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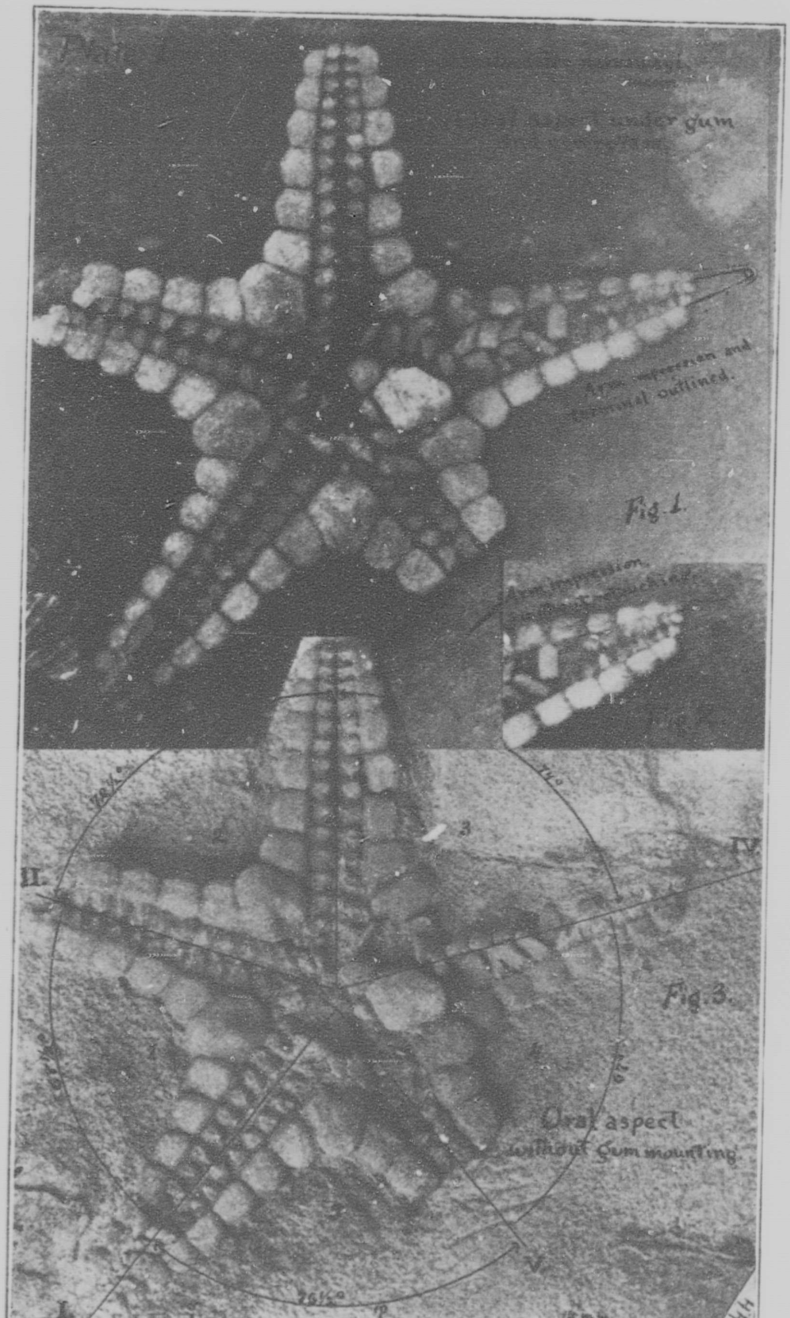
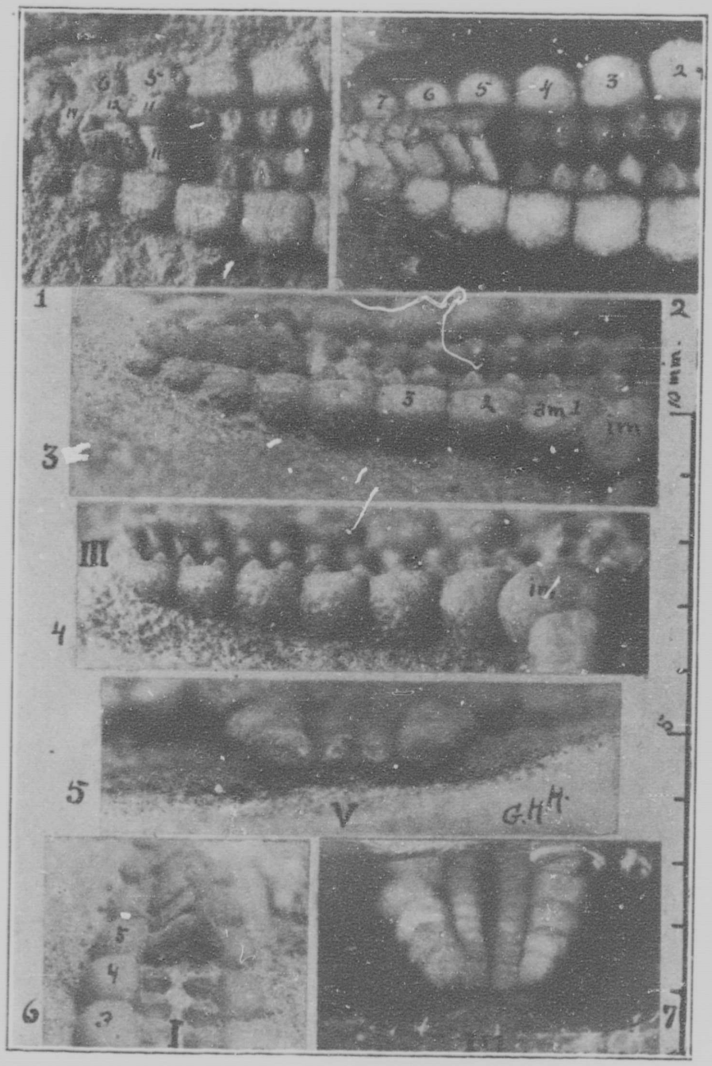
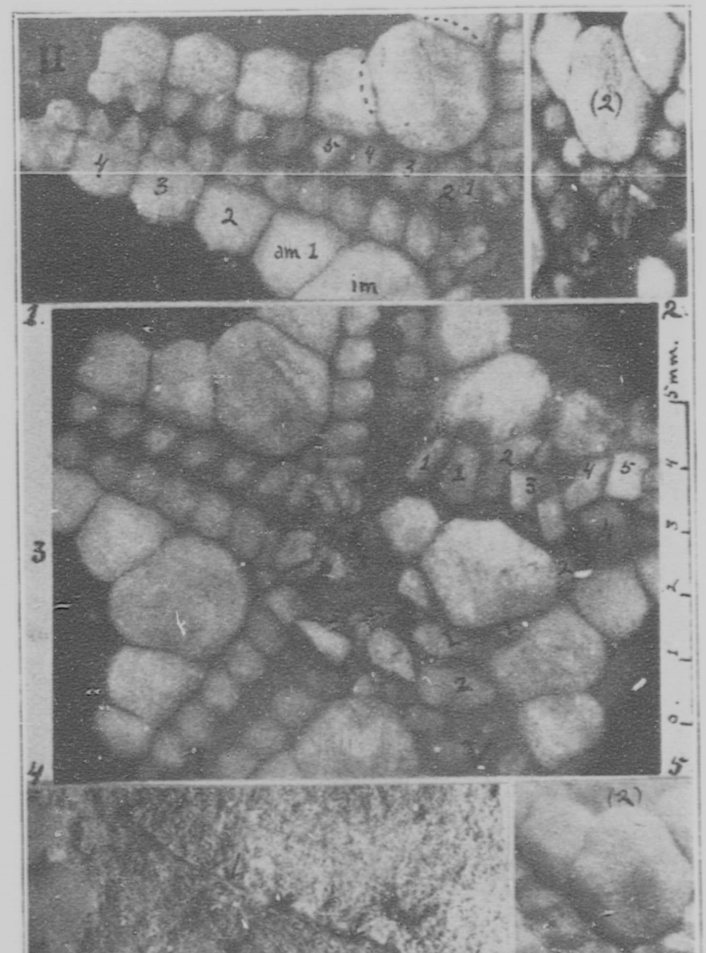


Protopalæaster narrawayi, Hudson.



Different arm views of ***Protopalæaster narrawayi***, Hudson, enlarged nearly nine and a half diameters. Millimeter scale at the right. Photomicrographs for figures 2, 5 and 7 were made under gum and coverglass.



Different views of portions of the disc of *Protopalaeaster narrawayi*, Hudson, enlarged nearly nine and a half diameters. Millimeter scale at the right. Photomicrographs for figures 1, 2 and 3 were made under gum and coverglass.

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A FOSSIL STARFISH WITH AMBULACRAL COVERING PLATES.

BY GEORGE H. HUDSON.

(Plates I-III, fifteen figures.)

Through the courtesy of Dr. Percy E. Raymond my attention was recently called to a very remarkable sea-star found at Ottawa, Canada. Mr. J. E. Narraway, the discoverer of the form, kindly allowed me to keep it through Dec., 1911, and Jan., 1912, for photographic work and study. During this period I made a series of forty-five different photomicrographic negatives of the specimen showing the whole or portions thereof under different conditions of light, angle, or mounting and at various stages of a partial development which was given the arms and oral cavity. Prints from fourteen of these negatives were selected for use in making the figures for the plates accompanying this article. Figures 1 and 2, plate I; 2, 5 and 7, plate II; and 1, 2, and 3, plate III, were made under a gum dammar mounting with coverglass. For a description of this process and some remarks concerning its value see "New York State Museum Report 149," page 218.

Figure 3 of plate I represents the specimen near the beginning of my work upon it. Lines drawn down the radii reveal two distinct centres. The elongation of the oral aperture along the line connecting these centres, the elongation of the disc itself in the same direction, the widening of the lower interradius of the figure and the narrowing of the next interradius at the right and at the left have been interpreted as indicating the position of the posterior interradius and the figure has been so oriented and marked. Figure 1 of this plate shows the condition of the specimen at the end of such development as I felt justified in making.

ELEMENTS OF THE SPECIMEN AND TERMINOLOGY.

The bordering plates will be called *marginals*; the large single marginals of the interradii will be designated as *interradial marginals* and the remaining marginals as *arm marginals*.

The single small interradial ossicle which rests against the orad face of each interradial marginal will be considered as an *oral*. The rows of ossicles which lie against the ambulacral faces of the marginals and orals will be called *adambulacrals* and considered as strictly homologous with the plates in a similar position in all species of Palaeaster. They bear true covering plates or *epineurals* as do the flooring plates in the Edrioasteroidea and this terminology will therefore also correspond with that used by Bather in that class. The single interradial plate placed orad of each adambulacral jaw (plate III, figs. 3 and 4, interradius 3), will for the present be considered as homologous with the torus angularis of the Ophiuroidea and called simply the *torus?*. Immediately exterior to these ossicles and resting on each adambulacral or *primary jaw* we find a pair of plates which will be designated as *secondary jaws*. Exterior to these again we find a pair of plates resting against the orad faces of the interradial marginals (plate III, fig. 3, interradius 3). These plates we shall call the *first epineurals*. So far as now known the specimen shows no other ossicles save the impression of a distinct *terminal* on radius IV (plate I, figs. 1 and 2). The arm marginals, adambulacrals and epineurals have been in part numbered on some of the figures presenting them.

The marginals of this species are so characteristic that one should be able to recognise its presence by them alone. Particularly should this be true of the large interradial marginals. A study of the form of the ridges and depressions on the oral faces of the latter and of their outlines when viewed as in plate III, figs. 1 and 3, or as in plate II, fig. 4, should give enough detail for determination.

Resting in part on the first epineurals of interradius 4 (plate III, fig. 3), there is a large plate that, with one or two others, was thrust over the specimen, after its death, from the fourth interradius. This movement thrust the third epineural of the lower row in this figure over against its fellow of the opposite row, caught it by one of its aborad edges and turned it on its long axis through a little more than ninety degrees. It was also the cause of slight displacement of four first epineurals and perhaps also, through plates now lost by weathering, of the displacement of the secondary jaw of the first interradius and the removal of other epineurals in advance of the moving mass. This large foreign plate possesses the same dimensions, the same curve of the convex distal end, the two slightly concave portions of the margin following this on either side and the broader, thicker orad end of an interradial marginal of this species. It was exposed to the effects of weathering before the other plates in its vicinity and has apparently lost a portion of its orad end by separation of weathered cleavage planes of the calcite. In spite of the losses it has received it still appears to be an interradial marginal of this species but belonging to another specimen.

A search for ambulacrals was made along the grooves left between the adambulacrals in the older portion of the arms. The weathering of the material filling these grooves had left a fine residual sand which could be easily removed. The groove of arm I was excavated to considerable depth (compare figures 1 and 3 of plate I), but no trace of any plates lying between the adambulacrals could be discovered.

That the arms had no true stelleroid ambulacrals and also no ossicles on their aboral surfaces is unmistakably suggested by two cross sections of the arms shown in plate II. Figure 5 is of ray V at the aborad surfaces of the second arm marginals. The rest of the arm had been here lost and the blackened corbonized bed on which the arm rested could be easily removed. The excavation was continued below the very definite line between the blackened bed and the lighter colored limestone of the matrix. After cutting down to a greater depth than that of the marginals themselves a bit of cover glass was placed on edge and allowed to rest against the faces of the marginals. The transparent liquid gum was then gradually filled in back of the glass and the photomicrograph taken from a position as near the horizontal as the specimen could be placed before the objective of the microscope. The blackened porous bed is seen to be attached to the outer edge of the marginals and to strike diagonally across the interradial spaces both to the right and to the left (interradii 4 and 5). No trace of any aboral plates is here revealed and ambulacrals are also wanting.

Figure 7 of plate II represents a cross section of arm III at the aborad surfaces of the sixth pair of arm marginals. The cut here under the lost portion of the arm was made to a still greater depth but sloping away from the arm plates in order to avoid accidental loss as these plates are very delicately attached to the bed. The lower edge of the circular covering glass is here seen and shows the depth of the excavation. The adambulacrals are almost in contact with each other. Again there is neither trace of ambulacrals or of aboral plates. The blackened porous bed is however still present.

In plate III, fig. 5, what is apparently the broken edge of the remains of a thick leathery integument is seen to run from arm IV across the interradius to arm III. Figure 3 of plate I shows that the remains of this integument blackened all the interradial spaces and followed the more distal borders of each arm. Before figure 1 of this plate had been made much of this blackened bed had been removed from the interradii 1 and 2 in order to photograph the arms from the side.

The specimen is so perfectly preserved and so free from distortion that we are not warranted in supposing that any large portion of the oral surface could be lost. The thick blackened layer is so loosely constructed and filled with minute flakes or grains of calcite (although these or many of them may be due to subsequent infiltration and crystallization) that we are obliged to interpret it as the remains of a thick leathery integument reminding us of the muscular integument of the Holthuroidea or more properly of the aboral integument of most of the Streptophiurae and of the Cladophiurae.

Further development may yet reveal traces of the radials and perhaps genitals but this should be undertaken only by some person whose knowledge of both the Asteroidea and Ophiuroidea is extensive, whose authority would be unqestioned and whose skill would be adequate for the task. Very valuable evidence might easily be destroyed and lost forever. It is possible that the plate here called "torus," belongs to an aboral circlet. Interradius 1 with its pieces composing the secondary jaw displaced and showing that they were not fixed to either the "torus?" or the first pair of adambulacrals but were bound to each other, should be left as it is. Interradius 2, with the secondary jaw in normal position, and interradius 3, with its first epineurals but slightly displaced, should also be left as they are. Interradius 5 should have the secondary jaw carefully removed to see if the "torus?" really rested against the orad ends of the adambulacrals and to fully reveal the oral aspect of the latter. Search should also be made for the madreporite of this species.

TAXONOMY.

There is enough now clearly shown by this specimen to make it very manifest that we are dealing with an unrecognized and very archaic morphological type which links the Edrioasteroidea with the Stelleroidea. Were it not for evidence I have yet to present as to habit, I should unquestioningly place this specimen with the Edrioasteroidea for it is almost as simple in its elements as Cystaster, Hall. On account of its stelleroid habit and the fact that we have described Stelleroidea which are closely related to it I feel that it should be retained in the latter class. In either case the type should be recognized.

EOSTELLEROIDAE, ORD. NOV.

This order is proposed for those Stelleroidea in which true ambulacrals (in the sense in which the term is used in this class) have not yet been developed. Ambulacral pores in a single linear series and occurring at the points of contact of four adambulacra, or in a double row and placed between the adambulacrals of a series.

It is in one sense unfortunate that our efforts in taxonomy all lie in the direction of *separation*. Generalized types or "missing links" must never be allowed to remain on border territory where their true relationships might be manifest to the uninitiated. This newly described sea-star seems likely to give taxonomists as much trouble as do some of the chlorophyll bearing flagellates. It is really an ancestral stellerid yet wearing the garb of the Edrioasteroidea. If we consider it a true member of the Edrioasteroidea we must recognize it as an "insurgent," for it lived the life of a stellerid and became one of the founders of that class.

PROTOPALAEASTERIDAE, FAM. NOV.

Eostelleroidae in which the marginals are large. Adambulacrals opposite, the interradial pairs meeting to form a primary jaw. Ambulacral pores in a single linear series. Arm epineurals long and stout and assisting in locomotion. Disc epineurals specialized to hold and crush shelled organisms and press food toward the oral aperture.

PROTOPALAEASTER, GEN. NOV.

Protopalæasteridae with single, very large interradial marginals. Arm marginals somewhat cubical and about twice as long as the adambulacral ossicles of the same region. Original peristomial covering pieces forming secondary jaws which slide over the faces of the primary jaws. First epineurals advanced orad to close together over the secondary jaws but not capable of completely closing the space over the mouth. The following new species is designated as the genoholotype.

PROTOPALAEASTER NARRAWAYI, SP. NOV.

Interradial marginals pear-shaped, the broad end set orad, length 2.25 mm. or nearly one-third of the diameter of the disc, greatest breadth 1.95 mm.; oral face smooth, convex (plate II, fig. 4), bearing characteristic plate impressions and muscle fields:—arm marginals cuboid, oral surfaces smooth, flat and inclined aborad about 5° from the oral plane, transverse diameter equal to about one-third that of the ray:—outer faces (abambulacral) of marginals strongly convex and ornamented with small, closely and alternately set mammillary tubercles having a diameter of about 0.1 mm. each (plate II, fig. 4). The inner (ambulacral) faces are set in a straight line which makes an angle of about four degrees with the axis of a ray. The rate of transverse thickening during growth determines the form of the outer border of the arms. In the new plates, near the ends of the arms, thickening in this direction is at first rapid. A straight line connecting the outer border of the fifth and seventh marginals makes an angle of sixteen degrees with the axis of the ray. The rate of widening is not so rapid during the later period of growth and a line connecting the outer borders of the second and fourth arm marginals makes an angle of only eight degrees with the axis. Function has demanded a greater growth of the first arm marginal and particularly of the side next the interradial marginal. The face against the latter is 1.3 mm. long while its distal face measures but 0.8 mm. This increase of growth near the disc has thrown the marginal line rapidly outward and it swings across the distal end of the interradial marginal in a broad, hyperbolic curve. The outer edges of each arm thus present a very gentle sigmoid "line of beauty." The extension of the arm is nearly equal to the diameter of the disc. Disc radius about 4.4 mm., arm terminal 11.6 mm. from disc centre. The species can be easily determined from its marginals alone. More detailed descriptions of the other ossicles will be given later.

The specimen was collected by Mr. J. E. Narraway from the lower part of the Black River limestone on the top of a small hill a few rods west of the City View Post Office and is now in his private collection. It was lying in its bed with oral face uppermost. I have named the specimen after Mr. Narraway in slight appreciation of the debt due him for the discovery of such a remarkable type.

In a following portion of this paper I shall deal specifically with habit and adaptation as revealed by the skeletal elements preserved.

VARIATION IN PLANT LIFE, ITS BIOLOGICAL SIGNIFICANCE AND PRACTICAL VALUE.*

All evolution, be it evolution of humanity from a lower to a higher level, or the evolution of the animal or vegetable kingdom from primary types to more perfect ones, is based upon two principles, the principle of heredity and the principle of variation.

*Synopsis of lecture delivered before the Ottawa Field-Naturalists' Club, February 13th, 1912, by Dr. M. O. Malte, Dominion Seed Branch Ottawa.

Unfortunately, the term "variation" has been applied to a great number of phenomena of a very different nature, and in the mind of most people is something that can not be clearly defined. As a result, the biological and practical significance of variation is not clearly appreciated.

1. The individual plants of a species sometimes present such striking differences at different stages of development that the observer might readily regard them as different species or even different genera, where, as a matter of fact, only different ages are represented. Thus, a great number of species of the genus *Acacia* present a delicate fern-like foliage when young, whereas the old plants are clothed with narrow and simple leathery organs, which in shape and texture resemble the leaves of the mistletoe. Conifers, such as *Thuja* and *Juniperus*, which when fully developed have flat, scale-like leaves, are when seedlings provided with typical needle-leaves. Such juvenile forms can be fixed by cuttings and they then keep their peculiar needle-leaves for many years, presenting small trees, which are no more like the *Thuja* or *Juniperus* than a spruce is like a pine tree. Such fixed, juvenile forms have been described as species of a special genus, *Retinospora*.

2. Light sometimes causes variations of the most astonishing nature. The well-known blue bell, *Campanula rotundifolia*, generally has only long, narrow leaves. When the plants are growing in grass, however, or when they are young, basal leaves occur, which are round or kidney-shaped. Whether or not a plant shall have the latter kind of leaves is a matter of light, as can be demonstrated by the following experiment: enclose the upper part of a blue bell plant in a box of wood, and the new shoots developed from the enclosed parts of the plant will carry leaves round or kidney-shaped and in all respects similar to the round or kidney-shaped root-leaves.

3. Amphibious plants often present one water-form and one land-form, which are widely different from each other. Numerous experiments have shown that the water-form can be changed into the land-form and vice versa, and that the same individual can present shoots of both types at the same time. Such variation, induced by the amount of water available, can be observed in such plants as water parsnip (*Sium*), water plantain (*Alisma Plantago*), knot-weed (*Polygonum amphibium*), numerous species of *Ranunculus*, etc.

4. Other plants, when placed in certain environments, often show striking variations. Thus, it is rather common for plants growing in a climate where hot winds prevail, such as in

deserts, to have a heavy coat of gray or white woolly hairs. In some cases it has been actually proven that the production of the woolly hairs is directly induced by the hot climate and that plants covered with dense hairs will drop these if transplanted into a climate of greater humidity.

The important influence upon the general configuration of plants exercised by the environmental conditions leads naturally to the practical question: "Is is possible to produce, by changing the climatic conditions, new types or new plant species?" If a species is defined as a unit, provided with certain *constant* characters, we must answer that, as far as our experience shows, it is not possible to produce new plant species by changing the outer conditions; no facts exist to support the opinion of Lamarck as to the hereditary quality of acquired characters in plants.

The aforesaid variations are all produced by the influence of different external factors upon individuals. When speaking of "variations" in ordinary parlance, however, we usually think of something quite different. We speak of the great variation in roses and apples, by which we mean that there occur a great number of types in apples and roses. The forms which generally are termed individual variations do not refer to the changing of a certain type or a certain individual, but simply to the existence of types possessing different characters. When speaking of "variation" people have been inclined to associate with the term the idea that something is changing. When speaking of individual variation within a species they ordinarily assume that a given individual can become permanently altered in character in one direction or another, that, in fact, a certain main type can produce a number of different, constant varieties. Such a conception, however, leads to confusion and to a misinterpretation of the phenomena connected with the species idea and the proper idea of variation.

When we speak of the apple species, for instance, we must remember that the word species is only an abstract which we use for all kinds of apples. And when we say that this species or that species is very variable, we simply mean that it consists of a number of distinct types.

The practical importance of "individual variation" in a plant species is now clear. It simply means that nature herself has provided for a great number of concrete types which, from a practical point of view, are of very different value. And, when we say that we use the individual variation of a species for practical purpose, we really mean that we use the life-types or bio-types of the species in question.

THE EVOLUTION OF THE WORLDS.*

BY J. S. PLASKETT, B.A., F.R.S.C., THE OBSERVATORY, OTTAWA.

I have felt considerable difficulty in preparing a suitable paper for presentation to the Ottawa Field-Naturalists' Club. The connection between natural history and astronomy is so slight that no subject was known to me, forming a sufficient connecting link between the two sciences, to base a paper upon. It was only upon learning that it was not essential for the paper to have any direct relation with the natural sciences that I undertook to prepare it. Although it is almost entirely astronomical in character yet the title suggests some analogy to one of the most important developments in your science, that of evolution. I hope to be able to trace for you, if only in an imperfect way, how the development of the celestial universe has taken place, and I think we will find as we go along, that there is in some respects considerable similarity in the scheme of evolution in the two sciences.

Although we, in our feeble way, can trace the process of development from the original primal material in its simplest forms to the very complex manifestations that we see all around us, both on the earth and in the heavens, and can see that this development in both sciences has followed by the operations of laws, which, simple in themselves, are yet so perfect and complete and far reaching as to excite our admiration and awe, yet we have in the very beginning to start with the Creator. Surely there is not one of us but feels that such a plan of creation as is here implied requires a higher, wider, and nobler conception of the Almighty Ruler of the Universe than the one which imagines it to have been made, as it were, in a moment.

It is only within comparatively recent years that we have been able to enunciate any definite theories in regard to the constitution and mode of formation of the universe and its component parts, in which is included, as a very insignificant portion, our own solar system. Undoubtedly the one discovery leading to this advance was that of the principles of spectrum analysis, first definitely enunciated by Kirchoff in 1859. On this epoch-making discovery is based the whole science of astrophysics, sometimes called the new astronomy, which treats of the constitution of the heavenly bodies, as apart from their positions and motions in the celestial sphere, which is the province of the older astronomy, or astrometry as it is now sometimes called.

*A Lecture given before the Ottawa Field-Naturalists' Club, 27th February, 1912.

As many of our deductions will be based on the facts ascertained by the spectroscope, it may be as well to briefly explain its principles. The spectroscope has, in its simplest form and as its essential elements, a narrow slit on which the light from the source to be analysed is thrown, a lens behind the slit, called the collimator lens, which renders the light parallel and a prism, a triangular piece of glass, which decomposes or analyses the light into its constituent colors. The spectrum, as the rainbow colored band which is formed is called, can then be examined with a telescope or photographed by a camera. I have a diagram which shows the arrangement of these parts of the instrument and I can form a spectrum on the screen.

The spectrum shown is that of the white hot carbon rods of the electric arc, which give us what is called a continuous spectrum, one in which the colors shade gradually from one to the other. Whenever you see a continuous spectrum, you know that the light source is an incandescent solid or liquid body. If we were to separate the carbon rods and burn a metal or any substance between them, we would get a spectrum of the vapor of that substance which would consist, not of a continuous band of color, but of a number of separated bright lines, distributed over the spectrum, and varying in number from about a dozen in the case of lithium to many thousands in the case of iron. Such a spectrum is called an emission or bright line spectrum and indicates, first of all, that it comes from incandescent gas or vapor, and, secondly, tells us unmistakably the element which produces it. For each element has not only a distinctive and invariable number of bright lines in its spectrum, but the positions and arrangements of these lines are always the same for the same element, and differ for different elements. When these positions are mapped for all the elements, it is evident that by examining the spectrum of any substance, no matter how complex, we can determine the elements of which it is composed. There is a third kind of spectrum called an absorption or dark line spectrum, in which the bright lines of the emission spectrum become dark lines in exactly the same positions, and it is evident that the elements producing it can be identified in exactly the same way. The absorption spectrum is produced when an incandescent source shines through gases or vapors at a lower temperature, and is the kind of spectrum given by the majority of the stars, showing that their glowing centres are surrounded by atmospheres of cooler gases.

Spectrum analysis tells us then, not only what elements any body emitting light is composed of, but also gives us information as to its physical condition, whether solid or gaseous, and whether surrounded by cooler or hotter gases. This is equally true of celestial as of terrestrial bodies, and when the light of the sun or of a star is projected on the slit of a spectroscope, we have at once an unfailing and accurate criterion as to the elements present in the atmosphere of the sun or star.

When we analyse the light of the sun in this way we find lines in its spectrum due to most of the terrestrial elements, and, as we have good grounds for believing that earth and sun had a common origin, we can safely assume that their composition is identical, and that, if some terrestrial elements do not show in the solar spectrum, it is either on account of their relative scarcity, or because their spectrum is weak and overpowered by others. On the other hand there is no convincing evidence of the presence in the sun of any elements not found on the earth, although this was not the case a few years ago. There is always present in the spectrum of the outer atmosphere of the sun a very bright yellow line of which there was no known terrestrial counterpart and the hypothetical gas producing this line was called helium. Sir Wm. Ramsay, in 1895, in examining the spectrum of a gas, obtained by heating a rare mineral called cleveite, found that it gave a strong line in exactly the same position as the yellow solar line and was consequently due to the same element, helium. Helium is a very light gas, does not combine with any other elements, and has not sufficient mass to enable the earth's attraction to retain it in the atmosphere. Consequently most of the helium, except that occluded by the mineral cleveite and, as we now know, that obtained from the degradation of radium had dissipated into space. This is an interesting incident, and as will be seen later a very important and widespread one—a new element discovered in the sun before being found on the earth.

Although we might possibly have reasoned from other evidence of the probable identity of composition of the sun and earth, we certainly could not, without the spectroscope, have known anything definite of the constitution and physical condition of the stars. When, however, we examine their spectra we find nearly forty per cent. of them practically identical with the sun, and the remainder shading off by gradual degrees into simpler and simpler spectra until only the lines due to hydrogen and to hydrogen and helium remain. The disappearance of the lines of the heavier elements is not, however, an indication that they are not present, but only that, owing to the higher temperature of the hydrogen and helium stars these light elements are the chief constituents of their outer atmospheres and the elements of higher atomic weight are nearer the centre.

The evidence then, spectroscopic and otherwise, of the chemical unity of all the matter in the universe is indisputable.

If the spectroscope had done nothing else than this, it would have established a far reaching and most important generalization, and one which enables us to develop a uniform and homogeneous theory of cosmical evolution, impossible without this knowledge.

If we look up at the sky on one of these brilliantly clear nights, we see stars scattered more or less irregularly over the whole hemisphere visible to us. The number visible to the unaided eye at one time is generally much overestimated, the maximum number being about 3,000 instead of millions as I have heard some people express. The great majority of these objects, as well as thousands of times as many more rendered visible by telescopic aid, are suns shining with their own intense light and heat, many of them similar to our own sun, while many are in earlier or later stages of development, and of larger or smaller size. Besides the stars and the planets, of which latter there are generally not more than two or three visible to the eye at one time, close scrutiny, and knowing where to look, will enable to detect a few objects which look like faint hazy stars but which, when viewed by the telescope, present an altogether different appearance, have a more or less extended, misty, hazy, nebulous appearance generally without sharply defined boundaries. These are what are called the nebulae, and, though not so numerous as the stars, nevertheless number many thousands throughout the sky.

When analysed by the spectroscope some of them give a continuous spectrum, indicating a source composed of luminous solid matter probably in the form of dust or small particles. Others, notably the Great Nebula in Andromeda, the largest in the sky, give an absorption spectrum similar in some respects to that of our sun, indicating a stellar origin of the light, and showing that these bodies are possibly Galaxies or Universes like our own situated at almost inconceivable distances. Many of the nebulae, the Great Nebula in Orion, the most beautiful in the sky, being a conspicuous example, give bright line or emission spectra indicating the elements hydrogen, helium and a gas unknown on the earth which, for want of a better name, we call nebulium. Considerable speculation has been indulged in as to the nature of nebulium which is generally considered to be a very simple form of matter. Only last month a paper appeared in the Monthly Notices of the Royal Astronomical Society by Dr. J. W. Nicholson which assumed the atom of nebulium to be of the nature of a positive charge of electricity surrounded by a revolving ring of negative ions three or more in number. Calculating mathematically the wave lengths of the lines given by such a system they were found to agree quite closely in position with the unknown bright lines in the nebular spectrum. We seem to be, with all the recent developments in radio-activity and the ultimate constitution of matter, on the eve of most important discoveries and generalizations not only in astronomy but in its sister sciences, physics and chemistry. Notwithstanding the diversity of composition indicated, it is believed that all these bodies contain the same elements, our terrestrial substances, and that only the spectra of the elements appear which are most easily produced by the particular forms of energy in action. It is not probable that the luminosity is produced by heat, for the enormously extended and attenuated matter of the nebulae must be at a very low temperature; it is rather a sort of luminescence, perhaps due to electrical action or to some form of radio-activity.

We have in the nebulae, according to the practically universal belief of scientific men, the primal form of matter, the material from which suns and worlds are made. From this world stuff, if I may use the term, we can trace the evolution, following simple and well known laws, to suns and stars in all their stages, to planets, comets and all the heavenly host. Further than this also, though this is the province more particularly of your science, following also other simple and well known laws, the gradual development of life on planets such as ours from the lower to the higher forms can equally well be traced.

In the tracing of this evolution in the heavens, it must not be for a moment supposed that it can be followed in any one star, any more than that the changes in living organisms can be detected in one generation. Stellar development is so inconceivably slow that it is very doubtful whether any change could be detected in a million years. But we have in the sky so rich a field for observation, such a great number of stars in all stages of their development, that by the aid of the spectroscope and by data obtained in numerous other ways it is possible to arrange in orderly sequence the process of evolution. If we suppose ourselves in an oak forest, though we could not expect to see the growth of any one oak from the acorn and seedling through small and large to a fully developed tree, and then through the process of decay to a crumbling log, yet we would have no difficulty, owing to the examples in all stages of growth around us, in correctly tracing and arranging the development.

Let us begin then with our nebula, whether gaseous or of finely divided particles does not matter, as, by the theory of the chemical unity of the cosmos, there are all the terrestrial elements present or perhaps, to be more precise, at least matter out of which all terrestrial elements may appear. It is practically certain that this matter is extremely attenuated or thinly scattered over enormous spaces, hundreds, thousands, aye, in many cases, probably millions of times the extent of our solar system, and is certainly much less dense than the highest vacuum we can obtain upon the earth. Notwithstanding its tenuity, it is not exempt from the universal law of gravitation, by which every particle of matter of every kind, in all places and under all conditions, so far as we know, attracts and is attracted by every other particle of matter by a force which is directly proportional to the product of the masses of the particles, and inversely proportional to the square of the distance between them. The law of gravitation with which you are all familiar was first enunciated by Newton and has been proved, not only for all matter upon the earth, but all the motions of the heavenly bodies as well as their development are governed by this law with the most marvellous exactitude. You can at once see what will happen when all the particles, whether solid or gaseous, of our nebula are acted on by this force, each pulling the other. Mathematical demonstration proves, what is indeed almost evident from common sense principles, that the resultant pull on each particle will be towards the centre of the mass, and this pull, although almost infinitesimally small in the originally attenuated material, will tend to condense the nebula.

(*Continued in next issue.*)

POISON IVY.

BY CHARLES MACNAMARA, ARNPRIOR, ONT.

Before reading Mr. Gussow's interesting note in the Oct.-Nov., 1911, number of THE OTTAWA NATURALIST, few people, I imagine, were aware of the existence of so many different kinds of skin-poisoning plants. To the list of indigenous plants of this class which Mr. Gussow mentions, I would add, though somewhat doubtfully, the prickly ash (*Zanthoxylum americanum*). For while no botanical work to which I have access attributes any poisonous properties to this plant, I know of two cases of severe skin irritation that could not easily be traced to any other cause.

But by far the most dangerous of all our toxic flora is the poison ivy (*Rhus Toxicodendron*). It is one of the commonest and most widely distributed plants in this part of Canada, and seems to thrive in almost any environment. A few years ago I noticed large quantities of it growing luxuriantly on the barren rock just below the Citadel at Quebec, and it is frequently found in dry woods and along road-sides all over the country. But perhaps its favorite habitats are the edges of swamps and in damp, shady places. In such situations it grows remarkably large, its leaflets sometimes attaining the size of a man's hand. It is often described in books as a "climbing shrub" or spoken of as a "vine," and sometimes it does clamber over stones or hoist itself a few feet up a tree trunk by means of its rootlets, but in this district at least the shrubby, erect form is much the commonest, and the plant is seldom found climbing. This is an important point, for those unacquainted with the plant on finding it described as a vine or a climber, naturally fail to identify the low growing erect form as the true poison ivy. Some botanists distinguish the climbing form as a "variety" and give it the cognomen "*radicans*," but both forms seem to be merely different habits of the same species.

In a recent book, Sir Ray Lankster notes several unaccountable cases of severe dermatitis that occurred in England a year or two ago, and which were finally traced to *Rhus Toxicodendron* that had been sold by nurserymen, innocently enough no doubt, instead of a kind of Virginia Creeper (*Ampelopsis Veitchii*) which the *Rhus* resembles rather closely. Such ignorance of the poison ivy is not, of course, at all surprising in Europe, where the plant is not indigenous; but in this country, if only as a matter of self-protection, everyone should be able to recognize the ominous triple leaf, and it is remarkable to discover how many people are not acquainted with it. I have seen it, when colored red in the late summer, occupying an honored place in a boquet of wild flowers gathered by an unsuspecting camper. It is true that in the fall when the sap is drying up, it is not as dangerous as in the summer when it is lush and green, but it is an exceedingly risky thing to handle at any time.

The poisonous principle is a fixed oil which is found in all parts of the plant, and persists in the dead leaves and the wood, even after long drying. Minute dust-like particles of the plant carry it, and very slight traces of it on the clothing may cause an attack in those susceptible. The pollen blown by the wind doubtless accounts for those mysterious and not infrequent cases that occur where no actual contact with the plant has taken place. This oil has no apparent effect on animals, and it is even said that the horse, mule and goat eat the leaves with impunity and that birds feed upon the seeds. Like other oils, it is insoluable in water alone, but may be readily washed off with soap and water, and is quite soluable in alcohol. From experiments made some years ago by Mr. V. K. Chestnut, of the United States Department of Agriculture, it appears that its effect on the skin is by no means instantaneous, and if washed off within about an hour of its first contact, no ill results ensue, unless, perhaps, if one is very susceptible; and, as is well known, individuals differ vastly as regards susceptibility. Some people contract the disease in a more or less severe form regularly every summer; others appear to be quite unaffected. And, after all, the large majority are practically immune. For, when one considers the wide distribution and great profusion of the plant, it is evident that only a comparatively small percentage of those who come within its evil sphere of influence are poisoned by it. At the same time it is very doubtful to my mind if any one is *perfectly* immune. Given certain favorable, or rather unfavorable conditions, particularly heat and moisture, and no one is safe from the attack. A friend of mine, a lumberman, who has spent all his life in the woods, and must have been continually exposed to the infection ever since his boyhood, was a few years ago badly poisoned for the first and only time in his life. One damp warm day in June he had occasion to walk some distance through a bush infested with poison ivy just when the latter was in bloom. In slapping at the mosquitoes, which were very troublesome, he doubtless transferred the acrid oil from the leaves or pollen to his face. For a day or two after he suffered a very severe attack which completely closed up his eyes. I was myself for years under the impression that I was quite immune, and often handled the plant with impunity, until one day I inadvertently dropped my cap into a clump that was in blossom. The pollen evidently shook off into the cap and thus came into contact with my skin, for a day or two later the familiar vesicular sore broke out across my forehead. Annual recurrences of attacks without any fresh exposure to the infection are occasionally reported. Some of these may safely be referred to traces of oil remaining on summer clothing that is resumed the next year; but, there are others that are not so easily accounted for. I have been told of an attack first contracted by stepping on the plant with a wet and naked foot, which recurred regularly, without new infection, every year for seven years. That mystic number "seven" might cast a shade of suspicion, if I had not the fullest confidence in the accuracy of my informant, who is an expert botanist and a scientific observer, and who had personal knowledge of the occurence. If, as seemed to be shown by some of Mr. Chestnut's experiments mentioned above, the irritation is purely local and external, it is exceedingly difficult to account for such attacks, and the only explanation I can offer, and that very tentatively is that they are the result of autosuggestion. But here we plunge into physiological psychology, and if I want to keep within my depth I had better stop.

Alleged remedies are numerous. Most of them owe their reputation to the fact that they have been used just as the disease was abating naturally, and straightway they got credit for a miraculous cure. A trapper of my acquaintance assured me that a fresh poultice of jewelweed (*Impatiens fulva*) was a sovereign remedy, but a personal trial failed to prove his assertion. I have heard of an infusion of *Antennaria* (species not stated) having been used with success, and a ten per cent. solution of sodium hyposulphite is sometimes prescribed, but there is really no specific known for the disease, and the most effective remedy only shortens the period of the attack. My friend, Dr. Graham Harkness, of Vineland, Ont., who is himself very susceptible to the poison, and consequently has had a great deal of experience in its treatment, has kindly given me the following notes on the therapeutics of the subject:—

"If a susceptible person finds that he has exposed himself to poison ivy, he should, as soon as possible, wash thoroughly in warm water and castile soap, and then apply a dilute solution of ammonia. This will often prevent an attack.

An attack untreated will run its course in about 18 days. Properly treated it will subside in a week or 10 days.

For small patches scrub thoroughly with a stiff brush, or if on the face, run over them with a safety razor, and apply alcohol. This treatment is somewhat painful, but causes the spots to dry up and disappear in 4 or 5 days, and besides it absolutely relieves the itching.

For a more generalized attack nothing is better than the old-fashioned lead and opium lotion: one teaspoonful each of lead acetate and laudunum to 4 oz. of water.

The principle of all treatment is the same: apply astringents. The more effectively this can be done the quicker the cure.

For the unhealthy condition in which the skin is often left after an attack, nothing is so good as arsenic in the form of Fowler's Solution, 2-5 drops in water three times a day."

But here the proverbial ounce of prevention may well be quoted a good deal above par, and the moral is, even if you are quite sure that you are immune, have no unnecessary commerce with poison ivy.

BOOK NOTICES.

THE EVOLUTION OF THE VERTEBRATES AND THEIR KIN, by William Patten, Ph.D.: P. Blakiston's Son & Co.; Philadelphia; price $4.50.

In this volume of nearly 500 pages, Dr. Patten has given us the result of a quarter of a century's effort towards the solution of one of the most fascinating and certainly one of the most difficult problems in the field of zoology.

Dr. Patten's paper, "On the Origin of Vertebrates from Arachnids" appeared in 1890; since then he has published many admirable studies in morphology, many of which have dealt with sections of the larger problem that has occupied his mind for so many years.

In presenting the arguments in support of his well-known "Arachnid Theory," the author covers a very large morphologic field and offers an immense amount of valuable material, concisely and clearly presented. The summary at the close of the chapters is an excellent feature. There are 309 very fine illustrations, many diagramatic and all of them instructive. The relegation of the "Explanation of the Lettering" to the close of the volume saves much space, but is rather inconvenient to the reader.

At the close of the last chapter the work of the comparative morphologist is earnestly impressed.

"Hence, comparative morphology and phylogeny must always constitute the fountain head whence comes our knowledge of creative evolution. Such problems as the phylogeny of vertebrates are, therefore, the most important ones the biologist has to deal with, for on their solution depends our conception of the way in which evolution actually has taken place.

The cytologist is too intent on the raw material of life; his field of operation is both too remote and too narrow to give either measurable detail or perspective. To discover the immediate causes of any given stage in the evolution of the nervous system or of the endocranium, by a study of chromosomes, or of protoplasm, or by juggling with imaginary hereditary units is as hopeless a task as it would be for the geologist to explain the delta of the Ganges by an appeal to the composition of cosmic matter.

The naturalist is bewildered by the amazing detail of the finished product, and so much absorbed in the social organization of the present moment, or in the relation of one plant, or animal to the other, and to the environment at large, that he fails to acquire an adequate historic perspective.

The experimental evolutionist, for a few hours, or months, arbitrarily narrows the environment of an organism and measures the results, if any, with instruments of precision, or with the aid of higher mathematics; but he generally ignores or looks with contempt on the vast experiments already performed for him, where the laboratory is nature, and the results are expressed in species, genera and classes.

The comparative morphologist aims, not merely to trace the identity of changing structures under the disguise of new forms, but to measure the rate of these changes, and to seek out the underlying causes that have brought them about. He is heavily handicapped by the lack of materials that can be precisely measured or controlled. But on the other hand there is a certain advantage inherent in the very size and remoteness of his problems, that is absent in the brief laboratory experiments that have taken place under the eye of man. His problems must be viewed from a great distance, but one that gives a large perspective, and draws a vast range of structural changes into a single horizon where sporadic details disappear, and only those events catch the eye that are massed around some central cause or are ranged with monotonous regularity along some common line of physiological upheaval."

Whether or not the reader accepts all the author's conclusions, there can be only the greatest admiration for the work that has preceded the writing of this important book, as well as for the marked ability with which the arachnid theory is presented. The work is a masterpiece, and marks an important step in the progress of zoology.

The publishers, P. Blakiston's Son & Co., are to be complimented upon the excellent get-up of the volume. The press work is very fine.—J. M. S.

A HISTORY OF THE BIRDS OF COLORADO, by William Lutley Sclater, M.A. (Oxon.), M.B.O.U., Hon. M.A.O.U., (lately Director of the Colorado College Museum), with seventeen plates and a map; Witherby & Co., 326 High Holborn, London: price $5.00.

This new volume of 576 pages is founded upon the very complete collection of Colorado birds formed, during the last thirty-five years, by Mr. Charles E. Aiken, of Colorado Springs. The number of Colorado birds included is 392, and of these 225 are considered as regular breeders within the State. The nomenclature and classification used are almost without exception that of the recently published third edition of the A. O. U. check list.

Under each species is given references to Colorado Records, Descriptions of the Adults, Distribution and Habits, which latter includes nesting habits with an account of the eggs. Pages 533 to 551 are devoted to a Bibliography which includes references to all articles on Colorado ornithology of importance, up to December, 1910.

Students of birds generally will welcome this important contribution to American ornithology. There is no apology necessary for the appearance of this additional bird treatise.

The author points out that the published work of Cooke is now out of print and difficult to obtain. This new book, in addition to the description of the birds, etc., gives keys by which the birds observed, or obtained, may be determined.

The plates are beautiful reproductions from photographs taken from nature, and add much to the interest and value of the volume. The printing and arrangement of the text, etc., are excellent, and the author and publishers alike are to be congratulated.—A. G.

In that valuable series of little books, the "Cambridge Manuals of Literature and Science," there are some numbers that may appeal in particular to readers of THE OTTAWA NATURALIST. The following have been added to the Carnegie Library, Ottawa:—

1. "Heredity in the Light of Recent Research," by Doncaster; a useful little book, giving outlines of the theories of DeVries and Mendel, and of the work of Bateson.
2. "Plant-animals," by Keeble; based on researches carried on for some years in a marine laboratory in Brittany—really a study of the life-history and habits of two marine worms, the green plant-animal and the brown plant-animal.
3. "Prehistoric Man," by Duckworth; an account with illustrations of various human remains of great antiquity, with brief mention of theories based thereon, and an attempt to arrange the primitive types in ascending order.
4. "Links with the Past in the Plant World," by Seward; an enquiry into the relative antiquity of existing plants, with reference to the evidence afforded by fossils—deals chiefly with ferns and coniferæ.
5. "The Migration of Birds," by T. A. Coward; titles of chapters are: Cause and Origin of Migration, Routes, Height and Speed of Flight, Route Finding, Distances Travelled, Perils.
6. "Plant-life on Land," by F. O. Bower; a series of short essays to illustrate the migration of plants originally aquatic, to the land, and their adaption to their atmospheric surroundings—shows the point of view of the present day botanist.
7. "The Natural History of Clay," by Searle: some topics are: clay and associated rocks, origins of clays, some clays of commercial importance.
8. "Earthworms and Their Allies," by Beddard.
9. "The Coming of Evolution," by Judd.
10. "The Natural History of Coal," by Arber.

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