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VARIATION IN RESPONSE OF CHANNEL CATFISH TO *Henneguya* SP. INFECTIONS (PROTOZOA: MYXOSPORIDEA)

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Abstract: Infections in channel catfish (*Ictalurus punctatus*, Rafinesque) induced by the sporozoan *Henneguya* (Protozoa: Myxosporidea) result in seven known and diverse disease manifestations. Most outstanding is an interlamellar branchial form responsible for significant losses among immature catfish, and a unique papillomatous form. The question of whether or not the species of *Henneguya* involved in these cases is *H. exilis* remains to be resolved.

INTRODUCTION

Probably the best known pathogenic Myxosporidians of North American freshwater fish are *Myxosoma cerebralis* and *Ceratomyxa shasta*.[5,9,14] Each of these species is an important pathogen of salmonids. They are unique, however, as damage inflicted by most sporozoans has not been extensively studied. This paper describes seven manifestations of *Henneguya* infections in channel catfish, including a form which inflicts serious losses among immature individuals.

Seventeen species of *Henneguya* have been described from North American freshwater fishes representing several widely diversified fish families.[1] Most species are histozoic and localize in specific tissues. Infections may appear as white cysts within gills, barbels, adipose fins, the skin, gall bladder, connective tissue of the head, subcutaneous tissues, or in the sclera and muscles of the eye.

Spores of *Henneguya* grossly resemble spermatozoa, possess two anterior polar capsules and have an elongate posterior process which may or may not be separated along the sutural plane (Fig. 1). Mode of transmission has not as yet been demonstrated. No means of chemical control is known.

In channel catfish, *Henneguya* infections are broadly categorized with respect to the tissue parasitized and site of spore formation. Two types of branchial (gill) infections are known: an intralamellar form that develops cysts within lamellae, and an interlamellar form that develops cysts between lamellae. Three cutaneous forms have been recognized: a papillomatous form that causes large tumor-like lesions; a skin infection that causes formation of cysts on the external body surface; and a rare adipose fin form that localizes solely within the tissue of that fin. Two other forms are also known: one in connective

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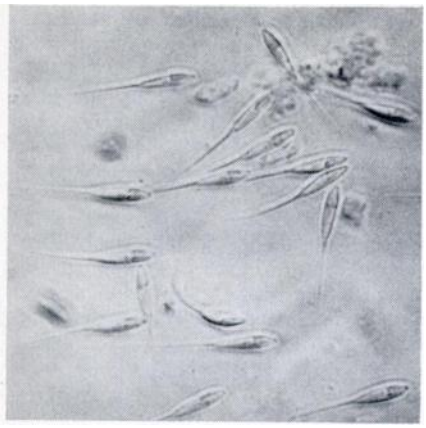

FIGURE 1. Spores of **Henneguya**. Unstained. 1000 X.

tissue surrounding the mandibular teeth; the other in the gall bladder.

Mature spores from the aforementioned infections are indistinguishable on the basis of shape and dimensions. They closely resemble *H. exilis* described by Kudo from channel catfish.[3] Further study is needed to determine if *H. exilis* is the species involved, or if sub-species or other species are implicated.

BRANCHIAL FORMS

Intralamellar. The intralamellar form is commonly observed among cultured channel catfish. Spore development occurs within capillaries of gill lamellae or blood vessels of gill filaments (Fig. 2).

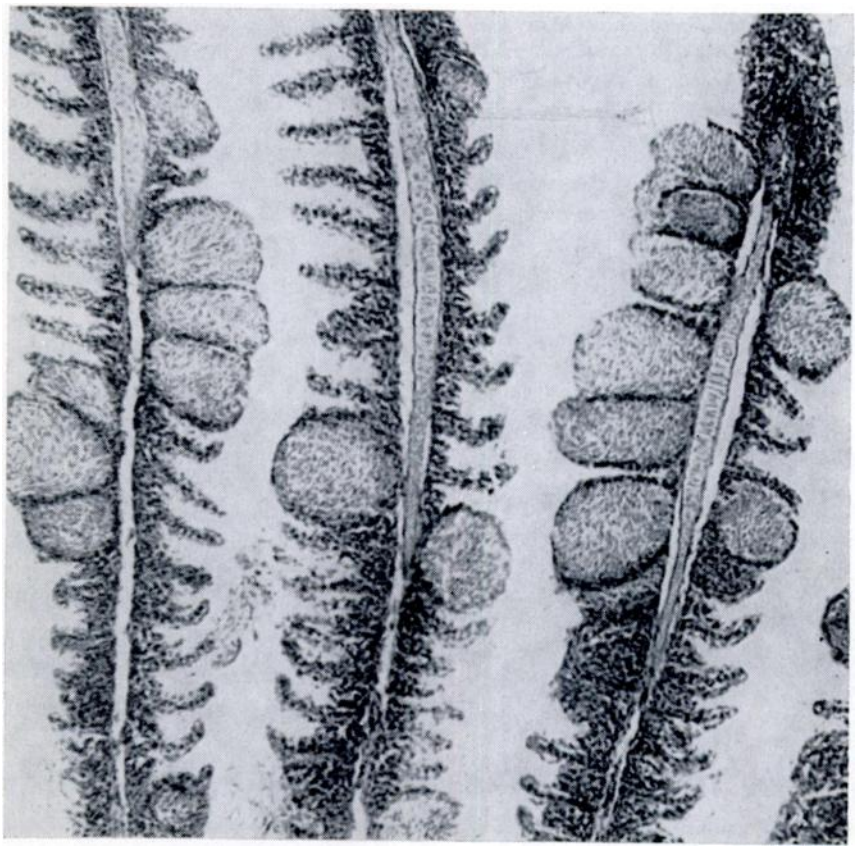

FIGURE 2. Cysts of intralamellar branchial form of **Henneguya** containing numerous spores. H. and E. 400 X.

The resultant opaque, spore-filled cysts may be found in large numbers and are readily observed in wet mounts. The role of this form as a debilitating agent is suspected but unproven.

Interlamellar. This form of *Henneguya* develops spores among basal cells between gill lamellae (Fig. 3). As spore formation progresses, lamellar tissue becomes greatly hypertrophied and gill tissue may lose all of its normal appearance. Large masses of spores may be noted among affected cells.

This form, in contrast to the intralamellar form, has been observed to be the causative agent of mass losses among very young cultured channel catfish. Epizootics involving losses of 95% among fingerlings less than 2 weeks old have been documented.[4] Fish up to 25.4 cm in total length have been observed in severe distress when heavily parasitized.

Nearly complete loss of respiratory function accompanies infection. Fish exhibit signs of anoxia, swimming at the surface of ponds with flared gill opercu-

lae. Affected fish do not tolerate handling, and most attempts to treat with parasiticides have caused additional loss.

Unfortunately, the interlamellar form appears to be spreading throughout the south-central states due to the unrestricted sale and transport of infected channel catfish fingerlings. It has been observed in five states and is likely to be found in others. It is the form of *Henneguya* that most seriously affects cultured channel catfish. Minchew has described the branchial forms in great detail.[5]

CUTANEOUS FORMS

Papillomatous. Tumor-like sporozoan-induced growths are known to occur in fish.[6,7] Growths attributable to *Henneguya* in channel catfish are white and granular (Fig. 4). They have been observed on dorsal, anal, and caudal fins of cultured catfish. The caudal peduncle may also be affected. The largest lesion we have observed measured 1 cm in dia-

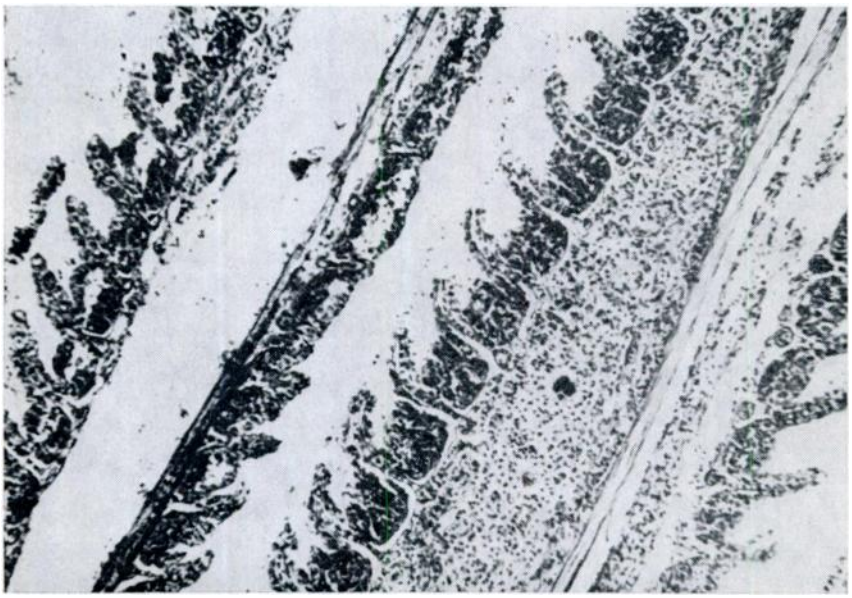

FIGURE 3. Interlamellar branchial form of **Henneguya**. Note the large numbers of spores between gill lamellae. 440 X.

meter and completely engulfed the dorsal fin. Hemorrhages are often associated with the lesions. Examination of tissue from affected areas revealed the presence of large numbers of trophozoites, sporoblasts, and spores of *Henneguya*.

Histologically, the growths consist of hyperplastic squamous epithelium and numerous goblet cells (Fig. 5). Islets partially walled off by condensation from epithelial cells are dispersed throughout the growths, and contain large numbers of *Henneguya* spores. Pronounced inflammation has not been observed. No connective tissue stroma or extensive vascular supply is associated with the

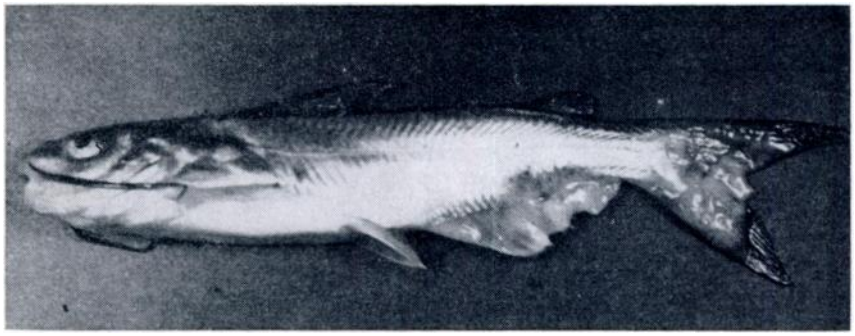

FIGURE 4. Channel catfish infected with papillomatous form of **Henneguya.**

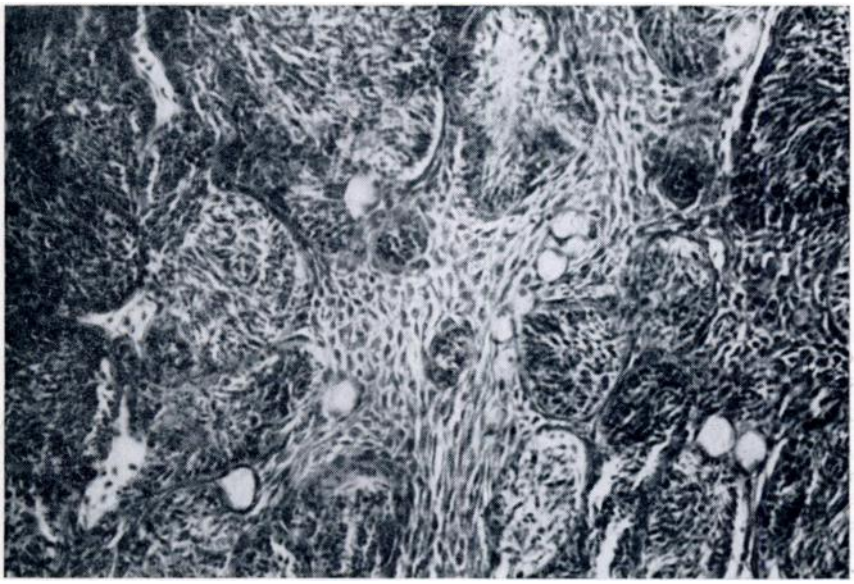

FIGURE 5. Papillomatous growth in X-section showing cysts containing **Henneguya** spores. H. and E. 1000 X.

growths. Tissue proliferation is superficial and does not extend beyond the basement membrane.

Cutaneous cysts. This type of infection is characterized by the presence of visible cysts in the skin. Cysts with diameters of 2-4 mm have been recorded. The condition has been noted in wild and cultured catfish.

Cysts are located in the dermal connective tissue of the dermis (Fig. 6). No evidence of cellular reaction is associated with the condition. Outer layers of cysts contain a germinative layer 100-140 μm thick. No recognizable trophozoites or sporoblasts have been noted, suggesting that the cysts represent a mature condition.

Adipose fin. On rare occasions, cultured fingerling channel catfish have been observed with long, narrow white cysts in the adipose fin. The cysts measure approximately 3 x 1 mm and are apparently peculiar to this tissue.

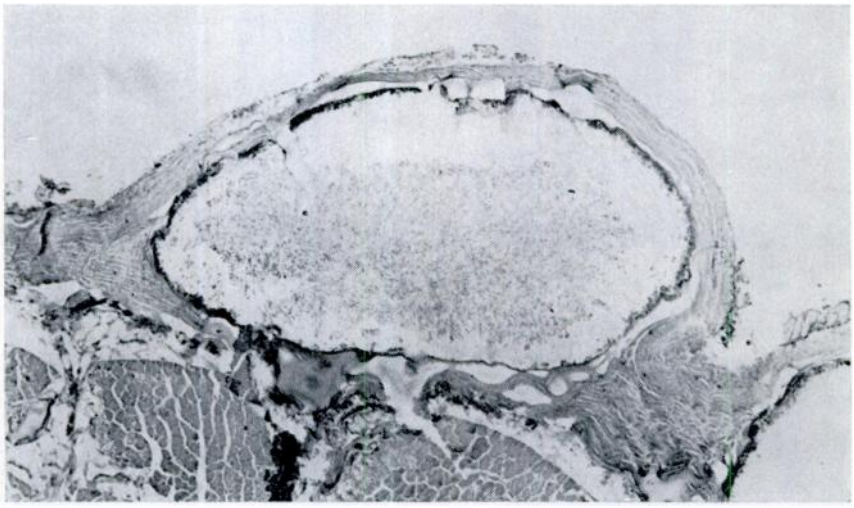

FIGURE 6. Section through cutaneous cyst. H. and E. 37.5 X.

MANDIBULAR FORM

In June of 1973 the senior author received a preserved portion of mandible collected from a wild channel catfish adult near Stillwater, Oklahoma (Richard D. Spall, personal communication). Eight cysts measuring approximately 1 mm in diameter were visible in the connective tissue surrounding the mandibular teeth. When several cysts were ruptured, and examined microscopically, they were found to contain numerous *Henneguya* spores. Histologically, tissue adjacent to the cysts was found to be necrotic.

GALL BLADDER FORM

On one occasion, distressed adult channel catfish (domesticated) were examined (3X) and spores of *Henneguya* were found in the gall bladder. The gall bladders were greatly enlarged. Obstruction of the bile duct was evident and the bile was dark green. No other contributing cause to the condition of the fish could be determined. These fish were also infected with the intralamellar branchial form of *Henneguya*.

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