Zoology

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ZOOLOGY.

On the Vertical Distribution of Pelagic Crustacea in Green Lake, Wisconsin.—Green Lake is the deepest body of water in the State of Wisconsin, having a maximum depth of about 60 meters. Because of its great depth it has not only the litoral and pelagic faunæ of the shallower bodies of water, but also the true abyssal fauna which is characteristic of the deeper lakes. In fact, the crustacean fauna of Green Lake is almost identical with that of the great lakes.

In the deeper waters of Green Lake are found fifteen species of crustacea. Of these, twelve may be fairly considered as belonging peculiarly to the deep water fauna. Most of these can be captured in very large numbers at night by means of the skimming net. During the day, very few are found at the surface, some few never come to the surface, and are only obtained by dredging in the deep water.

Of course, an open dredge, dropped from the surface to the bottom and then hauled up, will collect from all depths. After a little experience, the collector has no difficulty in distinguishing between pelagic and abyssal species, and can even draw inferences, with a reasonable degree of accuracy, in regard to the general vertical distribution of species. So far as I know, however, very little exact work has been done to determine the vertical limits of the various species. By means of dredges which could be closed at any required depth, it has been found that in the deep sea there is a surface fauna and a deepwater fauna, but that the immediate intermediate region is barren of animal life. According to Agassiz, the surface fauna extends to the depth of 200 fathoms, and the bottom fauna is limited to about 60 fathoms.

Is there a similar condition in the waters of our lakes? With a view to answering this question, I made some preliminary collections in the summer of 1893.

I used, for the collections, a vertical dredge, so constructed that it could be closed at any desired depth. The collections upon which this paper is based were made in the latter part of August, at all hours between five o'clock in the morning and nine o'clock at night. Each series included collections for every five meters in depth. Of course, until a much larger number of collections is made, and at different seasons of the year, no final conclusions can be drawn. But the results thus far are interesting, and I think later collections are not likely to modify, to any great extent, the conclusions I have formed.

The results were a little disappointing to me at first, I must confess. I had made up my mind that I should find the three regions characteristic of the deep sea—the pelagic, intermediate and abyssal. It was rather discouraging, then, when I found material in my dredge from all depths. Not only that, but when I began to examine the collections under the microscope, I found certain species, which I had considered peculiar to the surface—like *Diaptomus minutus*—occurring all the way from the surface to the mud of the bottom. The barren intermediate zone, then, does not exist in Green Lake. It is true, however, that the numbers of individuals are less at intermediate depths than near the surface or near the bottom, and that some species are vastly more numerous in the upper zone, while others are almost entirely confined to the lower.

I counted the number of individuals in each haul, and after reducing the numbers to percentages, tabulated the results.

I will give briefly the conclusions I reached in regard to those species which are found most commonly.

The species which is found in the greatest numbers is *Diaptomus minutus*. In one haul this was associated with *D. sicilis* (a somewhat rare form in Green Lake), and in my computation I did not separate the two, as their habits are identical. On the average, 46 per cent of this species is within five meters of the surface, and 59.4 per cent within ten meters. Within ten meters of the bottom are only 7.37 per cent. It is evident that more than one-half of the individuals of these species are found within ten meters of the surface, and that from that point to the bottom, the numbers steadily decrease.

Daphnella is more exclusively pelagic—79 per cent being found within ten meters of the surface, and only 5.6 per cent at the bottom.

Epischura is still more distinctly pelagic—81 per cent being in the first ten meters, and 3.3 per cent in the last ten.

Leptodora, *Bosmina* and *Cyclops fluviatilis* are also found much more abundantly near the surface. *Leptodora* rarely goes below fifteen meters.

Daphnia kahlbergiensis seems somewhat erratic in its distribution. On the average, nearly 43 per cent are found within the first ten meters, but nearly 25 per cent are found in the last ten. Generally speaking, they appear more numerous near the surface and the bottom, but less so at intermediate depths. But they may occur at all depths, and sometimes quite numerously in the intermediate region.

Limnocalanus macrurus rarely, if ever, comes to the surface, and is found most abundantly within 20 meters of the bottom. Nordqvist states that he found *L. macrurus* in Finland, in June, most abundant at twelve meters below the surface, where the total depth was 25 to 26 meters.

Pontoporeia and *Mysis* live at the bottom, and belong to the true abyssal fauna.

In regard to the diurnal migrations of the pelagic species, I found it difficult to fix any exact limits. As has been before stated, they come to the surface at night. In the daytime, few of them go below ten meters. *Daphnia kahlbergiensis*, however, seems to be an exception, for, apparently, its migrations are limited only by the depth of the lake, and sometimes from 40 to 80 per cent are in the last ten meters.

As a result of these collections, I was led to doubt the value of "Plankton" determinations, at least so far as crustacea are concerned. All such determinations must start with the assumption that the life of the deeper waters is distributed uniformly. If this were true, successive hauls in the same depth of water would contain approximately the same number of individuals. This was far from the case in my collections. The position in the successive collections varied only as the boat drifted very slowly; yet the number of *Diaptomi* varied from 291 to 2,966; *Daphnella* from 0 to 122; *Daphnia kahlbergiensis* from 6 to 103, and *Epischura* from 7 to 105. It seems probable that they are present in swarms, and that the positions of the swarms are continually changing.

Zacharias, in his last report from the biological Station at Plön, has reached the same conclusions, not only in regard to the crustacea, but also the other pelagic organisms. "Plankton" determinations, in order to have much value, must be almost infinite in number.

Beginning with the fall of 1894, systematic work of a more detailed character will be carried on at Green Lake, as the Trustees of Ripon College have made an appropriation for the purpose.

—C. Dwight Marsh, Ripon College, Wisconsin.

Rotatoria of the Great Lakes.—The Michigan Fish Commission have issued, as Bulletin No. 3, a list of the Rotatoria found in Lake St. Clair and some of the inland lakes of Michigan, prepared by Mr. H. S. Jennings. Of the 122 rotifers named in the list, 6 are here described and figured for the first time. Strongly swimming forms, commonly found in the open water, are designated pelagic; those found among the vegetation of the shores and bottom, littoral. Of the former, 20 were observed in Lake St. Clair. In the case of the inland lakes, collections were made from the shore only. The most abundant pelagic species are *Polyarthra platyptera* Ehrbg., *Anuraea cochlearis* Gosse, and *Asplanchna priodonta* Gosse, which agree, in this respect, with the condition found in European lakes.

The Internal Anatomy and Relationship of Pauropus.— According to Peter Schmidt, whose preliminary paper appeared in the *Zoologischer Anzeiger*,[1] the internal anatomy of *Pauropus* allies it most closely with *Polyxenus* among the Diplopoda. The absence of trachea, of malpighian tubes and of a circulatory system, together with the presence of a rather complicated genital apparatus in the male, seem to show that it is very degenerate. That it belongs along with the Diplopoda—a fact that has been questioned—the presence of the ovary below the intestine, of the genital openings in the third body segment behind the second pair of legs, and of only two pairs of oval appendages, abundantly testify. The biramose antennæ may possibly be explained by a comparison with the sense papillæ at the end of the terminal joint of the Diplopod antenna, the more readily, too, since, according to Schmidt, the distal portions of the rami, the geisseln of Latzel appear to be finely ringed and not segmented.

Several peculiarities are interesting. The mid-gut is without a *muscularis* and its epithelial cells are filled with rhomboid crystals with double refractive powers. The supra- and sub-œsophageal and the first body ganglia are fused into one mass which is pierced by a very short fore-gut. The small processes on the first segment represent rudimentary legs and possibly function in respiration like the abdominal sacs of Thysanura, Symphyla and certain Diplopods. The sense organ of the antennæ, the *globulus* of Latzel, consists of an outer and inner capsule with the intervening space filled with a fluid. The whole is surrounded by ten or twelve bristles while the nerve passes into the inner capsule and expands into a nail-like head. (Fig: 1.)

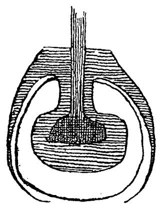

Fig. 1.

The female genital apparatus consists of an unpaired ovary lying, beneath the intestine, an unpaired receptaculum seminis and an oviduct opening to the exterior by an unpaired opening to the one side of the median line in the third segment. In the male there is an unpaired testis above the intestine, a complicated pair of ducts, a pair of seminal

[1] Zur Kenntniss des inneren Baues des Pauropus huxleyi Lubb. Zool. Anz., XVII, 189.

glands, and a pair of genital openings. Near the middle the testis communicates with the two small vasa deferentia that open into two

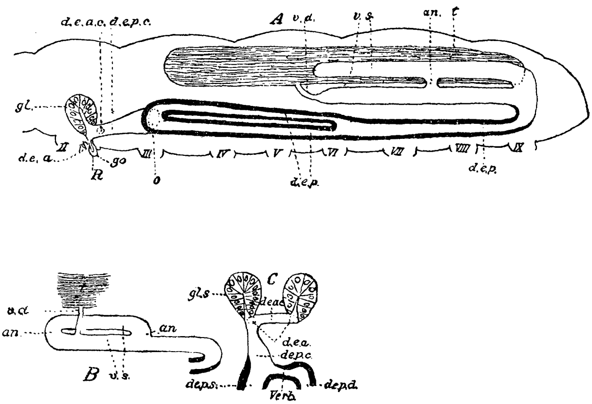

Fig. 2.

Diagrammatic representation of the male genital organs of *Pauropus huxleyi* Lubb. A. From the left side, II–IX the coxæ of the II–IX pairs of legs; t, testis; v.d, *vas deferens;* v.s., *vesiculæ seminales;* an, anastomosis; d.e.p., *Ductus ejaculatorius posterior;* o, opening between the d.e.p.; d.e.p.c., *Duct. ejac. post. communis;* d.e.a.c., *Duct. ejac. anterior communis;* gl., *glandula accessoria;* d.e.a., *Duct. ejac. anterior;* go, genital opening; R, penis.

B. From the right, somewhat shortened.

C. The anterior part from above.

large tubes which are bent upon themselves. These open posteriorly into two ducts that run forward beneath the intestine. The anterior half of each of them is double. In the fourth segment they unite into a short tube on the side of the body. This communicates with a transverse tube into which the seminal vesicles open, and which opens to the exterior by two openings.

The spermatozoa are pod-like. —F. C. Kenyon.

Thysanura from the Cave of Central France.—M. R. Moniez describes three new species of Thysanoures from the grotto of Dargilan in the Department of Lozére, France. The first, *Campodea dargilani,* appears to be the third of a series of forms adapted progressively for a life in darkness. That is, the characters of *C. staphylinus,* the type of the genus living in open air, are more accentuated in *C. coopei,* a cave form, and are carried to an extreme in *C. dargilani.* The second, *Sira cavernarum,* is white, covered with transparent scales, and is entirely blind. The third, *Lipura cirrigera,* is characterized by tufts of 6 or 7 cirrhi at the base of the second joint of the attennæ. These cirrhi are spaced at their insertion and recurved. These organs are present in the other Lipurae, but in so rudimentary a state that they have heretofore escaped observation. (Revue Biol. de Nord., Dec., 1893).

Result of a Comparison of Antipodal Faunas.—Prof. Gill's paper on a comparison of the piscine fauna of the British island with that of the New Zealand waters contains some important deductions. An analysis of a tabulated list of the families of these two regions shows that twenty-five families are represented in the New Zealand seas and not in the British; of these eleven are peculiar to the Southern Hemisphere; four are represented in the Northern Pacific, but not in the North Atlantic; and ten, although not represented in the British seas, have quite a general distribution.

Of the fresh-water species, those characteristic of the Northern Hemisphere are, with the exception of the Argentinidae, entirely unrepresented in the Southern, while the Antipodal types are wanting in the Northern zones.

According to Professor Hutton, the New Zealand Fishes belong to no less than six distinct geographical realms: Notalian, Antarctalian, Pelagalian, Bassalian, Tropicalian and Ornithogæan. A consideration of these various elements and comparison of them with those of other regions leads Dr. Gill to the following conclusions:

"The main marine fauna of New Zealand is derived from representatives of the general stock which has become developed in the great Notalian realm. The number of species apparently peculiar to the province, and, therefore, modified from other or earlier representatives, indicates a long period of isolation in accordance with its distance from the nearest continents and the depth of the intervening ocean. The percentage of such peculiar species seems to entitle it to rank as a distinct region (or subregion) rather than as an integral portion of the Notalian region composed of the isothermal portions of Australia and Tasmania, as has been generally done. A more extended study and actual comparison of the species of the two regions may, however, compel a reconsideration of this view."

"The fresh-water fishes must have been derived from the same common source as those of the isothermal portions of Australia (of course, including Tasmania) and South America. There may not have been a continuity of land at any one time between South America, Australia and New Zealand, but, at more remote period in the past, it is, at least, possible that there was a region in which the Galaxiids and Haplochitonids were developed, and subsequently representatives of those families might have found their way into the regions where they now abound."

In the discussion of the possibilities of the origin of the present types of the fresh-water fishes of New Zealand, it appears that Dr. Gill is of the opinion that "community in type must be the expression of community of origin, and the presence of fishes of long-established fresh-water types must imply continuity or at least contiguity of the lands in the midst of which they occur at some time or other." He then adds: "We may be permitted to postulate (fishes being congeneric in New Zealand, Australia and South America), that there existed some terrestrial passageway between the several regions at a time as late as the close of the Mesozoic period. The evidence of such a connection afforded by congeneric fishes is fortified by analogous representatives among insects, mollusks, and even amphibians. The separation of the several areas must, however, have occurred little later than the early Tertiary, inasmuch as the salt-water fishes of corresponding isotherms found along the coasts of the now widely separated lands are to such a large extent specifically different. In general, change seems to take place more rapidly among marine animals than fresh-water representatives of the same class." (Fifth Mém., Vol. VI, Natl. Acad. Sciences.)

The Carotid, Thymus, and Thyroid Glands form the subject of a rather lengthy paper by A. Prenant.[2] He had a good series of embryos, and studied carefully the histological changes during development. According to him the carotid gland originates from the third entodermal branchial pouch, and at first becomes closely connected with the primitive carotid artery, but later loses this connection and becomes united with the head of the thymus. In regard to the lymphoid transformation of the thymus, he says that in embryos, from 25 and 85 mm. in length, there appear small nuclear elements among the primitive epithelial cells, which stain deeply and are comparable to lymphocytes. The thymus in embryos of 85 mm. and upwards begins to differentiate itself into an outer cortical portion and an inner medulary portion. The latter is clearer, looser in texture and poorer in lympathic elements than the cortical portions. This further becomes differentiated into a peripheral and an inner portion. The former stains less, is richer in karyokinetic figures than the latter. It

[2]Contribution à l'etude de développement organique et histologique des Thymus de la glande thyroid, et de la glande carotidienne. A. Prenant, La Cellule, X.

is doubtless a germ of proliferation. Nothing surrounding the organ authorizes the supposition that this is a muscular connective tissue which produces the lymphocytes that fill the organ. It is probable that epithelial cells after multiplying actively by mitosis, give rise to the lymphocytes by simple division (stenose). For large nuclei with small buds frequently occur and small nuclear bodies may be seen by the side of large nuclei and within the same. This mode of division is more common in the earlier stages. In older embryos the lymphocytes are formed karyokinetically. The epithelial cells that probably persist even in the completely developed organ he compares with the cells forming the matrix of the testis and the coveys of lymphocytes arising from them with the seminal elements.

The lateral portions of the thyroid develop from the fourth entodermal branchial pouch, which is forked. From the angle of this there grows up an organ that in structure and appearance is comparable with the carotid gland. This he calls the *glande thyroidienne.* It finally comes to lie outside of the vascular-connective hilum of the thyroid. During development an anfractuous cavity appears in the thyroid and is prolonged in every direction by deep diverticula. At first its walls are stratified and then simple. The superficial cells disappear after a transformation comparable to that which occurs in the internal assizes of the epithelium of the æsophagus. The wall produces around itself a cellular reticulate structure of dense aspect, which later disappears. Whether the lateral gland gives rise to buds that become confusingly anastomosed and eventually transformed into thyroid vesicles, or whether the lobes of the median gland solder themselves to the tissue of the lateral gland, it is impossible to say.

There is very little of a comparative nature in the paper beyond an attempt to introduce a formula to represent the number and position of the glands in invertebrata. This is not nearly as readily understood as a simple diagramatic figure; moreover, it is entirely unnecessary.

Of possible interest in connection with the work of Prenant is a short paper by J. Beard on the Development and Probable Function of the Thymus.[3] In Raja he declares that the epithelial nature and appearance of the cells composing the gland is lost very soon after their formation. Their nuclei stain intensely, and the cell-body, i. e., the protoplasm, is very scant from the start. It is clear that there is no inwandering of lymph cells, but that these elements are the direct offspring of the epithelium of the gill cleft.

[3]Anat. Anz., IX, p. 476.

As to the function of the gland, bearing in mind the observations of Stöhr and Killian on the tonsils, he concludes that the thymus exists in fishes for the protection of the gills from bacteria, etc., by the formation of leucocytes. With the disappearance of the gills of fishes and perrennibranchiate amphibians, the gland undergoes a restriction in the area of its formation and its functions are transformed to other organs. In the higher vertebrates this protective function is transferred to the tonsils at the opening of the respiratory passage.

—F. C. Kenyon.