MATURATION, SPAWNING PERIOD, AND FECUNDITY OF THE WHITE CRAPPIE, *POMOXIS ANNULARIS* RAFINESQUE, IN BEAVER RESERVOIR, ARKANSAS

JANET L. THOMAS and RAJ V. KILAMBI
Department of Zoology
University of Arkansas
Fayetteville, Arkansas 72701

ABSTRACT

Gonosomatic indices and ovum diameter frequency distributions showed that the Beaver Reservoir white crappie spawns from late April through May. During the spawning season females release eggs more than once. Various stages of ovarian ovum development were described. Sexual maturity was found in 2-year-old females of 197 mm and 3-year-old and older fish. Regression analyses of fecundity on total length, weight and age of white crappie indicated that the fish weight was the best predictor of fecundity.

INTRODUCTION

The white crappie, *Pomoxis annularis*, is an important sport fish in Beaver Reservoir and is second only to largemouth bass, *Micropterus salmoides*, in total pounds harvested (U. S. Fish & Wildlife Service, National Reservoir Research, unpublished data). The reproductive habits of the white crappie have been studied, but information on sexual maturation process and fecundity is meager, especially in the southern states (Morgan, 1954; Whiteside, 1964; Siefert, 1969; Mathur et al., 1979). This paper describes the seasonal changes in ovarian ovum morphology, frequency of spawning, and fecundity of the Beaver Reservoir white crappie.

MATERIALS AND METHODS

A total of 109 female white crappie were collected by angling, rotenone, and electroshocking in 1974 (January - August), 1978 (September - December) and 1979 (January - August). Data on total length (mm) and weight (g) were taken for each fish. Ovaries were preserved in 10% formalin. Fish were aged by the number of annuli on the scales taken from the body beneath the tip of the left pectoral fin.

Monthly gonosomatic index (GSI), the percentage of the fish weight contributed by the ovaries, was estimated for individual fish. The diameters of 200 ova from the midsection of an ovary were measured to the nearest 0.02 mm. The ovarian ovum developmental stages were described on the basis of shape, yolk deposition, and color of the ova. Fecundity, the total number of maturing and mature ova in both the ovaries, was estimated by the wet gravimetric method based on a 5 - 10% ovary sample.

RESULTS

Seasonal Development of Ovaries.

The gonosomatic indices (Fig. 1) increased from September through April. The most rapid rate of development of ovaries occurred from March to April with a drop in GSI in May. The GSI values continued to decrease during June, reaching the lowest point in July or August, depending on the age of the fish. One-year-old crappie showed no increase in the index throughout the year and were presumed immature. The trends in GSI indicated that white crappie spawn from late April through May.

Morphological examination of the ovaries showed an increase in ovary size from December through March. The ovaries of the April specimens were large and full, appearing yellowish in color with the ova visible through the ovarian wall. In May, the ovaries were flaccid, and during June, July and August they were completely flaccid and smaller in size. These changes corresponded with those of the gonosomatic indices. Sixty-five percent of the 2-year-olds (49 fish) had typical seasonal ovary development. The smallest mature 2-year-old female was 197 mm in total length and weighed 84 g. All 3-year-old and older fish were sexually mature.

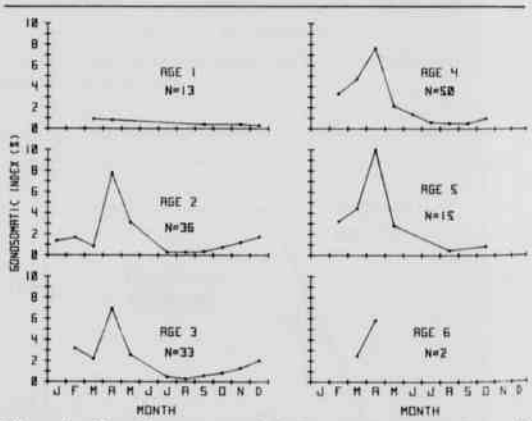

Figure 1. Monthly gonosomatic indices for the Beaver Reservoir white crappie.

Ovum Developmental Stages.

Developmental stages of the white crappie ova are described according to the criteria of James (1946) and Litt (1952). The five stages and ranges of ovum diameters are:

Stage I. Youngest oocytes (Primary ova). 0.02 - 0.16 mm.
These ova were platelike with a distinctly round or oval nucleus (Fig. 2A).

Stage II. Vacuolization of cytoplasm (Immature ova). 0.12 - 0.36 mm.
The ova in this stage were translucent and spherical. Cytoplasm

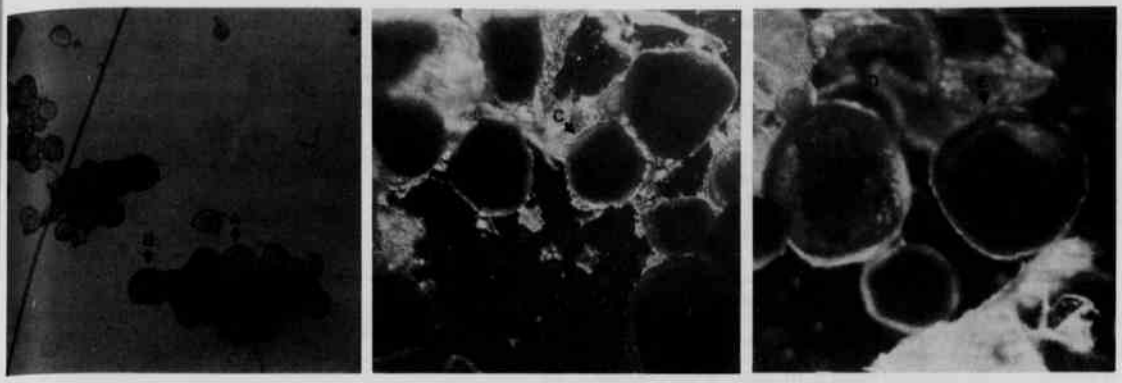

Figure 2. Ovarian ovum developmental stages (100×). A. Stage I B. Stage II C. Stage III D. Stage IV E. Stage V

showed vacuolization and nucleus was visible in some smaller ova. Most ova appeared whitish in color (Fig. 2B).

Stage III. Yolk deposition (Maturing ova). 0.34 - 0.64 mm.
The ova were opaque due to deposition of yolk in the cytoplasmic vacuoles. Nucleus was not visible (Fig. 2C).

Stage IV. Coalescence of yolk globules (Mature ova). 0.58 - 1.02 mm.
The ova were granular due to the presence of large yolk globules. The most advanced mature ova had large oil droplets visible within the cytoplasm. The color of the ova changed from whitish-orange to a yellow or orange (Fig. 2D).

Stage V. Residual ova.
These were the retained ova in the ovary after spawning. In addition to the ova in stages I and II, these spent ovaries had some stage III and IV ova as residuals. Many of the residual ova were in an atretic stage with the cytoplasm appearing to shrink away from the ovum membrane (Fig. 2E).

Ovum Diameter Frequency Distributions.

Six subsamples from the anterior, middle, and posterior parts of both the ovaries of a prespawning fish showed that frequency distributions of the ovum diameters were not significantly different either within an ovary or between the left and right ovaries.

The ovum diameters were pooled for the ages 2 through 6, and the frequency distributions are shown in Figure 3. Stage I ova were present in all ovaries throughout the year. Increase in ovum size to stage II occurred between August and October. The ovaries of November, December, and January contained stage III ova, and some stage IV ova were observed in February and March. The ovaries of April contained ova of all four stages, with ova in stages III and IV forming distinct and dominant modes. In May, large ova in stage IV were absent, indicating the occurrence of spawning. During the first two weeks of May, the ovaries contained large numbers of stage III and IV ova, but their percent frequency was much less than in April. By the end of May, few ova larger than 0.34 mm were observed. In June, although Figure 3 shows small number of ova larger than 0.34 mm, four of the five fish examined had few ova above this size. In July the retained ova larger than 0.34 mm were reabsorbed. The changes in frequency distributions of the ovum diameters indicate that spawning occurs from late April to middle of May and that the remaining stage III and IV ova are extruded by the end of May. It is also evident that white crappie spawn ova that are 0.34 mm and larger in diameter (stages III and IV).

Fecundity Estimates.

Ova in stages III and IV (0.34 - 1.02 mm) were used in fecundity estimates. This parameter was estimated for 16 mature females (GSI = 6.46 - 11.16), of ages 2 through 5 collected in April, that contained full complement of stage IV ova. The estimated fecundity ranged from 48,058 to 232,026 for fish ranging from 217 mm (118 g) to 335 mm (582 g) in size. The relationships between fecundity and total length, weight and age were described by the curvilinear function:

$$F = a X^b$$

where, F = fecundity and X = total length, weight or age.

The estimated parameters are given in Table 1. Based on the coefficients of determination (r^2) and standard error of estimates (S_{yx}), weight of white crappie gives the best estimate of fecundity.

Table 1. Statistics of curvilinear relationship between fecundity and total length, weight, and age of white crappie.

Variable (X)	Intercept (a)	Slope (b)	Coefficient of determination (r^2)	Standard error of estimate (S_{yx})
Total length	4.859×10^{-4}	3.397	0.798	0.091
Weight	631.749	0.897	0.846	0.079
Age	31,650.937	1.128	0.662	0.118

DISCUSSION

Based on gonosomatic indices, gross examination of ovaries and ovum diameter frequency distributions, the spawning period of the Beaver Reservoir white crappie extended from late April through May. In Oklahoma, they spawned in April and May (Whiteside, 1964), during May and June in Illinois (Hansen, 1951), from late May through June in South Dakota (Siefert, 1969), and in Ohio spawning season extended from April into July (Morgan, 1954). The white crappie attained sexual maturity in Beaver Reservoir between two and three years of age, and similar findings were reported by Hansen (1951), Litt (1952), Towery (1963), and Whiteside (1964).

Characterization of ovum developmental stages of the Beaver Reservoir white crappie closely paralleled the stages described by James (1946) and Litt (1952). According to Hansen (1951), Morgan (1954), and Whiteside (1964), the mature ovum size ranged from 0.82 to 0.92 mm. Litt (1952) stated that most of the mature ova (stage IV)

ranged in diameter from 0.42 to 0.67 mm; however, in our study, stage IV ova ranged from 0.58 to 1.02 mm in diameter. Although there is a difference in size range of stage IV ova in these studies, morphological descriptions of these ova were almost identical.

Large numbers of maturing (stage III) and mature (stage IV) ova were observed in ovaries of early May. By late May, few ova in these stages were noted, with only a few of these ova as residuals in June ovaries. By July, all residual ova were reabsorbed. These observations suggest that Beaver Reservoir white crappie do not release all of their stage III and stage IV ova in one spawning act but may extrude over a period of time during the spawning season. Fractional spawning was postulated by Hansen (1951), Morgan (1954), and Whiteside (1964).

Ovum size used in fecundity estimates varied considerably. Morgan (1954) and Whiteside (1964) used mature ova (≥ 0.82 mm) in their estimates of white crappie fecundity. Mathur et al. (1979) determined fecundity based on mature ova (≥ 0.75 mm). Siefert (1969) included secondary oocytes and maturing and mature ova, comparable in morphologic descriptions of stages II, III, and IV ova of our study. Huber and Brinkley (1935) and Towery (1963) reported on fecundity estimates but did not mention the ovum size. We included ova 0.34 mm and larger (stages III and IV) in fecundity estimates. Since fractional (multiple) spawning is indicated and ova above this size were reabsorbed in the postspawning ovaries, it is essential to include more than just the most advanced group of ova in fecundity studies.

Although fecundity estimates were reported in the literature, the relationship between fecundity and length, weight, and age was not determined with the exception of Mathur et al. (1979). Our study and that of Mathur et al. (1979) found that weight was the best predictor of white crappie fecundity.

ACKNOWLEDGMENTS

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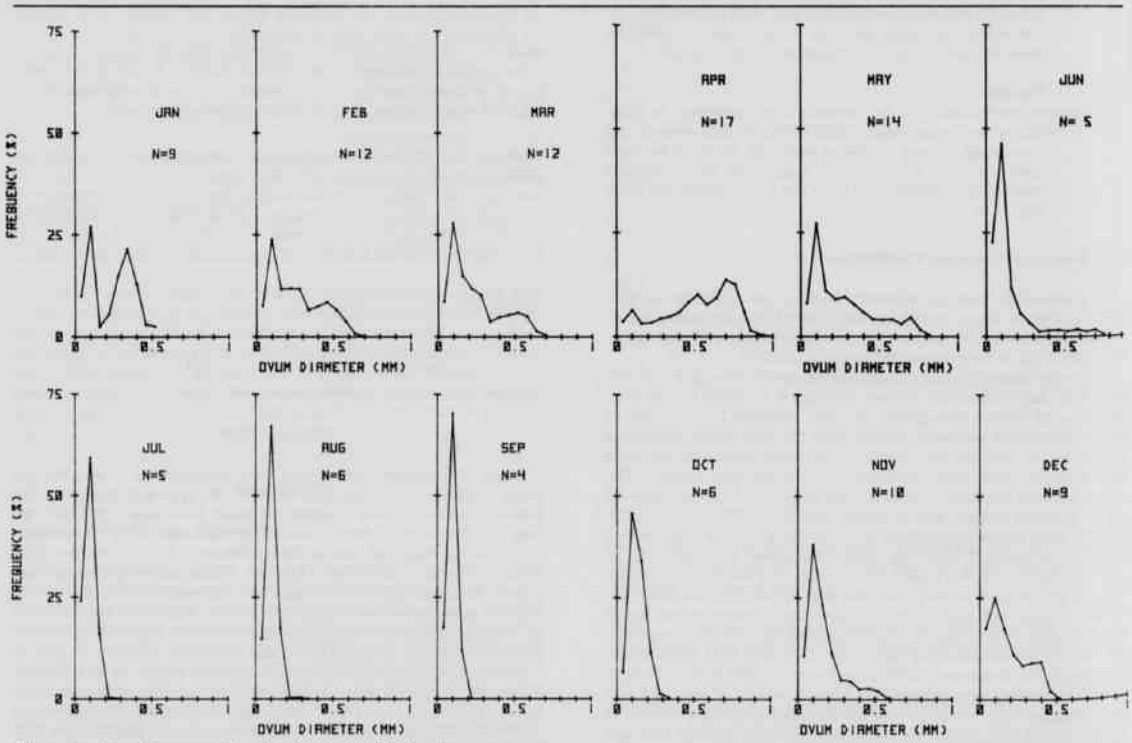

Figure 3. Monthly ovum diameter frequency distributions.

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