

# Prevalence, Mean Intensity, and Relative Density of *Lintaxine cokeri* Linton 1940 (Monogenea: Heteraxinidae) on Freshwater drum (*Aplodinotus grunniens*) in Lake Erie (1984)<sup>1</sup>

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**ABSTRACT.** A total of 309 freshwater drum (*Aplodinotus grunniens*), including 32 young-of-the-year (YOY), were collected from two localities in northern Ohio. Prevalence of infestation with *Lintaxine cokeri* was 9.71%, whereas relative density was 0.21. The highest prevalence (17.33%) and relative density (0.56) occurred in immature drum; highest prevalence (25.00%) and intensity (2-8) of infestation among the various size classes of drum occurred in fish ranging from 100-140 mm (standard length). All drum designated as YOY were uninfested, but may become infested with *L. cokeri* late in their first year. Excluding YOY, overall prevalence and relative density were 10.38% and 0.24, respectively. Immature drum (-YOY) showed a prevalence of 30.23% and a relative density of 0.98. Mean intensities were slightly higher than relative densities, but similar to the entire sample. Seasonal prevalences and relative densities increased, reaching summer highs of 11.11% and 0.34 in June and July, respectively. A seasonal low prevalence of 5.88% and a relative density of 0.058 occurred in November. Seasonal fluctuations in prevalence, mean intensity, and relative density are related to freshwater drum life history. This represents the first report of *L. cokeri* parasitizing freshwater drum in the area east of the Mississippi River.

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## INTRODUCTION

Freshwater drum *Aplodinotus grunniens* Rafinesque, 1920, are parasitized by three species of monogeneans belonging to two families in the order Polyopisthocotylea and Superfamily Mazocraeoidea (Llewellyn 1970). Two species, *Microcotyle spinicirrus* MacCallum 1918, and *M. eriensis* Bangham and Hunter 1936, are members of the family Microcotylidae, whereas the third species, *Lintaxine cokeri* (Linton 1940) Sproston 1946 belongs to the family Heteraxinidae (Price 1962a).

*Lintaxine cokeri* was originally described as *Heteraxine cokeri* from the gills of freshwater drum collected in Fairport, Iowa (Linton 1940). Using Linton's original specimens, *H. cokeri* was placed in the genus *Lintaxine* by Sproston (1946). Owing to the incomplete description of two taxonomically significant structures, opisthaptor clamps and genital armature, two subsequent redescriptions were presented by Manter and Prince (1953) and Price (1962b). Both were based on the original Iowa specimens, and were the only reports dealing with *L. cokeri* until Dechtiar (1972) conducted a survey of fishes collected from the Canadian portion of Lake Erie near Wheatly in the western basin and Port Dover in the eastern basin. Dechtiar sampled 79 drum, of which 10 (7.9%) were infested with *L. cokeri*. It is the objective of the present paper to examine the overall and seasonal prevalence, data concerning the mean intensity and relative density of *L. cokeri* on freshwater drum in Western Lake Erie and Sandusky Bay, and to relate these data to the life history of the host. The specimens of *L. cokeri* used here represent the first report of this parasite on freshwater drum inhabiting waters east of the Mississippi River, as well as the first report of its presence in Ohio.

## MATERIALS AND METHODS

During April to December, 1981-1983, a total of 309 freshwater drum were collected from two localities in northern Ohio. One site was between Green and Rattlesnake Islands in the island area of Lake Erie; the other was in Sandusky Bay.

Collection of drum was accomplished by various methods, depending on the site. In the island region seining, trapping, trawling, and hook-and-line were used, whereas in Sandusky Bay fish were taken from beach seines operated by commercial fishermen. Collection of drum was not possible from January through March owing to poor weather conditions and ice cover on Lake Erie.

The standard length, defined as the distance from the anterior most projection of the head to the hypural notch (Becker 1983), and sex of each drum were recorded. Sex determination was accomplished as follows: male drum were those fish with well developed, white, testes and/or pink to red "croaking" muscles lining the postero-dorsal portion of the body cavity; female drum were those fish with large, amber, ovaries containing developed ova. References to mature drum include those drum which were sexed accurately; immature drum were those lacking any observable differentiation of gonads and/or "croaking" muscles. The following terminology was used to describe the parasitic infestations (Margolis et al. 1982):

1. Prevalence = number of individuals of a host species infected with a particular parasite species ÷ number of hosts examined.
2. Mean intensity = total number of individuals of a particular parasite species in a sample of a host species ÷ number of infected individuals of the host species in the sample.
3. Relative density or Abundance = total number of individuals of a particular parasite species in a sample of hosts ÷ total number of individuals of the host species (infected + uninfected) in the sample.

Statistical analysis of the data was carried out with an IBM 1083 computer and the Statistical Analysis System (SAS). The specific tests that were used included chi-square, one-way analysis of variance (ANOVA), and least significant difference (LSD) procedure with a 95% significance level. The Yates correction factor was incorporated into the chi-square calculation, whenever the test possessed less than two degrees of freedom.

## RESULTS AND DISCUSSION

Thirty drum were infested with at least one specimen of *Lintaxine cokeri*. This represents an overall prevalence of 9.71% (Table 1), which is slightly higher than the 7.90% noted by Dechtiar (1972). Immature drum exhibited the highest prevalence of infestation (17.33%), followed by males and females with 7.78% and 6.94%, respectively. Sexually mature drum (mature males and females combined) exhibited a prevalence of 7.26% (Table 1). The chi-square test indicated that a significant difference existed between the expected and observed prevalences of male, female, and immature drum. The relative density of all drum collected was 0.21 (Table 1).

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TABLE 1  
Prevalence, mean intensity and relative densities of *Lintaxine cokeri* on various groups of freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

Group	No. examined	No. infested	Prevalence (%)	No. parasites	Mean intensity	Range of intensity	Relative density
Female	144	10	6.94	14	1.40	1-2	0.10
Male	90	7	7.78	9	1.29	1-2	0.10
Mature	234	17	7.26	23	1.35	1-2	0.10
Immature (+YOY)	75	13	17.33	42	3.23	1-8	0.56
Overall (+YOY)	309	30	9.71	65	2.16	1-8	0.21
YOY	32	0	0.00	0	0.00	0	0.00
Immature (-YOY)	43	13	30.23	42	3.23	1-8	0.98
Overall (-YOY)	277	30	10.83	65	2.16	1-8	0.24

Male and female drum each had relative densities of 0.10, whereas the value for immature fish (including YOY) was 0.56. The relative density of immature drum was significantly different from that of mature male drum ( $P < 0.0001$ ), and mature female drum ( $P < 0.0001$ ). The overall mean intensity was 2.16, with males possessing a mean intensity of 1.29, females 1.40, and immature drum 3.23 (Table 1). An analysis of the prevalence of infestation versus drum size revealed that drum having standard lengths of 100-149 mm possessed a higher prevalence of infestation (25.00%) than any other size class (Table 2). Drum with standard lengths less than 82 mm or greater than 335 mm were not infested.

The 200-249 mm length-class of drum possessed the largest number ( $N = 10$ ) of infested individuals, whereas the 100-149 mm length-class, which exhibited the highest prevalence of infestation, had only seven infested individuals. Despite the larger number of parasitized fish in the 200-249 mm length-class, the highest mean intensity (4.29) relative density of infestation (1.07), and range of infestation (2-8) occurred in the 100-149 mm length-class. The relative density of the 100-149 mm class was significantly (ANOVA,  $P < .0001$ ; LSD analysis) different than all of the other size-related means. The second highest range of intensity (1-5) and relative density (0.35) was recorded from drum 50-99 mm in standard length. Examination of the gonads of fish in the 50-99 mm and 100-149 mm length-class revealed that all of the individuals in these two classes were immature. All of the other length-classes were not parasitized by more than two worms, and possessed relative densities less than 0.15 (Table 2).

The only drum not parasitized were the young-of-the-year (YOY) fish. Thus, the overall infestation rate, disregarding the YOY fish, was 10.83%, whereas the infestation rate of immature drum was 30.23% (Table 1). The relative densities of the entire sample and immature drum increase to 0.24 and 0.98, respectively. Since mean intensity only takes into account those fish that were infested, and all YOY fish were uninfested, the mean intensity of the entire sample remained at 2.16. From the prevalences, relative densities, and relationship of drum size to infestation, it is evident that *L. cokeri* locates primarily on immature drum. Furthermore, those drum with standard lengths ranging from 80 mm to 150 mm seem to harbor the bulk of the infestation.

All YOY drum were collected from the deeper waters of the island region of Lake Erie. The mean length and range in size of the YOY fish in each of these months were as follows: July, 38.92 mm (33-44 mm); August, 56.88 mm (49-67 mm); September, 68.55 mm (60-80 mm). These values were similar to the results published by Becker (1983) for drum collected from Wisconsin lakes. In his study, YOY drum sampled in July were 29-43 mm in length, whereas the ranges for August and September YOY drum were 32-68 and 78-82 mm, respectively. Earlier investigations by Butler and Smith (1950), Edsall (1967), and Priegel (1969) indicated that age 1+ drum may possess mean total lengths of up to 132 mm. The 82-mm standard length of the smallest infested drum obtained in the present study is comparable to a fish with a total length of 105-109 mm (Krumholz and Cavanah, 1968). Since this total length of 105-109 mm falls well below the average

TABLE 2  
Prevalence, mean intensity, and relative densities of *Lintaxine cokeri* on various size classes of freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

Length-class (mm, standard length)	No. examined	No. infested	Prevalence (%)	No. parasites	Mean intensity	Range of intensity	Relative density
0-49*	14	0	0.00	0	0.00	0	0.00
50-99*	34	6	17.64	12	2.00	1-5	0.35
100-149*	28	7	25.00	30	4.29	2-8	1.07
150-199	39	0	0.00	0	0.00	0	0.00
200-249	108	10	9.26	14	1.40	1-2	0.14
250-299	63	6	9.52	7	1.17	1-2	0.10
300-349	17	1	5.88	2	2.00	2	0.12
350+	6	0	0.00	0	0.00	0	0.00

\*Immature drum

total length of 132 mm for age 1+ drum, it is possible that the smallest fish infested in the present study was a YOY drum.

The prevalence of *L. cokeri* for all fish collected during April and May was 10.00% (Fig. 1). The water temperatures of Lake Erie and Sandusky Bay are relatively low during the early spring months. As the water warms in the late spring, early summer initiation of egg production should occur, resulting in a subsequent rise in the monthly prevalence of infestation. This may be occurring since slightly higher prevalences of infestation, (11.11 and 10.94%) were observed in June and July, respectively (Fig. 1). After reaching 11.11% in June, prevalence of infestation gradually fell to a low of 5.88% in November. The seasonal high in prevalence (13.34%) occurred in December.

Young-of-the-year fish were collected from July through September. Since all were uninfested, the monthly prevalences calculated with these fish included were lower than those calculated excluding YOY individuals. The seasonal high prevalence remained the same since no YOY fish were collected in June. However, the seasonal low occurred in September (4.30%) rather than November (Fig. 1).

The monthly relative densities of all drum collected increased throughout the spring until a peak of 0.35 was attained in July (Fig. 2). Following this peak, relative density dropped to a low of 0.06 in November. These months corresponded exactly with the high and low prevalences mentioned earlier. After reaching a low in November, relative density rose to 0.20 in December, which was similar to the pattern noted for prevalence of infestation. A slight discrepancy resulted when the monthly mean intensities were examined (Fig. 3). A seasonal low of 1.00 occurred in November; the high value of 3.00 was observed in September. The September peak may be misleading since this value was based on a col-

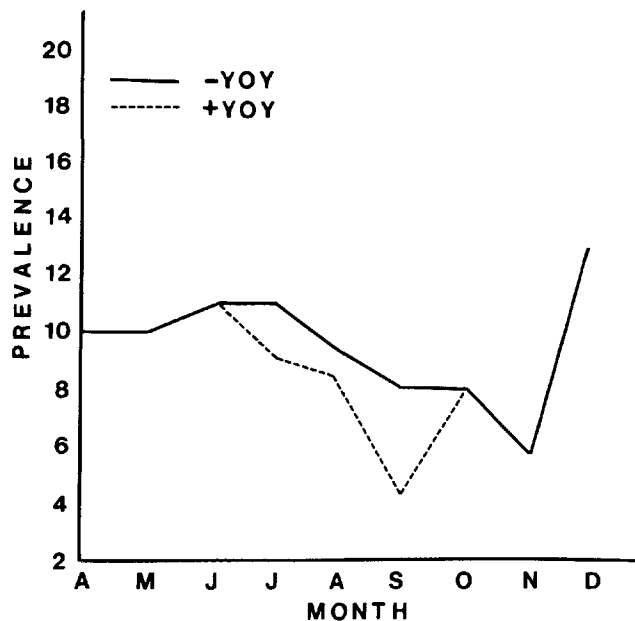


FIGURE 1. Monthly prevalence of infestation of *Lintaxine cokeri* on freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

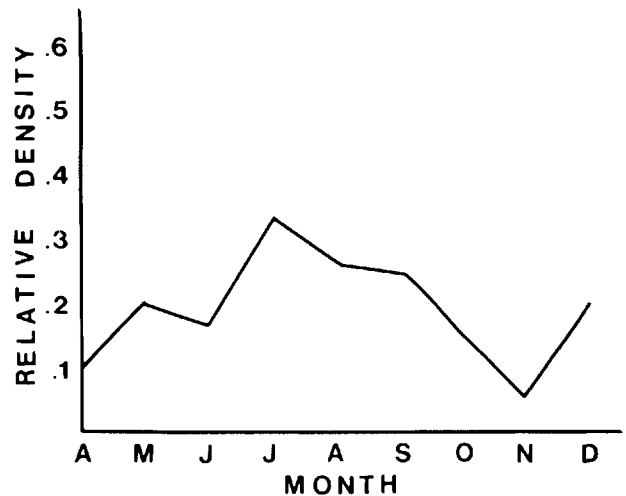


FIGURE 2. Monthly variation in relative density of infestation of *Lintaxine cokeri* on freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

lection of 34 drum, of which only one, possessing three worms, was infested.

Except for the September high, the mean intensity was similar to the relative density, with the high value observed in July and the low value in November. Therefore, infestations of *L. cokeri* increase in mean intensity, relative density, and prevalence throughout the spring, and reach their maximum in June or July. The prevalences for

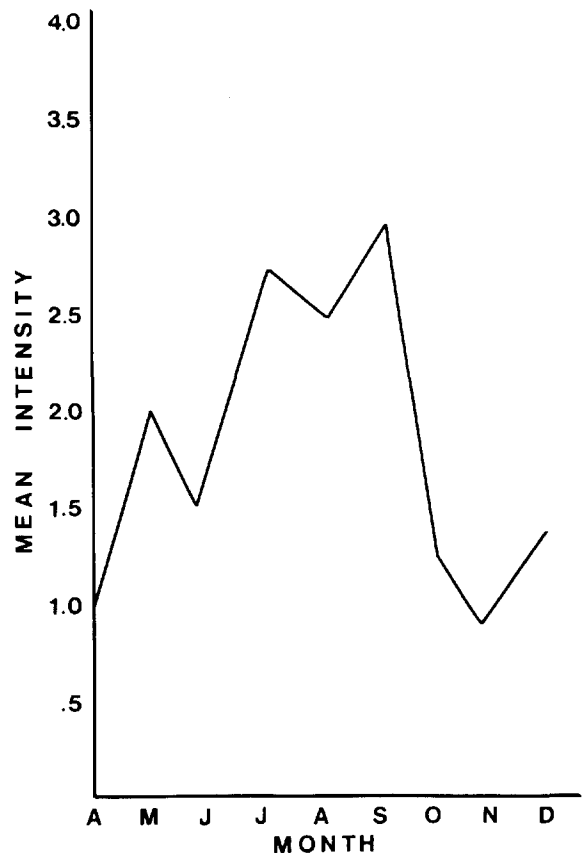


FIGURE 3. Monthly variation in mean intensity of infestation of *Lintaxine cokeri* on freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

male and female drum are highest in the spring and fall; low values are observed during the summer months.

Rates for immature drum increased from 0% in May to 30.23% in June. After reaching this June high, prevalence decreased slightly in the following months, but never dropped below 20.00% (Fig. 4). Furthermore, the seasonal relative densities of male and female drum were highest in the spring, fall, or winter (Fig. 5). Male highs of 0.27 and 0.29 occurred in May and October, respectively. The high values for females were 0.15 and 0.20 which occurred in May and December, respectively. The only group to exhibit a summer peak in relative density were the immature fish. Their peak of 1.40 was 1.00 higher than the highest summer relative density noted in male and female drum (Fig. 5). Since peaks in both prevalence and relative density for the entire sample occurred in June, July, or August, and only immature drum exhibited peaks in these parameters during these months, the high values in summer may be attributed primarily to the interaction of *L. cokeri* in the population of immature drum.

According to Dabier (1953a), freshwater drum in Lake Erie begin spawning in June in the open lake, river mouths, or bays. The spawning season reaches its peak in July, but may continue through August into September. Like other sciaenids, freshwater drum produce pelagic eggs (Davis, 1959). After the larvae have hatched at approximately 3 mm in length, they drift with the currents at or near the surface of the water until they are about 10 mm in length, when they move to deeper water (Walburg 1976). Similarly, Priegel (1967) reported that YOY freshwater drum are found near the bottom of the lake when they reach a length of approximately 25 mm. Once at or near the bottom (about 1 week after hatch-

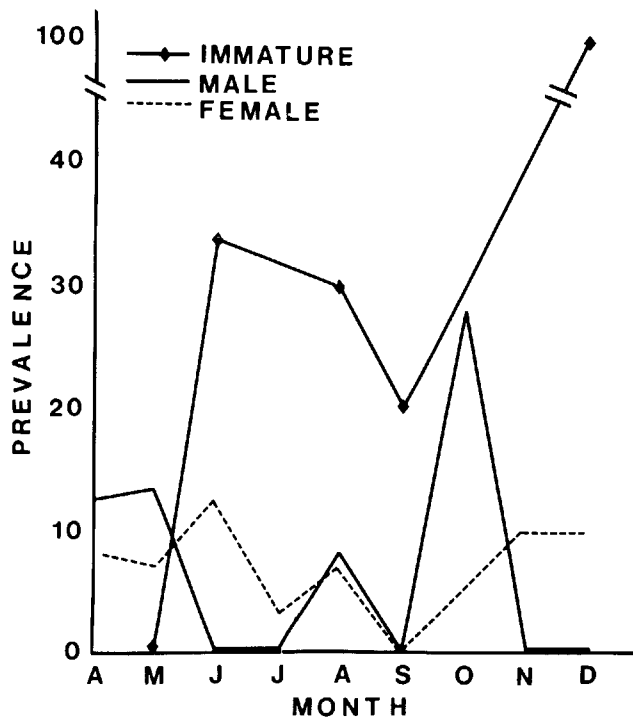


FIGURE 4. Monthly variation in prevalences of infestation of *Lintaxine cokeri* on male, female, and immature (-YOY) freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

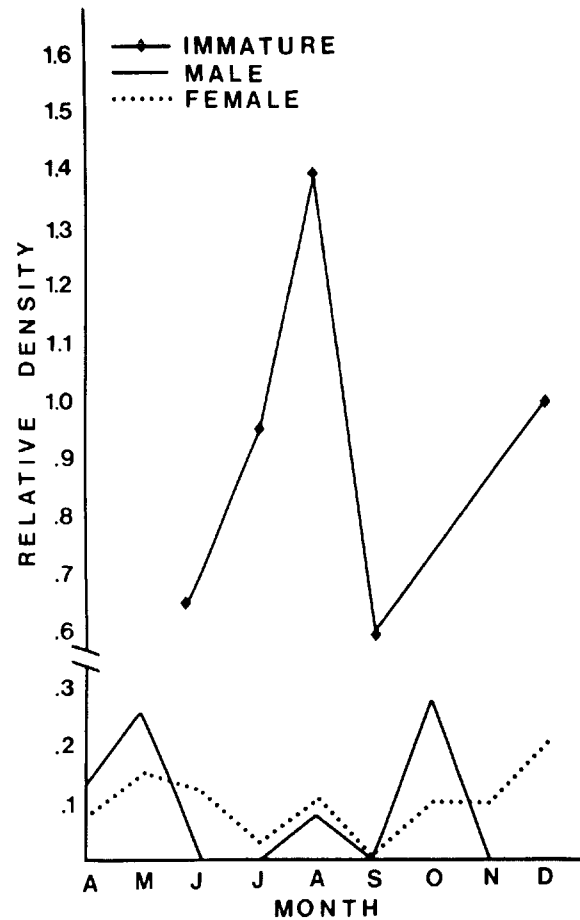


FIGURE 5. Monthly variation in relative densities of infestation of *Lintaxine cokeri* on male, female, and immature (-YOY) freshwater drum (*Aplodinotus grunniens*) collected from Lake Erie, 1981-1982.

ing), schooling begins and continues throughout the remainder of the life cycle (Becker 1983). Since the smallest drum infested in the present study was 82 mm in standard length, YOY drum most likely acquire an infestation with *L. cokeri* late in the first year, after they have moved to deeper water and started schooling with the larger fish.

Additionally, movements of drum populations have been linked to water temperature. According to Dabier (1953a) and Nord (1967), drum tend to move into shallow waters during April, May, and June, and back to deeper water in the fall. This late spring and early summer movement to shallower waters increases drum density in those lake regions. The higher density of drum and initiation of egg production in *L. cokeri* in the spring may result in an increase in the successful transfer of *L. cokeri* eggs and oncomiracidia from fish to fish. This assumption is supported by the spring elevation in prevalence of infestation (Figs. 1 and 4) and simultaneous peak in relative density observed in July (Fig. 2). Infestation rate, relative density, and mean intensity drop to seasonal lows in the fall months. This may be due in part to the recruitment of YOY drum into the drum population. Since the seasonal infestation rate of the sample, excluding YOY drum, exhibited a steady decline from July through September, the influx of YOY fish were not totally responsible for this trend. This decline may be related to the movement of drum to deeper water during the fall

months, or may have resulted from the immune response of the hosts to *L. cokeri*. Further research is needed on this aspect of drum infestation with *L. cokeri*.

After reaching seasonal lows in November, prevalence, mean intensity, and relative density of infestation increased in December. Two theories exist for this occurrence. Dabier (1953b) reported that smaller freshwater drum can tolerate colder water temperatures than larger drum. Furthermore, the larger drum that do not move to warmer, deeper water succumb to the cold. Since larger drum possessed a significantly lower relative density and higher prevalence of infestation in comparison to smaller fish (Table 2), death of larger drum during the cold winter months would increase these population characteristics. Another possibility involves the effect of temperature on the immune response of the drum to *L. cokeri*. Bissett (1947) demonstrated that the immune systems of cold-blooded vertebrates ceased to produce antibodies below 12°C. This temperature-dependent immune response was demonstrated by Beckert and Allison (1964) in the host-parasite interaction of *Ichthyophthirius multifiliis* with the white catfish, *Ictalurus catus*. It was also suggested by Rawson and Rogers (1972a, 1972b) for the December increase in ancyrocephaline worms on the bluegill, *Lepomis macrochirus* and largemouth bass, *Microp-terus salmoides*, in Alabama. These studies suggest that the ability of the host to eliminate the parasite is impeded by cold temperatures before parasite reproduction is affected. The consequence of this is the elevation of the late fall or early winter survival rate of larval parasites that come in contact with an appropriate host. In the present study, this increased survival was observed subsequently as an increase in the relative density, mean intensity, and prevalence of infestation in December.

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