Aspects of the Reproductive Biology of Tripletail, *Lobotes surinamensis*, in the Northern Gulf of Mexico

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ABSTRACT

Tripletail, *Lobotes surinamensis*, is a large pelagic fish that is becoming increasingly popular with recreational anglers throughout the Gulf of Mexico. There is, however, little information on the biology of this species and virtually nothing is known regarding the reproduction of tripletail. We examined tripletail captured from the northern Gulf of Mexico in the spring and summer between July 1994 and September 1999 to determine size at sexual maturity and reproductive patterns. No sexually immature male tripletail were captured during the course of the study. The size at 50% maturity for female tripletail is 485 mm TL, corresponding to an estimated age of one year. Mean monthly female gonadosomatic index (GSI) values were elevated throughout the summer, highest in July and near resting levels by September. Male GSI values were elevated from May through September. Histological analysis of gonadal tissue from 93 male tripletail showed the majority of males captured from May through September were running ripe. However, active spermatogenesis declined in the testis during the course of the reproductive season. Analysis of gonadal tissue from 118 females provides evidence that tripletail are a multiple spawning species. Females were found in the late developing ovarian maturation stage from June through August; regressed and spent females were captured from June through September. A high percentage of females captured during April, May and June were in the immature and early developing ovarian maturation stages. Females with oocytes undergoing final oocyte maturation (FOM) were found June through August, with the highest percentage in July. Thus, tripletail appear to have a three month spawning season in the northern Gulf of Mexico, with July the peak spawning time. However, most reproductively active female tripletail appear to remain well offshore. Estimates of batch fecundity, based on five tripletail undergoing FOM in July suggest fecundity is positively correlated with length; mean relative batch fecundity was 47.6 eggs/g ovary-free body weight. Preliminary estimates of spawning frequency, based on the percentage of females in the late developing ovarian stage undergoing FOM or containing postovulatory follicles during June through August, suggest that female tripletail are capable of spawning once every three days to five days in the northern Gulf of Mexico.

KEY WORDS: Tripletail, reproductive biology, histology

INTRODUCTION

The tripletail, *Lobotes surinamensis*, is a pelagic species that is found world wide in tropical and subtropical seas (Fisher 1978). Adult and juvenile tripletail, while never abundant, commonly occur along the north-central coast of the Gulf of Mexico during late spring and summer (Baughman 1941). Tripletail are often targeted by recreational fishermen along the northern Gulf of Mexico (Benson 1982) and enter the commercial catch along the west coast of Florida (Fischer 1978).

There is little life history information on tripletail, and virtually nothing is known about their reproductive biology in the Gulf of Mexico. Juvenile tripletail are commonly found in floating patches of *Sargassum* or other types of drift algae (Dooley 1972) and appear to be strongly associated with shaded structures (Baughman 1941). Adult tripletail are often found in deeper waters associated with rocky bottoms, channel markers, jetties and wrecks (Baughman 1941). Tripletail appear to be a summer spawning species, as females with ovaries containing large eggs have been reported in Texas from May through August (Baughman 1941, 1944) and in Mississippi in July and August (Baughman 1941). In North Carolina, Merriner and Foster (1974) found running ripe males from June through August and spent females in August and September. Ditty and Shaw (1993) found larval tripletail in the Gulf of Mexico from July through September and concluded that the species is an offshore spawner. The objective of this study was to provide more complete information on the reproductive biology of tripletail in the northern Gulf of Mexico. Aspects of the reproductive biology described include the size at sexual maturity, spawning season, gonadal maturation, oocyte frequency distribution and estimates of batch fecundity and spawning frequency.

MATERIALS AND METHODS

Tripletail samples were obtained from recreational anglers along the north-central Gulf of Mexico off the coast of Mississippi between July 1994 and September 1999. All fish were measured (mm TL) and weighed (0.1 lb, later converted to g) dockside and the sex was determined. Gonads were removed from each fish, placed in a labeled bag and stored on ice no longer than 36 h prior to laboratory processing. In the laboratory, gonads were weighed (0.1 g) and assigned a macroscopic maturity stage. The gonadosomatic index (GSI) was calculated for each fish as GSI = [gonad weight/gonad-free body weight] x 100. A portion of the gonad (2 - 15 g) was removed and preserved in 10% neutral buffered formalin for a minimum of two weeks.

A small (< 2 cm^2) portion of the preserved gonadal tissue was placed in individually labeled cassettes for histological processing. Following an overnight rinse in running tap water, gonadal tissue was dehydrated in a series of

graded ethanol solutions and embedded in paraffin following standard histological techniques. Tissues were sectioned at 2-3 μm, placed on slides and stained with hematoxylin and eosin for histological evaluation. Gonads were assigned to developmental stages based on microscopic appearance following Brown-Peterson et al. (1988). Spawning frequency was determined histologically following procedures in Hunter et al. (1986) and Brown-Peterson et al. (1988).

The remaining preserved ovarian tissue was used for oocyte size-frequency distributions and batch fecundity estimates. Approximately 1 g of preserved tissue was weighed to the nearest 0.0001 g and all oocytes > 60 μm were teased from the tissue. The oocytes were suspended in a known volume of water, stirred to a uniform distribution and three to five 1 ml subsamples were removed. All the oocytes in each subsample were counted and measured using a stereo dissecting microscope and a computerized image analysis system. Oocyte size frequency distributions were constructed using all the oocytes measured. Mean batch fecundity was determined for females undergoing final oocyte maturation from the number of oocytes $\geq$ 550 μm in each replicate subsample.

RESULTS

Size at Sexual Maturity

All male tripletail sampled during this study were sexually mature, exhibiting spermatogenic activity in the testis. The smallest male captured was 290 mm TL, suggesting that 50% maturity for male tripletail is reached at a length < 290 mm TL.

Overall, 26% of female tripletail collected from the northern Gulf of Mexico were sexually immature, with only primary oocytes in the ovary. Figure 1 shows the percentage of sexually mature females by 25 mm TL intervals. The smallest female captured was 300 mm TL and ovarian maturation did not begin until 444 mm TL. All females > 525 mm TL were sexually mature (Figure 1). Female size at 50% sexual maturity is calculated to be 485 mm TL, corresponding to an estimated age of one year.

Spawning Season and Gonadal Maturation

Tripletail were captured sporadically in the northern Gulf of Mexico between late April and late September during the years of this study. Due to the limited number of samples captured during each year, all data from 1994 through 1999 were pooled for the reproductive analyses. GSI values of female tripletail were elevated during June through August, with a peak in July, while male tripletail GSI values were elevated from May through September (Figure 2). Thus, the spawning season for tripletail in the northern Gulf of Mexico extends from June through August. Overall, GSI values of both male and female tripletail were low.

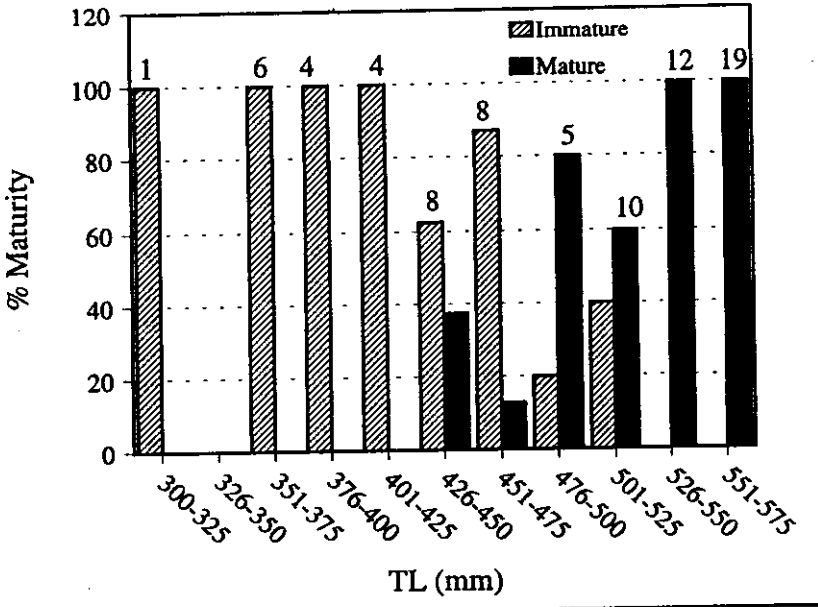

Figure 1. Size at maturity for female tripletail from the northern Gulf of Mexico by 25 mm TL intervals. The number of fish in each interval is above each bar.

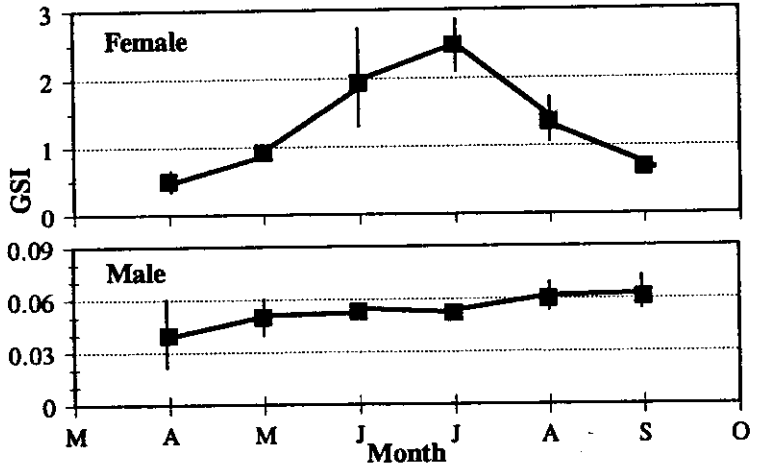

Figure 2. GSI values of female and male tripletail from the northern Gulf of Mexico. Data points represent $\bar{x} \pm 1$ S.E. Data from 1994 -1999 are combined.

Histological assessment of testicular tissue from 93 male tripletail captured between April and September showed that the majority of the males were in spawning condition (running ripe) from May through September (Table 1). Few spent fish were captured. There was a noticeable progression in spermatogenic stages in the testis during the course of the season. Most males in April were in the mid and late developing testicular stages and undergoing active spermatogenesis (Table 1). Active spermatogenesis occurred throughout the testis in the majority of running ripe males during May (100%) and June (53%; Figure 3A). Active spermatogenesis occurred only in the peripheral portions of the testis in the majority of running ripe males in July (50%), August (46%) and September (50%). At the end of the spawning season, only spermatozoa, with no evidence of active spermatogenesis, was seen in the testis of some running ripe males (Figure 3B).

Histological assessment of ovarian tissue from 118 tripletail revealed that a high percentage of females captured in April, May and June had not yet reached sexual maturity (Table 2). However, sexually mature fish began ovarian recrudescence in May and early stages of ovarian development were observed in

Table 1. Monthly histological testicular developmental stages of tripletail from the northern Gulf of Mexico. Data from 1994 through 1999 are combined. All values are expressed as percentages.

Stage	April	May	June	July	August	Sept
N	5	6	18	25	35	5
Early Developing	20	0	0	0	0	0
Mid Developing	40	17	6	13	0	0
Late Developing	20	17	0	17	3	0
Running Ripe	20	50	94	70	97	80
Spent	0	16	0	0	0	20
Regressed	0	0	0	0	0	0

females through July. A small percentage of fish were in reproductive condition during June, July and August, with ovaries in either the late developing (Figure 3C) or ripe (oocytes undergoing final oocyte maturation, or FOM; Figure 3D) stages. Regressed fish first appeared in samples by June and the majority of females captured in August and September were regressed (Table 2).

Table 2. Monthly histological ovarian developmental stages of tripletail from the northern Gulf of Mexico. Data from 1994 through 1999 are combined. All values are expressed as percentages.

Stage	April	May	June	July	August	Sept
N	2	7	23	42	34	10
Immature	100	71	52	19	12	0
Early Developing	0	29	22	17	0	0
Mid Developing	0	0	0	7	0	0
Late Developing	0	0	13	17	15	0
Ripe	0	0	4	14	3	0
Spent	0	0	0	0	12	10
Regressed	0	0	9	26	59	90

Tripletail are a multiple spawning species with asynchronous oocyte development, as shown in oocyte size-frequency diagrams (Figure 4). Females in the early, mid and late developing ovarian stages show continuous recruitment of oocytes in all size ranges with no distinct mode of oocytes (Figure 4). Females in the ripe ovarian stage represent those undergoing FOM. Oocytes $\geq$ 550 μm in diameter will undergo hydration and form a distinct mode of larger oocytes prior to actual spawning. Females in the ripe stage continue to show large numbers of developing oocytes, suggesting multiple batches of oocytes would be spawned during the reproductive season. Strong histological evidence for multiple spawning is the presence of developing oocytes in late developing ovaries (Figure 3C) and in ovaries that are undergoing FOM (Figure 3D). Finally, the presence of postovulatory follicles (POF; Figure 3C), indicative of spawning during the prior 24 hour period, show that tripletail have the ability to spawn more than once during the reproductive season. While POF were not common in tripletail ovaries, they were found during all months of the reproductive season.

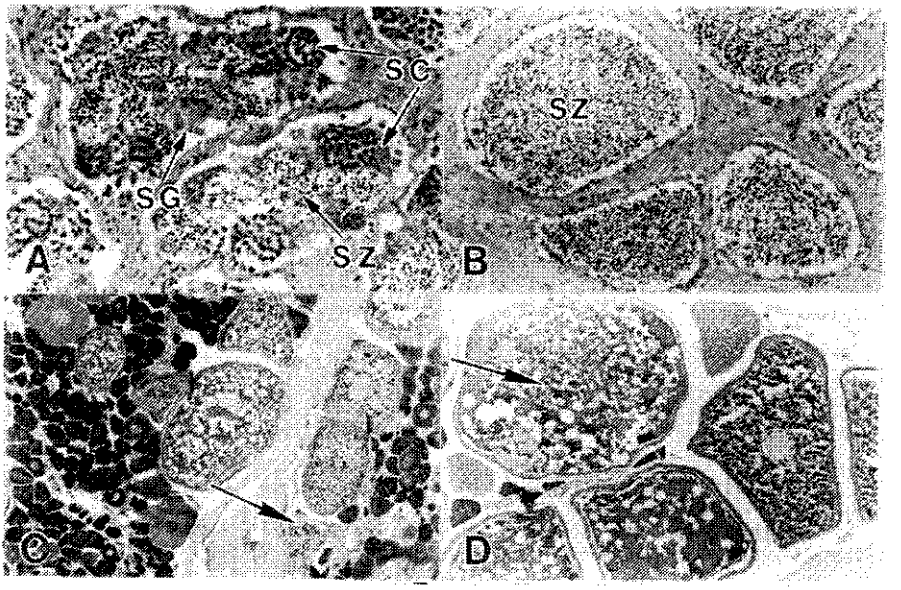

Figure 3. Histological sections of gonadal tissue from tripletail captured in the northern Gulf of Mexico. A. Testis from a tripletail captured in June showing spermatogenic activity throughout the testis. SG, spermatogonia; SC, spermatocytes; SZ, spermatozoa. 138X. B. Testis from a tripletail captured in September with only spermatozoa (SZ) and no spermatogenic activity in the testis. 227X. C. Ovary from a tripletail captured in August in the late developing ovarian stage. Note oocytes in all stages of development and post ovulatory follicle (arrow). 42X. D. Ovary from a tripletail captured in July in the ripe ovarian stage with oocytes undergoing final oocyte maturation (FOM; arrow). Note the presence of other mature oocytes not undergoing FOM in the section. 64X.

Batch Fecundity and Spawning Frequency

Preliminary estimates of batch fecundity were determined from five tripletail with oocytes undergoing FOM that were captured in July 1996 from the northern Gulf of Mexico. Mean batch fecundity values, the length of each fish and the relative batch fecundity, expressed as the number of eggs per g of ovary-free body weight, are presented in Table 3. The overall mean batch fecundity estimate for tripletail is 444,743 ± 201,139 eggs/female. However, batch fecundity appears to be related to fish length in tripletail (Table 3). Relative batch fecundity adjusts for fish size and is a better measurement for comparing fish of different sizes. The mean relative batch fecundity for tripletail is 47.6 ± 18.1 eggs/g ovary-free body weight.

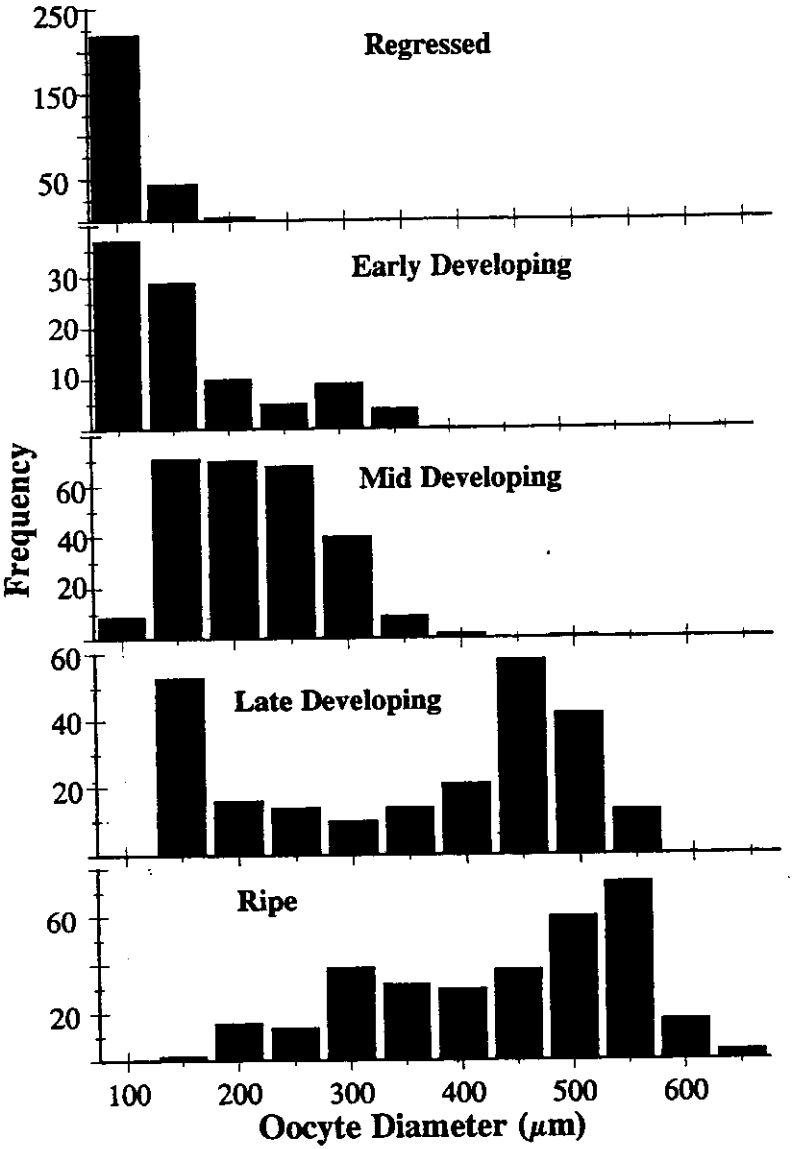

Figure 4. Oocyte size-frequency distribution of female tripletail. Frequency refers to the number of oocytes counted in each 50 μm oocyte diameter interval. Each graph represents data from a single fish at a different reproductive stage.

Table 3. Estimated batch fecundity for five tripletail captured in July 1996 from the northern Gulf of Mexico. Fecundity was estimated from oocytes undergoing final oocyte maturation (FOM).

TL (mm)	Batch Fecundity	Relative Batch Fecundity (eggs/g)
540	66843	20.3
660	335550	49.5
718	162960	22.5
725	455400	N/A[1]
787	1202960	98
Mean	444,743 ± 201,139	47.6 ± 18.1

[1]Fish weight not available for this specimen

Spawning frequency of female tripletail in the late developing or ripe ovarian stages for June, July and August combined (N = 22) was estimated using two methods; the percentage of ovaries containing oocytes undergoing FOM and the percentage of ovaries containing POF. Although the data are limited, spawning frequency estimates range from once every 2.7 days using the FOM method to once every 4.4 days using the POF method. Thus, female tripletail appear to spawn once every three to five days in the northern Gulf of Mexico. Assuming a three month spawning season (June through August), these estimates suggest that an individual female tripletail could spawn between 18 and 31 times during the spawning season, resulting in an estimated total annual fecundity for an average-size adult tripletail of 625 mm TL of 4, 619,866 to 7,956,429 eggs.

DISCUSSION

Data from this preliminary study show that tripletail from the northern Gulf of Mexico are capable of producing multiple batches of oocytes during a spawning season extending from June through August, with peak reproduction in July. Additional collections of tripletail at the beginning and ending of the reproductive season would provide more definitive information on the initiation and cessation of spawning activity. The duration of the spawning season is similar to previous reports of tripletail reproduction in the northern Gulf of Mexico and the southeastern Atlantic Ocean (Baughman 1941 1944, Merriner and Foster 1974). Furthermore, the July peak spawning time coincides with the time of peak larval collections reported by Ditty and Shaw (1993).

The relatively high occurrence of immature female tripletail, as well as the

low percentage of reproductively active fish in our collections, is no doubt related to the offshore spawning nature of the species as hypothesized by Ditty and Shaw (1993). The majority of our samples were taken well inshore of the outer shelf, the location where Ditty and Shaw (1993) captured the smallest tripletail larvae. It appears that non-reproductive fish are most common in Mississippi coastal waters during the spawning season. Juvenile and sub-adult female tripletail were captured most frequently during April through June while spent and regressed females made up the majority of the sample July through September. Although Ditty and Shaw (1993) reported the appearance of a small number of larval tripletail in the Gulf of Mexico in May, the histological data collected during this study does not support tripletail spawning in May. Additional collections of offshore adult fish would allow a more accurate description of the gonadal maturation and spawning of the species.

The gonadal maturation of tripletail is similar to most other multiple spawning species and the low mean GSI values of female tripletail are similar to other large pelagic species such as wahoo (*Acanthocybium solandri*; Brown-Peterson et al. 2000) and yellowfin tuna (*Thunnus albacares*; McPherson 1991). However, the exceptionally low GSI values seen for male tripletail (never > 0.1) have not been previously reported for any other species. The reduction in active spermatogenesis noted in the testis of tripletail at the end of the reproductive season has been reported for other multiple spawning, subtropical species such as snook (*Centropomus undecimalis*; Grier and Taylor 1998), cobia (Brown-Peterson et al. in review) and spotted seatrout (*Cynoscion nebulosus*; Brown-Peterson et al. 1988) and is relatively common in species with an extended reproductive season. Male tripletail appear to reach sexual maturity at a smaller size and younger age than female tripletail. Little information is available on size or age at sexual maturity for the species; Merriner and Foster (1974) reported that males in North Carolina were sexually mature at age 1+, corresponding to a size of 445 mm TL. This is much larger than the smallest sexually mature male from this study, a 290 mm TL individual with an estimated age of 0+. However, Merriner and Foster (1974) also reported that females probably reached sexual maturity at age 1+ in North Carolina, which is in agreement with our calculated 50% maturity of 485 mm TL and estimated age 1. Thus, tripletail appear to grow rapidly during their first year of life, but this rapid growth does not seem to interfere with early sexual development.

This study represents the first attempt to estimate batch fecundity and spawning frequency for tripletail. Although the fecundity measurments presented here are based on small sample sizes, they are similar to batch fecundities reported for other large, migratory pelagic species. The relative batch fecundity of 47.6 eggs/g calculated for tripletail is comparable to 57.7 eggs/g for wahoo (Brown-Peterson et al. 1999), 57 eggs/g for bluefin tuna (*Thunnus maccoyii*;

Farley and Davis 1998), 68 eggs/g for yellowfin tuna (Schaefer 1996) and 62.4 eggs/g for cobia (Brown-Peterson et al. in review). Additionally, the preliminary spawning frequency estimates of once every three to five days for tripletail are similar to estimates for other pelagic species that occur in the northern Gulf of Mexico, such as once every two to six days for wahoo (Brown-Peterson et al. 1999) and once every five days for cobia (Brown-Peterson et al. in review). Thus, although tripletail have a shorter reproductive season than other pelagic species in the northern Gulf of Mexico, their gonadal maturation, batch fecundity and spawning frequency appear to be similar to other species with comparative life histories. Future work on tripletail in the northern Gulf of Mexico should include efforts to obtain samples of offshore adults during spring and summer to increase the sample size of spawning fish which would allow more accurate estimates of spawning seasonality, batch fecundity and spawning frequency.

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