PREDATION ON BLUE TILAPIA BY LARGEMOUTH BASS, IN EXPERIMENTAL PONDS[1]

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Abstract: In pond predation studies, 4 total length (TL) groups (152 - 406 mm TL) of Florida largemouth bass (*Micropterus salmoides floridanus*) were each provided 4 length groups (51 - 140 mm TL) of blue tilapia (*Tilapia aurea*) as forage. Estimated maximum length of tilapia that 38 - 500 mm TL bass can swallow ranged from 36 - 61% of the bass's total length. Bass <254 mm TL ate tilapia which approximated the maximum estimated length they could swallow. Bass >381 mm TL rarely ate tilapia >27% of their total length. Regression analysis of blue tilapia total length (mm) versus body depth (D; mm) was $D = 0.322TL - 2.68$ ($r = 0.99$). Due to the importance of the bass fishery in Florida, the impact of blue tilapia may ultimately be judged largely on its value as bass prey.

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Tilapia possess nearly unique attributes which make them of interest to fish culturists and managers around the world. In the U.S. several species are being evaluated for aquacultural and other purposes. As a result, tilapia, which are native to Africa and range to Syria (Nelson 1976), have been both purposefully and accidentally introduced in open U.S. waters. Some have become established in several southern states, where they are being studied in an attempt to define their interactions with native species.

Blue tilapia are established and widespread in Florida and elsewhere (Buntz and Manooch 1969, Ware 1973, Germany and Noble 1977). The importance of blue tilapia as a forage species has not been documented. As a step towards understanding this relationship, we estimated maximum lengths of tilapia that bass could swallow. These estimates were then tested in small-pond predation studies.

METHODS

Mouth-width was measured on 36 Florida largemouth bass and compared to values reported by Lawrence (1958); no significant differences were found (see also Shireman et al. 1978). Regression analysis on total length (TL) and maximum body depth (D) with folded fins was conducted on 214 fingerling blue tilapia (≤143 mm TL). All measures were in millimeters. The resulting regression equation and equations for estimating largemouth bass mouth-widths (Lawrence 1958) were then used to estimate the maximum total lengths of tilapia that various lengths of bass could swallow.

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About 50 fingerling blue tilapia in each of 4 length groups were stocked in each of 6 0.01-ha weed-free ponds. Tilapia total length groups were 51 - 64, 76 - 89, 102 - 114 and 127 - 140 mm. Largemouth bass were separated into the following total length groups 152 - 178, 229 - 254, 305 - 330 and 381 - 406 mm. Some treatments with bass were not stocked with larger tilapia due to a shortage of these fish. The day after tilapia were stocked 3 bass (same length group) were added to each of 4 ponds. Both control ponds were left without bass. Tilapia had not been exposed to bass predation prior to stocking in experimental ponds.

Trials lasted 10 - 13 days and were replicated twice. After each trial, bass were removed by partially draining and seining ponds, which were then drained completely. All fish were counted and measured.

The difference between number of blue tilapia in a given length group harvested from control and experimental ponds was attributed to bass predation (= adjusted difference). When fewer tilapia were recovered from control than experimental ponds, the negative value was interpreted as no predation of the length group concerned (Lewis and Helms 1964). From these data, adjusted percent utilizations ($APU = D/S \times 100$; where D = mean adjusted difference and S = mean number stocked) were calculated for each bass length group. APU values greater than zero indicate predation; however, small values (e.g. <8) could result from experimental error due to differences in prey recovery.

Fingerling blue tilapia were produced in a 0.1-ha pond at the Non-Native Fish Research Laboratory from brood-fish collected in Polk County, Florida. Florida largemouth bass were collected from Dade and Palm Beach Counties and mouth-widths measured as the external distance between cleithrums per Lawrence (1958).

RESULTS

Regression analysis on blue tilapia total length versus body depth was $D = 0.322TL - 2.68$ ($r = 0.99$). Estimated maximum total lengths of blue tilapia that various sizes of largemouth bass can swallow are given in Table 1.

In pond studies, 152 - 178 mm TL largemouth bass ate 51 - 64 mm TL blue tilapia effectively in the absence of smaller fish (Table 2). This tilapia length group closely approximates theoretical maximum lengths (55 - 64 mm TL) of tilapia that these bass can swallow. Similarly, 229 - 254 mm TL bass ate 76 - 89 mm TL tilapia, which approximates the theoretical maximum lengths (84 - 94 mm TL) of tilapia these bass can eat.

Adjusted percent utilization of the smallest tilapia (51 - 64 mm TL) decreased with increasing bass size. Similarly, APU of 76 - 89 mm TL tilapia was inversely related to bass with lengths >229 mm TL. Tilapia >102 mm TL were rarely eaten; although, these were within the theoretical maximum lengths for the largest bass groups.

DISCUSSION

Predation on blue tilapia in experimental ponds was characterized by largemouth bass (1) feeding almost exclusively on the 2 smaller length groups of tilapia; (2) eating fewer tilapia with increasing size; and (3) rarely eating tilapia longer than the estimated maximum lengths they could swallow. Preferred prey lengths (=

Table 1. Estimated maximum total lengths (EML) of blue tilapia (BT) that various lengths of largemouth bass can swallow.

Bass TL (mm)	Tilapia EML (mm)	$\frac{\text{BT EML}}{\text{Bass TL}} \times 100$
38	23	61%
64	29	45%
89	36	40%
114	42	37%
140	51	36%
165	59	36%
191	68	36%
216	79	37%
241	89	37%
267	99	37%
292	109	37%
318	119	37%
343	130	38%
368	140	38%
394	151	38%
419	172	41%
445	187	42%
470	203	43%
495	219	44%

Table 2. Adjusted percent utilization (APU) of various sizes of blue tilapia by 4 size groups of largemouth bass. Each value is the mean of 3 trials (APU= D/S × 100; where D = mean adjusted difference and S = mean number stocked; EML = estimated maximum total length of blue tilapia that a given size of bass can eat).

Blue Tilapia Size Group	Largemouth Bass Size Group (mm TL)			
(mm TL)	152-178	229-254	305-330	381-406
51-64	67	50	26	16
76-89	8	30	26	16
102-114	0	0	0	2
127-140	22[a b]	0[a]	0[c]	4
EML	55-64	84-94	114-124	146-164

[a] Single value, no replications.
[b] Value due to in-pond mortality not associated with predation.
[c] One replication.

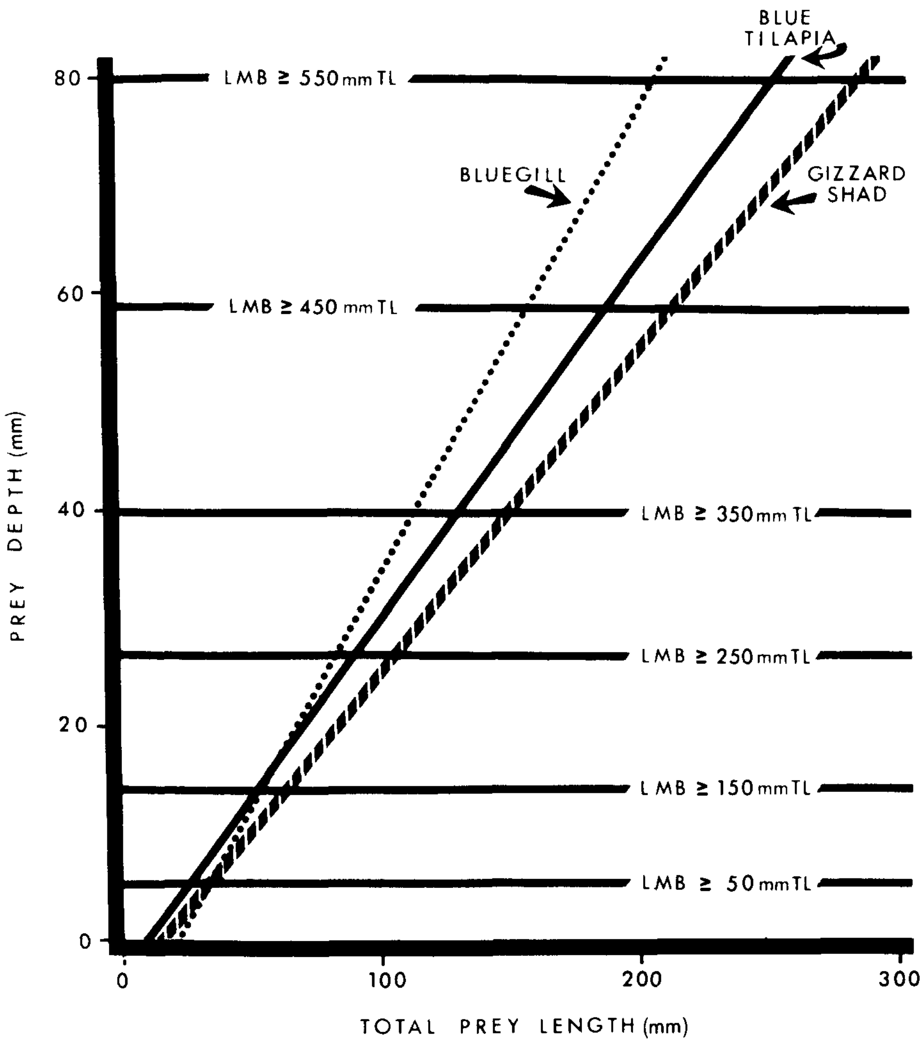

Fig. 1. Comparison of length-depth regressions for bluegill, blue tilapia and gizzard shad with calculated mouth-widths for various sizes of largemouth bass (LMB) indicating estimated maximum total length of prey these bass can swallow. Regressions for bluegill and gizzard shad taken from Lawrence (1958).

mean length of most utilized size group) of blue tilapia, expressed as a percentage of predator length, were inversely related to bass size. Smaller bass preyed on tilapia up to 35% of their length while larger bass preferred tilapia <26% of their length.

These results are consistent with the general pattern of predator prey length relationships reported by others (Tarrant 1960, Popova 1966, Wright 1970, Ludbrook 1974). Such data can be used to develop management plans involving these fishes and to determine size of bass necessary to control reproduction in tilapia culture.

The importance of considering blue tilapia as a forage species lies in its ablility to attain high population densities which may alter existing largemouth bass predator prey associations. There is some evidence that tilapia may be displacing native forage fishes particularly gizzard (*Dorosoma cepedianum*) and threadfin (*D. petenense*) shad (Ware 1973, Germany 1977). Shad are excellent forage for predatory fishes since their vulnerability permits them to be readily taken but not eliminated (Lewis 1967).

Spiny rays are a protective adaptation against predation (Popova 1966) and predators generally prefer soft-rayed fishes (e.g. shad) to spiny-rayed fishes (e.g. bluegill, tilapia). General body shape, spiny-rayed fins and intermediate length-depth relation of blue tilapia (Fig. 1) suggest their forage value may lie between that of shad and bluegill. If this is true, displacement of shad by tilapia, as noted above, may partially be the result of selective bass predation on shad.

There is little information available on tilapia largemouth bass predator prey relations. What data exists (Toots 1972, Ludbrook 1974, Noble et al. 1976) indicate that, under some conditions, bass can grow well but do not attain large maximum sizes (<4.0 kg) in lakes with tilapia forage bases. These data, however incomplete, suggest the value of tilapia as forage may change with bass size.

In conclusion, introduction of blue tilapia in open waterways may cause changes in existing largemouth bass predator prey relations, especially where they become numerous. Due to the importance of bass, these relations need to be quantitatively evaluated. The impact of blue tilapia in Florida and elsewhere may ultimately be judged largely on their value as bass prey.

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