Ten storm-tracks were traced across the ocean. Of these, a very severe one was felt in the north Atlantic from Feb. 4th to 7th. The winds were of unusual severity, and pressures as low as 28.1 inches were reported by several steamers. This storm, however, was exceeded in extent and severity by most violent gales from the 12th to the 16th, when pressures below 28 inches were recorded.

The total movement of the air on Mount Washington (as indicated by a specially devised Robinson's anemometer) was 32,404 miles, there being 1,825 miles on the 17th. Winds over 100 miles per hour were reported on the 1st, 17th, 26th, and 27th.

Ninety-two cautionary signals were displayed during the month; of which 75, or 81.5%, were justified by winds of at least 25 miles per hour within 100 miles of the station.

The most extensive auroral display was that of the 24th, which was observed on the New-England coast, and from the upper Mississippi to Washington Territory. Auroras are also reported on the 1st, 4th, 5th, 13th, 25th, 27th, and 28th. Prof. D. P. Todd of Amherst reports sunspots most numerous on the 12th and 13th, and least on the 23d and 24th. Unusual earthquake-shocks were experienced on the 4th in Illinois, Michigan, New Hampshire, and Maine. It would seem, that, at the same time, shocks were felt in Agram (Hungary) and Madrid (Spain), as cabled to the New-York Herald. On the 27th another notable shock was felt in Connecticut, Rhode Island, and Massachusetts.

THE LAW OF NUCLEAR DISPLACEMENT, AND ITS SIGNIFICANCE IN EMBRYOLOGY.

DURING his investigations upon the development of fishes, mollusks, and arthropods, the writer's attention has been drawn to the physiological relations of the food-yelk, and the germinal matter of the ova of these forms. A more thorough study of the relations of the two principal materials of the ova of various forms has led him to the conclusion that there is a general law which largely, if not entirely, determines the mode of cleavage apparent in various embryological types. Approximations towards a general statement of the law have been made by Von Baer, Haeckel, Balfour, Whitman, and Mark. My only object is to present what I believe to be some new evidence, and to extend the scope of what appears to be an important generalization.

There are only two clearly marked types of ova. These are, first, the holoblastic or evenly segmenting, and, secondly, the meroblastic or unevenly segmenting. The so-called centrolecithal type is found almost altogether amongst the arthropods, and seems to be in a great measure characteristic of them; but, upon close examination and comparison, I believe it will be found that this mode of segmentation is not so widely different from that met with in the ordinary meroblastic ovum. Whatever may be the opinion with regard to the claims for the recognition of two or three types of segmentation, there can be but two forms of ova discriminated in the animal kingdom; viz., those with, and those without, a food-yelk. Those without food-yelk may be called *homoplastic;* that is, they are composed of but one kind of plasma, all of which is germinal. The first segmentation-nucleus is central in position after fertilization, so that the first cleavage divides the ovum into two equal segmentation-spheres. The result of further segmentation is to divide the total germinal mass into tolerably even-sized spheres. The other type, opposed to the foregoing, may be called the *heteroplastic*, by which it is intended to signify that two or more proteids may enter into the composition of the egg, besides oils in the form of drops. At the time of maturation and impregnation the nucleus is displaced from its original central position to a remarkable extent; in fact, it may be so displaced, as compared with its position in very young eggs, as to appear as if it were altogether superficial or parietal; as in the large ova of fishes, reptiles, and birds. This parietal position of the first segmentation-nucleus is not its original one, as an investigation of the developing ovules in the ovaries of these forms will show; but, even long before the first segmentation-nucleus is formed by the fusion of the male and female pronuclei, we actually find, that in some cases the germinative vesicle has migrated from the centre of the ovum, towards the periphery, without having suffered any marked change in size.

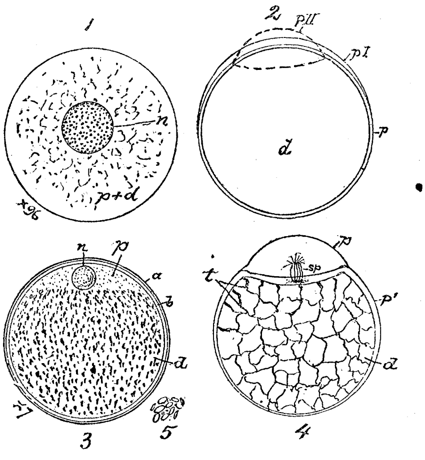
To what cause is this permanent displacement of the egg-nucleus due? We find it to occur only in those ova in which we may detect two sorts of plasma, or in those with germinal matter to which a second or passive quantity of matter has been added during the intra-ovarian growth of the egg. The added material may be in the form of a clearly defined yelk, or it may make its presence manifest only after the beginning of segmentation, by aggregating at one pole or centrally as a less homogeneous, more granular mass than the portion directly involved in the process of segmentation. The germinal matter, protoplasm of the egg, is the self-motile part. The yelk or deutoplasm, on the other hand, is often composed of spherules, granules, plates, or oval bodies, and is converted by metabolic processes into the first during the later stages of development. The first is the potential part of the egg: the latter is the passive and nutritive. Wherever the yelk is greatly in excess of the germinal matter, the embryo is often far developed, as regards morphological details, before the deutoplasm is nearly all absorbed, its final absorption being accomplished largely through the intermediation of the vascular system of the embryo; as in the ova of fishes, birds, and reptiles. The greater the mass of the yelk in proportion to the bulk of the germ, the more extensive is the permanent displacement of the nucleus from its original central position as observed in the young ovicell. The displacement of the nucleus, or germinative vesicle, would then appear to be due to the development of the yelk as a deposit of material of a lower grade of differentiation than the germinal protoplasm in the central part of the egg, as in meroblastic and centrolecithal ova, from the central portion of which the nucleus has been repelled, and taken up into the germinal matter.

In the eggs of osseous fishes it is certain that the protoplasm, or germinal matter, is arranged on the outside of the yelk, or deutoplasm, in some cases, or sends down processes or a meshwork into the latter, prior to the time of the formation of the germinal disk; so that the teleostean ovum actually passes through a centrolecithal stage. In birds and reptiles, this probably occurs during late intra-ovarian development, as impregnation must occur before encapsulation in the shell, which is formed in the oviduct after the albumen, or 'white,' has been added. Every grade of proportion, from a very small quantity of deutoplasm up to an excessive amount as compared with the germinal protoplasm, may occur; so that no sharp line of demarcation exists between truly holoblastic and truly meroblastic ova. The degree of inequality in the segmentation is therefore, generally speaking, dependent upon the amount of deutoplasm, or food-yelk, which is present, and the degree to which the germinative vesicle has been permanently displaced from its central position. This is, however, qualified by certain secondary modifications, to be discussed at the end of this paper.

This principle accounts for all the forms of unequal segmentation, even including the centrolecithal, where the peripheral segmentation of the germinal matter ultimately displays the working of the same principle of the repulsion of the nuclei from the deutoplasm, and their attraction for the outer protoplasmic segmenting stratum. It, however, explains most beautifully what it is that determines the degree of inequality between the first segmentation-spheres of all truly meroblastic ova. It is therefore of fundamental importance in a scheme of the primary laws of segmentation.

The expulsion of the germinative vesicle from the centre of an evenly segmenting egg, to develop the polar cells, is not to be confounded with the movement of the nucleus towards the periphery of the ovum while still in its follicle, in the large-yelked meroblastic type. The distinction between these two cases, I believe to be fundamental. In the ovum of Ostrea, Unio, Mya, etc., the nucleus at the time of the emission of the egg is still approximately central in position, although the ova are slightly meroblastic; while in Lepidosteus, for example, the nucleus of the nearly mature ovarian ovum is actually peripheral, but has not yet been broken up, or lost its form. Moreover, in the holoblastic type, the nucleus, after its metamorphosis and conversion, in part, into the first segmentation-nucleus, is again repelled towards the centre of the egg, — a phenomenon which does not occur in any meroblastic ovum with a germ-disk of relatively small dimensions, lying upon a disproportionally large yelk. This is a vital distinction, and one which, as far as I am aware, has not been insisted upon in the discussion of nuclear movements. A few illustrative diagrams from the actual subjects will make my meaning much clearer.

Fig. 1 represents an ovicell from the ovary of the common eel, enlarged ninety-six times to show the nucleus (n) in a nearly central position, with a very large number of very small, globular nucleoli adherent to its walls. The surrounding plasma ($p+d$) may be taken to represent both protoplasm and deutoplasm, but in a still undifferentiated state. Fig. 3 is an ovarian ovum of the bony gar (Lepidosteus osseus), very nearly mature, without its granulosa or follicle represented, enlarged seven times. The nucleus (n) in this section has approached the surface of the egg, and is almost or quite in contact with an almost homogeneous outer protoplasmic layer (b) just within the zona radiata (a). Upon examining the material contained within the inner edge of the protoplasmic layer (b), we find that still another differentiation of the egg-substance has occurred by which a portion (p) on either side of the nucleus (n), and extending around the egg as a thin film, has become quite different from the true deutoplasm (d), which consists of coarse, flattened, ovoidal bodies, as shown in fig. 5 more highly magnified. At the upper pole of the egg, and just below the nucleus (n), the coarser deutoplasm corpuscles or globoids



rapidly become smaller; so that the nucleus is invested by a disk (p) composed of very fine granules, which is in a condition intermediate between that of the external protoplasm layer (b) and the deutoplasm or yelk (d). In very immature ova from the same ovary of Lepidosteus, I find the nucleus in a central position, just as in the ovicell of the eel represented in fig. 1; differing, however, in details of its structure, containing, as it does, a distinct network of trabecular fibres.

The foregoing facts pretty clearly demonstrate the way in which the yelk and germ are differentiated in a meroblastic egg; namely, by a gradual separation of the germinal and deutoplasmic portions of the ovum, the first becoming concentrated peripherally and at one pole by a gradual metamorphosis of the deutoplasm. As this differentiation takes place, it appears that the germinative vesicle is repelled from its original central position, as shown in figs. 1 and 3, and that it never returns to the centre of the deutoplasmic mass, even after the polar cells have been extruded, and the remaining portion has been converted into the nucleus of the first cleavage. In this last regard the meroblastic ovum is in most striking contrast with the holoblastic. Mr. E. L. Mark[1] appreciates this when he remarks, "The nucleus appears ultimately to assume a position of equilibrium, not with respect to the whole mass of the egg, but in respect to its active constituents. Is not, then, this peculiarity ultimately, though indirectly, referable to the want of a uniform distribution of deutoplasm, —to the polar concentration of the protoplasm, in other words?" This covers the ground; but the writer is inclined to believe that the deutoplasm exercises a veritable repulsive force upon the nucleus, as shown in the egg of Lepidosteus, and that in this way only can we explain the failure of the nucleus to return to the centre of the meroblastic ovum after its metamorphosis attending the expulsion of the polar cells, and the fusion of the male and female pronuclei.

The displacement of the nucleus due to its migration during the maturation of the egg has a profound influence upon the mode of development of the various types, as already urged by Haeckel. A study of the mode in which the germ of a fish-ovum is developed may serve to make the nature of this influence clearer. Fig. 2 represents an egg of an osseous fish in diagrammatic outline, without its membrane, in three phases of maturation, up to the time of germ development, which may take place without the influence of the spermatozoon, as shown by the observations of Ransom, Hoffmann, and myself. In the first phase shown by the figure the protoplasm (p) may surround the deutoplasm (d), or it may form a scarcely perceptible layer on the surface of the egg; at a later stage this protoplasm has heaped itself up at one pole of the egg, as shown by the line pI; at a still later stage the germinal matter has aggregated itself into a biscuit-shaped germ-mass, the outline of which is shown by the dotted line $p\ II$. The process is sometimes quite complex, and takes as much as four hours for its completion, as in the cod's egg, in which, as in most fish ova, the disk is formed after the emission of the egg from the ovary. In other types a distinct meshwork of protoplasm, continuous with the external layer, is insinuated between large yelk-masses (d), as shown in fig. 4 at t. This arrangement seems to be the typical one amongst clupeoids. The process of germ-development in true osseous fishes is therefore essentially similar to that which we have described as occurring in Lepidosteus.

According to Hoffmann, the nucleus of the first segmentation is not the one usually hitherto regarded as such, which is concerned in the division of the germ-disk (p) into two equal blastomeres or cells, but its axis in its spindle stage is placed in a line coinciding with

[1] Maturation, fecundation, and segmentation of Limax campestris.—(*Bull. mus. comp. zoöl.*, vi., No. 12, p. 517.)

the axis or diameter of the egg, and not at right angles to it. This is shown in the diagram (fig. 4), in which the first segmentation-nucleus has been metamorphosed into the cleavage spindle (*sp*), with the upper end embedded in the germ-disk (*p*), and the lower end embedded in the protoplasmic layer (*p'*), which consists of the protoplasmic matter not incorporated into the germ, and left over to cover the deutoplasm (*d*). (The thickness of the layer (*p'*) has been exaggerated in the figure for the sake of clearness.) When the spindle (*sp*) has separated equatorially, leaving its upper end in the germ as its nucleus, and its lower end in the protoplasmic layer covering the yelk, as the parent of the free nuclei which afterwards appear in that layer, we may say that the true first segmentation has occurred, which has separated the deutoplasmic or yelk pole of the egg as a single cell from the germ-cell. We see, therefore, that the amount of deutoplasm in excess of the germinal matter actually determines the plane of separation between the germ and the yelk. We can also understand how such an arrangement would cause the mode of development to be modified. The meroblastic and centrolecithal types of ova, on account of the preponderance in bulk of the yelk-mass, are compelled to develop the blastoderm from the disk by spreading, or epibole, or by simultaneous superficial delamination, and cannot be directly transformed into a hollow blastula, as in a holoblastic ovum.

The consequences of the displacement of the nucleus are therefore of great significance in embryology; but the adaptations resulting from the permanent displacement of the nucleus of the ovicell during its development do not end with what has been said in the preceding paragraph. The layer *p'*, of fig. 4, acquires an important physiological function in conjunction with the blood-vascular system, in that it becomes an organ for breaking down and elaborating the yelk into blood-cells in fish ova, as shown by the researches of Vogt, Kupffer, Gensch, Hoffmann, and myself. From the remarkable similarity of the mode of development of the eggs of elasmobranchs, reptiles, and birds, to that of the osseous fishes, — in respect to the mode of germ-formation, spreading of the blastoderm, and the development of free nuclei, in the former and latter types at least, — I should not be surprised if it would be yet determined that such a structure exists in the ova of all of them.

The occurrence of free nuclei, under the blastoderm of the ova of Loligo, Sepia, and Octopus, embedded in the yelk, as found by Lankester; in arthropods by different observers; in those of osseous fishes by Kupffer, Götte, Oellacher, His, Klein, Ziegler, Gensch, Hoffmann, Rauber, and myself; in the ova of sharks by Balfour and Schultz; in those of birds by Götte, Rauber, and Balfour, — is strongly in favor of the doctrine that they have a similar function throughout all of these various forms. Their origin is, doubtless, not spontaneous, as has been believed by some; but, like the nuclei of the blastoderm itself, they have been primarily derived from the first segmentation-nucleus. In Clepsine, according to Whitman, it appears that they enter into the formation of the hypoblast.

Furthermore, it is probable that the development of the germ is actually to be viewed as a process of growth, — concentration of the germinal matter at the animal pole in virtue of its own power of movement. Finally, I would regard the deutoplasm as so much stored material, which — just as the fat globules in a fat cell have pushed the nucleus to the periphery, or as the accumulating fluids in the chorda cells, or as the enlarging sap-cavity in a plant-cell — has displaced the nucleus, and made it assume a parietal position. In evidence of this, I would cite the oval, flattened globoids of the deutoplasm of Lepidosteus (ichthine of Valenciennes and Frémy) as analogous to the stored proteids in many plant-cells. The frequent considerable displacement of the nucleus from the centre of the body in Amoeba, on account of the presence of great numbers of food-vacuoles in the endosarc, seems to be a phenomenon of a similar nature.

The rather anomalous segmentation of the eggs of the frog, lamprey, and Clepsine[1] must be noticed here, as they would appear to form an exception to the principle for which we have contended in truly meroblastic ova; viz., the final dissociation of germinal and deutoplasmic matter at the time of the first cleavage, which divides the whole egg into two nearly equal blastomeres. Immediately or very soon after the first cleavage, the segmentation again becomes unequal, in that smaller blastomeres are formed at the pole where the polar cells have been, or may be supposed to have been, extruded. In this way, it results that a certain mass of cells at the germinal pole of the ovum divide much more rapidly than those containing more deutoplasm at the opposite pole. Now, it is singular that in these types we actually have an approximation towards the develop-

[1] Whitman, Embryology of Clepsine. — (*Quart. journ. micr. sc.*, July, 1878.)

ment of a blastoderm in the more rapid division of the germinal cells at the animal pole of the egg; so that the coarser yelk-cells become included by the blastoderm, by epibole, just as in the typical meroblastic ovum. The segregation of the protoplasmic and deutoplasmic matter, therefore, occurs after the first cleavage in these types; in fact, manifests itself after the first and second cleavages in Clepsine and Rana. It is important to note, however, that in the vicinity where the polar cells have been extruded, the embryonic or germinal differentiation first begins to show itself, and that this is not improbably due to the lingering influence of the original polar displacement of the egg-nucleus at the time of maturation and impregnation. While the germinal vesicle, or rather what represents it, actually returns to the centre of the deutoplasm-laden ovum in these forms, may it not be that a path of germinal matter has remained over in the track of its original outward passage, through which it could return to undergo the first cleavage, shortly after which its segments were again repelled towards the germinal pole?

The mode of evolution of the yelk is of great interest, and doubtless occurred through the working of natural selection. It is evidently adaptive in character; and the necessity for its presence as an appendage of the egg grew out of the exigencies of the struggle for existence. The lower, hollow vegetative cell of a meroblastic egg, such as shown in fig. 4, is, to all intents and purposes, comparable to a fat cell, or to an endosperm cell of a seed containing stored reserve material, which may be, for the most part, in an absolutely non-contractile or static condition, like the oval globoids of the egg of Lepidosteus. John A. Ryder.

BALTIMORE SURFACE-GEOLOGY.

The 'Geology of the surface-features of the Baltimore area,'[1] by P. R. Uhler, bears evident marks of the author's unfamiliarity with his subject. No proof is offered in support of a number of assertions concerning the age and the physical changes of the Baltimore strata. After mentioning several rocks, which are referred, apparently without any evidence, to the Laurentian and archaean epochs respectively, we are told, that, "during the *Jurassic* period, these archaean upfolds seem to have attained their maximum development." Not a particle of evidence is offered in support of this assertion, which, we think, would need very strong proof indeed; and we are surprised at the facility with which the author handles 'wide-spreading, while comparatively local changes,' for metamorphic purposes. We also fail to see how the abundance of hornblendic and pyroxene rocks is a "restricted element in the structure of the Baltimore rocks, which serves to give them character, and to separate them broadly from members of the series found in other parts of eastern North America." We were not before aware that a prevalence of such rocks was confined to the vicinity of Baltimore.

Leaving the azoic rocks, the author reaches what he calls the Jurassic period, and says that only the upper member of this great age of reptiles, the 'Wealden,' remains within the Baltimore area. The English Wealden is considered by European geologists as the equivalent of the marine Neocomian of the continent, the lowest member of the cretaceous. Moreover, the Wealden is a fresh and brackish water formation, considered to be the local deposit at the mouth of a large river; and, as shown by Mr. Judd,[1] the actual marine representative of the continental Neocomian occurs at the south end of Filey Bay, in Yorkshire. Sir A. C. Ramsay, although describing the Purbeck and Wealden as a special local fresh-water formation, does not hesitate to consider the Wealden as the equivalent of the Neocomian. The preceding facts will show that it is difficult to see why Mr. Uhler uses the term 'Wealden' in connection with the Jurassic period, or why, if the Baltimore strata are the equivalents of the local fresh-water cretaceous deposit of England, he speaks of them as of Jurassic age.

Mr. Uhler, also says that in the upper Jurassic the flora has made a step in advance, gymnosperms taking the place of the old calamites and their relatives. But this step in advance was made already in the triassic keuper, where cycadites and gymnosperms make their appearance. The Wealden flora belongs to that degree of development of the vegetable kingdom which begins with the Rhetic, and ends with the lower cretaceous. This flora does not completely change till we reach the lower Quadersandstein, or upper greensand, where dicotyledons make their appearance; so that, judging on the evidence of flora alone, we should have to place the Gault or lower greensand also in the Jurassic.[2]

At the close of this Wealden (?) period, Mr. Uhler makes the climate colder, and brings great masses of ice to tear things to pieces, but gives no evidence in support even of this assertion.

[1] Johns Hopkins univ. circ., February, 1883.

RAINFALL OF UBERABA, PROVINCE OF MINAS GERAES, BRAZIL.

The following observations on the rainfall of the city of Uberaba, by Friar Germano, are interesting as being, so far as known, the first that have ever been made in the great interior Paraná basin; those hitherto published being either for the coast-towns and the maritime range of mountains, or, if actually within the interior basins, too near the margin to represent accurately the rainfall of the interior.

Uberaba is situated about 300 miles from the coast, in latitude 19° 44′ 30″ S., on the elevated grassy plains between the Paraná and its great tributary the Rio Grande. Its position as regards the maritime range and the Paraná-Paraguay basin — the South-American homologue of the Mississippi valley — may be compared with that of Cincinnati, or, better, some of the Ohio towns on or near the divide between the Great Lakes and the Ohio River. It is at an elevation of 750 metres above the level of the sea, according to the determination of Friar Germano.

The material is not at hand for an accurate comparison of its rainfall with that of other points where observations have been recorded. It is, however, not

[1] Quart. journ. geol. soc. Lond., xxiv. 218.
[2] Heer, Monde primitif de la Suisse, pp. 59, 269.