 0030-0950/81/0005-0225 $2.00/0

INCIDENCE OF TERATOLOGICAL FISHES FROM CEDAR FORK CREEK, OHIO[1]

TIM M. BERRA and RAY-JEAN AU, Department of Zoology, Ohio State University, Mansfield, OH 44906

Abstract. A total of 18,361 specimens belonging to 34 species and 6 families was examined for external morphological anomalies. Forty-seven defective fishes (0.26%) were found. The most widespread abnormality was spinal curvature, occurring 16 times in 5 species. Deformed or missing fins were found in 10 specimens of 4 species. Two deformed mouths were recorded from 2 species, and one specimen had an incomplete operculum. There were 18 cases of pugheadedness in *Pimephales notatus.* The frequency of anomalies in this undisturbed community agrees well with figures in the literature for other areas. This information is intended to serve as base line data for future studies of Cedar Fork Creek.

OHIO J. SCI. 81(5): 225, 1981

The first figure of a teratological fish was published in 1553. Pierre Belon, the French naturalist, illustrated the head of an old male Atlantic salmon with a deformed upper jaw and a characteristically hooked lower jaw. Belon thought it was a normal female head and made no comment on the anomaly. The second deformed fish to be figured was a pugheaded carp illustrated by Guillaume Rondelet in 1555. These modest but historically interesting beginnings of fish teratology have been recorded by Gudger (1936). The scholarship of Dawson (1964, 1966, 1971) and Dawson and Heal (1976) has provided ichthyologists with an extensive bibliography of fish anomalies.

This paper records the anomalies present in a fish community from Cedar Fork Creek, an unpolluted headwater tributary of the Mohican River in north central Ohio. This information will serve as base line data for comparing future collections from this stream. A related study on the incidence of blackspot disease in fishes of this creek was published recently (Berra and Au 1978). The underlying hypothesis is that some anomalies can be caused by environmental factors such as pollution during the sensitive embryonic or larval stages of development and, therefore, the frequency of abnormalities may be useful as an index of pollution. Hickey (1973) reviewed this assumption, the common abnormalities in fishes, and their causes including environmental factors.

METHODS AND MATERIALS

Fishes were collected from a 137 m section of Cedar Fork Creek, Ohio River drainage, in Richland County, Ohio, with a 3 m seine (1.6 mm mesh). A total of 43 collections was made in all seasons from 24 July 1975 through 27 August 1978. This gravel-bottomed, clear stream flows in alternating pools and riffles through rolling agricultural land. Its width ranges from 6 m to 15 m and depth varies from 0.15 m to 2 m. Vegetation consists of filamentous algae. Water temperature varies from 0 °C in winter to 22 °C in summer. The fishes were fixed in 10% formalin and stored in 40% isopropyl alcohol. Each specimen was examined for visible morphological defects.

RESULTS

A total of 18,361 specimens belonging

[1]Manuscript received 25 July 1980 (#80-42).

TABLE 1

Number, size and % anomalies of 34 species of fishes from Cedar Fork Creek.

Species	No.	% Total	Range TL (mm)*	% Anom. (No.)
Campostoma anomalum	3017	16.43	22-153	0.30 (9)
Clinostomus elongatus	2	0.01	66-70	—
Cyprinus carpio	3	0.02	57-61	—
Ericymba buccata	912	4.97	25-88	0.33 (3)
Hybopsis amblops	25	0.14	39-75	—
Notropis cornutus†	5774	31.45	26-182	0.16 (9)
Notropis photogenus	69	0.38	33-106	—
Notropis rubellus	43	0.23	33-90	—
Notropis volucellus	3	0.02	52-59	—
Phoxinus erythrogaster	12	0.07	32-62	—
Pimephales notatus	2771	15.09	17-93	0.69 (19)
Pimephales promelas	4	0.02	50-63	—
Rhinichthys atratulus	261	1.18	25-75	—
Semotilus atromaculatus	1027	5.59	20-227	—
Carpiodes cyprinus	4	0.02	35-72	—
Catostomus commersoni	667	3.63	22-250	0.90 (6)
Hypentelium nigricans	192	1.05	30-260	—
Moxostoma sp.	26	0.14	17-57	—
Moxostoma duquesnei	28	0.15	51-342	—
Moxostoma erythrurum	2	0.01	330-350	—
Culaea inconstans	6	0.03	29-47	—
Cottus bairdi	431	2.35	24-94	—
Ambloplites rupestris	41	0.22	21-189	—
Lepomis sp.	58	0.32	24-143	—
Lepomis cyanellus	13	0.07	44-73	—
Lepomis gibbosus	9	0.05	39-90	—
Lepomis macrochirus	5	0.03	43-120	—
Micropterus dolomieui	47	0.26	14-143	—
Micropterus salmoides	29	0.16	37-78	—
Etheostoma blennioides	367	2.00	22-86	—
Etheostoma caeruleum	1381	7.52	24-57	—
Etheostoma flabellare	99	0.54	27-64	—
Etheostoma nigrum	1009	5.50	20.64	0.10 (1)
Etheostoma zonale	61	0.33	31-57	—
Percina caprodes	3	0.02	90-106	—
Percina maculata	5	0.14	56-70	—
TOTAL	18,361			0.26 (47)

*TL=Total length (mm).
†May include some *N. chrysocephalus.*

to 34 species and 6 families was collected (table 1). The most abundant species was the common shiner, *Notropis cornutus* with 5,774 (31.5%) individuals. Other abundant species that numbered more than 1,000 were the stoneroller (*Campostoma anomalum*), bluntnose minnow (*Pimephales notatus*), rainbow darter (*Etheostoma caeruleum*), creek chub (*Semotilus atromaculatus*), and the johnny darter (*E. nigrum*). These 6 species made up 82% of the sample. Six others (*Ericymba*, *Catostomus*, *Cottus*, *E. blennioides*, *Rhinichthys*, and *Hypentelium*) were common. They numbered from 192 to 912 individuals and constituted 15% of the sample (table 1). The other 3% of the fish population was composed of 22 species, which ranged in abundance from 2 to 99.

Of the 18,361 fishes, 47 (0.26%) had a single anomaly each (table 1); no specimen had more than one defect. Table 2 lists the size range and the anomaly of these fishes. Spinal curvature (lordosis) was the most widespread anomaly, occurring 16 times in 5 species. Defective or missing fins were

TABLE 2

Type and number of anomalies found in 6 species of fish from Cedar Fork Creek.

Species	Anomalies		
	Type	No.	TL (mm)*
Campostoma anomalum	spinal curvature	6	32-95
	deformed r. pectoral fin	1	83
	missing r. pectoral fin	1	79
	deformed mouth	1	80
Ericymba buccata	spinal curvature	2	63-79
	incomplete l. operculum	1	48
Notropis cornutus	spinal curvature	6	31-61
	deformed l. ventral fin	1	63
	deformed l. pectoral fin	1	42
	deformed mouth	1	96
Pimephales notatus	spinal curvature	1	37
	pugheaded	18	27-49
Catostomus commersoni	spinal curvature	1	176
	deformed r. ventral fin	3	44-87
	missing r. ventral fin	1	52
	missing l. ventral fin	1	89
Etheostoma nigrum	missing l. pectoral fin	1	46

*TL=Total length (mm).

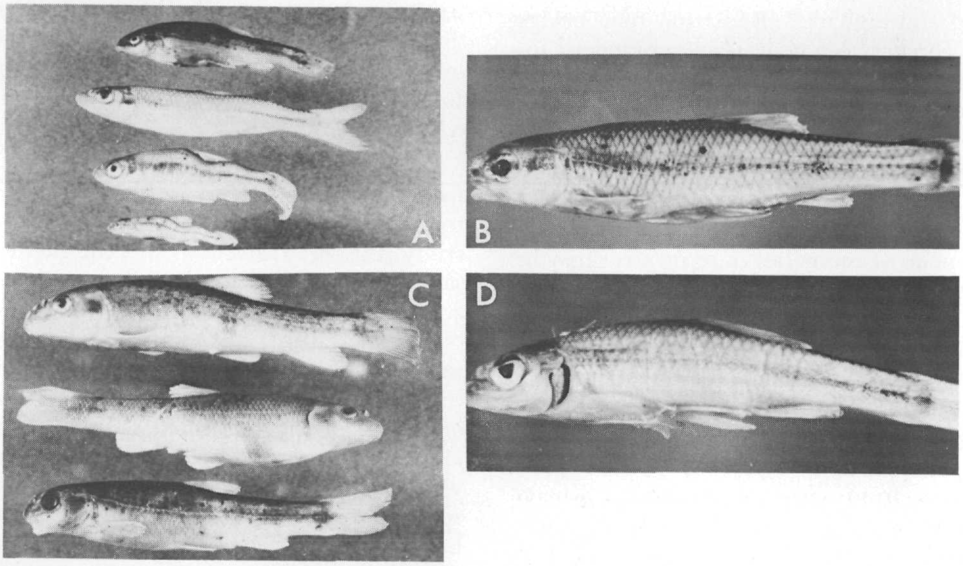

FIGURE 1. A. Spinal curvature, top to bottom. *Campostoma anomalum* 60 mm TL, *Ericymba buccata* 79 mm, *Notropis cornutus* 61 mm, *Pimephales notatus* 37 mm; B. Pugheaded. *Pimephales notatus* 47 mm; C. Fin and mouth anomalies, top to bottom. *Catostumus commersoni* 89 mm missing left pelvic fin; *Campostoma anomalum* 79 mm missing right pectoral fin; *Campostoma anomalum* 80 mm deformed mouth; D. Incomplete operculum. *Ericymba buccata* 48 mm.

found in 10 individuals of 4 species; deformed mouths were recorded twice from two species. One specimen of *Ericymba* had an incomplete left operculum, and 18 specimens of *P. notatus* were pugheaded. These anomalies are illustrated in figure 1. No color abnormalities were found.

DISCUSSION

Anomalies in fishes may be either genetic or epigenetic (Dahlberg 1970). Genetic anomalies result from mutations or recombinations and are heritable provided they are not lethal. Rosenthal and Rosenthal (1950) presented evidence that lordosis is the result of recessive alleles. Other evidence in favor of genetic origin of some anomalies is given by Gordon (1954) and Nelson (1971). Epigenetic defects are acquired during the development of the embryo or larva. It is well known that anomalies can result from the influence of temperature, salinity, dissolved oxygen, diet, radiation, chemical pollution, *etc.* Hickey (1973) reviewed references that demonstrated the increase in structural abnormalities in embryos exposed to sulfuric acid and algicides. Radiation may bridge the gap between genetic and epigenetic influences by being an environmental factor that can induce genetic change (Mong and Berra 1979).

Komada (1980) stated that morphological abnormalities are uncommon in natural populations, and that unusually high frequencies of anomalies in some areas may be due to numerous industrial effluents and hypertrophic waters. Of 100,000 fish specimens from freshwater streams in the state of Washington, Patten (1968) found 236 deformed fishes (0.24%). Dahlberg (1970) reported a 0.06% incidence of deformities among 20,654 specimens of 17 species from Georgia estuaries. Scherer (1973) found an incident of skeletal deformities for shad (*Alosa sapidissima*–35,933 specimens) and blueback herring (*A. aestivalis*–1,983 specimens) from the Conneticut River in 1970 of 0.03% and 0.05%, respectively. In 1971 he found 0.14% of 9,381 shad to be defective. The frequency of morphological abnormalities among 42,936 white perch, *Morone americana,* from the Potomac River was 0.23% (Moore and Hixson 1977). In the ayu, *Plecoglossus altivelis,* from the Yahagi River, Japan, the frequency of observable morphological deformities was 0.15%, while hatchery reared fish showed a rate of 70.14% and a greater variety of anomalies (Komada 1980). This finding was attributed to unfavorable environmental conditions during ontogeny and rearing.

The 0.26% frequency of anomalies noted from Cedar Fork Creek is in close agreement with several other studies and with the weighted average of 0.18% from the literature. The most numerous anomalies found in this study (spinal curvature, missing fins, pugheadedness) are among the more common and well studied defects reviewed by Hickey (1973). The deformed fins had only about half the normal number of fin rays and only one fin was affected in each case. All of the deformed fishes were under 96 mm long (TL) except one white sucker, *C. commersoni,* of 176 mm. The average TL of the 47 deformed specimens was 53 mm, which is considerably smaller than the normal specimens. The deformed fishes may not live as long or may have more difficulty obtaining food than their normal counterpart.

Because of the low incidence of defects in fish populations, a large sample is required to detect the presence of anomalies. In our study, the 667 *Catostomus* was the smallest sample in which deformities were noticed and this species had the greatest frequency of defects (table 1). *Notropis cornutus,* containing the largest number of individuals (n=5774), had the second lowest frequency of defects of the 6 affected species. A fair amount of variation occurs among species with respect to anomaly frequency. Two species, *E. caeruleum* and *S. atromaculatus,* numbering over 1,000 showed no deformities. *Pimephales notatus* seemed unusually susceptible to pugheadedness. The cause of this deformity is unknown, though Hickey (1973) reviewed evidence suggesting it has a genetic basis, and is transmissible.

Dawson (1971) warned that listing the

frequencies of anomalies should be done with caution because only the most obvious, sub-lethal defects are reported and the less obvious, but possibly common micro-anomalies are neglected. Many anomalous fishes may die in the egg or larval stages from the severity of their defects and are never reported. Ecological factors such as lack of predation (Hubbs 1959) or lack of competition (Dahlberg 1970) may lower selection pressure and allow more defective individuals to survive than would under other circumstances, thereby making it difficult to compare different populations and habitats.

The use of the frequency of anomalies as a measure of pollution as advocated by Dahlberg (1970) and Hickey (1973) is an interesting concept, but only time and further testing will determine its validity. Anomalies of the types reported here were mentioned 400 years ago, well before the Industrial Revolution and pollution. On the other hand, there is no denying that various environmental pollutants can induce defects in fish populations.

Acknowledgments. We are grateful for the helpful comments of Drs. Roy Stein and Robert Carline of the Department of Zoology of the Ohio State University. Ruth Thornton typed the manuscript, and David Dennis arranged the plate.

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