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CHARLES BRANCH WILSON

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# NORTH AMERICAN PARASITIC COPEPODS.

## PART 9.

## *(THE LERNÆOPODIDÆ.)*

BY

CHARLES BRANCH WILSON.

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Dissertation submitted to the Board of University Studies of the Johns Hopkins University in conformity with the requirements for the Degree of Doctor of Philosophy: Baltimore, 1910.

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WASHINGTON
1910

# VITA.

Charles Branch Wilson was born October 20, 1861, at Exeter, Maine. He graduated from Colby College in 1881 with the degree of A. B.; was a postgraduate student and tutor in Botany at Colby from 1881 to 1884, receiving the degree of A. M. in the latter year, and was given the honorary degree of Sc. D. in 1908.

From 1884 to 1891 he was a private tutor; from 1891 to 1894 Professor of Natural Sciences at the State Normal School at Gorham, Maine; from 1894 to 1896 a postgraduate student and student assistant in Biology at Johns Hopkins University; since 1896 Professor of Biology at the State Normal School at Westfield, Massachusetts; a postgraduate student and fellow by courtesy at Johns Hopkins University during the school year 1909–1910.

During the summer months of 1895 and 1896 he was director of a summer school in Biology at Harpswell, Maine; in 1897 a member of the Johns Hopkins Biological Expedition to Jamaica; in 1898 and 1899 a research worker in the Tufts College Biological Laboratory at Harpswell, Maine; since 1899 a temporary assistant of the U. S. Bureau of Fisheries. In this latter work the summers of 1900 to 1904 were spent at Woods Hole, Massachusetts, 1905 at Beaufort, North Carolina, and 1906 at Lake Maxinkuckee, Indiana, in investigating the Copepod parasites of our food fishes. The summer of 1907 was spent on the Mississippi, Ohio, and Tennessee rivers as a member of the Fresh-water Mussel Commission; 1908 on the Maumee and Wabash rivers in Indiana and Ohio, and 1909 on the Kankakee river in Indiana and Illinois, investigating the life and habits of fresh-water mussels.

During the summer of 1910 he was again a member of the Johns Hopkins Biological Expedition to Jamaica.

In 1901 the collection of Parasitic Copepods belonging to the U. S. National Museum was placed in his hands for study and determination. The nine papers belonging to the present series, which are

enumerated on the first page of this thesis, are the outcome of this work. Beside these there have also been published the following papers.

1897. The Wrinkling of Frog's Eggs during Segmentation, Amer. Nat., 1896, pp. 761 to 773, pls. XIII and XIV.

1898. Activities of Mesenchyme in Certain Larvae, Zoological Bulletin, vol. 2, no. 1, pp. 15–22, 4 text figs.

1899. The Habits and Early Development of Cerebratulus lacteus Verrill, Quart. Jour. Micr. Sci., n. s, vol. 43, pp. 97–198, pls. 9–11.

1900. Our North American Echiurids, Biol. Bull., vol. 1, pp. 163–178, pl. 1.

1904. The Fish Parasites of the Genus Argulus found in the Woods Hole Region, Bull. Bureau of Fisheries, vol. 24, pp. 115–131, 31 text figures.

1905. New Species of Parasitic Copepods from the Massachusetts Coast, Proc. Biol. Soc. Washington, vol. 18, pp. 127–132.

1906. On Some Parasitic Copepoda, Ceylon Pearl Oyster Report, pt. 5, supplementary report 34, pp. 189–210, pls. 1–5.

1909. Dragonflies of the Mississippi Valley, Proc. U. S. Nat. Mus., vol. 37, pp. 653–671.

# NORTH AMERICAN PARASITIC COPEPODS.—PART 9. THE LERNÆOPODIDÆ.

By CHARLES BRANCH WILSON,
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## DEVELOPMENT OF ACHTHERES AMBLOPLITIS KELLICOTT.

### INTRODUCTORY.

The present paper is the ninth[a] in the series dealing with the North American Parasitic Copepods. It takes up the development of a species which is the American representative of the European *Achtheres percarum* Nordmann, and which may serve as the type of the family Lernæopodidæ.

This American species is very common upon the gill arches of the rock bass or red-eye, *Ambloplites rupestris*, and is occasionally found upon other species of the Centrarchidæ.

At the present time it has never been obtained from the American perch, or from any other of the Percidæ.

It lives fastened to the inner surface of the gill arches and easily escapes detection, especially in the larval stages, by concealment among the large teeth which cover that portion of the arches, and by being covered with the slime that envelops the whole of the gill surfaces.

The surest method of detecting its presence and the one by means of which all the larval stages here described were discovered, is to cut out the gills carefully, separate each arch from the others, and

[a] The other eight papers are as follows: 1. The Argulidæ, Proc. U. S. Nat. Mus., vol. 25, pp. 635–742, pls. 8–27. 2. Descriptions of Argulidæ, idem, vol. 27, pp. 627–655, 38 text figures. 3. The Caliginæ, idem, vol. 28, pp. 479–672, pls. 5–29. 4. The Trebinæ and Euryphorinæ, idem, vol. 31, pp. 669–720, pls. 15–20. 5. Additional Notes on the Argulidæ, idem, vol. 32, pp. 411–424, pls. 29–32. 6. The Pandarinæ and Cecropinæ, idem, vol. 33, pp. 323–490, pls. 17–43. 7. New species of Caliginæ, idem, vol. 33, pp. 593–627, pls. 49–56. 8. Parasitic Copepods from the Pacific Coast, idem, vol. 35, pp. 431–481, pls. 66–83.

float it out in water under a dissecting microscope. The buoyant power of the water will lift the larva or adult into view above the slime and teeth, particularly if the dish be agitated a little.

The living material upon which the following observations were made was obtained at Lake Maxinkuckee, Indiana, during the summers of 1906, 1908, and 1909, while the author was in the employ of the U. S. Bureau of Fisheries. For this valuable opportunity acknowledgment is gratefully made to the Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries. The serial sections and the study upon them were made in the biological laboratory of Johns Hopkins University, and the sincere thanks of the author are due to Dr. E. A. Andrews for many valuable suggestions and corrections.

## METHODS.

For external study, including the mouth-parts and other appendages, a mixture of 95 per cent alcohol and 5 per cent formalin in equal parts was found to be the most satisfactory preservative. Specimens kept in this mixture for three years have retained their anatomical form and structure perfectly, and have become neither unduly hard nor brittle.

For the histological work the material was preserved in alcoholic corrosive-acetic, the corrosive being removed immediately after fixation with iodine.

The specimens to be sectioned were first stained in bulk with Delafield's hæmatoxylin, and after clearing were counterstained with eosin in 95 per cent alcohol.

These methods were found to give excellent results both in fixation of the tissues and in differential staining.

## HISTORICAL.

The genus *Achtheres* was established by Nordmann in 1832, with the type species *Achtheres percarum*, found in great abundance on the gill arches of the common European perch, *Perca fluviatilis*. Nordmann not only described the adults of both sexes minutely, but he also gave a good account of the breeding habits and the development up to the first copepodid stage. In the same paper he established another genus, *Tracheliastes*, closely related to *Achtheres*. He did not obtain the male of his type-species, *Tracheliastes polycolpus*, but did secure some newly hatched larvæ, whose development he also followed up to the first copepodid stage. In a third new genus, *Basanistes*, with the type-species *huchonis* described at the same time, he was not so fortunate, and no developmental stages are mentioned.

Three years later (1835), however, Kollar reinvestigated this third species and included with the adults a good description and figures of the first copepodid larva.

Here the development of the Lernæopodidæ rested for nearly thirty years until Claus in 1862 filled in one of the missing stages in the life history of *Achtheres percarum*. But Claus himself stated that he was unable to finish his investigations, and many gaps were still left in our knowledge of this crustacean family.

In 1870 Édouard Van Beneden gave as the fourth paper in his researches on the embryogeny of the crustacea what might be called a mosaic development of the Lernæopodidæ.

His series of stages, which began with the segmentation of the egg and closed with this same first copepodid larva, were selected from the genera *Anchorella*, *Lernæopoda*, *Brachiella*, and *Hessia*.[a]

Olsson in 1877 published the figure of a larva of *Achtheres percarum*, but gave an extremely meager description, while the figure itself was so small as to show no details.

Finally Vejdovský in the same year (1877) worked over again the anatomy and development of *Tracheliastes polycolpus*, but like Nordmann and Kollar he followed the metamorphosis only to the first copepodid stage. His description and figures of the development inside the egg, however, are the most complete and the best that have ever been published.

These five papers (beside Olsson's single figure) comprise practically all that has appeared upon the development of this family, the Lernæopodidæ, up to the present time.

The reason why so many of them stop with the first copepodid larva is readily understood when it is recalled that this is the only free swimming stage, and is therefore the one during which the larva seeks out its host. Even Claus, who is the only one to describe any of the subsequent stages, was forced to be content with female larvæ 2 mm. long (really adults) and a male larva that was practically fully developed. But he described both of these in considerable detail and thus furnished an important contribution to their life history.

Claus gave it as theoretically probable that this first copepodid stage, at which all the accounts stop, passed at the next molt into an attached form in which the number of body segments and appendages was not increased, but the frontal filament was put into operation for attachment to the host, the mandibles were inclosed in the proboscis, and the setæ of the swimming legs and the furca were degenerated from lack of use. He was not able to find such a form, but it has been discovered in connection with the present work, and while it does not conform in all details to what he prophesied, it shows a remarkably accurate conception on his part of its general features. But his actual observations were made upon larvæ and

[a] This was a new genus named for the first and as it has proved the last time, but not described or figured, except in one or two embryonal stages.

adults entirely, that is, without the aid of dissection or serial sections, and the same may be said of all the other investigators, whether working with eggs, larvæ, or adult stages. Since all of these are more or less opaque it is not surprising that some mistakes were made in observations. The wonder rather is that so many of these observations of the exterior are substantiated by sectioning the different stages.

### COMPARISON WITH OTHER PARASITIC SPECIES.

On comparing carefully and in detail the metamorphoses which the different species exhibit, we may separate the parasitic copepods into five groups according to the relative lengths of the free-swimming and parasitic periods:

I. Those whose larvæ are free swimmers during their entire development and become parasites only upon reaching the sexually mature adult condition.

The Ergasilidæ are examples of this group, and in the genus *Ergasilus* the males never become parasites at all but remain free during life.

II. Those in which the earlier larval stages and the mature adult are free-swimming, while the intervening stages are parasitic and sometimes degenerate.

Here belong the Monstrillidæ and the males of certain genera among the Ascidicolidæ. The males and often the females of some of the Caligidæ might also be well placed here, since the mature adults are frequently captured swimming at the surface, and only attach themselves temporarily to fish in order to obtain food.

III. Those whose larvæ are free swimming during early development, passing through typical nauplius, metanauplius, and copepodid stages, and then seeking a host upon which to become parasitic during the remainder of life.

The stage at which the change is made varies considerably, as does also the life history subsequent to it. In some of the Ascidicolidæ the larvæ remain free-swimming until the second copepodid stage, as in *Enterognathus*. In the Pandarinæ, Cecropinæ and Chondracanthidæ they become parasitic at the beginning of the first copepodid stage. In the latter family they are transformed at the next molt into the adult, the other copepodid stages being suppressed.

IV. Those in which the early stages are often passed inside the egg, while later free-swimming stages alternate with others which are both parasitic and degenerate.

The Lernaeidæ are examples of this group; the larvæ are free-swimming until the first copepodid stage, then become parasitic and degenerate into a pupal form in which the power of movement is lost. Later they regain this power, leave their host, and swim about freely