similarly marked, the dorsal and anal with a dark blotch on each eighth or tenth ray, the pectoral sometimes with one or more brownish bars.

Not abundant in the Bay of Panama; several specimens were taken, the largest about 10 inches in length.

INDIANA UNIVERSITY, *December* 2, 1881.

ON THE NUCLEAR CLEAVAGE-FIGURES DEVELOPED DURING THE SEGMENTATION OF THE GERMINAL DISK OF THE EGG OF THE SALMON.

By JOHN A. RYDER.

The fact that very complex changes are undergone by nuclei during the segmentation of cells has been known for only a comparatively short time, and, we may add, our knowledge has been greatly increased by the recent advances made in the perfection of histological methods. The titles of the principal memoirs on the subject are given below.*

From the list of papers, it will be gathered that all are German, and by only a few authors. The first of them, Professor Flemming, has described and figured such remarkable cleavage-figures, which he has claimed to have observed in segmenting cells, that it is not to be wondered at that some cotemporaries have been inclined to be incredulous. Since I have been enabled, however, to observe some of these phenomena for myself, I am quite well convinced that he has given us results, the value of which cannot perhaps just yet be properly estimated.

I recently received a series of ova of the common salmon, some of them in the second day of development, from Mr. H. H. Buck, of Orland, Me., in which very complex and interesting nuclear changes were in progress. The germinal disk had not yet begun to spread to form the blastoderm, but the cleavage had advanced so far that it had been segmented into several thousand cells, each measuring about $\frac{1}{800}$th of an inch in diameter. These salmon ova had been preserved in weak alcohol, so that they were not quite as good, perhaps, for our studies as they would have been had they been hardened in very weak chromic acid. The cells were, however, very clear, so that any nuclear figures could be well seen even without other reagents, though upon immers-

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* W. Flemming. Beiträge zur Kentniss der Zelle und ihrer Lebenserscheinungen. I Part, Arch. f. mikr. Anatomie, XVI; II Part and supplement, Ibidem, XVIII; III Part, Ibidem, XX.

W. Flemming. Ueber das Verhalten des Kerns bei der Zelltheilung und über die Bedeutung mehrkerniger Zellen. Virchow's Archiv, LXXVII.

Peremeschko. Ueber die Theilung thierischer Zellen. Arch. f. mikr. Anatomie, XVII.

W. Pfitzner. Die Epidermis der Amphibien Morphol. Jahrb., VI.

W. Pfitzner. Ueber den feineren Bau der bei der Zelltheilung auftretenden fadenförmigen Differencirungen des Zellkerns. Morph. Jahrb., VII, Hft. 2.

W. Pfitzner. Beobachtungen über weiteres Vorkommen der Karyokinese. Arch. f. mikr. Anatomie, XX, Hft. 1.

ing the disk for some time in acid carmine, the nuclei were very distinctly brought out, so that all the phases of change which they undergo could be observed in different individual cells composing the disk. In some cells the nuclei were in the resting stage; in fact, such was the case with the majority, and a comparatively small number were observed to be undergoing cleavage with the nuclear matter aggregated at opposite ends of the now elongating nuclear figure. Every phase of nuclear metamorphosis could be studied deliberately after I had made permanent balsam preparations, and from these I have been enabled to make a number of camera sketches, which are almost as complex as any figured by Flemming. These sketches are appended in an accompanying plate.

It is not known in what respect the nucleus differs chemically from the rest of the protoplasm of the cell in which it is embedded, but it is known that it is in some way very intimately concerned in the process of cell-division, a phenomenon which always accompanies growth and development. In the case of almost all, perhaps all organisms, the cells which compose them are constituted of a central more or less refringent body, the nucleus involved in a covering of protoplasm usually more or less different in optical properties from that composing the former. Huxley observes (Anat. Invert. 19), "when nucleated cells divide, the division of the nucleus, as a rule, precedes that of the whole cell." This appears to be the fact in the case of the segmentation of the cells of the germinal disk of the egg of the salmon, but just what share the enveloping protoplasm may take in the process we do not certainly know; doubtless the enveloping protoplasm is just as necessary as an aid or accessory in the process as the nucleus itself; they are probably in some way complementary to each other. To support this view we have the additional fact that we know nothing of absolutely naked nuclei, nor is the evidence in favor of absolutely non-nucleated cells much more than negative. The constancy with which complex cleavage-figures have recently been observed in plants, *Infusoria*, *Protoplasta*, *Mollusca*, *Echinodermata*, *Arthropoda*, and *Vertebrata*, both in the adult and embryo condition, would argue that they invariably accompany and characterize cellular fission or segmentation, and, inasmuch as the reputedly non-nucleated *Monera* propagate by fission, pass through a resting stage just like the cells of other organisms, it would not be surprising to find that they too were provided with nuclei which would develop cleavage-figures in the act of fission. Their complete parity of behavior in all other respects leads us to look for important revelations respecting their complete morphological correspondence with other types of cells as soon as they are studied by the help of improved methods.

Having given the preceding sketch of the function and characteristics of nuclei throughout the animal kingdom, we are prepared to deal somewhat more intelligently with the special case of the cleavage-figures which we have observed in the ova of the salmon. The changes observed in the cells of *Salmo salar* agree in all essential particulars with those seen by Flemming in the cells of the skin and branchiæ of the Salamander of Europe, and are of interest as confirming his observations and also as showing clearly for the first time that similar phenomena occur in the segmenting cells of a species of fish which has been perhaps more thoroughly studied embryologically than any other.

Fig. 1 represents a cell of the germinal disk of *Salmo* with its nucleus in the quiescent or resting stage magnified about 800 times, which is the amplification of most of the figures. In this condition the nucleus is approximately globular and traversed by a very irregular and interrupted network of aggregations, consisting of broken thread-like and rounded granular bodies. This condition is the one which may be supposed to exist during the long intervals of rest between the periods of active segmentation which have been observed by different biologists during the very early stages of development of the ova of various types. This interval of rest may also include a portion of the stages of change undergone by the nucleus preparatory to cleavage, and which will be next described.

Fig. 2 represents the nucleus of a cell from the germ disk of *Salmo* which is elongating and undergoing a rearrangement of its contents preparatory to division. With careful study it was found that nuclei were present in different cells in this stage of metamorphosis. The irregular broken granular threads and granules observed in Fig. 1 were seen, with careful focusing, to have rearranged themselves in the form of an intricate skein-like meshwork of threads, the direction of which was generally more or less in conformity with the long axis of the nucleus. This stage corresponds very closely with similar preparatory stages figured by Flemming and observed by him in *Salamandra*.

Figs. 3, 4, and 7 represent other stages, also preparatory or progressive. In Fig. 4 the nuclear matter exhibits a tendency to aggregate at the opposite poles of the nucleus, while in Fig. 3 aggregations are taking place around the equator of the nucleus as well as at the poles. The equatorial ring of granular aggregations is viewed somewhat obliquely, showing that they occupy a peripheral position against its wall. Fig. 7 represents a nucleus similar to the last, in which we may likewise note the equatorial and polar accumulations of nuclear matter. Cleavage or segmentation of the cell will take place across the plane marked by the equatorial aggregations.

Other phases in this strange cycle of phenomena are represented in Figs. 8, 11, and 12. In Figs. 8 and 12 the nuclear equatorial plate seems to be developed. In Fig. 11 the nucleus has apparently lost its contour, but in all of the last three the nuclear matter has been aggregated into definite stout threads, with enlargements at their ends in two of the cases.

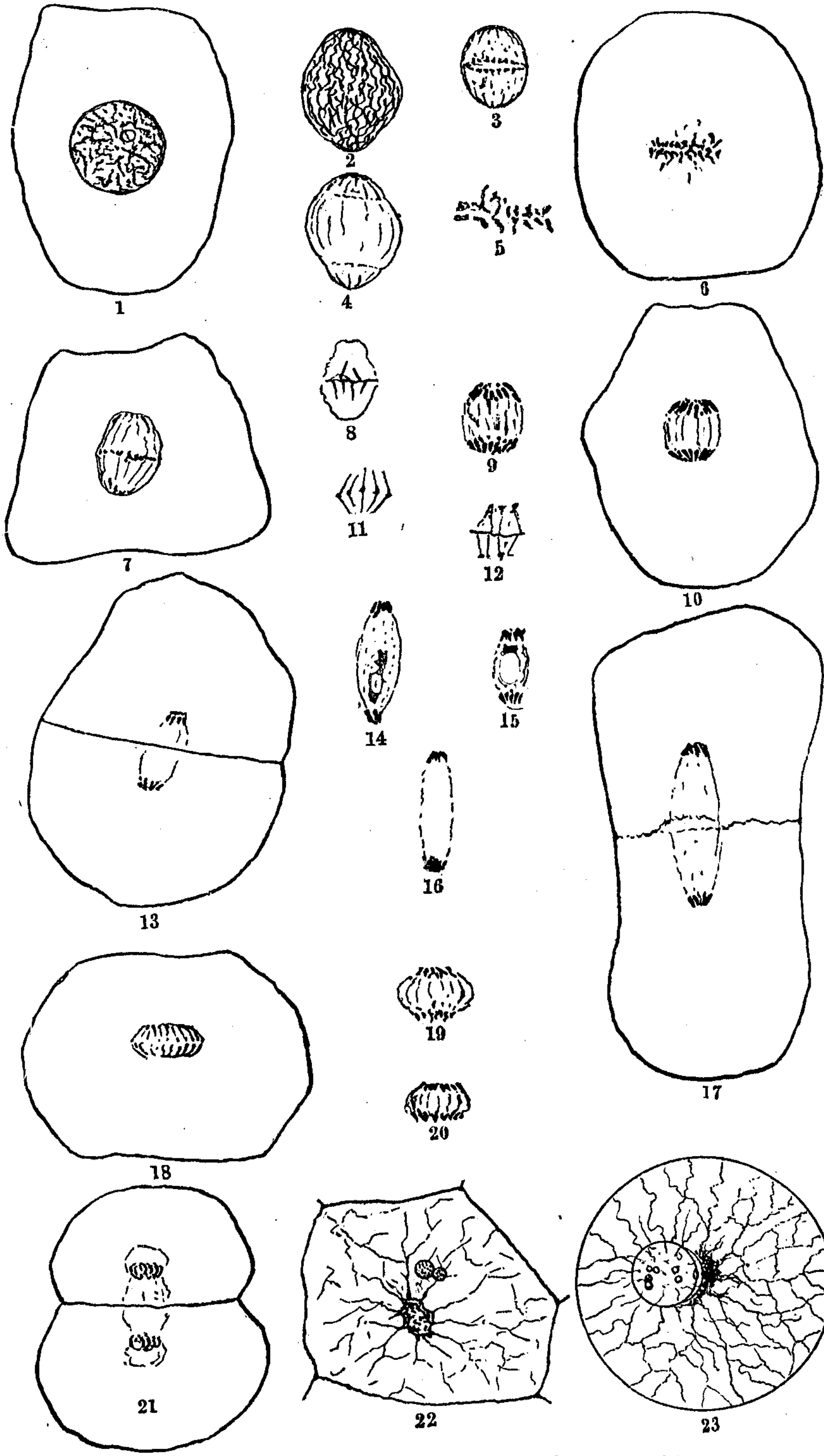
In Figs. 5 and 6 the sharp contour of the nucleus has been finally lost; short, thick, and highly refringent rods have been developed on either side of its equator. In Fig. 5 they are very irregular; in Fig. 6 much more regular.

Fig. 18 represents another phase of the progressive stage, in which the refringent nuclear rods at the opposite poles of the nucleus form a loaf-like figure. In this phase the rods seem to be about ready to part at the equator so as to assume the arrangement observed in Figs. 19 and 20. These are also progressive and approximating the conditions shown in Figs. 13 and 15. Figs. 14, 16, and 17 are still further stages in the process and indicate the stage when the cleavage or segmentation may be said to have been completed. In Figs. 9, 10, and 13 to 20, inclusive, it may be observed that the refringent nuclear rods have been aggregated at the poles of the nucleus, where they lie in a bundle somewhat like a bunch of fagots, or in the form of a crown or wreath. As the polar crown-like figures are separated the refringent rods of which they are composed are more and more compacted together into a closer bundle, as indicated in Figs. 14, 16, and 17.

In Fig. 21 the cleavage seems to have been completed, as the two polar nuclear aggregations lie more nearly in the centers of the two new cells. There is still a trace of the rod-like condition of the nuclear matter discernible, but the tendency is retrogressive, that is, to the phase indicated in Fig. 2. This apparently completes the series of rhythmical phenomena which we have observed in the cleavage of the nuclei and cells of the germinal disk of the egg of the common salmon. In Fig. 21 the two new nuclei will undergo a retrogressive metamorphosis until they are like Fig. 1; when this has been done, they will pass into the so-called resting stage, only to repeat the series of changes of form and rearrangement of their substance in subsequent cleavages as described above.

In my paper on the retardation of development of the eggs of the shad I have endeavored to explain why it was that segmentation appeared to go on rhythmically; data similar to these were there laid under contribution to explain away the fact. I had, up to that time, not been able to make any observations of my own on the behavior of the nucleus during the acts of segmentation, and this notice is designed to supplement and reinforce the arguments there put forth. As far as I am aware, the foregoing account is the first which minutely describes the behavior of nuclei in the segmenting germinal disk of any fish, and for that matter, the segmentation of any of the cells of a teleostean.

The stages represented in Figs. 3, 5, 6, 7, 8, 11, 12, and 18 appear to represent, in successive order as named, the *systole* of the nuclear matter towards the equator of the nucleus, while Figs. 18, 20, 19, 10, 9, 13, 15, 14, 16, and 17 similarly and successively represent the *diastole* phases of repulsion from the nuclear plate or equator. The rhythmical nature of the phenomena can, I think, hardly be questioned, nor will any one doubt the propriety of the application of the terms systole and diastole as suggested by Flemming. Lest it be objected that the nuclear figures



NUCLEAR CLEAVAGE FIGURES OF SALMON EGGS.

are the result of the disturbing effects of reagents, let it be remarked here that precisely similar changes have been observed in the living nuclei of both plants and animals.

No connecting granular fibers could, as a rule, be clearly made out between the aggregations at the opposite poles of the nucleus. The connecting lines, when present, appeared to be more or less broken as represented in our sketches, and only a faint outline of the nuclear field between the aggregations could be clearly made out. Neither was it possible to find any granular lines radiating outwards from and beyond the ends of the aggregations into the surrounding protoplasm of the cell in which the nuclei were embedded.

This condition is in very marked contrast with that constantly observed in the connective tissue-cells of the oyster, one of which is represented in Fig. 22 enlarged 800 times. Here a complex network of granular threads passes outwards in all directions from the irregular nucleus through the enveloping protoplasm; besides the threads there are usually one or two globular granular accessory bodies present, as shown in the figure. A still more complex arrangement of granular threads around the nucleus is shown in Fig. 23 of a cell, enlarged 1,000 times, from the reproductive tissues of the smooth limpet, *Crepidula glauca*. This last figure is from a sketch made two years ago from fresh material studied in neutral fluid.

THE DESTRUCTION OF YOUNG FISH BY UNSUITABLE FISHING IMPLEMENTS.

By B. P. CHADWICK.

BRADFORD, MASS., *December* 23, 1881.

Prof. SPENCER F. BAIRD:

DEAR SIR: I take this method of calling your attention to a subject that has occupied my mind for a long time, and that is, the destruction of the young fish along our coast from Cape Henry to Nova Scotia, by the use of ill-constructed nets, pounds, weirs, and traps of every description. For instance, in the seining of mackerel it often happens that 200 barrels are taken at a time; of this amount only 25 barrels are found to be large enough to be of any value in the market, the other 175 barrels are thrown back into the sea, all dead. This is a daily occurrence in a hundred places, and countless millions of young fish are destroyed during the mackerel season annually. The catch of mackerel is of vast importance to this country, and the useless destruction of the young fish is four times the amount of that sold as food. This wanton waste of the young fish can all be avoided by act of Congress, compelling fishermen to use seines, the mesh of which is large enough for the young of a useless size to pass through; thus there would be no fish taken except such as are marketable. This subject is probably nothing new to