Observations on the Spawning Ecology of Buffalos (Ictiobus bubalus and I. cyprinellus) in Relation to Parasitism[1]

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Spawning and reproductive activities of *Ictiobus cyprinellus* (Val.) and *I. bubalus* (Raf.) were investigated as part of a study dealing with the life cycle of their gonadal parasite, the digenetic trematode *Nematobothrium texomensis* (McIntosh and Self, 1955).

These studies were made on buffalos from two lakes in southern Oklahoma. One, Lake Oberlin, is an oxbow of the Red River of approximately 50 acres located in Bryan County, Oklahoma. It has a maximum depth of 26 inches and a bottom of soft silt and mud. The water contains considerable suspended material and has a reddish muddy appearance at all times. The other, Lake Texoma, is impounded by Denison Dam on the Red River in Bryan County, Oklahoma and Grayson County, Texas. It has a power pool area of approximately 95,000 acres (Okla. Planning and Res. Bd., 1953).

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Material and Methods

Fish were collected by gill nets, seines and electric shocking. Over 1,000 ovaries from fish taken by two commercial fishermen from Lake Texoma were also examined. Gill nets were of 1-, 3.5- and 5-inch mesh. Size, sex and weight of fish were determined and scale studies used for age and growth determinations. Estimations of the number of eggs produced by single fish were made by a modified von Bayer method (von Bayer, 1912). Over 1,100 fish were examined during the course of this study, a period of 38 months.

Spawning

Buffalo are natural river fish but thrive in reservoirs, where they are often abundant. Spawning occurs from March through May and has been said to take place in shallow waters (Trautman, 1957; Okla. Dept. Wildl. Cons., 1963). The apparent stimulus to spawn is in part spring rains and flooding. Our observations indicate that some spawning occurs in stream tributaries of Lake Texoma up which the fish migrate. Lacking the proper conditions, spawning may not occur or the spawn may be light. Ideal conditions may result in heavy spawning, thus producing an age group that will be noticeable for several years (Johnson, 1963). Females produce up to 800,000 eggs, but without proper spawning conditions may retain and eventually resorb them.

Study of *I. cyprinellus* taken from Lake Oberlin illustrates the need for spring floods for their spawning. During 1962 and 1963, over 100 sexually mature fish were taken from this lake and none showed evidence of spawning. By June and July, the eggs were being resorbed. Seining with 1-inch mesh gill nets produced no spawn-of-the-year specimens. Scale counts showed all the 1962 catch to be 5 and 6 years old. In 1963, again no small buffalos were found and all fish taken were at least 6 years old. These age studies indicate that spawning took place last in this lake in 1957.

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Since Lake Oberlin is 40 miles below the Denison Dam, is 0.5 mile from the Red River and is not stream-fed, only flooding of the river would allow entry of buffalos for spawning. The flow of the Red River below Denison Dam is controlled at the dam. Records maintained there show 1957 to have been the last year in which water in the Red River was of sufficient height to flood Lake Oberlin. During that spring the level of Lake Texoma above the dam, which has a normal power-pool level of 617 ft above mean sea level, reached 643.18 ft above sea level and remained approximately that high for 14 days. The normal height of the river at the tailrace below the dam is 510 ft. For 30 days during this flood on the Red River, the average rate of discharge of water through the dam was 60,525.33 cfs, and the reading at the tailrace reached 525.9 ft above sea level. This flooded Lake Oberlin. Records also show that this lake has not been flooded again since 1957. Spawning apparently took place in Lake Oberlin during the 1957 flood and the fish taken for this study were the result of that spawn. In contrast to this, Lake Texoma has had yearly spawning of buffalos since 1957 although just where the spawning occurs is not known.

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Examination of over 1,000 pairs of ovaries reveals that, as was noted by Johnson (1963), not all sexually mature females spawn each year. The number of eggs produced varies with ovarian size. Estimation of the number of eggs produced by an 18-inch (standard length), 7-lb. smallmouth buffalo was approximately 300,000, while for a 27-inch (standard length), 20-lb. 9-oz. largemouth buffalo the estimate was 800,000. Not all eggs are always discharged at spawning.

Dr. George A. Moore (personal communication) states that in nine years of seining in Lake Texoma he has not taken a young-of-year or yearling buffalo fish. Riggs and Bonn (1954) stated "the fact that few young-of-year or yearlings of any of the species of this genus are taken in the lake, even with rotenone, is probably indicative of the lack of knowledge of the habits of the young." A sampling study of the fish of this lake made by the Oklahoma Wildlife Conservation Dept., (Okla. Fish. Res. Lab., unpublished data) using rotenone produced 240 buffalos in the years 1957 and 1958. Only 11 of these were 5 inches or less in length.

By seining creeks leading into Lake Texoma, we have collected young-of-year buffalo. The length range of 35 of these fish taken on 1 July 1964 was 30-38 mm. They were taken in shallow running water rather than deep pools. Yearlings in their second summer, as shown by scale examination, were also taken in creeks that enter the lake. It appears that the adult fish tend to migrate up streams to spawn and that the young may remain in the spawning areas until at least the end of their second summer before moving into the lake proper.

Another possible explanation of stream occurrence of young is that the fish spawn in the lake and that the young move immediately into the streams where they remain for 2 years. In either case, there are unanswered questions. The number of 1- and 2-year fish collected in stream tributaries of Lake Texoma can scarcely account for the large populations of adults in the lake. Also, no one has ever observed the movement of large number of adults into the streams during the spawning season. This, however, may be due to their migrations occurring during high water periods when they are said to spawn.

Another puzzling question, relative to the spawning of buffalo, arises from the unusual apearance of *Nematobothrium texomensis* in their gonads (Self et al., 1963). This worm is known only as a sexually mature adult in Lake Texoma fish. It appears suddenly in fully developed gonads of buffalo during the first or second week in November (Fig. 1), and at that

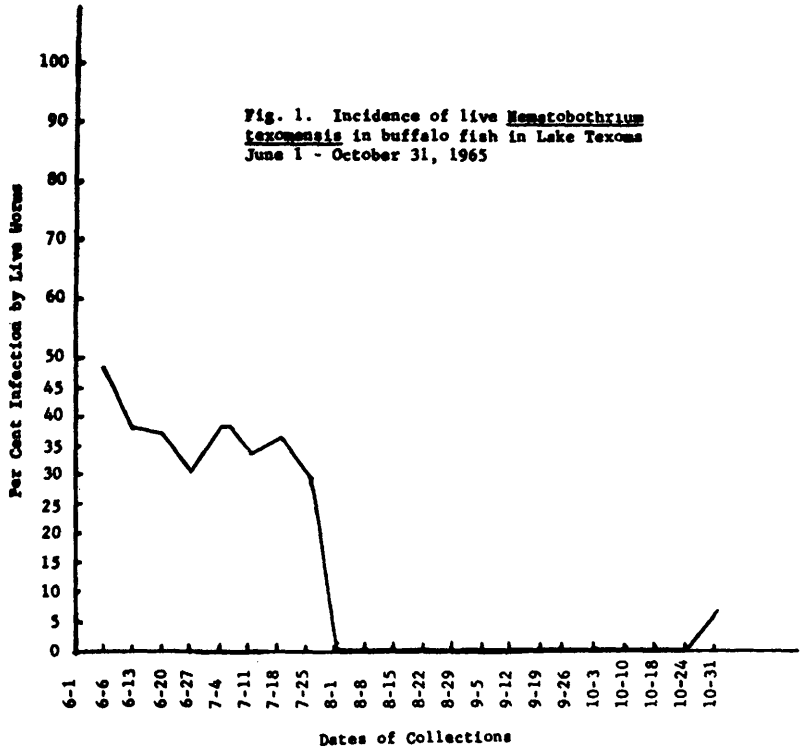

Fig. 1. Incidence of live Hemstobothrium texomensis in buffalo fish in Lake Texoma June 1 - October 31, 1965

time is fully mature and producing eggs. Being filamentous, it attains a length of 8.5 ft. When it appears in the fish in November, it is at least 2 ft in length. Fig. 1 shows the per cent of fish ovaries infected with live worms from 6 June to 31 October 1965. Note that the last live worm taken in the summer was 25 June when 30% of ovaries examined were infected. From 1 August through 24 October 1965, the eggs of ovaries in unspawned fish were resorbed and beginning with August, ova began developing in sexually mature fish. By October they were well developed and the ovaries were large and gravid. However, no new infections by *N. texomensis* were recovered on the examination of an average of 50 pairs of gravid ovaries taken at random from commercially caught fish taken on the dates shown on the chart.

On 31 October, 6% of the ovaries examined were infected with fully adult worms. This is typical of findings every year since 1960, the infections always appearing by 15 November. Fish having these infections are taken in the same areas from which collections were made throughout the period covered in Fig. 1, except that the commercial fishermen move their nets within the area to places where they have found fish. Where the infected fish come from is a question we cannot answer. Obviously, however, either the infected fish have been somewhere else prior to November and move into the netting areas suddenly, or the infections take place suddenly and the worms grow to maturity within a very few days (less than 2 weeks). The latter seems quite improbable, otherwise after 5 years we would have recovered immature worms. The question concerning the movements of the fish in relation to where they become infected and the

conditions under which they move into the collecting areas challenges investigation. This ultimately should fill in the gap in our information as to how these fish are infected with *N. texomensis*.

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