The Iowa Darter
Etheostoma exile Girard

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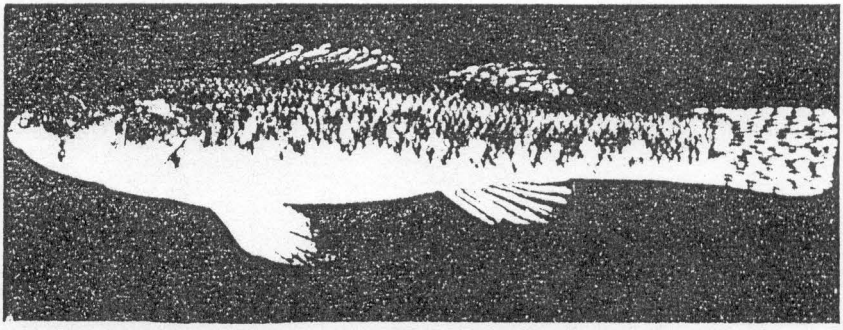
The Iowa darter is a member of the perch family, Percidae, subfamily Luciopercinae, and is an excellent aquaria fish. No major life history studies of this species were found in the literature. Carlander (1941) reported meristics of the Iowa darter. Winn (1955, 1958 A, 1958 B) and Lutterbie (1976) studied the reproductive behavior of the Iowa darter.



Etheostoma exile Girard. Photo by Frederick A. Copes.

Distribution

The Iowa darter ranges from Saskatchewan to Quebec and southward to Colorado, Iowa, Illinois, and Ohio (Eddy and Surber, 1947). In Wyoming it is found in North and South Platte river drainages, and the Sweetwater and Niobrara Rivers (Simon, 1951 and Baxter, 1970). It is found in all major drainages except Lake Superior drainage in Wisconsin (Lutterbie, 1976) and in eastern N. Dakota (Copes, 1966).

Areas of Study

As part of the field investigations reported here, extensive studies of the Iowa darter were conducted from December 1967 to August 1970, and in July 1975, in Sand Creek and Laramie River, Albany County, Wyoming. Additional studies were conducted from March 1971 through 1975 in Mill Creek and Plover River, Portage County; Tomorrow River, Portage and Waupaca Counties; and Castle Creek, Bayfield County, Wisconsin. Twenty lakes were surveyed in central and northern Wisconsin from 1971 through 1976. Laboratory aquaria investigations were conducted periodically from 1967-1975.

Habitat and Behavior

In Sand Creek, Wyoming the Iowa darter was found in

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upstream and downstream areas. It was considered rare in the upstream sections, where it made up less than 0.5% of the estimated total fish population. It was abundant in downstream areas, where it was the second most numerous fish making up 25% of the estimated total fish population and 5% of the total fish biomass in September, 1969. Its abundance in downstream areas indicated a preference for sluggish water with vegetation and a mud bottom. Eddy and Surber (1947) reported that the Iowa darter was commonly found in the weeded margins of lakes and streams. Harlan and Speaker (1956) stated that the Iows darter reached its greatest abundance in natural lakes in Iowa and was found occasionally in the overflow or impounded pools of rivers. Bailey and Allum (1962) reported that the species was partial to clear sluggish or standing water with vegetation and restriction of this type of habitat was a chief factor limiting its occurrence in the northern plains area. Beckman (1952) reported that the Iowa darter preferred colder streams and lakes with sandy bottoms.

The Iowa darter is generally not a schooling species except during the spawning period when females and smaller males formed schools. Iowa darters were found in or under shelter much of the time, making observation difficult. Individuals were found scattered throughout the aquatic vegetation and under shelter in all habitats of slow moving streams. In the Tomorrow River, Wisconsin, three specimens were collected from under rocks in a riffle. The Iowa darter was also found to aggregate in areas of good shelter and under banks. Iowa darters observed in swift currents were behind rocks or other physical shelter.

Iowa darters, when undisturbed, remained quietly on the bottom with the pelvic and pectoral fins braced and the caudal region curled to one side or the other. When alarmed, they would swim (dart) forward 6 to 24 inches and usually assume a position on the bottom and on several occasions they burrowed into debris.

Young-of-the-year Iowa darters were found scattered on the bottom in vegetated pools and lateral depressions of streams and in shallow vegetation in lakes. In August, 1968 over 100 young-of-the-year were counted in a one square meter area of a sand bottom cattle crossing in Sand Creek. They were 1 to 3 inches apart. When alarmed, they darted in all directions and became scattered over a 3 or 4 square meter area.

Iowa darters were observed to be active throughout the day. Activity appeared to increase in the late afternoon. Temperature changes appeared to have little effect on their activity. The Iowa darters were most active during periods of increasing or decreasing flow.

The Iowa darters were generally the first fish to move into temporarily flooded areas. They were seen entering recently flooded areas before the water temperature had increased from the daily minimum, and were found scattered throughout the vegetation of the temporarily flooded areas. Many Iowa darters were trapped in lateral

Table I. Stomach contents of Iowa darters collected from Sand Creek, expressed in percent frequency of occurrence and estimated percent of total volume (in parentheses).

Food Item	Aug. 1968	Oct. 1968	May & Jun 69	July 1969	Aug. 1969	Sept. 1969	Aug. 68-Sept.69
Diptera L*	52 (27.5)	60 (31.4)	53.3 (32.6)	63.6 (32)	60.0 (37.6)	55.5 (32)	54 (34.3)
Enhemerontera N	31 (20.0)	70 (28.5)	46.6 (19.5)	33.3 (16)	45.7 (16.8)	33.3 (20)	42 (18.1)
Trichontera L	25.5 (17.5)	10 (3)	13.3 (4.3)	13.3 (4)	11.4 (3.2)	22.2 (8)	15 (5.4)
Odonata N	12.5 (5.0)	20 (8.5)	13.3 (4.3)	6.6 (2)	20.0 (6.4)	22.2 (8)	14 (5.4)
Coleontera A	5.0 (2.5)	0	6.6 (2.2)	0	5.7 (2.4)	0	4 (1.5)
Hirudinea	0	0	0	6.6 (4)	0	0	1 (.7)
Amphipoda	12.5 (12.5)	40 (14.3)	20.0 (13.0)	20.0 (10)	37.1 (18.4)	33.3 (20)	31 (14.6)
Ostracoda	0	0	0	0	5.7 (3.2)	0	1 (1)
Conenoda	0	10 (3)	0	0	2.8 (.8)	0	2 (.6)
Gastronoda	0	0	0	0	5.7 (3.2)	0	2 (1.7)
Rotifera	0	0	0	0	2.8 (.8)	0	1 (.3)
Fish Eggs	0	0	0	13.3 (20)	0	0	2 (1.2)
Animal Remains	18.7 (15.0)	30 (11.4)	33.3 (23.9)	33.3 (14)	17.1 (7.2)	22.2 (8)	21 (14.4)
Number of empty stomachs	1	1	3	2	3	2	12
Number of fish examined	16	10	15	15	35	9	100

* L = larvae, N = nymph, A = adult

depressions in Sand Creek by decreasing stream flow in July, 1969.

Some Iowa darters were observed in runs in November and December, but most Iowa darters aggregated under the banks and shelter of runs and smaller pools during the winter.

Feeding Habits and Food

Iowa darters generally fed as individuals, and in the summer they fed throughout the day on drift organisms and invertebrates which were associated with aquatic vegetation. Maximum feeding activitiy occurred during the late afternoon and when the flow was decreasing. In the early spring and late fall, they were observed searching the

bottom for food. During the spawning season, schools of females and smaller males were seen feeding together in eddies below the beaver and irrigation dams in Section 2. Iowa darters were observed feeding on surface drift on three occasions in shallow runs. On June 6, 1969 at 8 am Iowa darters were seen in creek chub nests and they appeared to be searching the gravel for eggs. Fish eggs were found in the stomachs of two Iowa darters collected in July, 1969.

In an aquarium, Iowa darters fed on small sucker fry, young guppies, mosquito larvae, rotifers, ostracods, amphipods, small oligochaetes, daphnia, dried commercial foods and bits of hamburger.

The contents of the stomachs of 100 Iowa darters, collected periodically from July, 1968 to September, 1969, were examined. Aquatic insects made up 64.7%, amphipods 14.6%, and animal remains 14.1% of the total volume of food consumed and the

Table II. Stomach contents of Iowa darters collected from Wyoming and Wisconsin, expressed in percent frequency of occurence and estimated percent of total volume (in parentheses).

Food Item	Adult Fish		Age 0
	Wyoming	Wisconsin	Wyoming
Diptera L*	65 (41.5)	60 (38.4)	50 (28.5)
Ephemeroptera N	40 (14.7)	40 (16.0)	30 (9.4)
Trichoptera L	15 (3.2)	20 (4.4)	20 (8.1)
Odonata N	25 (8.2)	15 (8.0)	10 (1.7)
Amphipoda	45 (19.8)	60 (25.0)	40 (9.2)
Gastropoda	10 (4.3)	10 (4.0)	0
Copepoda	5 (0.2)	5 (0.2)	50 (24.0)
Ostracoda	10 (2.2)	10 (2.1)	0
Rotifera	5 (trace)	10 (trace)	10 (3.0)
Animal remains	25 (6.3)	20 (2.2)	40 (16.1)
Number of empty stomachs	1	1	0
Number of fish examined	20	40	10
Number of food items per stomach	4.2	4.8	2.7

* L = larvae, N = nymph

remaining 6% was composed of leeches, ostracods, copepods, gastropods, rotifers, and fish eggs (Table I). The stomachs of 12% of the Iowa darters examined were empty. Iowa darters collected from Wyoming averaged 4.2 food items per stomach, while those from Wisconsin averaged 4.8 food items. Aquatic insect larvae made up 47%, copepods 24%, animal remains 16.1%, amphipods 9.2%, and rotifers 3% of the total volume of food consumed by the age-class 0 fish (Table II). The compositions of stomach contents of Iowa darters collected in Wisconsin and Wyoming were not the same (Table II). The differences in the composition of stomach contents of fish collected in Wisconsin and Wyoming were apparently the result of differences in the abundance of various aquatic organisms and drift organisms.

The contribution each food item made to the diet of the Iowa darter varied throughout the year. The changes in diet composition, frequency of occurrence, and per cent contributed by each food item, can be seen in Table I. Changes in the composition of the diet represented changes in abundance and availibility of food items. The Iowa darter is best described as an insectivore. Beckman (1952) reported that the food of the Iowa darter was principally small insect larvae and small crustacea. Simon (1951) listed its food as small insect larvae.

Reproduction

The spawning season was determined from dates on which collections of sexually mature male and female Iowa darters were made. The spawning season was believed to have extended from April 27 to July 25. Forbes and Richardson (1908) reported that it spawned in April and May. Beckman (1952) stated that the Iowa darter spawned in the early spring and eggs were deposited on stones and in crevices between stones in shallow water. Simon (1951) reported that its spawning period was June and July and Winn (1958 B) listed late March and April.

Most male and female Iowa darters were found to have been sexually mature at age 1. Sexually mature males were collected from April 12 to July 25. Sexually mature females were collected from April 27 through July 22. The largest collections of sexually mature Iowa darters were collected from May 25 to July 1. Collections made before and after this period usually contained only one or two sexually mature specimens. Most females collected after July 1 were spent.

Larger sexually maturing male Iowa darters underwent a color change in April. The sides of the males developed 9 to 11 vertical green lateral bands; the color of the 10 vertical red or orange lateral bands intensified; the bases of the pelvic and anal fins became bright green; and the spinous dorsal developed a band of red or orange and a band of green. Sexually maturing and mature age 1 males did not undergo a color change. Some larger females developed a red band in the spinous dorsal and reddish vertical bands on the sides. The females did not have any green coloration and the reds were not as intense as those of the males.

Males were observed guarding territories, presum. , nesting territories, on June 6, 16, and 20, 1969 in Sand Creek. The territories appeared to be about one foot square located along the shore of a vegetated run in 4-6 inches of water with a current velocity of 1 to 2 feet per second. Winn (1958 A and B) described the territories and territorial behavior of the Iowa darter in detail. Two territorial males were observed attacking intruding Iowa darters, presumed males, on June 16 in Section 2. Sexually mature males were very territorial in Aquaria.

The actual spawning act was not observed in Wyoming or Wisconsin. Winn (1958 A and B) found that when a ripe female entered a larger male's territory, she would stop on the bottom. The male then mounted her with his pelvic fins in front of the female's spinous dorsal fin and his caudal peduncle curved around so that it was beside the female's caudal region. The anal and caudal fins of the males were on the same side of the female's caudal peduncle. Then there was simultaneous vibration of both sexes concomitant with the laying of eggs and their fertilization. The male then dismounted. He found that females mated with one to several males and 3 to 7 eggs were laid per time, usually on fibrous clumps of earth or roots and occasionally in sand or gravel.

Winn (1958 A) observed Iowa darters spawning in an aquarium in roots, algae, gravel, and once on the blade of *Vallisneria* sp.

Schools of Iowa darters in all states of sexually maturity were observed below the beaver and irrigation dam in Section 2 periodically from May 20 to June 20. They were believed to be spawning fish. Winn (1958 A) reported hundreds of spawning Iowa darters below a dam. He reported that there was a relaxation of the territorial behavior and males mounted males as well as females. The large concentration of Iowa darters observed below the dams in Section 2 indicated that the Iowa darters migrated upstream to spawn. Jaffa (1917) reported Iowa darters spawning from April 22 to June 1 in Dry Creek near Boulder, Colorado when water temperatures were 50 to 60°F. He believed spawning occurred in pools in masses of debris and algae.

Age and Growth

Iowa darter fry, 10 to 15 mm in length, were collected periodically from July 15 to August 1, 1969. No Iowa darter fry under 15 mm in length were collectled after August 7, 1969. On July 17 large numbers of fry were found in lateral depressions which were isolated from the stream.

Scales were laid down by the time the Iowa darters had grown to 25 mm in length. The scales of age-class 0 Iowa darters were found to have 4 to 12 circuli in September, 1968 and 1969.

No scales from Iowa darters examined for age in September, 1968 and 1969 had more than two annuli, and the fish were ranked in age-classes 0, 1, and 2. Apparently few, if any, Iowa darters live longer than through four summers in Sand Creek.

Table III. Growth and population structure of the Iowa darter in Sand Creek, based on a sample of 328 fish collected by chemically treating 800 feet of stream in sand creek 2, September, 1969.

	Age-Class		
	0	1	2
Number of fish examined	74	241	13
Per cent of total	22.4	73.4	3.9
Number per 100 feet of stream	9.3	30.1	1.6
Mean weight per fish	0.4	1.6	2.3
Annual increment of weight	0.43	1.2	0.7
Biomass (g) per 100 feet of stream	4.2	48.7	3.7
Range of lengths (mm)	33-44	45-61	61-66
Mean total length (mm)	39.2	53	63.8
Annual increment of length	39.2	13.8	10.8

There was no overlap between the range of lengths of each succeeding age-class (Table III). Data obtained from Iowa darters collected in October and November, 1968 and in April and May, 1969 indicated that little or no growth occurred after the first of September. Therefore, the ranges of the lengths in Table III for age-class 0, 1, and 2 Iowa darters in September applied to age-classes 1, 2, and 3 respectively in the spring prior to the formation of the new annulus. The increments of length and weight calculated for the September fish sample represent the annual increments of growth for each age-class.

The annual increment of weight increased from .45 g the first year to 1.1 g the second year and decreased the third year to .7 g, whereas the annual increment of length decreased with each year of life (Table III). The females were slightly larger than the males. Winn (1958 B) found that spawning females were larger than the males. Trautman (1957) reported that the young-of-the-year Iowa darters were 25 to 45 mm in length in October and adults were usually 45 to 63 mm in length in October. The largest specimen he found was 67 mm in length. The largest Iowa darter collected in this study was a 3 year old female which was 76 mm in length, and the largest male collecteld was a 3 year old which was 71 mm in length.

None of the scales of Iowa darters collected in May and early June showed the new annulus. The new annulus showed on the scales of 9 specimens collected on July 15.

Population Structure

The sample of Iowa darters collected on September 4 and 5, 1969 was composed of 22.4% age-class 0, 73.4% age-class 1, and 3.9%

age-class 2 fish. The low percentage of age-class 0 Iowa darters indicated poor spawning success, poor fry survival, or the sample was biased. All Iowa darters collected from May, 1968 to September, 1970 were of age-classes 0, 1, 2, and 3. One age 4 Iowa darter was collected from Upper Clam Lake, Wisconsin in 1975.

Weight-length Relationship

A general weight-length relationship was calculated for a combined sample of 100 fish collected from Sections 1 and 2 on September 4 and 5, 1969. The Iowa darters ranged in size from 33 to 66 mm in length and from .31 to 2.7 grams in weight. The weight-length equation was Log W=-1.3244 + 2.55 Log L. The correlation coefficient between the length and weight was .93.

Coefficient of Condition

The coefficient of condition (K_{tl}) was computed for each age-class of Iowa darter in the September, 1969 sample. The K values ranged from .81 to .92 with an average of .88.

Survival

The rate of survival for Iowa darters was estimated from four collections and were .05, .18, .22 and .28. The .05 survival value did not include age-class 0 fish. Survival estimates of .22 and .18 were based on samples collected with electrofishing gear, which may have been selective for larger fish. The September, 1969 survival estimate of .28 was biased by the large number of age-class 1 fish and small number of age-class 0 fish. The lack of age-class 3 fish in the September samples suggested a population turnover every 3 to 4 years, which indicates a survival rate of between .1 and .14. The survival rate between age-class 1 and age-class 2 in the September, 1969 sample was .06, which was very close to the September, 1968 estimate of .05.

Predation and Disease

Iowa darters were found in the stomachs of 3 creek chubs and one brown trout. One Iowa darter was found infected with *Ligula* sp. Predaceous diving beetles attacked Iowa darters while they were in fish traps during the summer of 1968.

Meristics

The Iowa darter was found to have 51 to 58 scales in the lateral series of which 31 to 34 were pored and 19 to 26 were not pored. The dorsal fin was found to have 9 spines and 9 to 12 soft rays, and the anal fin had 2 spines and 7 soft rays. Carlander (1941) found the number of scales in the lateral line varied from 49 to 69 of which 16 to 61% were pored. Simon (1951) reported 9 to 10 spines and 9 to 12 soft rays in the dorsal fin, and 2 spines and 7 to 9 soft rays in the anal fin. ‡

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