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## Infection of Cyclops with Coracidium of Oriental Diphyllobothrids and their Development to Mature Procercoid Stage.

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Janicki and Rosen[1] showed that certain copepod crustaceans belonging to the genera Cyclops and Diaptomus were the first intermediate hosts of *Diphyllobothrium latum*. Okumura[2] found that *Cyclops leukarti* was the necessary first intermediate host of a species of Diphyllobothrium which he designated as *"Sparganum mansoni"*. Since considerable doubt has been indicated as to whether the spargana found in man and other vertebrates in the Orient belong to one of several species, the present writers have undertaken to study the life cycle of forms found in North China.

In one series of cases eggs from naturally infected dogs and cats have been utilized as the starting point of the experiment; in another, spargana commonly found in the somatic musculature of the hedgehog, *Erinaceus dealbatus*, have been fed to uninfected dogs and cats, resulting in the development of these larvae into adult worms, from which, eggs were readily obtained. Morphological study of the mature worms in these cases has shown that the former type belongs to the species *Diphyllobothrium decipiens* (Diesing), while the latter is *D. erinacei* (Rudolphi). The eggs were washed and incubated at temperatures from 15° to 35° C. Both species developed equally well. At the lower temperatures 21 to 30 days were required, while at 35° C. only 9 days for complete development and hatching. Under favorable conditions about a 90% hatch was obtained. Once the opercular caps of the eggs had opened, the ciliated hexacanth embryos (coracidia) all emerged in about an hour. Agitation of eggs containing fully mature embryos resulted in a slightly earlier hatching.

Eight species of Cyclops were obtained in considerable number from the ponds, rice-fields and streams in the environs of Peking. None of these were ever found naturally infected with tapeworm larvae. The Cyclops were introduced one at a time into watch-glass cultures containing numbers of free-swimming coracidia and usually began immediately to ingest the coracidia, which showed no avoiding

[1] Janicki, E., and Rosen, F., *Bull. Soc. neuchateloise Sci. nat.*, 1917, xlii, 19.

[2] Okumura, T., *Kitasato Arch. Exp. Med.*, 1919, iii, 190.

reaction. In 15 minutes such a Cyclops might swallow 20 to 60 larvae, which packed the whole digestive tract. Meanwhile the ciliated embryonic membrane had been cast off by the larvae, which then proceeded to excavate a hole in the wall of the digestive tube of the Cyclops, utilizing its 3 pairs of hooks for this purpose. In 25 minutes some of the onchospheres had worked their way through into the body cavity, but a longer time was frequently required. The several species of Cyclops showed different resistances to the injuries produced in their intestinal wall, some succumbing in 2 or 3 days, others harboring as many as 8 larvae for 3 weeks or more after infection. In controlled experiments a single coracidium swimming about in a watch glass was never successful in producing an infection in a Cyclops (species A) introduced into the medium, although where large numbers of larvae were utilized the same species of Cyclops ingested the entire number. Under similar conditions species B and C ingested 70% of the coracidia, species F, 20%, and species H, 30%, while species D only swallowed 5% or less of those in the container.

The percentages of ingested larvae which arrived in the body cavity were as follows: Species A, (36); B, (26); D, none; F, (3); G, (5.5) and I, (28.5). No essential differences were found in the susceptibility of these several species of Cyclops to infection with the coracidia of *D. decipiens* and *D. erinacei*. In the body cavity of the Cyclops the onchosphere metamorphosed into a procercoid, which was characterized by having a spinose integument, with a special spinose armament around the anterior end, a complex of histolytic glands opening into the anterior end, excretory system with exact flame-cell multiples, and calcereous bodies. Meanwhile the original 3 pairs of spines of the onchosphere had become oriented posteriorly in the cercomer, which gradually became constricted off and degenerated as the procercoid approached maturity. With the exception of species D, mature procercoids were obtainable experimentally in all species of Cyclops tested, although species A produced the highest percentage. This optimum host-parasite relationship was not correlated with size, since certain small species of Cyclops harbored larger numbers of mature procercoids than did large Cyclops.