastrea spinulosa	Lastrea dilatata.
1840	Hooker	Flora Boreali-Americana, vol. ii. p. 261	Aspidium spinulosum	A. spinulosum var. dilatatum.
1841	Link	Filices Horto Berolinensi, pp. 105-6	do do	do do
1843	Döll	Rheinische Flora, p. 17-18	A. spinulosum var. elevatum	do do
1844	Koch	Synopsis Flora Germanica, p. 979	Polystichum spinulosum var. vulgare....	Polystichum spinulosum var. dilatatum.
1848	Asa Gray.	Manual of Botany, ed. 1st. pp. 630-1	Dryopteris intermedia.....	Dryopteris dilatata.
1850	Fée	Genera Filicum, p. 291	Aspidium spinulosum et A. intermedium.	Aspidium dilatatum.
1851	Lange	Haandbok i den Danske Flora, p. 682	Lastræa spinulosa	L. spinulosa var. dilatata.
1856	Asa Gray	Manual of Botany, ed. 2nd. p. 597	Aspidium spinulosum	A. spinulosum var. dilatatum.
1858	Mettenius......	uber einige Frangattungen, iv. Nos. 136-7..	do do	Aspidium dilatatum.
1862	Hooker	Species Filicum, vol. iv. p. 127	N. (Lastrea) spinulosum var. bipinnatum	N. (Lastrea) spinulosum var. dilatatum.
1864	Moore, Thomas .	British Ferns, pp. 48-49, (and elsewhere)	Lastrea cristata var. spinulosa	Lastrea dilatata.

Linnė probably included both forms in his *Polypodium cristatum*. Spinulosum appears to have been the first which was separated thus giving the name priority, but Müller's views of the allied forms was somewhat confused; he makes no mention of the Linnean cristatum and misunderstands *P. Dryopteris.* Hoffman was the first to characterize the form dilatatum, but he made two species out of it and applied the Linnean name cristatum to Müller's spinulosum. Then comes Roth, who is the first to make one species of the two forms, his name is multiflorum and spinulorum is reduced to a variety under Weiss's name spinosa; somewhat later, when Roth founded his genus Polystichum, he changed his mind and made a species of each form, without altering his names. Swartz copied Roth throughout, borrowed his genus, calling it Aspidium, and copied him in making the plants in question first one species and then two. Botanists do wrong to ignore Roth; his genus has undoubted priority, and his correct views of the plants in question give his names good claims to be continued. His view of the identity of the two forms has been followed by most modern authors; many able botanists (Mettenius, etc.), however, hold them to be distinct. The changes have been so often rung that the question of priority of name has become somewhat complicated; there is, however, no doubt whatever that Gray's name was applied by Hornemann to the *A. dilatatum* of Swartz and Wildenow as long ago as 1829; that Hooker applied it to the British form in 1830, and to the American form in 1840; while Dr Gray's publication is 1856. The literature to which I have access is of course limited, else the list of synonyms would have been very much longer; and the matter, in itself trifling, is alluded to, only because of its connection with the important subject of correct botanical nommalcture, which is presently being discussed.

D. A. W.

Botany of the West Coast of North America.—The following general account of the botany of the region west of the Cascade Mountains, from Puget Sound southward as far as Tillamook Bay, given by Prof. I. W. Marsh, of Pacific College, Forest Grove, Oregon, in a letter to a friend in this city, has been furnished to us for publication:

"The trees which are most conspicuous, and which cover far the larger part of the country, are conifers. The Douglas spruce

(*Abies Douglasii*) is, perhaps, the most common, and grows sometimes to the height of three hundred feet. It does not, however, attain the diameter of some others, nine to twelve feet being as large as I have seen it.

"Menzies's spruce (*Abies Menziesii*) is the giant in respect to diameter. I have seen one of fifteen feet, and they are said, as are also the cedars, sometimes to reach twenty-five feet. This latter spruce is only found near the coast. The Cedar here is *Thuja gigantea*, the great Arbor Vitæ, and is a very handsome tree. I think, however, the handsomest of them all is the Noble Fir (*Picea nobilis*). It is not quite so large as some of the others, but is more graceful. It usually grows in thick forests, and has a straight, slender stem, from two to three feet in diameter and one hundred and fifty feet without branches, with a graceful bend perhaps fifty feet in height above. A species of hemlock is common, especially near the coast, which bears a general resemblance to that of Canada, yet is not, I think, the same. It grows to two hundred or two hundred and fifty feet, and seven to nine feet in diameter. There is also a pine, but I do not know the species; it is not as common as the others I have mentioned.

"An Oak (*Quercus Garryana*) is the most common deciduous tree. It is found all through the Willamette Valley, and, in the northern part of it is the only oak, as far as I know. An Ash is also common near water. Along streams, Alder, Vine, Maple, Large-leaved Maple, Wild Cherry, a kind of Crab Apple, and some other trees form a margin of green.

"The flowers of the fields and woods are most of them different from their Eastern congeners, and where the same kinds are found they have probably been introduced. Dandelion, Sorrel, Oxeye Daisy, and others have come to plague the farmer,—Sorrel, especially, being very widely spread and troublesome, while Wild Oats, Cheat, and Fern (mostly *Pteris aquilina*), of indigenous growth, are obstinate possessors of the soil.

"In the Ranunculus family, a kind of Coptis is common in the deep woods, also, a pretty Anemone, an Actæa, and a Thalictrum, besides one that I cannot find described, while in the open ground several kinds of Ranunculus and Delphinium are common. Two species belonging to the Barberry family, differing chiefly in size, go by the name of Oregon Grape, and another (*Achlys triphylla*) has odd triangular and three pointed radical leaves, which, when dry, are used to scent clothes, etc. The Yellow

Water Lily is found here, but not the white. The Escholtzia is here, but, I think, escaped from cultivation. We have the pretty Dielytra which is cultivated in Canada, and several other species of the Fumariaceæ. A number of Crucifers are native, and the Shepherd's Purse and Mustard, introduced here, have spread considerably. The Blue Violet (*V. cucullata*) is the same, I think, as the eastern, and is native, probably. A St. John's wort is common, and a Claytonia, representing the Portulaca tribe, is one of our earliest visitors. Several kinds of Geranium and Malvaceæ are abundant. Of the other families, the Leguminosæ and Liliaceæ are most fully represented. There are, also, a great number of Orchids. The most curious of these is one I take to be a Calypso, perfectly white all over, like the Indian Pipe. Among the Leguminosæ we have several species of Lupine, some of them very handsome. The Saxifrages are very delicate and pretty, though rather obscure. One of the Ericaceæ (*Gaultheria Shallon*), called here sal-lal, in leaf and fruit resembles your Winter-Green, though it grows up into quite a bush. There are several kinds of Vaccinium, none of them to my taste quite as good as your blueberries. The 'big-root,' with a flower and leaf like your running cucumber and an intensely bitter root, as big as a person's head, represents the Cucumber tribe. Two or three kinds of Mimulus, one of the Musk Plant and a pretty blue Collinsia are the most common of the Schrophulariceæ. The Nemophila covers the prairies in April and May, and several kinds of flowers soon follow it.

"Several kinds of Willow are common, and an ugly thing, neither an herb nor a bush, a thorny stick with a spreading top of immense prickly leaves and disagreeable scent, represents your sarsaparilla. It is called Elk-Brush, or the Devil's Walking-stick, and is a pretty sure sign of water on the mountains.

"The Grasses are various and interesting, but I have not yet done much with them. I hope by another year to examine them and the Cryptogams somewhat. Much of the botany of the country remains undescribed, and what has been described is scattered in so many books, I am afraid that I shall never get hold of them all."

SPECTROSCOPIC EXAMINATION OF THE DIATOMACEÆ: BY H. L. SMITH.—"The vegetable nature of the Diatomaceæ is now generally admitted, but if any further proof is needed we have it in marked results from the application of the spectroscope. I have been enabled to prove the absolute identity of *chlorophyl* or the green endochrome of plants with *diatomin* or the olive yellow endochrome of the Diatomaceæ. The spectrum-microscope is now too well known to need any description here. The one I have used was made by Browning of London. It is not at all difficult to obtain a characteristic spectrum from a living diatom, and to compare it directly with that of a desmid, or other plants.

I need not here give the results in detail. Suffice it that from about fifty comparisons of spectra, I can unhesitatingly assert that the spectrum of chlorophyl is identical with that of diatomin."—*Silliman's Journal.*

MISCELLANEOUS.

How to Furnish a Freshwater Aquarium.—It is useless, even were it possible, to give the exact amount of plants that are necessary to keep an aquarium in order. A very few pieces will be sufficient to purify the water, but as some water plants are very beautiful, it may be desirable to have the maximum rather than the minimum amount of them in the aquarium. The fishes should have space enough to move around freely, and at the same time to be seen to advantage. Bearing this in mind my own taste would be to have as many plants as the tank would allow. As the water in the tank is changed from time to time the plants can be thinned out and the decaying stalks cut off.

The live stock of the aquarium is generally selected from fishes, lizards, snails, and mussels. One word as to the propriety of having many kinds of fish together in one tank. Some fish, such as sticklebacks or pickerel, are so voracious that either the other fish are wholly eaten up by them, or else their fins or tails are so maimed that they become objects of pity instead of amusement.—Again, in selecting a stock of fish we should try to have them of a size proportioned to the tank they are to be put in. It is a great mistake to have in the tank a fish so large that it can hardly turn about; as a general rule, in our common sized tanks, the smaller the fish the better. At the same time we thus have a chance of having more specimens without diminishing too much the supply of oxygen. It is often very difficult to get small specimens of some kind of fish, such as perch or eels. At certain seasons of the year it is the custom, in some places in the country, to draw off the water in the mill-pond and make repairs; if such a time presents then is the time for the lover of the aquarium to enjoy himself, for as the water is left in small, shallow holes, here and there, we shall find in these places multitudes of specimens only waiting to be preserved,—small perch in great numbers and many rare larvæ among the plants. At such a time too, we can make a choice of mussels, selecting for their beauty those whose shells are rayed with the darker shades of green. Very young bream are easy to catch in the net. Not so with those an inch or more long, and now is the chance offered to get as many as we wish. Perch and bream both need a good deal of care to make them live the year round in the tank, but they will repay a little trouble, as they become so tame if properly cared for. Speaking of the tameness of fishes, it seems to be more a question of food than anything else; if fishes are fed at certain times, and are compelled to come to the top for the food, they soon get into the way of coming up whenever one is near by, and will even jump out of the water at the bare finger. There is a little fish, found mostly in slowly running streams, called the roach; it is a very interesting fish for the aquarium on account of its peculiar shape and habits; it has two large side fins just behind the head, which it always keeps fully extended, looking as if it had an old fashioned collar on. It remains motionless for the most part of the time on the bottom of the stream, occasionally starting off, perhaps in search of food, only to sink down again to its former quiet position in the aquarium. Young pickerel are desirable fish to have in the tanks if one can afford to keep only that kind of fish; placed with larger fish they do very well and constantly recommend themselves for their elegant movements, but with small fish, such as minnows, they live in constant war. In one of my tanks twenty-four minnows were killed within a week by a pickerel about an inch and a half long, and this while giving the pickerel a regular course of feeding on beef. Minnows have always held a high rank among the fishes to be selected for the aquarium; collecting together in schools, tame, hardy, and lively, they have qualities which few aquarial specimens possess. The stickleback

(*Gasterosteus*), of which there are several varieties, is hardly a fish for the general collection; although of exquisite form, it is so fierce, especially in the breeding season, that it incessantly attacks the other fishes in the aquarium, and in a short time deprives them of more or less of their tails, making the unfortunate victims literally top-heavy, swimming with their tails, or rather what were once tails, much higher than their heads,

Sticklebacks should have a tank devoted exclusely to them, and this especially if we wish them to build a nest, one of their peculiar accomplishments. Early in the spring the sticklebacks may be found in great numbers in the small ditches which drain the salt-water marshes. The male is easily distinguished from the female by its deep red color around the gills and its blue eyes, while the female has only the silvery scales. A pair taken at random usually live peaceably together; if it is in the right season they will soon look about for materials for a nest, taking bits of water-plants, and even coming to the surface for small pieces of straw and sticks; with such materials they build a round nest about as large as a small English walnut, hollow in the centre, and having two holes large enough to admit the fish on either side; the nest is built upon the branches of some of the water-plants. While the female is laying the eggs, the male acts as guard, fiercely driving away anything coming within a certain radius of the nets. When the eggs are laid they resemble small globules of wet sago more than anything else. The female will be seen to fan these eggs quite often with her fins; this is probably to give them fresh water and to prevent any sediment collecting upon them. After a fortnight or so, instead of eggs, we see in different parts of the tank what at first look like very minute gold spangles as large as the head of a small pin. On closer examination we find that they are the eyes of a very small fish. Their growth is so slow that in order to preserve them it will be well to remove them to a small tank by themselves, where they can be fed by placing a piece of raw beef on the end of a string, and hanging it over the edge of the tank into the water until it is turned white, when another piece can be introduced.—The stickleback, as also the minnow, is easily accustomed to fresh water by freshening the salt water gradually until it is quite fresh and then introducing the fish into the tank. The stickleback is not the only fresh-water nest-building fish. Wood mentions a curious fish, found in tropical America, called by the natives the hassar; a fish which builds a nest as carefully as the stickleback, though one "not placed in the water but in a muddy hole just above the surface." Whether we have gold fish or not in the aquarium, is a matter of taste, some persons thinking that they give the aquarium a common fish-globe look. It seems to me if we can get some small ones of a brilliant colour, and of good proportions, we should be glad to receive them into the tank. The great trouble with gold fish is that they are so apt to be deformed, some with the gaunt look of a starved fish, others with a hump on the back or a larger or smaller number of fins than usual. Gold fish would be worth keeping in the aquarium for their remarkable colour alone, if for nothing more.

Small eels and horned pouts add to the variety of fishes in the aquarium, but both are so uneasy and so very voracious that they are not pleasing inmates of the tank; wandering up and down the sides of the tank, they seem discontented and ill at ease.—Young alewives are so beautiful that one is tempted to try them in the aquarium; rarely do they flourish in it.

One of the most interesting animals for the aquarium is the triton, or water-newt; these tritons are often found in what are called, in the country, pond-holes, seldom in brooks or ponds; they are perfectly harmless and will remain on the warm hand as long as one has patience to hold them; they come up to the surface to breathe, and therefore do not consume much oxygen; they are perfectly hardy and easy to keep alive, eating small pieces of beef eagerly; they occasionally change their skins, bringing the old skin over their heads, and then swallowing it just as the toads do. Their odd motions in the water, often poising themselves on the end of the tail or on one toe, are very amusing. They lay their eggs in the early spring either on or between the leaves of water-plants. By the middle of August the young are nearly two inches long; they breathe at first with gills, but by September they come to the surface for air, as the older ones do. These tritons outlive all the other specimens in the tank, and they live so peaceably with their companions that they are invaluable as aquarial specimens.—*C. B. Brigham, in American Naturalist.*