THE FEEDING PREFERENCES OF *TILAPIA AUREA* (STEINDACHNER) FOR FIVE AQUATIC PLANTS*

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Excessive abundance of aquatic plants in ponds and lakes has detrimental effects on fish populations, sport fishing, and dissolved oxygen concentrations. A widely used method of controlling aquatic vegetation is through the use of exotic herbivorous fish, including *Tilapia* spp. (Family Cichlidae). The feeding preferences of the blue tilapia, *Tilapia aurea* (Steindachner), for five aquatic plants were tested in two replicated experiments. Individual tilapia (94-176 g) were placed in heated (25 C), aerated, 75-liter aquaria and offered randomly assigned individual plants in experiment A or 1 of 10 possible paired combinations in experiment B during a 48-hr feeding period. The blue tilapia preferred plants in the following order in both experiments ($p < 0.05$): [1] *Najas guadalupensis* (Spreng.) Magnus and *Chara* sp., [2] filamentous algae (predominantly *Cladophora* sp.), [3] *Potamogeton pectinatus* L., and [4] *P. nodosus* Poir. The data were in agreement with the results of a field study in which the blue tilapia was tested as a biological vegetation control agent. The blue tilapia may, therefore, offer potential for controlling certain species of nuisance aquatic macrophytes.

INTRODUCTION

Emergent, submersed, and floating-leaved macrophytic plants are common and integral component of many ponds and lakes. However, excessive vegetation may result in stunting of fish populations due to excessive escape cover for forage species and the young of predators (1, 2) and limit fishing success (3, 4). Additionally, macrophytes compete with phytoplankton for light and nutrients (5).

A widely used method of controlling aquatic vegetation is through the use of exotic herbivorous fishes, including *Tilapia* spp. (6). Schwartz (7) reported that the blue tilapia, *T. aurea*, controlled vegetation successfully in small ponds dominated by *Najas* and the macrophytic alga *Chara*, stocked at densities of 500/ha and 2500/ha. Shell (8) and Avault (9) similarly observed some control of macrophytes and filamentous algae by blue tilapia at high stocking densities.

Although it has been reported that blue tilapia prefers filamentous algae over macrophytes (8, 9, 10, 11, 12), there are little published data on the feeding preferences of the species for macrophytes. Shell (8) and Avault (9) stated that blue tilapia consumed *Najas*, *Eleocharis*, and *Potamogeton*, but they did not rank preference.

The objective of this study was to determine the feeding preferences of blue tilapia for *Najas guadalupensis*, *Chara* sp., *Potamogeton pectinatus*, *P. nodosus*, and filamentous algae (predominantly *Cladophora* sp.). The results were used in conjunction with data from a field study to determine the effectiveness of *T. aurea* as a biological vegetation control agent.

PROCEDURE

The feeding preferences of blue tilapia for *N. guadalupensis*, *Chara*, *P. pectinatus*, *P. nodosus*, and *Cladophora* were tested in two replicated experiments. Tilapia were maintained in aerated aquaria and fed a daily ration of commercial catfish feed. Test fish were selected at random from this stock and a fish that weighed 110-176 g (experiment A) or 94-130 g (experiment B) was placed in each of 10, 75-liter opaque plastic aquaria. The mean weights of fishes among treatments within each experiment were

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similar. The water in the aquaria was aerated, filtered, and warmed to 24.9 ± 0.8 C in experiment A, and 24.7 ± 0.5 C for experiment B.

The test fishes were starved for 48 hr to allow clearing of the digestive tract and then offered randomly assigned individual plants in experiment A and 1 of 10 possible paired combinations in experiment B. Preliminary testing indicated that consumption would not exceed 25 g for any plant. Plants were selected from a fresh stock for each replicate. The plants were rinsed and blotted with paper towels, weighed (wet weight), and 25-g samples of each plant were offered at the start of a 48-hr feeding period. Lead plant anchors were fastened at the base of each plant or pair of plants to prevent them from floating in the aquaria. At the end of the test period, all uneaten plants and plant fragments were removed, rinsed, blotted, and weighed to determine the amount ingested.

Each individual fish was used in only one feeding trial, i.e., new fishes were used in each replication of each experiments. All aquaria were cleaned thoroughly, filter material was replaced, and water changed before the start of each replication.

The data from experiment A were analyzed by analysis of variance (ANOVA) and Duncan's multiple range test. A paired *t*-test was used to measure effects in experiment B. In addition, mean consumption of individual plants in experiment B was analyzed by ANOVA and Duncan's multiple range test.

RESULTS AND DISCUSSION

In experiment A, mean consumption of *Najas* (17.5 g) and *Chara* (17.9 g) were not significantly different, and both were eaten in significantly greater quantities than any other plant (Table 1). Preference declined significantly ($p < 0.05$) for consumption of these two species compared to that of filamentous algae (14.0 g), *P. pectinatus* (9.1 g), and *P. nodosus* (.04 g).

The observed preferences among plant pairs in experiment B were in agreement with the results of experiment A (Table 2). There was a significant difference ($p = 0.0031$ to 0.0425) among five pairs, and in four additional pairs there were appreciable, but non-significant, differences. There was no preference when *Najas* and *Chara* were offered simultaneously. A comparison of mean consumption of individual plants, irrespective of pairing, resulted in a ranking of preference identical to that in experiment A ($p < 0.05$).

Maximum mean consumption of any individual plant during 48 hr was about 18 g regardless of whether one or two plants were offered. However, in experiment B, total consumption, i.e., the total amount of both plants ingested within a pair, exceeded 25 g among the pairs representing the most preferred plants *(Najas* and *Chara*, *Najas* and filamentous algae, and *Chara* and filamentous algae). Conversely, mean total consumption among the least preferred pair, *P. pectinatus* and *P. nodosus*, was only 5.1 g.

Herbivorous fishes, including tilapia, have been shown to favor the softer, more easily broken up and digestible macrophytes in feeding preference tests. For example, Lahser (13) reported that *T. mossambica* preferred the small, floating *Lemna* and *Azolla* over larger, rooted macrophytes. In the present study the fine leaves and stems of *Najas* and the short branches of *Chara* were torn apart whereas the larger stems and leaves of *Potamogeton*, particularly *P. nodosus*, were not.

Data on macrophyte consumption in the aquarium experiments were in close agreement with the results of a pond study in which blue tilapia was tested as a biological agent for vegetation control. Schwartz (7) reported that *Najas* and *Chara* were controlled successfully by blue tilapia stocked to 500/ha and 2500/ha, while *P. nodosus* persisted in the test ponds throughout the study.

TABLE 1. *Mean consumption of four macrophytic plants and filamentous algae (predominantly* Cladophora*) by* Tilapia.*

Mean consumption, g					ANOVA		
Najas guadalupensis	*Chara* sp.	Filamentous algae	*Potamogeton pectinatus*	*Potamogeton nodosus*	MSE	F	Prob> F
17.5[a]	17.9[a]	14.0[b]	9.1[c]	0.4[d]	5.123	41.13	0.0001

*Means with a common superscript were not significantly different at $p < 0.05$ as determined by Duncan's multiple range test. Mean weight of fishes was 138 g (range 110-176 g).

TABLE 2. *Mean consumption of four macrophytic plants and filamentous algae (predominantly* Cladophora*) by* T. aurea.*

Plant pair†	Mean consumption, g					t-test	
	Najas guadalupensis	Chara sp.	Filamentous algae	*Potamogeton pectinatus*	*Potageton nodosus*	T	Prob >T
NG - C	15.7	14.1	—	—	—	0.25	0.8226
NG - FA	17.8	—	8.4	—	—	1.65	0.2407
NG - PP	15.3	—	—	3.5	—	2.41	0.1372
NG - PN	16.1	—	—	—	0.0	4.70	0.0425
C - FA	—	18.0	10.3	—	—	3.76	0.0641
C - PP	—	15.3	—	4.6	—	11.79	0.0071
C - PN	—	16.3	—	—	0.0	14.13	0.0050
FA - PP	—	—	8.2	3.7	—	2.45	0.1338
FA - PN	—	—	9.1	—	0.2	17.29	0.0031
PP - PN	—	—	—	5.0	0.1	5.01	0.0375

Plant pair	Plant category					t-test	
	Najas guadalupensis	Chara sp.	Filamentous algae	*Potamogeton pectinatus*	*Potageton nodosus*	T	Prob >T
Mean‡	*16.2*[a]	15.9[a]	9.0[b]	*4.2*[c]	*0.1*[d]	—	—

*Mean consumption of paired plants was considered significantly different if $p < 0.05$ as determined by a paired *t*-test. Individual means with a common superscript were not significantly different at $p < 0.05$ as determined by a Duncan's multiple range test. Mean weight of fishes was 106 g (range 94-130 g).

†NG = *Najas guadalupensis*, C = *Chara* sp., FA = filamentous algae, PP = *Potamogoton pectinatus*, and PN = *P. nodosus*.

‡ANOVA: MSE = 11.67 (variance among replicates within plant categories); F = 52.46; Prob > F = 0.0001.

The previously reported preference of blue tilapia for filamentous algae, e.g., *Pithophora* over macrophytes (8, 9, 10, 11, 12) did not occur in our study (Tables 1 and 2). In addition, field data did not reveal a preference for filamentous algae over macrophytes (7). This difference from previously published observations may have resulted from differences in genera of algae involved in the studies. Feeding preference for *Cladophora* has not been tested previously.

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