EFFECTS OF STORMS ON THE SHALLOW-WATER FISH FAUNA OF SOUTHERN FLORIDA WITH NEW RECORDS OF FISHES FROM FLORIDA[1]

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ABSTRACT

The passage of storms or persistence of onshore winds result in turbulent conditions in shallow, inshore waters and in fish kills of varying intensity. Species of fishes not normally found in shallow exposed locations may become established in such a habitat during periods or seasons of calm weather. These species are unable to withstand turbulent conditions and are killed apparently due to erosion of gill filaments by accumulated sediments. The importance of storms as a limiting factor in the shoreward distribution of many fishes is noted. The specimens collected after a storm kill in the region of Miami, Florida, include several species previously unrecorded or of rare occurrence in Florida waters. *Otophidium grayi is* shown to be a species distinct from *O. omostigmum* with which it had been previously synonymized.

INTRODUCTION

Large kills of marine fishes are often recorded in the literature. They are associated with diverse causes, among them shifts in ocean currents (e.g., El Niño along the Peruvian coast, see Sverdrup *et al.*, 1942: 704-705), turnover of stagnant bottom waters of fjords or other similarly isolated basins, abrupt changes in water temperature (Gunter, 1941, 1952; Gunter and Hildebrand, 1951), outbreaks of red tide (Ingle and deSylva, 1955, and papers cited therein), and volcanic activity (Gosline *et al.* 1954; Gosline, 1954). For a discussion of these problems the reader is referred to the numerous references cited by Geyer (1950).

Less spectacular but more frequent are kills that follow several days or weeks of steady onshore winds in regions where this is not the usual condition. Normally quiet waters over broad shoals and behind sand bars are hit by heavy seas and, at such times, quantities of sand and other sediments are stirred up and carried in suspension beyond their normal limits of deposition. In the Florida region, passage of hurricanes and lesser tropical disturbances are marked by accumulations of dead fish along the beaches. Marco Beach near Marco, and Sanibel Island near Fort Myers, both on the western coast of Florida, are noted for such occurrences. Similarly, large kills have been noted in these regions after unusually severe cold spells (Storey and Gudger, 1936; Storey, 1937).

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Life in the upper segment of the eulittoral zone is precarious at best and successful forms must be tolerant of rapid and drastic environmental change. Relatively few species of fishes spend their entire juvenile and adult life in this zone; many more occur here as juveniles but move into somewhat deeper water as they mature. Among the fishes that live successfully in the shoal waters of southern Florida are several species of *Harengula* (Clupeidae), two species of *Eucinostomus* (Gerridae), four cyprinodontids (*Floridichthys carpio, Cyprinodon variegatus, Fundulus grandis* and *F. similis*), the molly (*Mollienesia latipinna*), *Abudefduf saxatilis* (Pomacentridae), several blennioid fishes (*Paraclinus*), numerous gobies (especially those of the genera *Gobiosoma, Bathygobius* and *Lophogobius*) and juveniles of a filefish (*Stephanolepis hispidus*), the grey (*Lutjanus griseus*) and schoolmaster snappers (*L. apodus*), the permit (*Trachinotus falcatus*), and several jacks (*Caranx*). They abound at the water's edge and move back and forth with the changing tides.

It is important to note that such species are not often noted in lists of fishes killed by sudden environmental fluctuation. At Marco and Sanibel, broad expanses of shallow water lie adjacent to the beach and into such marginal habitat forage numerous species normally associated with somewhat deeper water. Also, many bottom forms from adjacent deeper regions become established in these waters during prolonged periods of favorable conditions. Such forms unknowingly court disaster and are the ones killed by freezes and storms, trapped as they are in suddenly adverse habitat.

The importance of sudden freezes as a limiting factor in the establishment of species in shoal water has been amply discussed in the literature cited above and by Geyer (1950). That tropical storms or merely the occurrence of strong or steady onshore winds constitute another important limiting factor has not been noted. Sand and other suspended sediments accumulate in the gill chambers of fishes. Should roiled conditions persist, death occurs either directly due to the destruction of gill filaments or by the weakened animal being swept onto the beach.

An opportunity to study this phenomenon on a small scale came in October of 1956 in the Miami region. From October 6th to 15th, steady onshore winds of 30 miles per hour, with gusts considerably higher, buffeted the southeastern coast of Florida. There was no drop in temperature. Key Biscayne, outermost of several islands connected to the mainland at Miami by Rickenbacker Causeway, and near to

the Marine Laboratory on Virginia Key, was the study site.

Observations

The beach between the lighthouse and Crandon Park was very badly eroded. Mr. and Mrs. John D. Gill notified the laboratory that fish were drifting ashore and Durbin Tabb and Alan Moffet investigated and obtained the specimens reported on below. At this site a slightly submerged offshore bar traps several hundred yards of deeper water (to 20 feet or more) between itself and the beach. This area, protected from normal seas, and covered with weed beds, was severely roiled with sediments from both sides. Some of the fishes were still alive when collected on the beach but all had the gill chambers filled with sand and the filaments themselves were very frayed. None of the common shore species (see listing above) were collected. Since they could scarcely move from the area it seems likely that they were unaffected. Of the species taken, only the puffer, *Spheroides spengleri,* commonly frequents the water's edge although it prefers more sheltered sites in muddy and weedy rather than sandy environs. The other species would be expected in somewhat deeper water several hundred feet or farther from shore.

Twenty-four specimens representing 16 species were collected (number of specimens, if more than one, in parentheses): *Aulostomus maculatus* Valenciennes, *Apogon binotatus* (Poey) (4), *Lutjanus analis* (Valenciennes), *Calamus bojanado* (Bloch and Schneider), *Chaetodon striatus* Linnaeus, *Chaetodon ocellatus* (Bloch), *Holacanthus isabelita* (Jordan and Rutter), *Lachnolaimus maximus* (Walbaum) (4), *Acanthurus bahianus* Castelnau (2), *Otophidium grayi* Fowler, *Scorpaenodes caribbaeus* Meek and Hildebrand, *Monacanthus tuckeri* Bean, *Chilomycterus antillarum* (Jordan and Rutter), *Canthigaster rostratus* (Bloch) (2), *Spheroides spengleri* (Bloch) and *Lophiocharon tenebrosus* (Poey). Several of them are new to the known Florida fauna or only rarely noted. They are discussed below.

Otophidium grayi.—Only three species of cusk eels in Florida waters have prominent dark marking on the body: *Otophidium welshi, O. omostigmum* and *O. grayi. O. welshi* is easily distinguished by the three dark stripes which it possesses, one along the base of the dorsal fin, a second along the lateral line and a third and somewhat ill-defined stripe on the mid side. The other two species are blotched. Recently, Briggs and Caldwell (1955) combined *grayi* and *omostigmum* as variants of a single species. Several factors precipitated this action.

The unique type of *omostigmum* was a small specimen whereas the extant material of *grayi* were all considerably larger, an illustration of the type published subsequent to the description was poorly executed, and the type is no longer in good condition.

TABLE 1

COMPARISON OF *Otophidium omostigmum* AND *O. grayi.*

Character	*omostigmum*	*grayi*
Anal-fin color	largely black	clear with black margin posteriorly
Insertion of dorsal fin	well behind opercular flap	over tip of opercle
Pigment in dorsal fin	blotches submarginal	blotches in fin membrane and along margin
Pectoral fin	pointed, the upper rays longest except for first two	rounded, the central rays longest
Pattern on occiput and opercle	unmarked	variously blotched with dark
Humeral spot	large, black and sharply defined. Most striking feature of color pattern	absent or small and ill-defined. Not so prominent as other blotches
Diameter of eye	longer than snout. Enters head less than 3 times	shorter than snout, enters head length more than 4 times (usually about 5)
Eye diameter into distance from occiput to dorsal insertion	less than 2 times	2 or more times
Infraorbital canal	pores easily seen, suborbital bones cavernous	pores very small, suborbital bones not visible externally
Gas bladder	with large funnel shaped opening caudally	with small ventral slit or long tube-like process from ventral surface
Pectoral rays	16-18	20-22
Dorsal-fin rays	99-104 (2 spec.)	130-136 (4 spec.)
Anal-fin rays	85 (2 spec.)	99-109 (4 spec.)
Scalation above lateral line on anterior part of body	overlapping; in regular rows	*Anguilla*-like; rows staggered.

Study of the Miami specimen of *grayi* (UMML 49:279) and a second specimen of *omostigmum* (UMML 49:440) suggested differences beyond that expected in infraspecific variation. The writer is indebted to John C. Briggs and David K. Caldwell for a loan of speci-

mens of *grayi* in the collection at the University of Florida (UF), to Royal D. Suttkus of Tulane University for the opportunity to examine a specimen of *omostigmum* in his care (TU) and for providing ray counts, and to Thomas J. McKenney of The Marine Laboratory for notes on the holotype of *omostigmum* at the United States National Museum (USNM 29670). I am especially grateful to Giles W. Mead of the Fish and Wildlife Service for additional remarks on the holotype and for generously checking distinguishing features of the two species in unsorted collections from the Gulf of Mexico.

The difference between *omostigmum* and *grayi* are summarized in Table 1. Differences in pigmentation, body shape and in the gas bladder may best be seen in Figure 1. Material examined includes (number of specimens and range of standard lengths in millimeters in parentheses): three specimens of *omostigmum,* USNM 29670 (1, 91—holotype), UMML 49:440 (1, 90), TU 10924 (1, 125) and four specimens of *grayi,* UMML 49:279 (1, 270), UF 4572 (2, 248-256) and UF 4485 (1, 160). Additional material was checked by Dr. Mead as noted above.

O. omostigmum is a small species previously reported only from the type specimen (taken off Pensacola, Florida). The Tulane specimen is from Campeche Bay (OREGON station 1058; 18° 45′ N, 93° 20′ W) while the Miami specimen is from the region between Jacksonville, Florida, and Brunswick, Georgia, along the 25.50 fathom contour. The color pattern seems quite constant, its most striking components being the large and intensely black humeral spot, the heavily pigmented anal fin and a few large, ill-defined dark blotches on the upper portion of the body. The holotype is in poor condition; the body is hard and brittle and the fins broken. Nonetheless the humeral spot is still discernible. Fortunately, Jordan and Gilbert (1882:301-302) described the pattern and in particular recorded the anal fin as largely black. Goode and Bean (1895: fig. 305) later figured the type but the anal fin, perhaps faded by that time, was indicated as uncolored and other diagnostic features are not evident. Their figure was reproduced by Jordan and Evermann (1900: pl. 354) but these writers (1898: 2490) persist in noting the anal fin as black.

O. grayi exhibits much variation in color pattern, a fact that would lead one to incorrectly suspect the constancy of color pattern in other cusk eels, as *omostigmum* and *welshi.* The correlation of morphological differences with those of pattern suffice to distinguish them.

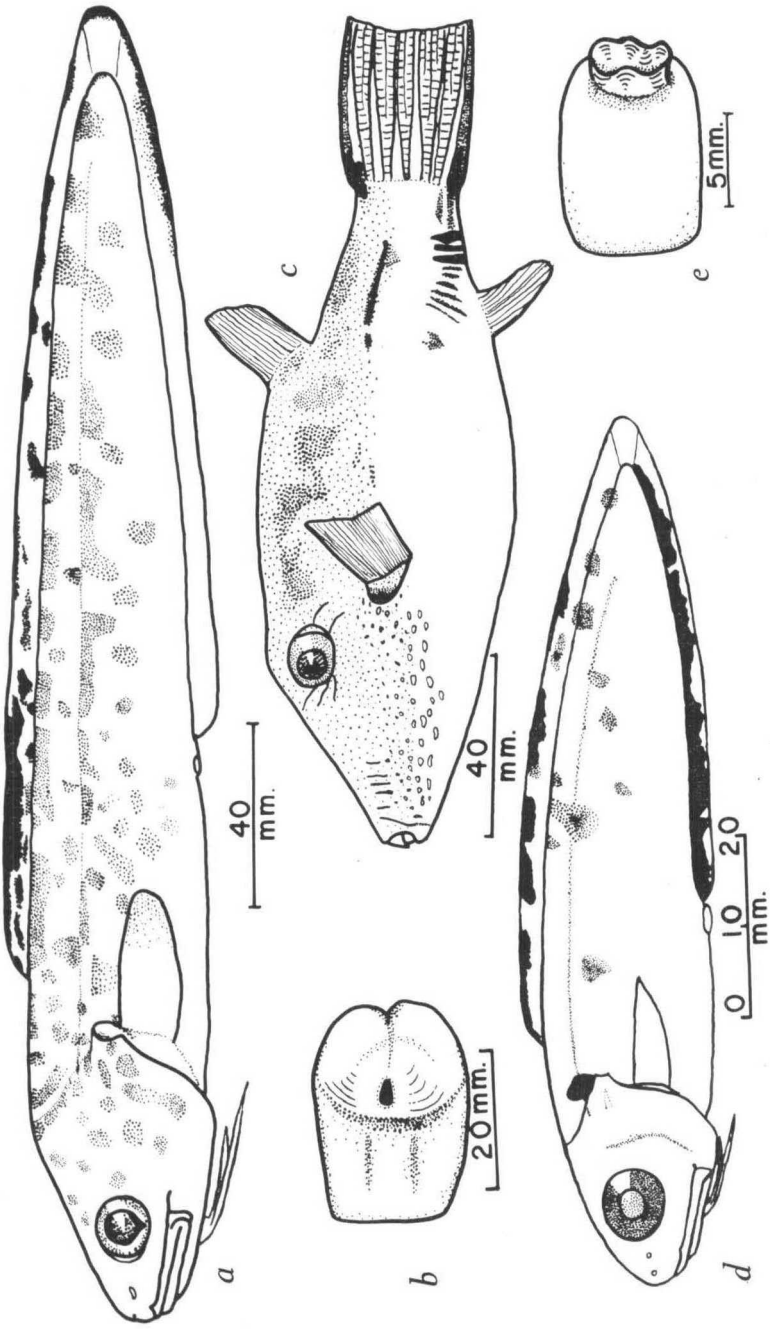

FIGURE 1. a, *Otophidium grayi* (UMML 49:279, S. L. = 270 mm). b, ventral view of gas bladder of *O. grayi* (anterior end to left). c, *Canthigaster rostratus* (UMML 49:122, S. L. = 72 mm). d, *Otophidium omostigmum* (UMML 49:440, S. L. = 90 mm). e, ventral view of gas bladder of *O. omostigmum* (anterior end to left).

Both the figure of the holotype (Fowler, 1948: fig. 1) and that in Briggs and Caldwell (1955: fig. 4) clearly demonstrate the prominent blotches on the head and body, the spotted dorsal fin, the rounded pectoral fin and the unpigmented anal fin, all diagnostic features of *grayi*. The Miami specimen, a female, is illustrated in Figure 1a. It differs from the other samples in having a more elongate body, lower vertical fins, more numerous and much smaller spots on the body and a longer gas bladder with an open slit on its posterior ventral surface (see Figure 1b). The possibility may not be ruled out that a third species of spotted cusk eel exists in the warmer waters off southern Florida.

Scorpaenodes caribbaeus.—The one juvenile, 56.8 mm in standard length (UMML 49: 520), agrees well with the description by Ginsburg (1953: 38-40). Elements on the upper arm of the first gill arch number seven. The interorbital ridges are well developed and end in spines. There are three spines in a row below the suborbital ridge. Many of the head spines have dark brown fleshy tabs at their tips. A distinct dark brown blotch marks the distal two-thirds of the spinous dorsal membrane between spines 9 and 12. Counts are: dorsal rays, XII, I-9; anal rays, III, 5 (second spine very well developed, 11.3 mm); pectoral rays, 19-19; pelvic rays, I, 5-I, 5; lateral-line scales, 42; head length, 25.3 mm, longest pectoral ray, 18.6 mm. Palatine teeth are absent. There is a small slit behind the fourth gill arch. The scales are ctenoid and the inner surface of the pectoral fin and its axil are spotted with brown. The species has not heretofore been recorded from Florida waters.

Monacanthus tuckeri.— Longley and Hildebrand's (1941: 296-297) report on Tortugas material is the only previous mention of *tuckeri* in Florida. It has perhaps been mistaken for *M. ciliatus*, a common species. A brief description and counts are provided by Clark (1950) for specimens from Bimini in the western Bahamas.

The following counts and measurements were made from the single storm-killed individual (UMML 49: 522): standard length, 63.2 mm; head length, 19.4; eye diameter, 5.2; height of dorsal spine, 13.6; snout length, 15.4; depth of body at anus, 15.4; dorsal rays, 34; anal rays, 34; pectoral rays, 11-11. Small black cirri are scattered over the body. The dorsal spine has two well developed rows of recurved spines. There are four strong, recurved accessory spines at the base of the free portion of the ventral spine, two projecting spines are at

its tip and a pair of recurved spines lie on each side between the tip and the basal row of accessory spines. The species is distinguished from *ciliatus* at a glance by its slender body form.

Chilomycterus antillarum.— This burrfish is an addition to the known fish fauna of Florida. Color notes were recorded shortly after the specimen (UMML 49: 129) was picked up. The ventral portion of the iris is light orange (forming a ring about the pupil) The belly is generally dark. However, the fleshy processes on the ventral spines are light orange and the area around the vent is marked by fine yellow lines. The species is best characterized by the network of lines on the dorsum and sides that combine to form a series of hexagons of varying size. The lines themselves are dark brown becoming rust colored in certain areas while the interspaces are grey with a brownish tinge. All species of *Chilomycterus* are apparently marked by several very large dark spots. In *antillarum,* those above the pectoral fin have a rust-colored border. The gular region has yellow-orange vermiculations whereas the flesh covering the dorsal spines (especially cephalad) is olive-yellow. The nasal flaps, the caudal and anal fins and the distal portion of the pectoral fins are orange.

Specimens from the Bahamas have the hexagonal lines much broader and less well defined, and the hexagons are fewer. Curiously, Bahaman specimens of *C. schoepfi* also have their dorsal stripes broad and ill-defined.

Canthigaster rostratus.— The sharpnose puffer has been recorded from Florida waters only by Longley and Hildebrand (1941: 300-301). Two juveniles (UMML 49: 122), the largest of which is illustrated in Figure 1c, were taken in the collection under consideration. Recently, another juvenile (UMML 49: 515) was dip netted at the Causeway Terminal Yacht Basin at Miami Beach (again following a week of strong winds). Apparently it is truly uncommon on our coast for numerous shore collections in southern Florida have failed to reveal it whereas at Bimini harbor in the western Bahamas the writer and Vladimir Walters of the Lerner Marine Laboratory found it abundant in shallow water. For a description of this species see Clark (1950: 166).

Lophiocharon tenebrosus.— The single specimen of this antennariid has been deposited in the United States National Museum (USNM 174940). The species has not been recorded from Florida and indeed has not been taken since Poey described his unique example. Leonard

P. Schultz of the National Museum identified the specimen and is reporting on the status and relationships of the species elsewhere.

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