INTERTIDAL FEEDING AND REFUGING BY CUNNERS, *TAUTOGOLABRUS ADSPERSUS* (LABRIDAE).

The cunner, *Tautogolabrus adspersus,* is the northernmost representative of the wrasses (Labridae) in the western North Atlantic (Bigelow and Schroeder 1953). While its food habits have been studied (Olla et al. 1975; Shumway and Stickney 1975), there is only one report of feeding behavior (Olla et al. 1975). During the summer of 1981, I studied the foraging behavior of cunners in an intertidal habitat and found a feeding pattern which may be an adaptation to predators.

Methods

The study site was a rocky intertidal area at Scituate, about 25 km south of Boston, Mass. Boulder density ranged from 1 to 4 per m^2 in the area. Observation sites were completely exposed at low water and submerged to a depth of 1.8 m during high tides. Water temperature was 15°-21°C during the study period.

From 5 July to 21 August 1981, I spent 57 h in underwater observations, primarily at three refuges in the intertidal zone where cunners were seen during each high tide. On three occasions I followed the initial occupancy (first fish in) and final desertion (last fish to leave) of the largest refuge during flood and ebb tides, respectively. On 9 d I followed 69 feeding forays by individual fish from the three refuges, recording the estimated size of the fish, the duration of the foray, the number of feeding acts per foray (these consisted of pecks at items on the bottom or rare rises to strike at objects in the water column), the prey at which the feeding was directed, the maximum distance ventured from the refuge on a foray, and fidelity of return to the starting point. On two occasions the same fish was followed on consecutive forays (two and three forays each, respectively); otherwise, each observation was made on different fish. A 9 m × 9 m grid marked every 30 cm was laid out over the bottom to help in determining the distance covered per foray and to aid in the estimation of fish size.

Other underwater observations included three high and two low tide dives with scuba on the seaward side of the intertidal zone in areas which remained permanently submerged (minimum depth 2 m), and two 100 m snorkel transects swum over the intertidal area during the high tide for 9 d (18 transects total). The dives were to determine qualitatively if a portion of the cunner population stayed in the subtidal region throughout the tidal cycle (high tide dives were made after confirming the refuges were occupied). The subtidal habitat consisted of patches of small (20 cm diameter), substrate-embedded rocks, interspersed with sand bar areas. These rocks were typically covered with Irish moss, *Chondrus crispus.* Larger rocks (≥2 m diameter) were scattered within the area and provided shelter for cunners in hollows and macroalgal (principally *Laminaria* sp.) growth. Water depth was 2-6 m. The snorkel transects served to identify other fish species, which moved into the intertidal zone with high tide, especially potential predators of cunners.

Available foods for cunners in the rock range were measured by randomly placing a 0.25 m^2 hoop in the area where the fish fed during low tide and by enumerating the animals found on the surface within the hoop.

Finally, the species and the number of potential bird predators in the study area during high tide were recorded.

Results

Cunner activity in the intertidal zone centered about the refuges where 2-8 fish were seen at a given time. The refuges were boulders from 0.5 to 1.0 m in diameter with hollows underneath in which the cunners remained when not foraging. Similar boulders with hollows were present in the study area but were not used as refuges. The only difference I noticed between the occupied and unoccupied sites was that the occupied refuges had two entrances while unoccupied hollows had only one. Both entrances were used in the occupied sites.

Cunners moved into the refuges an average of 107.2 min (SE = 64; range 64-150; $n = 17$) before peak high tide. Water depth at the time the refuges were first occupied was 126 cm (SD = 5; $n = 3$). The fish approached singly from a seaward direction. Feeding forays could start immediately, but up to 20 min might pass between first occupancy and the observation of the first foraging activity.

On the average, forays by 10-20 cm fish lasted 106 s, included 6 feeding acts, and took fish 3.7 m from the refuge ($n = 69$; Table 1). The cunners showed a remarkable fidelity to their refuges. In 69 observed

TABLE 1.—Feeding behavior of cunners in the intertidal zone.

	Mean	SE	Range	*n*
Duration of foray (s)	106	16	5-840	69
Maximum foraging distance from refuge (m)	3.7	0.3	0.6-12.2	58
No. of feeding acts per foray	6	1	0-65	67

forays only four fish (6%) did not return to the home refuge upon termination of the foray.

The fish generally fed on the bottom and were seen taking mussels, barnacles, and, on occasion, littorinid snails. All of these were abundant (Table 2). If the prey was not taken on the first strike, the cunner often repeatedly struck at the object until it was dislodged. In some cases a cunner gripped a food item that was firmly anchored, bent its body into a U, and then made a series of violent flexing motions which continued until the prey was freed. On 3 of the 69 forays, cunners rose and struck at free-floating plants (*Ceramium* sp.). Amphipods were concealed within some of these plants, and were probably the targets of the strikes.

Cunners abandoned the refuges and retreated seaward an average of 61.5 min (SE = 8.6; range 14-108; $n = 11$) after high tide peaked. Water depth at the time the last fish left the refuge was 71 cm (SD = 10; $n = 3$). Again the movements were made by individuals, not groups.

I made one observation as sunset fell during the high tide. The seven cunners that were foraging retreated from the refuge within 17 min after the sun dipped below the horizon. The timing of this retreat was 66.9 min (SE = 4.6) after peak flood tide with a water depth at the refuge of 122 cm. The timing was similar to the normal retreats, but the water was considerably deeper than during the other last fish retreats.

Cunners similar in size to those which foraged intertidally were found in the subtidal site during both high and low tides. I counted 43 cunners here, but no feeding behavior was observed. In three random 0.25 m^2 hoop drops, all fell on sand areas, turning up no potential food organisms. I found no mussels or barnacles during the dives, perhaps because sediment load owing to wave action renders the habitat unsuitable. Some littorinids were present.

Since the refuges were occupied during the high tide dives, this suggests that only part of the local cunner population makes the intertidal movement.

During the eighteen 100 m snorkel transects I saw pollock, *Pollachius virens*; tautogs, *Tautoga onitis*; one American eel, *Anguilla rostrata*; one ocean pout, *Marcrozoarces americanus*; and one winter flounder, *Pseudopleuronectes americanus*, as well as cunners. Pollock and tautogs were both rare, and I never saw more than three per transect. In the same distance 10-20 cunners were typically counted.

The only birds observed in or slightly seaward of the study site during high tides were double-crested cormorants, *Phalacrocorax auritus*. From 2 to 25 individuals were seen during high tide on 8 of 9 d. None were present during low tides of the same dates. They appeared wary of divers, and I was able to make only one observation of a foraging cormorant. Surface visibility was only 5 m due to fog so I did not see the bird when it dived; but when viewed, it was swimming along the bottom poking its head into the hollows under rocks. It did not capture a fish before it noticed me and fled.

TABLE 2.—Potential food resources for cunners in the intertidal zone. Values are means from three 0.25 m^2 surface samples taken on low tide on 9 August.

Taxon	No. of individuals per 0.25m^2	SE	Range
Crustacea			
Balanus balanoides	1,475	651	546-2,730
Neopanope texana	2	1	0-5
Mollusca			
Mytilus edulis			
alive[1]	40	11	57-18
dead[1]	31	17	5-64
spat[2]	7,726	4,554	585-16,192
Littorina littorea	691	101	489-792
Thais lapillus	1	1	0-1
Anthozoa	4	4	0-12

[1]Valve length 2.5-4.4 cm.
[2]Valve length 1 cm or less.

Discussion

Olla et al. (1975, 1979) have described the dependance of subtidal cunners on home shelters, from which they seldom ventured more than a few meters. Yet in this study I found that part of the cunner population abandoned subtidal sites to forage in the intertidal zone during high tides. These fish moved individually to specific refuges in which they congregated and from which individuals conducted rhythmic feeding forays over the surrounding area (Table 1). The cunners appeared to choose as refuges only sites with two entrances. A possible reason for this is that two entrances provide quicker access (or exit) during times of danger. During the ebb tide fish abandoned the refuges and moved off, again singly.

It is generally assumed that temperate wrasses use cover as an antipredator strategy (Olla et al. 1979; Hobson et al. 1981), though these threats have not been documented. The adoption of refuges in the intertidal area, similar to the pattern in the subtidal zone, is presumably also in response to a predator threat. During the snorkel transects I saw no piscine predators of cunners. In previous work at the study site I observed striped bass, *Marone saxatilis*; blue fish, *Pomatomus saltatrix*; and spiny dogfish, *Squalus acanthias*, all of which could eat cunners (Bigelow and Schroeder 1953), but these sightings were rare events. In contrast, bird predation may be more important. During eight of nine observations I saw double-crested cormorants, known fish eaters

(Godfrey 1979), more near to or into the intertidal zone as the tide rose. My one observation of a foraging cormorant found it poking its head into the hollows under rocks. This searching pattern, and the paucity of other fish in the area, suggests that the birds were hunting cunners. Though I have not demonstrated that the double-crested cormorant is a predator of cunners, it is of some interest to note that the closely related European cormorant, *Phalacrocorax carbo*, forages successfully on labrids similar to the cunner in habits and habitat preference (Steven 1933; Dipper et al. 1977).

In making the movement from the subtidal area to the intertidal zone, the cunners expend energy and may face an increased predation threat (Olla et al. 1979). Presumably the advantage gained by having access to the rich intertidal food supply (Table 2) offsets the costs and risks. In this study, intertidal cunners were observed striking at mussels, barnacles, and littorinids, items which are important components of the cunners' diet in other sites (Olla et al. 1975; Shumway and Stickney 1975). The cunners may be driven to the intertidal resources by a shortage of food in the subtidal area. The mussels,barnacles, and littorinids common in the intertidal area were not found (mussels and barnacles), or appeared rare (littorinids), subtidally. However, alternative prey may have been present and used. Conversely the high density of food items might permit more efficient foraging and make the intertidal area quite attractive to cunners. In this case a lack of suitable refuges might limit the numbers of individuals able to forage intertidally.

Access to the intertidal food supply is limited to high tide and daylight hours (Olla et al. 1975; Dew 1976). Based on initial refuge occupancy and final abandonment times, cunners could forage for about 169 min before retreating. While I know each refuge was occupied during high tide, I have no evidence of recurring use of a given refuge by an individual on more than one tide. Hobson (1972) found low specificity to nocturnal refuges in tropical labrids, but Olla et al. (1975, 1979) demonstrated a high specificity to subtidal home shelters in the cunner. Determining whether individual fish are specific to the intertidal refuges would contribute greatly to an understanding of the system.

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LITERATURE CITED

BIGELOW, H. B., AND W. C. SCHROEDER.
1953. Fishes of the Gulf of Maine. U.S. Fish Wildl. Serv., Fish. Bull. 53, 577 p.

DEW, C. B.
1976. A contribution to the life history of the cunner, *Tautogolabrus adspersus*, in Fishers Island Sound, Connecticut. Chesapeake Sci. 17:101-113.

DIPPER, F. A., C. R. BRIDGES, AND A. MENZ.
1977. Age, growth and feeding in the ballan wrasse *Labrus bergylta* Ascanius 1767. J. Fish Biol. 11:105-120.

GODFREY, W. E.
1979. The birds of Canada. Natl. Mus. Can., 428 p.

HOBSON, E. S.
1972. Activity of Hawaiian reef fishes during the evening and morning transitions between daylight and darkness. Fish. Bull., U.S. 70:715-740.

HOBSON, E. S., W. N. MCFARLAND, AND J. R. CHESS.
1981. Crepuscular and nocturnal activities of California nearshore fishes, with consideration of their scotopic visual pigments and the photic environment. Fish. Bull., U.S. 79:1-30.

OLLA, B. L., A. J. BEJDA, AND A. D. MARTIN.
1975. Activity, movements, and feeding behavior of the cunner, *Tautogolabrus adspersus*, and comparison of food habits with young tautogs, *Tautoga onitis*, off Long Island, New York. Fish. Bull., U.S. 73:895-900.
1979. Seasonal dispersal and habitat selection of the cunner, *Tautogolabrus adspersus*, and young tautog, *Tautoga onitis*, in Fire Island Inlet, Long Island, New York. Fish. Bull., U.S. 77:255-261.

SHUMWAY, S. E., AND R. R. STICKNEY.
1975. Notes on the biology and food habits of the cunner. N.Y. Fish Game J. 22:71-79.

STEVEN, G. A.
1933. The food consumed by Shags and Cormorants around the shores of Cornwall (England). J. Mar. Biol. Assoc. U.K. 19:277-292.

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