Niche specificities of eleotrid fishes in a tropical estuary

by

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Abstract: Five species belonging to the teleost fish family Eleotridae (sleepers) are known to coexist in the Tortuguero estuary of Caribbean Costa Rica and adjacent estuaries. Three of these forms, *Dormitator maculatus, Eleotris amblyopsis,* and *Gobiomorus dormitor* are found amongst the root masses of water hyacinths along the borders of the lower estuary. The study was carried out to determine how these forms divide their environmental resources to avoid competition. Field investigations were carried out at Tortuguero in September of 1977. Results suggest that *Eleotris amblyopsis* is the dominant species in the hyacinth root masses and is largely carnivorous, feeding on invertebrates and larval fishes. Only small individuals of *Dormitator maculatus* are found in this habitat and these forms utilize plant materials in addition to invertebrates. *Gobiomorus* has feeding habits similar to *E. amblyopsis* but occupies benthic areas sheltered by the hyacinth mats. A fourth eleotrid in the system, *Eleotris pisonis,* has food habits similar to *E. amblyopsis,* but appears restricted to fresh-water tributaries of the estuarine system where *E. amblyopsis* is less abundant. The fifth eleotrid species, *Leptophilypnus fluviatilis,* appears to inhabit benthic areas of the lower estuary, but is extremely uncommon in this system.

Tropical estuarine systems remain among the least studied of the world's natural ecosystems. While it is difficult to find an estuarine system that is unaltered by human activities, the Tortuguero estuarine system (Caribbean Costa Rica) presently shows little direct human influence. Its fortuitous proximity to the Green Turtle nesting beaches and the facilities of the Caribbean Conservation Corporation have stimulated several workers to study this system (Caldwell, Ogren and Giovannoli, 1959; King, 1962; Gilbert and Kelso, 1971; Frost, 1974; and Nordlie and Kelso, 1975). Among the multitude of fascinating new questions that have been posed following these works is that of how the various closely-related members of several faunal groups are able to coexist in this and similar situations. The group that will be considered here is the teleost family Eleotridae which is represented in the fauna of the Tortuguero estuary by 5 species: *Dormitator maculatus* (Bloch); *Eleotris amblyopsis* (Cope); *Eleotris pisonis* (Gmelin); *Gobiomorus dormitor* (Lacepède); *Leptophilypnus fluviatilis* (Meek and Hildebrand). This group was singled out for study based upon the following:

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a. This is a euryhaline "peripheral" division family of world-wide distribution and as such the species are expected to be tolerant of wide ranges of environmental salinities, but little hard information exists on the salinity tolerances and preferences of these forms.
b. Little is known about the feeding habits of these forms in their natural habitats.
c. Several of the eleotrid species are reported to be largely confined to the hyacinth root masses in the Tortuguero estuary (and similar estuaries?) begging the question as to whether or not they compete with one another under these circumstances.
d. Several of the eleotrids that are present in the Tortuguero estuary have wide distributions, ranging from the temperate east coast of the U.S.A., southward, deep into the tropics. The Tortuguero situation is an ideal one in which to evaluate environmental requirements of these species where they coexist in a tropical habitat.
e. Little is known of the importance of hyacinth rafts in the economics of tropical rivers. The works of Knöppel, 1970, stand almost alone in this area. This investigation should ultimately yield further insight into the contributions of hyacinths to estuarine food chains.
f. The fact that larvae of at least two of the species are members of the aggregations known as *tismiche*, makes the study all the more interesting.

The broad question being asked in this study is: "How do 5 closely related species of eleotrid fishes manage to coexist in this system? " The question was subdivided to deal with physical, chemical, and biological interactions. These will be considered sequentially in the text.

MATERIAL AND METHODS

Fishes were collected in the hyacinth mats of the estuary (see Fig. 1 for collecting stations) using a dip net with a nylon bag of fine mesh. The net was inserted under a clump of hyacinths, lifted to pick up the clump, and the contained hyacinths were lifted out and shaken over the bag to dislodge any fish. The material in the bag was sorted to separate fish from plant debris. All fishes taken were preserved in 10% formalin and later transferred to 70% ethyl alcohol. The periods of collecting at each station were of roughly equal duration so the numbers of specimens in the various collections give a very crude index of relative abundances at the collecting stations. Lengths of specimens were measured in the laboratory and are expressed as standard lengths (tip of snout to base of caudal peduncle).

Field measurements of dissolved oxygen concentrations and water temperatures were made with a YSI Model 57 Oxygen Meter and the included thermister. Salinity determinations were made in the field using an AO-Goldberg temperature-compensated refractometer.

Food preferences were determined from preserved specimens by removing each alimentary tract, teasing it open with dissecting needles and conducting a microscopic examination of the contents.

Salinity tolerances of *Eleotris amblyopsis* were evaluated by subjecting groups of this species to transfers from the salinity at which they were collected ($1^{o}/oo$) to salinities higher or lower than this: (a) fresh water; (b) Caribbean sea water diluted

1:1 with fresh water; (c) undiluted Caribbean sea water ($29^{o}/oo$). Groups (8 individuals) were transferred from the original bath directly to each of the experimental salinities. The individuals were checked every hour for the first 4 hours, at 8 hour intervals for the next two days and thereafter once a day until the experiment was terminated at the end of 4 days.

Statistical procedures followed Simpson, Roe and Lewontin, 1960, Siegal, 1956, and the application of Spearman rank correlation to diet comparisons followed Fritz, 1974.

RESULTS AND DISCUSSION

Teleost species collected from the hyacinth root masses: Efforts to collect fishes in the estuary in the fall of 1977 were confined to the hyacinth root masses as all of the species of eleotrids known from the Tortuguero estuary had previously been taken in or beneath hyacinth mats. The results of these collecting efforts in 1977 at 17 stations within the estuary during the wet season of the late summer are found in Table 1. A total of 190 individuals belonging to this family were taken from stations located in the area between the Boca and station 6, a distance of 9 km upstream (see Fig. 1 for locations). Only 2 species of eleotrids were taken in the 1977 collections–*Dormitator maculatus* and *Eleotris amblyopsis,* the latter of which constituted 97% of the individuals collected. Collections made prior to 1977 included a recorded total of 356 specimens (not considering the unidentified individuals taken in *tismiche* collections) of which 260 or 73% were *Eleotris amblyopsis.* Individuals of *Dormitator maculatus* constituted 10% of earlier collections compared with the 3% in 1977. However, the bulk of individuals of *D. maculatus* collected prior to 1977 were taken in a single collection from near Tortuguero village (Caldwell, Ogren and Giovannoli, 1959). The absence in the 1977 collections of three species of eleotrids that were previously taken from similar habitats and by similar techniques cannot be explained at this time.

A summary of the recent collection records along with those of the previous collectors enables one to construct a preliminary habitat matrix for members of this family group in Tortuguero estuary. An analysis of the notes of Caldwell, Ogren and Giovannoli (1959), and Gilbert and Kelso (1971), leads to the following conclusions regarding the distributions of the 5 species of eleotrids: *Dormitator maculatus* was collected largely from hyacinths, both in the estuary and freshwater tributary streams. *Eleotris amblyopsis,* the most abundant of the eleotrids in this system is also the most ubiquitously distributed of the species, being common in the estuary among and near hyacinths, in the freshwater tributary streams and, as juveniles, in the *tismiche* of the open waters of the estuary. The closely related *Eleotris pisonis* was found inabundantly in similar habitats with relatively more specimens taken in the freshwater streams. Gilbert and Kelso (1971) suggested that both *E. amblyopsis* and *E. pisonis* were likely present in the *tismiche* though they were unable to distinguish between the species in individuals of the sizes found in the *tismiche*. *Gobiomorus dormitor* was taken in the shallows of the estuary and in freshwater streams, but only rarely found associated with the hyacinths. The least abundant of the 5 species of eleotrids in the estuary, *Leptophilypnus fluviatilis,* was taken in or near hyacinths in the estuary, but not from freshwater streams.

Gilbert and Kelso (1971) commented that *Dormitator maculatus* appeared less common in their collections than in those of Caldwell, Ogren and Giovannoli (1959), but they attributed this to the greater emphasis on collecting in and around hyacinth mats by the earlier workers.

TABLE 1

Summary of fish collections from hyacinth root-mats, September, 1977, by stations as indicated on map in Fig. 1

Station N^0	Species	Number of Individuals
1	*Eleotris amblyopsis*	2
2	*Eleotris amblyopsis*	9
3	*Dormitator maculatus*	1
	Eleotris amblyopsis	16
4	No fishes taken	
5	*Dormitator maculatus*	1
6	*Eleotris amblyopsis*	8
7	*Eleotris amblyopsis*	16
8	*Eleotris amblyopsis*	22
9	*Cichlasoma friedrichsthali*	1
	Dormitator maculatus	2
	Eleotris amblyopsis	15
10	*Eleotris amblyopsis*	19
11	*Eleotris amblyopsis*	12
12	*Dormitator maculatus*	1
	Eleotris amblyopsis	1
13	*Eleotris amblyopsis*	3
14	*Astyanax fasciatus*	1
	Eleotris amblyopsis	13
15	*Cichlasoma friedrichsthali*	1
	Eleotris amblyopsis	15
16	*Eleotris amblyopsis*	27
17	*Eleotris amblyopsis*	7
TOTALS:	Family Characidae	
	Astyanax fasciatus aeneus	1
	Family Cichlidae	
	Cichlasoma friedrichsthali	2
	Family Eleotridae	
	Dormitator maculatus	5
	Eleotris amblyopsis	185

The only species taken from the hyacinth root mats in the 1977 collections, in addition to the two eleotrids, were a characid, *Astyanax fasciatus*, and a cichlid, *Cichlasoma friedrichsthali*, both of which are known to be relatively abundant in the estuary. Since the totals for these forms in the hyacinth mat collections included only one individual of the former species and two individuals of the latter species, it seems reasonable to assume that neither is regularly associated with this habitat.

Physico-chemical environment of the hyacinth root masses: Measurement of dissolved oxygen concentrations, water temperatures and salinities were made in the waters beneath the hyacinth root masses at all collecting stations, during the late summer of 1977. As one might expect, during the rainy season in such a flowing system water temperatures and dissolved oxygen concentrations differed little, amongst the hyacinth root masses, from those in the adjacent open waters of the estuary. Water temperatures differed no more than 1-2 C from the open water conditions and dissolved oxygen concentrations amongst the hyacinth roots were found to be no lower than 65-70% of saturation for the existing temperatures and salinities. Obviously these conditions obtained during a wet season when fresh water flow was high. A second part of this evaluation will be to make similar measurements of oxygen concentrations and water temperatures at the height of a dry season.

The Tortuguero estuarine system shows a stratification with respect to salinity due to the interfacing of fresh waters and tide waters. The depth to the zone of mixing between these layers is obviously a function of the rate of fresh water inflow and the stage of the tide. This was previously discussed by Nordlie and Kelso (1975). During wet seasons this area of mixing is typically at depths of 1-4 m. During the height of the dry season when there is little fresh water inflow, high salinity levels are found even at the surface. The highest salinities detected in the hyacinth root zone in the 1977 work were of 2°/oo in the lower regions of the estuary, with the highest salinities approaching 0°/oo at stations higher in the estuary. Results of these evaluations for a selected series of stations are found in Table 2. The hyacinth root masses do not appear to extend below a depth of 0.5 m thus, during the wet season the hyacinth root zone is one of low salinities. Again, we must wait for an opportunity to make similar evaluations during the height of the dry season to comment on the other extreme, though the salinities can go no higher than those of the tide waters which are typically in the range of 29-30°/oo.

TABLE 2

Salinities at a selected group of collecting stations in the Tortuguero Estuary, September, 1977

Location	Station N° on Map	Depth of Sample	Salinity °/oo
Boca	13	surface	1.0
		0.15 m	1.0
		0.50 m	2.0
Midway between Boca and GTL	10	surface	0.0
		0.15 m	1.0
		0.50 m	1.9
Canal south of Cuatro Esquinas	11	surface	0.0
		0.15 m	0.0
		0.50m	0.0
Up river from Cuatro Esquinas	14	surface	0.0
		0.15 m	0.0
		0.50 m	0.0

Salinity tolerances of eleotrids: Experiments were carried out with individuals of *Eleotris amblyopsis* to determine their salinity tolerances and rates of acclimation to altered salinities. It was assumed that fishes in this system would not encounter waters of salinities lower than those of the local ground waters nor higher than those of the open Caribbean. A large collection of individuals of this species was made at station 3 just off the Green Turtle Station. These were maintained for one day in water taken at the collecting station. Three groups of 8 individuals each were then taken at random with respect to size, and were transferred directly to test salinity baths. The 3 test salinities were fresh water, 50% sea water, and full sea water(29°/oo). No individualsdied, either during the initial day when all were held in water taken at the collecting site, or subsequently in any of the test salinity baths. The fishes were held in the test salinities for a period of 4 days, with no evidence of stress symptoms in any of the individuals. At the end of the 4th day the experiment was terminated. It is obvious that individuals of *E. amblyopsis* can tolerate instantaneous changes in salinity of any magnitude that they would encounter in this system.

No experimental work has yet been carried out to determine salinity tolerances of the other 4 species found in the estuary. However, certain tentative conclusions can be drawn from information in the literature along with observational data. The 5 specimens of *Dormitator maculatus* taken in the 1977 collections were from stations 3 (1 specimen), 5 (1 specimen), 9 (2 specimens), and 12 (1 specimen). All of these stations are in the lower region of the estuary. All of the individuals were small, ranging in standard lengths from 2.3 to 3.6 cm, well below the size of sexual maturity as given by Sterba, 1962. Gilbert and Kelso, 1971, had previously noted the small sizes of specimens of *D. maculatus* taken in Tortuguero collections. Obviously there must be a breeding population of this species somewhere in the estuarine system, as specimens have previously been collected from the freshwater tributaries of the system where tidewaters could not carry them. Sexually mature individuals or individuals large enough to become sexually mature have never been taken at any depth or in any habitat in this system. Bailey, Winn and Smith, 1954, took *D. maculatus* in freshwaters in spring collections from the Escambia river system of Florida and Alabama. Specimens were taken from waters ranging in salinity from1.8-22.6°/oo in fall collections. They assumed the species to be anadromous. McLane, 1955, found specimens of *D. maculatus* only in freshwater streams tributary to the St. Johns river in Florida. His collections included both sexually mature individuals (December) and juveniles (over a good part of the year). He also suggested that this species has anadromous breeding habits. Tagatz, 1967, also reported sexually mature individuals of this species in freshwater (60 miles upstream) in the St. Johns river system. Tabb and Manning, 1961, reported *D. maculatus* from brackish Florida mangrove swamps. Brockman, 1974, took gravid females from canals in south Florida at salinities of 0°/oo, 8.9°/oo and 35.3°/oo. Sterba, 1962, comments that *D. maculatus* cannot be kept in pure freshwater. However, Darnell, 1962, reported *D. maculatus* to live and breed in freshwater in the Río Tamesi of Mexico. Thus the situation is still confused. Our next collecting efforts for this species will be concentrated on the freshwater tributaries of the Tortuguero system. The distribution of young through the system does seem consistent with anadromous breeding habits.

Habitat restrictions of the other species are also less than clearly defined. Koenig, *et al.*, 1976, report *Gobiomorus dormitor* as a resident of Lake Nicaragua. This species is also known from the brackish canals of south Florida (Kushlan and Lodge, 1974). It may be that *Gobiomorus* is another anadromous form that has become landlocked in some areas.

Breder, 1948, referred to *Eleotris pisonis* as the "freshwater goby". Its distribution in the Tortuguero estuary suggests that it does prefer the freshwater tributary streams of the system. However, Bailey, Winn and Smith, 1954, took adult and subadult *E. pisonis* from brackish waters (1.8-24.4^{o}/oo) of the Escambia River system in the fall of the year. Young specimens were taken from fresh waters in the spring, leading to the provisional classification of this species as anadromous.

The only information on *Leptophilypnus fluviatilis* is the statement of Caldwell, Ogren and Giovannoli, 1959, that they collected this species from brackish water in the lower estuary.

Distribution of *Eleotris amblyopsis* **by size-groups:** The estuary was arbitrarily divided into upper and lower zones—the region between the Boca and Cuatro Esquinas the lower zone, and the region from Cuatro Esquinas to the island the upper zone—for purposes of evaluating the size distributions and food habits of *Eleotris amblyopsis* within the study area. A Chi-square test for homogeneity was run on grouped data with the null hypothesis that there would be no differences in distributions of *E. amblyopsis* by size-group between the lower and upper regions. The results of this analysis are found in Table 3. A Chi-square value of 18.57 with 5 degrees of freedom was obtained, resulting in the rejection of the null hypothesis as the individuals collected from the two areas would be expected to show the indicated variation by chance alone only 0.5% of the time if they were taken from a homogeneous population. An inspection of the data presented in Table 3 reveals that the range in sizes of individuals in the downstream zone is greater, with a larger fraction of large individuals from this region. However, the population composition in any specific area may not be the direct result of differential habitat suitability within the hyacinths but rather be due to some factors associated with the likelyhood of the planktonic juveniles attaining shelter in a certain hyacinth mat under prevailing environmental conditions. One can speculate that if the rainfall is

TABLE 3

Chi-square test of homogeneity

SIZE-CLASS Standard length in cm	Downstream	Upstream	Total	Ratio	Sample 1 X Ratio
less than 2.0 cm	10	2	12	0.833	8.33
2.0-2.9	45	46	91	0.495	22.28
3.0-3.9	44	11	55	0.800	35.20
4.0-4.9	12	5	17	0.706	8.47
5.0-5.9	4	3	7	0.571	2.29
6.0 and greater	3	0	3	1.000	3.00
Totals	118	67	185	0.638	79.57

$\chi^2 = 18.57$
5 degrees of freedom
Significant at 0.5% level

heavy and thus the freshwater discharge is great that a particular group of planktonic larvae may be swept downstream and thus develop a greater strength of their age and size-group in the lower region. When tides are the major distributional force, the occupation of hyacinth mats may be more at random. It remains to be determined where this, or any of the other eleotrids, actually deposit their eggs in the Tortuguero system.

Feeding habits of eleotrids: The available information on feeding habits of the eleotrid fishes that inhabit the Tortuguero estuary is very limited. The summary given here includes information gathered in the several collecting efforts that have been made in the estuary as well as elsewhere, but with an extensive analysis of feeding habits only of *Eleotris amblyopsis.*

TABLE 4a

Correlation of food preferences of 2.0-2.9 cm E. amblyopsis *in lower and upper regions of Tortuguero Estuary (Spearman rank correlation)*

	Lower Estuary		Upper Estuary	
Food Item	%occur.	Rank, corrected	%occur.	Rank, corrected
Plant material, macrophyte	9.3	5.5	8.9	5.5
Mollusca	4.7	4.0	6.7	4.0
Insecta, immature	51.2	12.0	80.0	12.0
Thrips	0.0	1.0	2.2	2.5
Diptera, mature	2.3	2.5	11.1	7.5
Shrimp, post-larvae	41.9	10.0	81.9	5.5
Ostracoda	9.3	5.5	11.1	7.5
Copepoda	25.6	8.5	22.2	10.0
Cladocera	44.2	11.0	73.3	11.0
Isopoda	25.6	8.5	15.6	9.0
Amphipoda	2.3	2.5	0.0	1.0
Teleost fish, juvenile	11.6	7.0	2.2	2.5

r_s = 0.713, N = 12, significant at 0.01 level

The alimentary canals of all 185 individuals of *E. amblyopsis* taken in 1977 collections were examined and the contained materials identified. These data were analyzed to determine whether or not small and large individuals utilized similar food resources and whether or not the individuals in the downstream region of the system utilized food resources similar to those utilized in the upstream region. The results of these analyses are found in Tables 4a and 4b, and 5.

The first analysis—to compare food preferences of individuals between the lower and upper regions of the system—was carried out by utilizing data for the two size-groups that contained the largest numbers of individuals. This was done because of the previous demonstration that the distributions of individuals by size-groups differed between the upper and lower regions of the estuary. Individuals

TABLE 4b

Correlation of food preferences of 3.0-3.9 cm
E. amblyopsis *in lower and upper regions of Tortuguero Estuary*
(Spearman rank correlation)

Food Item	Lower Estuary %occur.	Lower Estuary Rank, corrected	Upper Estuary %occur.	Upper Estuary Rank, corrected
Plant material, macrophyte	23.8	8.5	10.0	7.0
Mollusca	19.0	7.0	0.0	3.0
Insecta, immature	71.4	11.0	60.0	10.5
Diptera, mature	16.7	5.5	0.0	3.0
Egg masses, insect	4.8	1.5	0.0	3.0
Shrimp, post-larvae	23.8	8.5	20.0	9.0
Ostracoda	4.8	1.5	10.0	7.0
Copepoda	11.9	4.0	0.0	3.0
Cladocera	38.1	10.0	60.0	10.5
Isopoda	16.7	5.5	0.0	3.0
Teleost fish, juvenile	7.1	3.0	10.0	7.0

r_s = 0.641, N = 11, significant at 0.05 level.

of the 2 groups that showed greatest abundances–the 2.0-2.9 cm group and the 3.0-3.9 cm group–were utilized in this analysis. The analysis for the smaller group is found in Table 4a, and for the larger group in Table 4b. Comparisons were made by use of Spearman rank correlations. It can be seen from the data that in both cases the correlations were highly significant, leading to the conclusion that at least

TABLE 5

Correlation of food preferences of small and large E. amblyopsis *(Spearman rank correlation)*

Food Item	Small Individuals %occur.	Small Individuals Rank, corrected	Large Individuals %occur.	Large Individuals Rank, corrected
Plant material macrophyte	8.0	8.0	22.4	11.0
Mollusca	5.0	5.0	17.1	10.0
Insecta, immature	61.0	14.0	61.8	14.0
Thrips	1.0	2.5	0.0	1.0
Diptera, mature	6.0	6.5	11.8	9.0
Egg masses, insect	0.0	1.0	2.6	4.0
Shrimp, post-larvae	25.0	12.0	23.6	12.0
Ostracoda	14.0	9.0	6.6	5.0
Copepoda	23.0	11.0	7.9	6.5
Cladocera	58.0	13.0	36.8	13.0
Isopoda	20.0	10.0	10.5	8.0
Amphipoda	1.0	2.5	1.3	2.5
Hydracharina	2.0	4.0	1.3	2.5
Teleost fish, juvenile	6.0	6.5	7.9	6.5

r_s = 0.757, N = 14, significant at 0.01 level the larger fraction of individuals of this species are utilizing similar food resources with similar frequencies throughout the estuary.

The next question considered was whether or not the smaller individuals of *E. amblyopsis* (less than 2.0 cm) showed food preferences similar to those of the larger individuals. Each individual collected was assigned to one or the other of the size-groups based upon its standard length. Again the results for the two groups were highly correlated (Table 5). Consequently all results were pooled and the food preferences of *E. amblyopsis* were summarized by calculating the total frequencies of occurrence in individuals of each of the food items. These results are presented in Table 6. It can be seen that *E. amblyopsis* is predominantly a carnivorous form though individuals do ingest some plant material. Immature insects, cladocera, and postlarval shrimp were the food items with the highest frequencies of occurrence. These were also the most important items in terms of volume of food taken, based upon my subjective evaluation.

The only other eleotrids taken in 1977 collections were individuals of *Dormitator maculatus.* Information on food preferences of this form included recent data as well as from other sources as indicated in Table 7. Plant material would appear to be of greater importance in the diet of *D. maculatus* than of *E. amblyopsis,* but *Dormitator* is by no means an herbivorous form. *D. maculatus* individuals taken from the Tortuguero estuary were found to utilize the same arthropod forms as were found in the diets of *E. amblyopsis.* A summary of food habits of *D. maculatus* is found in Table 7.

Information on *Gobiomorus dormitor* in Table 8 was taken from Kelso (1965), Nordlie and Kelso, (1975), and Zaret and Rand, (1971). This form has been found to feed on shrimp in the Tortuguero estuary and on fish and immature insects in a river in Panama (Zaret and Rand, 1971).

TABLE 6

Summary of food preferences of
E. amblyopsis—*all size-classes pooled*

Food Item	% of individuals with food item in alimentary canal
Immature insects	61.4
Cladocera	48.9
Shrimp, post-larvae	25.6
Copepoda	16.5
Isopoda	15.9
Plant material, macrophyte	14.2
Ostracoda	10.8
Mollusca	10.2
Diptera, mature	8.5
Teleost fish, juvenile	6.8
Hydracharina	1.7
Amphipoda	1.1
Egg masses, insect	1.1
Thrips	0.6

TABLE 7

Summary of information on feeding habits of
Dormitator maculatus

Food Items	% of individuals containing these items
Tortuguero, 1977	
Copepods	80
Plant material macrophyte	60
Immature insects	40
Ostracoda	40
Algae (diatoms)	20
Coleoptera, mature	20
Shrimp, post-larvae	20
Cladocera	20
Sterba, 1962	
Small fishes	
McLane, 1955	
Primarily plant material	

TABLE 8

Summary of information on feeding habits of
Gobiomorus dormitor

Food Item	% occurrence (wet season)
Kelso, 1965, and Nordlie and Kelso, 1975	
Shrimp	
Zaret and Rand, 1971	
Fish	67
Ephemeroptera	33
Odonata	33
Chironomidae	33

No Tortuguero data exist for feeding habits of either *Eleotris pisonis* or *Leptophilypnus fluviatilis.* It seems reasonable to expect that *E. pisonis* differs little in food preferences from *E. amblyopsis* as Sterba (1962) suggests that *E. pisonis* and other members of this genus are primarily carnivorous. What the food preferences are of the smallest of the Tortuguero eleotrids, *L. fluviatilis,* remain to be determined.

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TABLE 9

Niche partitioning of 5 species of eleotrid fishes in the tortuguero estuary

Species	Salinity of Habitats	Depth in Water Column	Cover	Abundance	Food Preferences
Dormitator maculatus	freshwater streams and lower estuary	young in hyacinths	hyacinths	rare	omnivorous
Eleotris amblyopsis	ubiquitous	upper	hyacinths	abundant	largely carnivorous
Eleotris pisonis	largely streams. Called "freshwater goby" by Breder, 1948	upper	hyacinths	rare in estuary	carnivorous
Gobiomorus dormitor	mainly lower estuary	benthic	indifferent	common	carnivorous
Leptophilypnus fluviatilis	lower estuary	benthic?	under hyacinths	rare	carnivorous?

RESUMEN

Cinco especies de peces teleosteos, pertenecientes a la familia Eleotridae coexisten en el estuario de Tortuguero y otros estuarios adyacentes en las costas del Caribe en Costa Rica. Tres de estas especies, *Dormitator maculatus, Eleotris amblyopsis,* y *Gobiomorus dormitor* se encuentran entre las masas de raíces del lirio acuático *Eichornia crassipes* a lo largo de las márgenes del estuario bajo. Este estudio fue llevado a cabo para determinar la manera en que estas especies se dividen los recursos ambientales para evitar la competencia. Los experimentos de campo fueron realizados en Tortuguero en septiembre de 1977. Los resultados indican que *Eleotris amblyopsis* es la especie dominante y es principalmente carnívora, alimentándose de invertebrados y larvas de peces. Solamente pequeños individuos de *Dormitator maculatus* se encuentran en este hábitat y se alimentan de materia vegetal además de invertebrados. *Gobiomorus* tiene hábitos alimenticios parecidos a los de *E. amblyopsis* pero ocupa áreas bénticas protegidas por las macollas de lirio. El cuarto eleótrido en el sistema, *Eleotris pisonis,* tiene hábitos alimenticios similares a los de *E. amblyopsis* pero parece restringido a los tributarios de agua dulce, donde *E. amblyopsis* es menos abundante. La quinta especie de eleótridos, *Leptophilypnus fluviatilis,* parece habitar áreas bénticas del estuario bajo pero es extremadamente raro en este sistema.

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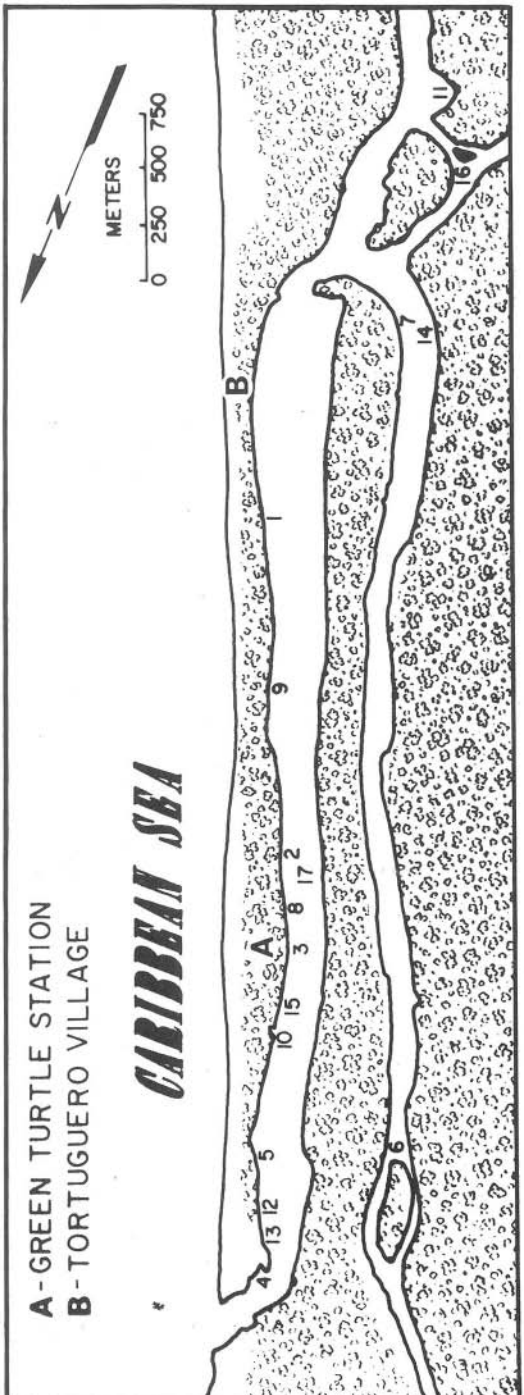
Fig. 1. Outline map of Tortuguero estuary indicating the collecting stations.



A - GREEN TURTLE STATION
B - TORTUGUERO VILLAGE
CARIBBEAN SEA
N
METERS
0 250 500 750
A
B
1
2
3
4
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