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Life History and Ecology of Western Blacknose Dace, Boone County, Iowa, 1963-1964

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Life History and Ecology of Western Blacknose Dace, Boone County, Iowa, 1963-1964[1]

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Abstract. A life history and ecology study of the western blacknose dace, *Rhinichthys atratulus meleagris* (Agassiz), was made on Elkhorn and Pease creeks, Boone County, Iowa. Total length equals 1.23 standard length; live length equals 1.03 preserved length; and live weight equals 0.90 preserved weight. Dace reached maturity at age II. Spawning occurred from early May through July over gravel. Number of eggs increased with length of females. Scale formation proceeded forward from the caudal peduncle at 16-20 mm standard length. Scale growth was not directly proportional to body growth. Annuli formed between March and May. Fish which lacked scales until spring of the second year lacked a first annulus. Fastest growth occurred during May, June and July for age I and II dace. Age 0 fish reach an average of 24-27 mm in length during their first year. Age I fish reach 49-50 mm. Few fish reach age III. Length-weight relationships differed significantly between sexes and populations. Diptera larvae were the only consistently utilized food item. Predation by creek chubs occurred. Up to 100 nematodes of the genus *Rhabdochona* per dace were found with no apparent harmful effects. Although dace over-wintered in pools of both streams, some moved into the Des Moines River. During summer, dace concentrated in cool headwaters.

INTRODUCTION

An extensive study of the minnows of Boone County in 1946 and 1947 indicated that western blacknose dace were confined to the upper stretches of small, steep-gradient creeks, and only two specimens occurred in intensive collections from the Des Moines River (Starrett, 1948). A 1963 continuation of the study (Kelling and Noble, 1963) revealed high populations of blacknose dace in only two steep-gradient tributaries, but dace were taken in 23% of Des Moines River collections.

DESCRIPTION OF THE STUDY AREA

Headwaters of Elkhorn Creek (Sec. 19, T85N, R26W) and Pease Creek (Sec. 34, T84N, R26W), consisted of pools up to 15 feet wide, separated by long stretches of narrow stream with rock or gravel bottom and overhanging vegetation. Headwater gradients in both creeks were approximately 29 feet per mile. Springs and drainage tiles kept water temperatures below 60

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degrees Fahrenheit during most of the summer. Elkhorn Creek ceased to flow near its mouth in mid-summer each year, whereas Pease Creek was a permanent stream. Creek chubs, *Semotilus atromaculatus*, were abundant in both headwaters. Pease Creek also had high populations of bigmouth shiners, *Notropis dorsalis*, most of the year.

Materials and Methods

Collections were made from June through November, 1963, and March through August, 1964.

Fish were transferred directly from a common-sense minnow seine to a live box from which they were taken individually for measurement of standard length (distance from tip of snout to hypural plate). Quinaldine anesthetic was used in 1964 to permit faster and easier handling.

Small samples of fish were preserved in 10% formalin for laboratory analyses. Since there was no indication of food regurgitation due to formalin, fish were not suffocated before preservation.

Weights were determined to the nearest hundredth gram and converted to live basis. Scales from the first two scale rows above the lateral line were examined under a standard scale projector at 80X magnification.

Stomach analyses were made by examining the content of the first loop of the digestive tract under 30X magnification. Sex was determined externally by relative size of anal and pectoral fins (Becker, 1962) unless external sex determination was questionable.

All statistical treatments follow Snedecor (1956).

Conversion Factors

Relationship between standard length and total length (distance to tip of caudal fin with lobes compressed) was determined for 91 dace. Since no change in the relationship existed for fish as they increased from 20 mm to 63 mm standard length, the 91 fish were averaged for the conversion: TL = 1.23 SL, with ratios at each stream ranging from 1.20 to 1.29.

Since some fish were measured and weighed after preservation in formalin, it was necessary to determine proper conversions to live lengths and weights. Live lengths of 93 fish exceeded preserved lengths significantly by 3% (Chi-square, .05 level). Weight increase due to formalin uptake, based on 14 fish ranging from 0.80 to 1.86 grams live weight showed increases in weight (0.10 to 0.25 grams) to be significant at 2 days (paired data t-test, .01 level), but weights decreased slightly (0.03 to 0.10 grams) during the following 23 days. Since the percentage change was not correlated with size of the fish, the ratio live weight = 0.90 preserved weight was used. The ratio for individual dace ranged from 0.87 to 0.93.

Reproduction

Female dace began to mature late in their second year. By the following mid-May, some females reached spawning condition, their eggs attaining a maximum size of 1.2 to 1.5 mm (after preservation of the ovaries in formalin). Dobie *et al* . (1956) reported that eggs of subspecies *meleagris* were one-sixteenth inch (1.6 mm) when spawned and swell to one-eighth inch in water. Traver (1929), however, reported that eggs of subspecies *atratulus* collected after spawning were 0.8 mm in diameter.

At maturity, only two sizes of eggs were found, the smaller adhering closely to the connective tissue in the ventral part of the ovary. Ratios of mature to immature eggs at the time of spawning varied from 1:1 to 1:4, indicating a great variability in percentage of total eggs spawned. Since a range of 166 to 523 ripe eggs, and 375 to 2,500 total eggs, was found for 14 females 38 to 61 mm standard length, a regression of mature eggs against length was plotted (Figure 1). Only one point, representing the only age III dace, deviates noticeably from the regression.

The smallest mature female captured was 38 mm standard length and was taken May 22, 1964. Only one smaller two-year-old fish was taken in that sample. One mature dace of age I was noted, a 45 mm male taken on June 8, 1964.

Only 6 of 33 2-year-old fish examined were immature. Of

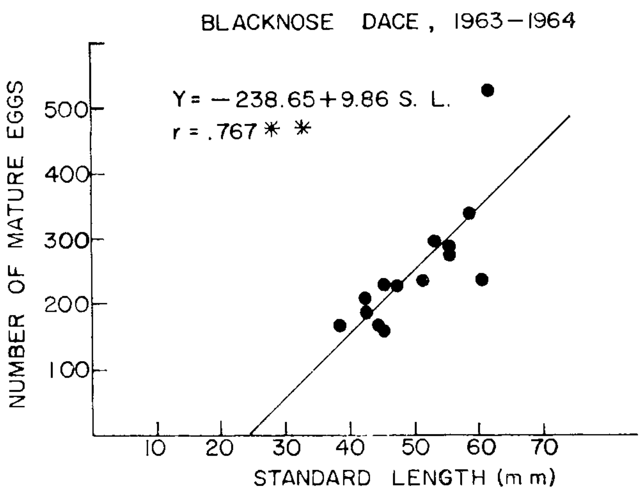

Figure 1. Number of mature eggs produced per female blacknose dace, Elkhorn and Pease Creeks, 1963 and 1964.

these immature fish, five were near the lower end of the length frequency distribution, indicating that size as well a age may affect sexual maturity. Sex ratios did not deviate significantly from the 1:1 ratio (Chi-square, .05 level).

Although a few unmated males in breeding color were taken from pools during the early part of the spawning season, mature females and breeding males were most often taken from swift water 3 to 6 inches deep over gravel, especially from the areas protected by overhanging vegetation. Traver (1929) reported spawning under similar conditions, but did not mention any relationship to overhanging vegetation which he reported in the area. Raney (1940), however, considered the downstream ends of pools over sand and fine gravel as preferred spawning areas. Such areas were rare in Boone County streams.

Ripe females were not taken before May 1 at either creek, but, thereafter, spawning females were taken through July. The collection of very small dace in late August also indicated that spawning probably continued into late July. Although males in breeding color were frequently picked up later in the year, they were usually found in association with other males.

Analysis of stomachs gave no indication of dace feeding on their own eggs as was reported by Raney (1940) and Schwartz (1958). One creek chub stomach taken from Pease Creek in late June, 1963 contained four eggs which closely resembled dace eggs. If eggs predation by the creek chub is common, it might be a significant factor affecting egg survival since creek chubs are abundant in the two streams.

Formation and Growth of Scales

In order for scales to be used for back calculation of length at the end of each year, scale growth must be in proportion to increase in length of the fish (Van Oosten, 1929), or the relationships between scale and body growth must be described. A regression of standard length on scale radius showed that the intercept of the regression line was negative (Fig. 2). If scale growth and body growth are proportional, the intercept should have occurred in the vicinity of the length at scale formation.

Dace fry from 15 to 22 mm in length were examined to establish size at scale formation and pattern of scale development (Fig. 3). Scales had begun to form in the vicinity of the lateral line on the caudal peduncle at 15 mm. At 20 mm length, scale formation had occurred in the area of scale removal. At all times during scale formation, more scales had developed below than above the lateral line.

If a line were fitted to the data of Fig. 2 by using approximately 20 mm standard length as the intercept, a curvilinear relation could be visualized. If this is true, the scale method cannot be used for direct proportion back calculation lengths.

Scale growth occurs by the adding of somewhat evenly spaced circuli throughout the summer. As growth slows in the fall, the circuli begin to form closer together and crowd in the anterior field. When growth resumes in the spring, an annulus is formed by the first new circulus cutting across the crowded circuli in

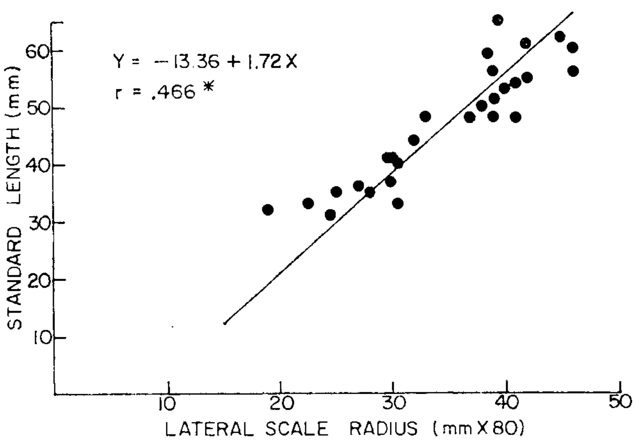

Figure 2. Relationship of body length to lateral scale radius of blacknose dace, Boone County, Iowa.

the anterolateral field. Parts of circuli which are being formed at the time of annulus formation often do not fuse, but remain as an irregular threadlike partition. A combination of these three criteria was used to distiguish annuli (Fig. 4). Traver (1929) was not able to detect annuli on eastern blacknose dace scales.

Age and Growth

Collections of length data on 3,787 fish were used to construct length-frequency histograms. By scale analysis of a few fish from the tails of the length-frequency distributions, the amount of overlap between age groups was determined.

Length-frequency histograms usually showed distinct modes of young, age I, and age II fish, except late in the year when age II fish began to disappear. Usually the overlap of young-of-the- year and age I fish was negligible.

Young fish first appeared in the latter half of July and ranged from 13 to 32 mm. Most growth of these small fish occurred in July and August, the average lengths reaching 24 and 27 mm at Elkhorn Creek and Peace Creek, respectively, and increasing only to 28 and 29 mm by the end of the year (Fig. 5). The

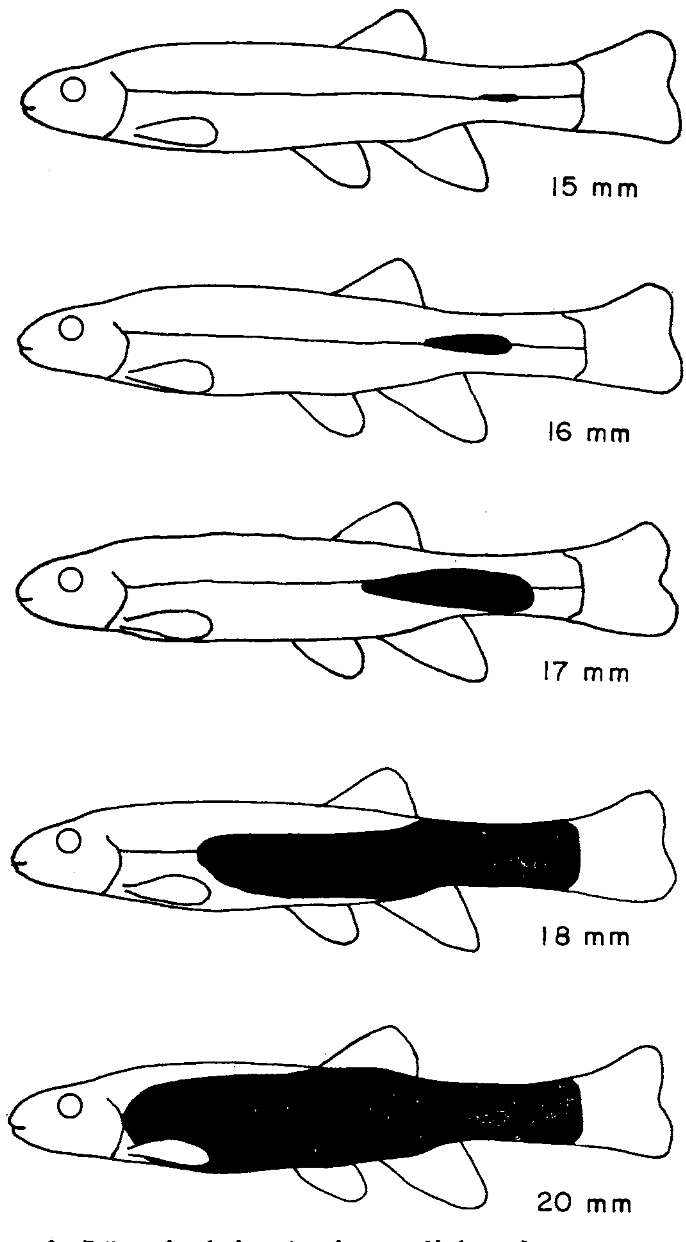

Figure 3. Pattern of scale formation of western blacknose dace.

range of age 0 dace taken in the November 27 sample was 22 to 34 millimeters, but the early collections of the following spring produced fish as small as 18 mm. Fish which overwinter

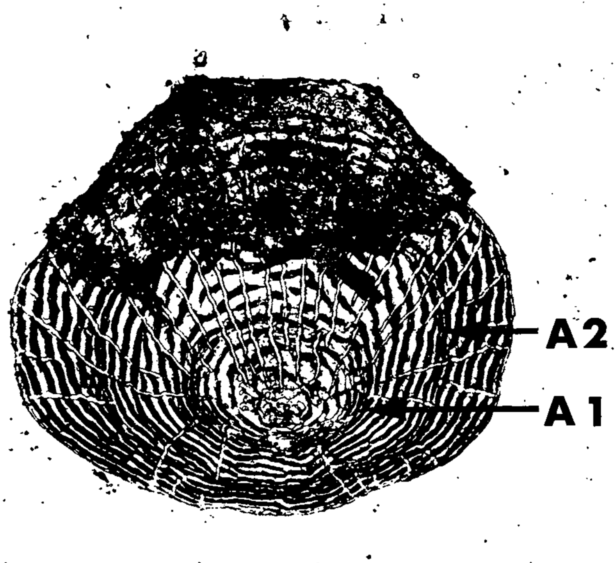

Figure 4. Scale of age II blacknose dace showing two distinct annuli.

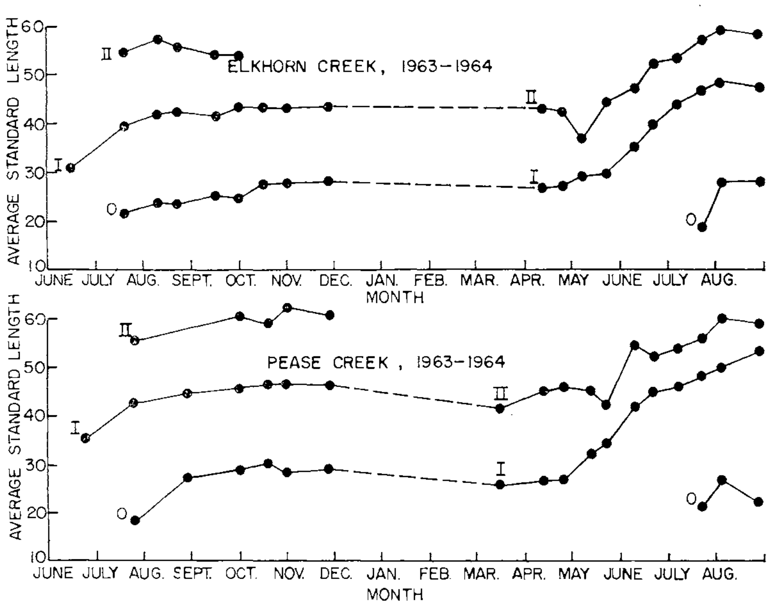

Figure 5. Average standard lengths of age groups of blacknose dace, 1963-64
A. Elkhorn Creek
B. Pease Creek.

at this small size lack a first annulus and are therefore erroneously aged by the scale method.

Age I fish resumed growth about May 1, 1964 in both streams, after which growth was rapid through July. In 2 months, the dace grew 13 and 18 mm respectively in Elkhorn and Pease creeks. By the end of 1963, the age I fish averaged 44 and 46 mm, respectively, ranging from 37 to 54 mm. Age I dace had already exceeded these means in August 1964, averaging 48 and 54 mm and ranging from 37 to 58 mm. Traver (1929) reported a range of 37 to 44 mm for age I dace at the end of the year.

Age II fish resumed growth in late May, and grew 21 and 14 mm in Elkhorn and Pease creeks, respectively, from May, through July, after which the means for the 2-year-old fish became less reliable because of a decline in abundance. A noticeable similarity between growth curves for fish in the two creeks is the sharp decline in mean length of age II fish in the spring. Since few age II fish normally lived beyond July, the additional stress of spawning or preparation for spawning appeared to affect the larger fish to a greater extent. Over winter, a less noticeable decline in mean length of each year class occurred.

Dace of each age group were several millimeters longer in Pease Creek throughout the study. These higher averages may be related to the more consistent flow of water and to the lower population density.

Examination of entire collections of age I and II dace revealed a random distribution of individuals of each sex within each length-frequency distribution. Although females did not grow faster as stated by Hubbs and Cooper (1936), they did grow to a larger size. The fourth age group consisted of 3 males, all less than 60 mm, and 8 females mostly over 60 mm. Except for young-of-the-year- fish, all age groups had exceeded the maximum mean length of 1963 by early August 1964. However, from June through August, the only period in which growth of the 2 years could be compared, was approximately equal.

The maximum age attained by blacknose dace in the two streams was three years.

Length-weight Relationship and Condition

Since the length-weight relationship, $W = a L^n$ (Lagler, 1956), is non-linear, a logarithmic transformation was used to determine the regression of weight on length (Table 1).

Analysis of covariance revealed significant differences of slope between males and females for each creek and between creeks for males (F-test, .01 level). Even though the difference between slopes for females in the two creeks was large, high variance prevented detection of any significant difference of slope; however, difference between elevation of regression lines for females was significant (F-test, .01 level). Since these differences were found, length-weight relationships could not be combined by sex or population.

Coefficients of condition, K_{SL}, were calculated by the formula:

$$K = \frac{W \times 10^5}{L^3}$$

where K = coefficient of condition
W = live weight in grams
L = standard length in millimeters.

If this cube law describes growth of dace, values of *n* in the length-weight relationships should equal 3.0. Only the *n* values for males, 2.5737 and 2.7720, differed significantly from 3.0 (t-test .05 level). Their lower values indicate that coefficients of condition for males decrease with increase in length.

Table 1. Length-weight relationships of western blacknose dace in Boone County, Iowa, as expressed by the formula:

$$\text{Log } W = \log a + n \log L$$

where W = live weight in grams X 10
a = intercept of regression line
n = slope
L = standard length in mm

		Number specimens	Range of SL
	Elkhorn Creek		
Males	$\log W = -3.0651 + 2.5737 \log L$	25	33-65
Females	$\log W = -3.3702 + 2.7515 \log L$	31	32-60
	Pease Creek		
Males	$\log W = -3.3985 + 2.7720 \log L$	25	34-65
Females	$\log W = -3.9297 + 3.1054 \log L$	31	29-60

Coefficients of condition for 167 fish indicated that Elkhorn creek males were consistently more robust than females, except prior to spawning. Males from Pease creek, however, had consistently lower condition coefficients than females. Condition declined during the summer, followed by an increase again for the spawning season in late spring.

Food Habits

Diptera larvae, primarily from the family Chironomidae, were the most important food items (Table 2), appearing in 58% of the stomachs and in every collection. The high utilization of chironomides during June and July may be related to the high growth rate of dace during that period. In late November and in March, desmids and diatoms were important food items. No appreciable change in food habits with age or size of dace was detected.

Since creek chubs were abundant in both streams, their food habits were determined. In Elkhorn Creek, Diptera larvae were the most important and only consistent food of small chubs. In Pease Creek, however, terrestrial insects were the most frequently occurring food.

Terrestrial insects and Diptera larvae were the most frequently occurring food items of 21 creek chubs 75 mm and longer. Fish, including one dace, occurred in three of the stomachs.

Movements and Abundance

High numbers of dace in seine hauls at the mouth of Pease Creek in March 1964 indicated that some dace move into the Des Moines River for the winter. During early spring, many dace attempting to move upstream were observed near the mouth of Pease Creek.

In a headwater pool of Pease Creek, dace, which had been fin-clipped on November 27 and 28, 1963, were recaptured on March 14, 1964, indicating overwintering in the area. A population estimation indicated approximately 400 dace, exclusive of young, in the pool on November 28, 1963; however, on March 14, 1964, only 33 fish were found.

Since the lower stretches of Elkhorn Creek were dry from August 8 through the time of freezing, dace were unable to move into the Des Moines River. Although at least 34 dace occupied the largest pool in late November 1963, only 10 dace occupied the pool on April 12, 1964, but an abundance of dace were found about 100 yards downstream. By the middle of June, dace had again become well established in the largest pool. By August 8, 1963, and August 3, 1964, many dace had migrated into the pool. One seine haul in 1963 produced 463 dace. In 1964, one haul yielded 426 dace and 244 creek chubs. Since the lower stretches of Elkhorn Creek had dried up by early August in both 1963 and 1964, decreased water flow probably resulted in higher temperatures, causing the dace to seek the cooler headwaters. Population estimates of blacknose dace in Michigan trout streams have shown population densities of up to 3,450 dace per mile (Shetter and Hazzard, 1939), with high variability in their estimates from month to month, indicating similar population movements. Usually dace were more abundant in Elkhorn Creek than in Pease Creek.

Parasites

Parasitic nematodes, *Rhabdochona* sp., occurred in stomachs of 7 of 178 fish. When worms were found they were in the first loop of the digestive tracts.

Discussion

The following factors were associated with the high populations of western blacknose dace which have become established in Boone County, Iowa, since 1947:

(1) Low water temperatures. The tile drainage system provides

a continuous flow of cool water which is maintained by the overgrowth of vegetation.

(2) Negligible competition. The creek chub is the only associated fish which has thrived, but its abundance seldom exceeds one-third that of dace. Although chironomids are the primary food of both species, secondary food preferences overlap little.

(3) Adaptability of food habits. When Diptera larvae are plentiful and other conditions are favorable, the dace are capable of high growth rates. At other times, dace may feed entirely on other food.

(4) Motility. By moving into deep water each winter, and moving toward the cooler headwaters each summer, dace avoid unfavorable stream conditions.

(5) Abundance of spawning areas. Both streams have gravel bottoms sheltered by overhanging vegetation, providing suitable spawning conditions for dace.

The conditions of the Des Moines River, probably prevent a breeding population from becoming established, but do allow survival of blacknose dace which overflow from the two dense populations.

Acknowlegments

The author wishes to extend appreciation to Dr. Kenneth D. Carlander for his supervision and to all those who helped in the collection of the field data.

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Conodonts from the Aplington Formation of Northcentral Iowa

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Abstract. Conodonts comprising six species have been recovered from the Aplington Formation from five localities in northcentral Iowa. Although the Aplington conodont fauna is meager it suggests a correlation with the Maple Mill Shale of southeastern Iowa. The Aplington Formation is regarded as representing the youngest Devonian formation exposed in northcentral Iowa.

INTRODUCTION

Stainbrook (1950) excluded the upper, dolomitic portion from the Sheffield Formation and established the Aplington Formation for these carbonate beds. He designed the type section as a quarry just north of Aplington in Butler County. Stainbrook, on the basis of a brachiopod fauna, assigned the formation to the lower part of the Kinderhood Series. However, it is known that most of the original type Kinderhook is of Late Devonian Age (see Collinson, 1961).

Stainbrook considered the Aplington brachiopod fauna to be similar to a brachiopod fauna from the Percha Shale of New Mexico. Since Miller and Collinson (1951) reported a goniatite cephalopod from the Percha Shale which is indicative of Upper Devonian, *to*III-*to*IV of western Europe it could be argued the Aplington Formation is also of Late Devonian Age.

APLINGTON CONODONT FAUNA

Conodonts have been recovered from the Aplington Formation from five localities (see fig. 1).

Locality 1, Peterson no. 1 core, N. of Vincent, NE¼, NE¼, NW¼, sec. 10, T. 90 N., R. 27 W., Newark Township, Webster County.

Locality 2, East side of Highway 65, SW¼, SW¼, Sec. 10, T. 93 N., R. 20 W., Clinton Township, Franklin County.

Locality 3, East side of Highway 65, opposite Chapin Road,