ACTIVITY, MOVEMENTS, AND FEEDING BEHAVIOR OF THE CUNNER, *TAUTOGOLABRUS ADSPERSUS*, AND COMPARISON OF FOOD HABITS WITH YOUNG TAUTOG, *TAUTOGA ONITIS*, OFF LONG ISLAND, NEW YORK[1]

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ABSTRACT

Field observations off Long Island, N.Y., using scuba and ultrasonic tracking, showed the cunner, *Tautogolabrus adspersus*, to be active during the day and inactively lying in shelter at night. Fish restricted their movements during the day, remaining within 2 m of the structure providing the nighttime shelter. The fish overwinter within their home territory in a torpid, nonfeeding state. Cunner fed primarily on invertebrates, foraging both benthically and in the water column. Competition between cunner and young tautog, *Tautoga onitis*, for *Mytilus edulis* was apparent during May-June when it is the major food item for both species. But beginning in July and extending through October, while tautog continued to feed primarily on mussels, cunner shifted to a diet consisting mainly of the isopod, *Idotea baltica*.

Almost any bottom relief, natural or man-made, including rock outcroppings, piers, pilings, and boat docks, provides the basic physical structure for temperate-water reef communities of fishes. While not as diverse in the number of residents as tropical and subtropical coral reefs, these communities represent an important component of the inshore marine resources of the Atlantic coast of North America. The cunner, *Tautogolabrus adspersus*, is a prominent member of temperate-water reef communities. This ubiquitous inshore species ranges from northern Newfoundland to the mouth of Chesapeake Bay (Leim and Scott 1966) and between Cape Cod and Delaware Bay is often found co-residing with the tautog, *Tautoga onitis*, the only other labrid inhabitant of the region. The close relationship of the cunner to inshore structures makes the species highly available to the angler while at the same time placing the fish in proximity to the potential effects of inshore pollution.

Our aim in this study was to describe daily and seasonal movements of the cunner as well as their feeding habits as compared with those of young tautog of similar size.

MATERIALS AND METHODS

Observations of activity and movements of the cunner were made indirectly by ultrasonic tracking of individual fish and directly with scuba. The detailed procedures used in capturing, handling, and tracking individual fish have been described by Olla et al. (1974). The ultrasonic transmitters, manufactured by Chipman Instruments,[3] (Henderson et al. 1966) measured 30 × 9 mm and emitted pulsed signals at frequencies of 58 to 70 kHz. These were attached externally to the fish by monofilament line passed through the dorsal musculature just below the midpoint of the dorsal fin. The transmitters were made neutrally buoyant by the addition of a styrofoam collar encased in silicone.

Eight fish were captured and tracked at one of three locations (Sites A, B, and C; Figure 1) in the west end of Great South Bay, Long Island, N.Y., during July and August 1973. Site A was the end of a small peninsula with 0.2- to 0.6-m diameter riprap covering the bottom from 1.2 m above the high water mark extending out 100 m. Water depth ranged from 2.0 to 10.0 m. Site B, the Fire Island Coast Guard basin, was a 110 × 52 × 47 m open pentagon, constructed of tongue-and-groove

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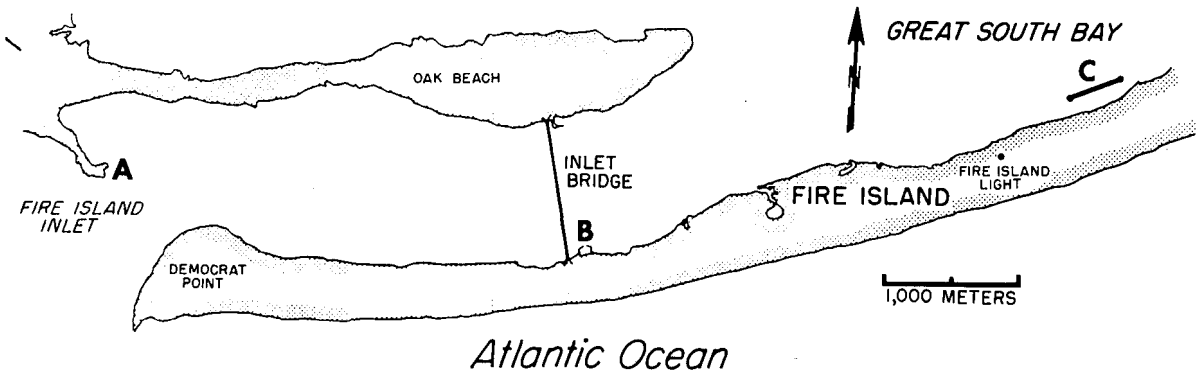

FIGURE 1.–Study area and Sites A, B, and C where cunner were tracked.

planks, steel sheeting, and piles. Water depth along the basin walls varied between 2.4 and 8.8 m with the bottom composed primarily of sand, gravel, and shell. Site C was an artificial reef, 457×46 m, consisting of submerged barges and tires on a sand and gravel bottom in 6 to 7 m of water (Briggs and Zawacki 1974).

Cunner were observed directly with scuba both day and night at weekly intervals from May through October in 1972 and 1973, and at monthly intervals from November 1972 to April 1973 for a total of 200 h (150 h daytime; 50 h nighttime).

Cunner and tautog were collected weekly, May through October at Site A for food habit analysis. The fish were either speared by scuba divers or trapped, and specimens were preserved in 10% Formalin. The contents of the entire digestive tract were examined, the food was identified, and its volume measured (Windell 1968).

RESULTS

Daily Activity and Movements

All fish tracked (Table 1) were active during the day and inactive at night. Tagged fish initiated daytime activity 16 to 41 min following the start of morning civil twilight; cessation of activity occurred 5 to 55 min before the end of evening civil twilight (Table 2). Direct scuba observations confirmed that the fish were active by day and inactive during the night. During the night, the fish were lying against, in, under, or between bottom or vertical structures. While the fish were quiescent at night, general responsiveness was low as indicated by divers being able to touch or capture fish with a hand-held net.

TABLE 1.–Release site, tracking duration, and the maximum distance traveled along the shelter site structure.

Cunner no.	TL (mm)	Release site[1]	Release date	Release time	Tracking duration (h)	Distance traveled (m)
1	190	B	7/10/73	1010	70.8	50
2	197	B	7/11/73	0920	46.7	50
3	172	B	7/16/73	1415	89.8	50
4	180	B	7/17/73	0935	34.9	5
5	215	B	7/23/73	1300	91.0	30
6	200	C	7/31/73	0937	70.8	75
7	220	C	8/ 6/73	1345	90.8	150
[2]8	220	A	7/24/73	0932	69.0	25

[1]Refers to Figure 1.
[2]Track intermittent.

TABLE 2.–The onset (minutes after morning civil twilight) and the end (minutes before evening civil twilight) of the daily activity of individual cunner as determined by ultrasonic tracking.

Cunner no.	Time	Day 1	Day 2	Day 3	Day 4	Day 5
1	Morning	—	36	34	20	—
	Evening	55	22	23	—	—
2	Morning	—	22	16	—	—
	Evening	37	39	—	—	—
3	Morning	—	22	24	34	18
	Evening	37	30	26	34	—
4	Morning	—	31	—	—	—
	Evening	44	41	—	—	—
5	Morning	—	28	—	29	25
	Evening	16	—	15	21	—
6	Morning	—	39	41	25	—
	Evening	42	35	43	—	—
7	Morning	—	26	31	27	24
	Evening	19	13	20	5	—

All of the fish tracked (Table 1) were highly localized in their daily movements, remaining within 2 m of the structures affording cover. The maximum distance traveled by any of the fish along structures ranged from 5 to 150 m.

Due to extreme ambient interference of the transmitter signal encountered during adverse water conditions, cunner no. 8 (Table 1) was

tracked intermittently. When tracking was possible, the fish exhibited the same movement pattern as the other seven fish. All observed movements were restricted to the area of riprap surrounding the release point and did not exceed 25 m from the release point.

While using scuba, we were able to sight three of the tagged fish directly (no. 1, 2, and 4; Table 1). They were feeding and appeared to be normally responsive. The attached transmitter had no apparent effect on orientation or swimming ability.

Seasonal Activity

In late fall, when water temperatures dropped to 5° to 6°C, cunner were observed to be inactive and torpid, lying in cracks and crevices both day and night, similar to what Green and Farwell (1971) described for cunner in Newfoundland and what we described for young tautog (Olla et al. 1974). Some of these fish were covered with a fine layer of silt. Examination of digestive tracts from 17 torpid fish indicated that they were not feeding. The fish remained torpid throughout the winter with water temperatures ranging from 2.5° to 5.0°C until the early spring when they became active as the water temperature rose above 6°C.

Feeding

Cunner generally occur in loosely formed aggregations and feed primarily as individuals rather than in any organized social grouping. One exception to this is the social interaction and facilitation which occur when one or more fish come upon a particularly abundant concentration of food. An increase in the intensity of feeding above that which constitutes the normal grazing, picking, and searching activity serves to attract cunner from the surrounding areas. As the number of fish attracted to the feeding area increases, so does the intensity of feeding, serving to attract more and more fish until the food has been consumed. On a number of occasions (30-40), after placing a clump of *Mytilus edulis* with crushed shells at a particular place on the bottom, we have observed the attraction of 50 or more cunner within 1 to 2 min after the first few fish had found the food and begun to feed.

Cunner feed both in the water column and benthically. When feeding in the water column with a current present, the fish face into the current while maintaining position and visually scanning for suspended food items. Water column foraging is typified by high frequency of eye and head movements as the fish search in all directions. When a food item is sighted, the fish swims to it, grasps the item, and then returns to the original search posture. Fish often search the water column while remaining in close proximity to objects affording cover from the full force of the current. Only after sighting a food item does the fish move into the current to ingest it and then return to its searching position. In this manner, the fish effectively conserves energy otherwise required to maintain its position in the current between ingestions. Discontinuities of the bottom, while providing cover from the current, also act to cause turbulence and upwellings, aiding in separating and spreading the food items. Fish may feed in this manner during the day for an entire tidal cycle, the duration and frequency depending both on food density and level of satiation. A typical food item which cunner may be ingesting during this type of feeding and which occurred in significant quantities in stomach samples was the isopod, *Idotea baltica* (Table 3). This species may occur free floating, attached to bits of flotsam, such as algae or eel grass, or on fixed substrates.

In situations where there is little or no current, cunner search the water column by actively moving. There is a general dispersal and lack of any particular directional orientation in the absence of a current which is similar to Stevenson's (1972) observations of reef inhabitants at Bimini.

When feeding on bottom or vertical substrates, the fish, exhibiting a high intensity of eye movements, visually search the forage area, their snouts touching or within several centimeters of

TABLE 3.–Contents of cunner and tautog digestive tracts.

	Percent of total contents[1]					
	Cunner			Tautog		
Item	May-June	July-Aug.	Sept.-Oct.	May-June	July-Aug.	Sept.-Oct.
Mytilus edulis	57.1	4.3	13.0	74.3	87.9	83.1
Idotea baltica	0.5	72.1	61.7	4.6	2.7	—
Microcrustaceans[2]	4.4	—	—	0.5	—	—
Cirripeds	0.2	1.6	1.9	15.3	2.7	7.4
Brachyurans	13.4	2.0	10.9	4.2	3.6	5.9
Fish remains	11.8	18.1	10.6	—	—	—
Debris	7.6	1.9	1.9	1.1	3.1	3.6
Fish eggs	0.4	—	—	—	—	—
Gastropods	1.2	—	—	—	—	—
Carideans	3.2	—	—	—	—	—
No. fish	31	21	12	14	12	13
TL (mm)	63-215	108-240	154-223	105-254	136-260	177-235

[1]Determined by volume (Windell 1968).
[2]Amphipods, copepods, and mysids.

the substrate surface. On a vertical substrate, they may swim up and down and from side to side, slowly searching an encrusted pile or bulkhead wall for food. When a food item is sighted, the fish grasps and ingests it as well as some of the encrustations, ejecting much of the excess. Foraging in this manner, the fish may cover an area of no more than 4 to 5 m^2 until satiated. Similar search patterns occur along the bottom or in close proximity to rocks, logs, and other structures.

When feeding on *M. edulis*, which comprise a significant part of their diet during part of the year (Table 3), the fish grasp and ingest with the anterior canine teeth, then crush the shell with their pharyngeal teeth in much the same manner as described for tautog (Olla et al. 1974).

Food Habits

Our analysis of digestive tract contents showed that cunner forage on a variety of organisms (Table 3), mainly invertebrates, as has been reported previously (Richards 1963; Chao 1973). While Richards found amphipods to be the most important food item for cunner in Long Island Sound and Chao reported mussels (both *Mytilus edulis* and *Modiolus modiolus*) to occur most frequenty in gut contents of fish collected at Nahant, Mass., our analysis for the sizes studied showed two major food items, *Mytilus edulis* and *Idotea baltica*, comprising 24.8% and 44.8%, respectively, of all food consumed. Our data showed a significant seasonal shift in the utilization of these two major forage species. During the May-June period, *M. edulis* predominated with 57.1% with only 0.5% *I. baltica* present. During July-August, the foraging pattern changed with *I. baltica* then being the major component of the diet at 72.1% and only 4.3% *M. edulis* present. This trend continued into the September-October period with 61.7% and 13.0% for *I. baltica* and *M. edulis*, respectively.

Examination of the digestive tract contents from young tautog (105-260 mm) showed that they were feeding predominantly on *M. edulis* throughout the feeding season (Table 3). Other items present occurred in varying and significantly lesser amounts. Olla et al. (1974) reported the same pattern in feeding for larger tautog.

DISCUSSION

Cunner and tautog, the only labrid inhabitants of north temperate waters of the western Atlantic, are often found co-residing on "reef" habitats south of Cape Cod. The geographical area in which these animals are found is beyond the northern limit for hermatypic corals. Hence, the "reef" habitat, as we define it, includes any natural or artificial structure or relief which provides a habitat for various species dependent, to some degree, on shelter sites (Smith and Tyler 1972), e.g., cracks and crevices, and also serves as a substrate for a variety of attached fauna and flora utilized as food items for resident fish.

Both cunner and tautog are active during the day and inactive at night. The inactive phase of nighttime is characterized by complete quiescence or sleep, a typical trait for labrid species in general (for examples see Hobson 1965, 1968, 1972; Starck and Davis 1966; Tauber and Weitzman 1969; Collette and Talbot 1972).

As was discussed in an earlier paper (Olla et al. 1974), the low level of responsiveness which is characteristic of the sleep phase of labrids and species of similar habit indicates that there is a reduction in the potential to avoid or escape environmental stress that may be imposed during the night.

Both of these species require shelter sites as resting places during the night sleep phase. Cunner of all sizes and tautog of less than 250 mm also appear to require a close association with objects affording shelter by day and during the winter, when they remain in a torpid condition. It is, therefore, obvious that the "reef" habitat, as a provider of shelter sites, would be a limiting factor in the population size of these two species. Any interspecific competition for shelter sites encountered by the cunner would probably be limited to tautog less than 250 mm, with both species requiring shelters of similar type and size. The amount of available shelter for coral reef species is an obvious limiting factor of population size (Sale 1972; Smith and Tyler 1972, 1973).

An attempt to attract or to increase populations of shelter-dependent species has been the development of man-made reefs using a variety of substances including automobile tires and bodies, construction rubble, sunken barges or ships, etc. (see Rickards 1973; Steimle and Stone 1973). The construction of man-made reefs would be most successful in areas in which sufficient food resources are available for the fish to be attracted or where the potentiality for food accretion would be increased by the addition of an appropriate

substrate. These structures would be most effective when placed where both forage species and fish species may be recruited naturally, the only element having prevented their presence previously being the absence of the structure.

The most obvious difference in the feeding habits of cunner and tautog is the greater diversity of organisms eaten by cunner (Table 3). While *Mytilus edulis* makes up the bulk of the diet during the feeding year of the tautog, it comprises a significant part of the cunner diet only during May and June. For the remainder of the feeding year, *Idotea baltica* predominates, with a variety of other invertebrates and fish being ingested by the cunner. The food habits of these fish not only show a change of season, as in this study, but also vary widely with geographic location. Comparing the results of this study with those of Richards (1963) in Long Island Sound and Chao (1973) at Nahant, the diversity in the cunner's feeding is even more apparent.

The more diverse diet of the cunner as compared with the rather restricted one of the tautog in this particular habitat may in part be related to morphological differences between the two species. The cunner, with its narrower, more streamlined body, pointed snout, and thinner lips, is well suited for feeding on the small motile crustaceans, e.g., *I. baltica*, occurring both benthically and in the water column. Davis and Birdsong (1973) in their review of water column foraging in coral reef fishes show morphological differences distinguish water-column foragers from benthic foragers within the same family.

The depletion of specific foods such as *M. edulis* (Olla et al. 1974) in this community, would appear to be far more detrimental to tautog than to cunner. Competition for the same food items would likely occur only during May and June.

Shifts in feeding habits may relate to other variables besides obvious differences in the abundance of the forage species. For example, *I. baltica*, occurring in waters of Denmark, shift their daily rhythm of activity on a seasonal basis while held in the laboratory (Hørlyck 1973). In the spring this species is primarily nocturnal; during late spring and early summer the species becomes more active by day. The cunner, which feeds by day, ingested significantly larger amounts of *I. baltica* during approximately the same time that this species had changed to a diurnal activity pattern. Of course this is, at best, conjecture, since it is not well understood how closely these laboratory observations relate to the field and whether this species would show the same seasonal shift in such widely separated geographic locations.

All of the cunner tracked and observed directly remained within several meters of some structure. This behavior agreed with earlier observations on young tautog (≤250 mm; Olla et al. 1974). Furthermore, we found that tautog of this size and cunner of all sizes studied (50-240 mm) remained inshore during the winter in a torpid state, agreeing with the observations of Green and Farwell (1971). Apparently, the home range for cunner of this size is restricted throughout all seasons to the length and breadth of the structure to which they were originally recruited.

Offshore reefs (primarily shipwrecks) appear to support a population of older and larger cunner than are found in inshore waters. During trawl vessel surveys conducted by the Northeast Fisheries Center (see Grosslein 1969 for a description of the survey program) cunner, 21 to 42 cm, have been collected at stations approximately 100 km southeast of Cape Cod, Mass. These larger fish do not represent any significant part of the cunner population as far as is known at this time, but it is of interest that they do exist. Whether they were originally recruited to these offshore areas and remained there, or were part of an inshore population that moved offshore when reaching a certain size (as is the habit of older tautog) and then remained there, can only be surmised.

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