ANATOMICAL TRAUMA TO SPONGE-CORAL REEF FISHES CAPTURED BY TRAWLING AND ANGLING

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ABSTRACT

External signs of trauma were examined in 15 sponge-coral reef fish species captured while trawling and angling at 37 m depth. Internal evidence of trauma was noted for all species and quantified for a sample of angling-caught black sea bass, *Centropristis striata*. Distinct differences were noted in the types and frequencies of trauma experienced among species, and between gear types within species. Black sea bass; red snappers, *Lutjanus campechanus*; short bigeyes, *Pristigenys alta*; and *Mycteroperca* groupers exhibited high frequencies of oral protrusions. Planehead filefish, *Monacanthus hispidus*; orange filefish, *Aleuterus schoepfi*; and blue angelfish, *Holacanthus bermudensis*, were particularly prone to cloacal protrusions. External signs of trauma were few in vermilion snappers, *Rhomboplites aurorubens*; porgies (*Stenotomus chrysops*, *Calamus leucosteus*, and *Pagrus pagrus*); tomtates, *Haemulon aurolineatum*; and two trawl-caught serranids (*Centropristis ocyurus* and *Diplectrum formosum*). Angling produced oral protrusions in black sea bass more frequently than trawling. Trawl-caught red snappers had a higher stomach eversion frequency when brought to the surface more quickly. Angling-caught black sea bass experienced high frequencies of tissue emphysema and swim-bladder rupture. These results should be considered in studies of feeding biology, released-fish survivorship, and fishery management.

Anatomical trauma experienced by fishes during capture is interesting from several standpoints. Mortality of individuals caused by stress, tissue damage, organ displacement, and resulting aberrant behavior has been recognized primarily for its effects on the survival of released fish in mark-and-recapture studies (Ricker 1949; Parker et al. 1959, 1963; Gotshall 1964; Beamish 1966; Moe 1966; Laird and Stott 1978; Pawson and Lockwood 1980; Fable 1980; Grimes et al. 1983). Mortality of fishes released by fishermen is an important consideration for stock assessment and management (Black 1958; Pawson and Lockwood 1980; Matheson and Huntsman 1984). Recent management plans for the U.S. Gulf and South Atlantic snapper-grouper fisheries (GOMFMC 1981; SAFMC 1983a, b) recommended implementation of minimum sizes for several species. The sizes in the South Atlantic were determined from yield-per-recruit (YPR) models incorporating assumed survival rates for undersized, released fishes (SAFMC 1983a). Size regulations were predicted on survivorship of ≥60%. Gulf YPR models did not incorporate survival rates, effectively assuming 100% survival.

Other workers have indicated difficulty in obtaining specimens of snapper-grouper species for quantitative analyses of feeding biology from depths which caused stomach eversion and loss of gut contents (Stearns 1884; Adams and Kendall 1891; Camber 1955; Mosely 1966; Moe 1969; Bradley and Bryan 1975; Link 1980; Ross 1982). This is of particular concern for studies comparing food habits across depth zones (Moseley 1966). Differences between fish species captured by identical gear at similar depths and differences within species between gear types introduce additional variation. This study addresses the types and frequencies of anatomical trauma experienced by sponge-coral reef fishes captured by angling and trawling at a single depth. These data are discussed in relation to trophic studies, future studies of trauma during capture, survival following release, and management of snapper-grouper fisheries.

METHODS

Fishes were caught by angling and trawling at a low-relief (<1 m) sponge-coral reef 37 m deep on the continental shelf 84 km east of Sapelo Island, GA

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(lat. 31°26′N, long. 80°20′W; central South Atlantic Bight). Angling gear was standard hand-operated boat rods rigged with double-hooked terminal tackle and baited with squid. Hook sizes were 3/0 to 5/0. Fishes were brought to the surface as quickly as possible (about 1 m/s; somewhat slower for large snappers and groupers). Trawling was conducted from two vessels, each rigged for stern trawling but with some differences in gear and handling.

The trawl gear on the RV *Georgia Bulldog* was a 25 m, 4-seam high-rise roller trawl with tongue. Meshes were (stretched) 20 cm in the wings and tongue, 10 cm in the belly and bag (2 cm liner), and 7.5 cm in an extension. Cables connecting the trawl and doors produced a sweep of 31.1 m; the rise on the tongue was 6.1 m (J. B. Rivers[4]). The rig had a vertical haulback rate of 0.12-0.15 m/s.

The trawl gear on the RV *Blue Fin* was a modified No. 36 Yankee flat roller trawl. Meshes were (stretched) 5 cm in the wings and belly and 3.5 cm in the bag (2 cm liner). The total sweep was 22.1 m and the rise at the center of the headrope was 3.7 m (Rivers fn. 4). The rig had a vertical haulback rate of 0.1 m/s. Gear handling was otherwise identical.

Tows were 20 min long. The fish catch was sorted to species and the alimentary tracts samples removed; or samples were placed in 20 L buckets with ice-seawater mixture, frozen on board, and processed in the laboratory. Data on anatomical trauma were recorded during dissections. An angling catch of 34 black sea bass, *Centropristis striata*, was put on ice and dissected 2 days later for examination of internal trauma. No samples were subjected to the bin-type icing procedures common on commercial snapper-grouper vessels. Fishes were collected from July through December in 1983 and in September 1984.

External evidence of trauma consisted of several types of protrusion of the gastrointestinal tract. These were classified as

1) Oral eversion - stomach everted into the pharynx and often present in the mouth, pulling the pyloric area and the intestine with it.
2) Cloacal protrusion - intestine protruded from the cloacal area. Initially such protrusions were not classified further; however, detailed dissections showed that they were either
    a) Herniations - disruptions of the body wall in the pericloacal area through which the gut protruded or
    b) Intussusceptions - actual eversion of the terminal portion of the intestine through its own lumen.
3) Branchial protrusions - portions of the gut protruded through the branchial opening.

Results are expressed as occurrences and percentage frequencies. Frequencies of herniations and intussusceptions were calculated by dividing the observed number in a class by the total number of classified cloacal protrusions, then multiplying the result by the total proportion of cloacal protrusions. Example (from Table 1): planehead filefish herniations, $(99/(99+22))\ (160/440) = 0.30$.

Internal evidence of trauma included 1) the presence of gas in the tissues (tissue emphysema) and 2) rupture of the swim bladder. Although notes on both phenomena were kept for all fish species, their frequencies were enumerated only for the 34 carefully examined, angling-caught black sea bass.

Among-species and between-gear comparisons of trauma were performed by using Pearson's test for goodness of fit (yielding a χ^2 value). The null hypotheses were specified as homogenous (equal) proportions of specimens exhibiting a particular symptom, based on the overall proportion of fish with the symptom across species or gears (significant departures were $P < 0.05$).

RESULTS

Dissection records of 1928 trawl-caught and 235 angling-caught fishes of 15 species were collated for external evidence of trauma (Table 1). Seven species were not caught with angling gear. Scamp, *Mycteroperca phenax*, and gag, *M. microlepis*, were combined to form a *Mycteroperca* grouper category due to low numbers collected.

Trawl-caught red snappers, *Lutjanus campechanus*; *Mycteroperca* groupers; short bigeyes, *Pristigenys alta*; planehead filefish, *Monacathus hispidus*; orange filefish, *Aleuterus schoepfi*; and blue angelfish, *Holacanthus bermudensis*, experienced frequent gut displacements (Table 1). These were oral eversions in red snappers, short bigeyes, and *Mycteroperca* groupers; cloacal protrusions in orange filefish and blue angelfish; and all three categories (including branchial protrusion) in planehead filefish. Alimentary tract displacements were minimal in trawl-caught black sea bass; bank sea bass, *Centropristis ocyurus*; sand perch, *Diplectrum formosum*;

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TABLE 1.—Numbers and percentage frequencies (in parentheses; a = 1%) of alimentary tract displacements in sponge-coral reef fishes collected by trawling (T) and angling (A) in 37 m depth. Dashes (—) indicate no data. Within cloacal protrusions, H = herniations, I = intussusceptions, U = unclassified, and TC = total cloacal. *N* = number of specimens examined.

Species		Oral eversions	Cloacal protrusions H	I	U	TC	Branchial protrusions	Total displacements	*N*
black sea bass	T	4(2)	0	0	0	0	0	4(2)	200
Centropristis striata	A	45(27)	0	0	0	0	0	45(27)	169
red snapper	T	26(55)	0	0	0	0	0	26(55)	47
Lutjanus campechanus	A	1(50)	0	0	0	0	0	1(50)	2
bank sea bass	T	0	0	0	0	0	0	0	39
Centropristis ocyurus	A	1(33)	0	0	0	0	0	1(33)	3
short bigeye	T	8(22)	0	0	0	0	0	8(22)	37
Pristigenys alta	A	—	—	—	—	—	—	—	0
sand perch	T	0	0	0	0	0	0	0	19
Diplectrum formosum	A	2(18)	0	0	0	0	0	0	11
Mycteroperca groupers	T	5(29)	0	0	0	0	0	5(29)	17
	A	0	0	0	0	0	0	0	1
planehead filefish	T	3(1)	99(30)	22(7)	39	160(36)	14(3)	177(40)	440
Monacanthus hispidus	A	—	—	—	—	—	—	—	0
orange filefish	T	0	1(4)	4(17)	7	12(21)	0	12(21)	58
Aleuterus schoepfi	A	—	—	—	—	—	—	—	0
blue angelfish	T	0	4(30)	1(8)	4	9(38)	0	9(38)	24
Holacanthus bermudensis	A	—	—	—	—	—	—	—	0
vermilion snapper	T	0	0	0	0	0	0	0	339
Rhomboplites aurorubens	A	0	0	0	1	1(4)	0	1(4)	28
whitebone porgy	T	0	1(3)	1(3)	0	2(6)	0	2(6)	33
Calamus leucosteus	A	—	—	—	—	—	—	—	0
scup	T	0	1(1)	0	2	3(1)	0	3(1)	286
Stenotomus chrysops	A	—	—	—	—	—	—	—	0
tomtate	T	0	0	0	2	2(a)	0	2(a)	372
Haemulon aurolineatum	A	—	—	—	—	—	—	—	0
red porgy	T	0	0	1(6)	0	1(6)	1(6)	2(12)	17
Pagrus pagrus	A	0	0	0	0	0	0	0	21

tomtate, *Haemulon aurolineatum*; scup[5], *Stenotomus chrysops*; whitebone porgies, *Calamus leucosteur*; red porgies, *Pagrus pagrus*; and vermilion snappers, *Rhomboplites aurorubens*.

Angling-caught black sea bass had high frequencies of oral eversion. Angling-caught red porgies and vermilion snappers exhibited few or no protrusions. Angling data for all other species are too sparse to estimate protrusion frequencies.

There was a significant lack of homogeneity in the frequencies of oral eversions between species within trawl (χ^2 = 695, df = 13, $P \ll 0.01$) and angling-caught (χ^2 = 14.2, df = 6, $P < 0.05$) samples. The trawling value resulted from high frequencies for red snapper, *Mycteroperca* groupers, and short bigeye; these three categories accounted for 95% of the χ^2 statistic. Among angling-caught fishes, a high value for black sea bass and low values for red porgy and vermilion snapper accounted for 91% of the χ^2 statistic.

The high frequencies of cloacal protrusions in trawl-caught planehead filefish, orange filefish, and blue angelfish (21-38%) and low values in all other species (<7%) produced a highly significant departure from homogeneity (χ^2 = 470, df = 13, $P \ll 0.001$). Seven of the 15 fish species did not display the symptom (Table 1). Only one of the angling-caught specimens (a vermilion snapper) experienced cloacal protrusion. Of those cloacal protrusions classified for blue angelfish and the two filefish species, all herniations (Table 1) had fecal material in the protruded gut portion.

Only planehead filefish experienced branchial protrusions. Tomtate, vermilion snapper, scup, red porgy, and whitebone porgy were notably free of all forms of alimentary tract displacement.

Swim-bladder rupture was noted for all fish species. Tissue emphysema was detected only in black sea bass. Of the 34 black sea bass examined in detail for internal trauma, 33 (97%)

[5]The taxonomic status of this species is unclear (B. Roumillat, South Carolina Marine Resources Research Institute, POB 12559, Charleston, SC, 29412 pers. commun.) and is properly listed as scup (*Stenotomus chrysops* (Robins et al. 1980; SAFMC 1983a, b)) although several authors have recently used the nomen southern porgy (*S. aculeatus* (Miller and Richards 1980; Wenner 1983; Sedberry and Van Dolah 1984)). Still others have classified South Atlantic-caught *Stenotomus* as longspine porgy (*S. caprinus* (Chester et al. 1984)).

exhibited swim-bladder rupture (1 specimen had 2 points of rupture), and 27 (79%) had tissue emphysema.

Significantly more angling-caught black sea bass had oral protrusions than those caught by trawling (χ^2 = 138, df = 1, $P << 0.001$). For trawl-caught red snappers, significantly more fish caught aboard the *Georgia Bulldog* (26 of 39) had oral eversions than those caught aboard the *Blue Fin* (0 of 8) (χ^2 = 5.34, df = 1, $P < 0.025$). No other comparisons for combinations of symptoms, species, and gear types yielded significant results. However, all oral eversions noted for *Mycteroperca* groupers were produced by *Georgia Bulldog* trawling gear, and those noted for sand perch were produced by angling gear.

DISCUSSION

Differences Due to Species and Gear

Differences between fish species (captured by identical gear) in the type and frequency of gut displacement are likely due to differences in bone structure and relative swim-bladder volume. Except for planehead filefish, which exhibited all forms of external evidence, those species which experienced frequent oral eversions did not present cloacal eversions and vice versa (Table 1; refer also to the analyses of categorized data). In this study the leatherjackets (Balistidae) and angelfishes (Holacanthidae) experienced high frequencies of gut displacements toward the cloacal area. These taxa have a relatively restricted pharyngeal area and the leatherjackets have a bony sternum which further defines a "path of least resistance" toward the cloaca. Other fishes which may be similarly susceptible to cloacal protrusions include other balistids, acanthurids, chaetodontids, and scarids.

Larger mouthed species such as lutjanids (Stearns 1884; Adams and Kendall 1891; Camber 1955; Moseley 1966; Bradley and Bryan 1975; this study), serranids (Moe 1969; Link 1980; Matheson and Huntsman 1984; this study), priacanthids (this study), and scorpaenids (Gotshall 1964) experience oral eversion more frequently than cloacal protrusion. Fishes with medium-sized mouths and "nondirecting" body morphologies (e.g., vermilion snapper, tomtate, and sparids in this study) exhibit neither type of gut protrusion, instead having a general swelling of the body cavity.

The relative volume of the swim bladder varies from 0 to 6% of total body volume in marine fishes (Jones 1957). Although measurements were not made, the patterns of protrusion in this and other studies (above) suggest that species-specific differences in swim-bladder volume result in varying degrees of internal pressure on ascent. This may contribute to differences in gut protrusion and the extent of body cavity swelling.

It is not clear why varying rates of ascent would induce varying frequencies of gut protrusion within a fish species. Differences between fish species in the rates at which gases can be resorbed from the swim bladder likely had little effect on patterns of protrusion. Achievement of equilibrium through resorption requires time on the order of hours (Brown 1939; Jones 1951). This is a longer time-scale than the normal vertical movements of most fishes (Steen 1970) and vertical displacements while trawling and angling. Also, the absolute magnitude of swim-bladder expansion is independent of the rate of ascent and should not be considered a factor. Yet, a pattern is apparent in the higher values for angling versus trawl-caught black sea bass and also for red snappers caught with *Georgia Bulldog* versus *Blue Fin* trawling gear. Mosely (1966) reported higher oral eversion frequencies for red snappers taken by angling versus those taken while trawling at intermediate shelf depths (42-60 m). Bradley and Bryan (1975) also noted for red snappers that angling produced more stomach eversions than trawling, but stated that their data were confounded by differences in the average depths of fishing efforts. Additionally, stomach eversion frequencies for our trawl-caught red snappers (83% taken with "rapid ascent" *Georgia Bulldog* gear) were 7.5-9.5 times higher than those reported in the literature from similar depths (Fig. 1A; Moseley 1966; Bradley and Bryan 1975). It is tempting to attribute these results to differences in vertical haulback rates. The rate of swim-bladder expansion, linked directly to changes in hydrostasis (Steen 1970) and therefore qualitatively more or less "violent", may govern the nature and extent of injuries.

An additional factor contributing potentially to the types and frequencies of gut protrusion is the consistency, amount, and position of prey material in the alimentary tract. Firm material may function as a bonelike directing structure or be what an expanding swim bladder acts upon. It is interesting that all of the herniated intestines in planehead filefish, blue angel fish, and orange filefish contain fecal material. If hydrostatic forces within a fish's body cavity are influenced by gut contents, unequal and variable allocation of sampling effort and catch over a diel feeding cycle could alter estimates of protrusion frequency for a given fish species. The major-

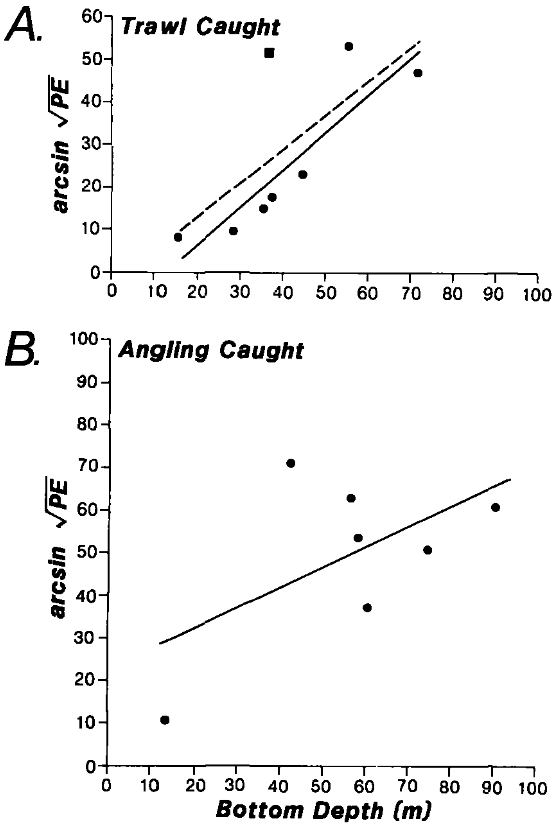

FIGURE 1.—Plots of the proportions of red snappers with everted stomachs (PE) captured by (*A*) trawling and (*B*) angling as a function of bottom depth (data from Camber 1955; Moseley 1966; Bradley and Bryan 1975; except this study). Ordinates were arcsine transformed (Snedecor and Cochran 1980). Abscissas are plotted as actual depths or midpoints of ranges. The dashed line (plot *A*) is the least-squares line including data from this study. The only significant relationship was for trawl-caught fishes from the literature (r = 0.90, df = 5, $P < 0.01$).

ity of orange filefish were collected during periods of the day when there was very little material in the alimentary tract, which is likely responsible for herniation/intussesception rates at variance with planehead filefish and blue angelfish values. Sampling of other species was more equitably distributed over the 24-h period.

Considerations for Feeding Studies

Negligible biases in stomach and intestinal contents are expected among trawl-caught black sea bass, bank sea bass, tomtate, the three porgy species, sand perch, and vermilion snapper at depths of 37 m. Angling-caught red porgies and vermilion snappers should be equally free of bias-producing gut displacements at these depths. However, caution is necessary in analyses of stomach contents for trawl-caught red snappers, *Mycteroperca* groupers, short bigeyes, and angling-caught black sea bass from 37 m. Stomach content data for angling-caught red snappers, groupers, bank sea bass, and sand perch should also be interpreted with attention to the likelihood of bias. These considerations have been previously acknowledged for angling-caught black sea bass and bank sea bass (Link 1980), trawl and angling-caught red snappers (Stearns 1884; Adams and Kendall 1891; Camber 1955; Moseley 1966; Bradley and Bryan 1975), angling-caught red groupers, *Epinephelus morio* (Moe 1969), and angling and longline-caught blueline tilefish, *Caulolatilus microps* (Ross 1982), from southeastern U.S. shelf and slope waters. Moseley (1966) and Link (1980) both stated that partial or full stomach eversion renders quantification of consumed prey suspect, particularly with respect to across-depth comparisons (e.g., Godfriaux 1974). Studies of food habits of fishes in the South Atlantic and Gulf of Mexico shelf snapper-grouper complex have either not discussed depth as a diet-determining variable (Camber 1955; Moseley 1966; Moe 1969; Bradley and Bryan 1975; Dixon 1975; Henwood et al. 1978; Ross 1982; Steimle and Ogren 1982) or if depth was considered, dealt with fishes not prone to stomach-eversion bias (Manooch 1977; Grimes 1979; Sedberry 1985).

Species and gear-specific considerations should also be made for analyses of daily feeding chronologies and rations based on stomach content weights. Fishes with partially or completely everted stomachs should be eliminated from the data set. It is clear that trawl-caught specimens of most species are more suited to such analyses than those caught with angling gear. However, some species cannot be efficiently collected with trawling gear at certain times of day, over certain types of bottom, or indeed at all. Extra angling effort (offsetting eversion rates) and well-designed multigear approaches (including traps and longlines) can be used to complete data sets for such fishes.

Displacements of the posterior portion of the alimentary tract can also have significant effects on studies of feeding biology. Trawl-caught planehead filefish, blue angelfish, and orange filefish are subject to such bias. Prey position data used to examine the rate of movement and evacuation of material through the gut (e.g., Klumpp and Nichols 1983) will be affected by both herniations and intussusceptions. During herniation, fecal material is either shifted into the protruded portion of the intestine or the material already present in that segment is isolated from what might otherwise be a continuous column of material. Both potentially produce gaps or "clumping" of intestinal contents. Collection of data affected by intestinal displacements should also incorporate increased sampling so that specimens with herniations or intussusceptions can be eliminated from the data set without a significant loss of information.

Survivorship: Experimental Design and Fishery Management

Our data show that experimental studies of survivorship and the physiological responses of sponge-coral reef fishes following capture and release should stratify their designs by gear. Traps and longlines should be considered in future studies because of the gear-specific vertical haulback rates and other stress factors. Additional considerations are capture depth (Gotshall 1964; Moe 1966, 1969; Moseley 1966; Bradley and Bryan 1975; Grimes et al. 1983), predation on injured and disoriented fishes (Parker et al. 1959, 1963; Randall 1960; Topp 1963; Gotshall 1964; Fable 1980), crowding and abrasion in the gear (Pawson and Lockwood 1980), degree of gut fullness (related to stress from diverted blood supply; Beamish 1966), physiological state related to long-term feeding/activity cycles (Parker et al. 1959), water column temperature structure, currents, and turbidity. Many of the factors covary with depth and fluctuate seasonally.

The anatomical derangements investigated in the present study are severe trauma. Oral and cloacal protrusions would very likely cause high rates of mortality in subsequently released fishes. Obstruction of the gastrointestinal tract would normally be serious and interference with the blood supply to the gastric and intestinal walls would lead to severe circulatory impairment. Gotshall (1964) has shown that returns from tagged blue rockfish, *Sebastes mystinus* requiring stomach replacement and swim-bladder deflation were less than half those from fish requiring only swim-bladder deflation. These fish endured everted stomachs for only a few minutes. Topp (1963) has noted that the everted stomachs of *Lutjanus* snappers are frequently perforated by the fish's teeth. The effects of such injuries on survival require further study.

Expansion of the swim bladder in specimens which do not experience gut protrusions likely induces internal damage undetected by external examination. Aquarists commonly use swim-bladder deflation techniques to increase survivorship of specimens suffering from decompression symptoms (D. Miller[6]). Gotshall (1964) increased tag returns of blue rockfish by deflating expanded swim bladders of specimens collected as deep as 90 m. The technique also reduces the effects of exopthalmia (protruding eyes produced by expansion of gas into the cranial region) on blue rockfish (Gotshall 1964), vermilion snapper, big eye (*Priacanthus arenatus*), and short bigeye (D. Miller fn. 6).

Although tissue emphysema per se may not be lethal, swim-bladder rupture probably is for some species. Jones (1949) reported 90% mortality of 600 perches, *Perca fluviatilis*, with swim bladders ruptured while being raised rapidly from 13.7 m. Topp (1963) speculated that survivorship of sponge-coral reef fishes with ruptured swim bladders is very low. However, R. O. Parker[7] has observed healing of ruptured swim bladders in black sea bass. Further experimentation is needed to determine the effects of swim-bladder rupture on a species-specific basis.

It is likely that survivorship following release varies with depth due to hydrostatic factors alone. Regression of trawl-caught red snapper stomach eversion proportions on capture depth (values from the literature) explains 80% of the variance in the observed data (Fig. 1*A*; $r = 0.90$, df $= 5, P < 0.01$). Inclusion of our trawl-caught red snapper data rendered the relationship nonsignificant (Fig. 1*A*; $r = 0.70$, df $= 6, P < 0.05$). A similar plot of angling-caught red snapper data from the literature was not significant (Fig. 1*B*; $r = 0.58$; df $= 5$; $0.10 < P < 0.05$), possibly because of the differences in the sizes of red snappers hooked with respect to depth (see Figure 1 citations) and resultant differences in the rates of ascent, or ontogenetic differences in relative swim-bladder volume. Note that increased depth eventually outweighs any real effect of the size of the fish and tenacity of its struggle against the angling gear, or anatomical variation, rendering the overall relationship positive albeit nonlinear. The above data (Fig. 1*A*, *B*) also indicate that red snappers caught with any gear over bottoms <30 m deep do not suffer significant trauma. Similarly, depths $\leqslant$ 20 m introduced no difficulties to a food habits study of this species (Moseley 1966).

Clearly, regulations which diminish removal of fishes (e.g., gear/method restrictions, area/time closures) will be more effective over a larger depth

[6]D. M. Miller, Curator, University of Georgia Marine Education Center, POB 13687, Savannah, GA 31416, pers. commun. November 1984.

[7]R. O. Parker, National Marine Fisheries Service, Southeast Fisheries Center, Beaufort Laboratory, POB 500, Beaufort, NC 28516, pers. commun. October 1984.

range than release measures. Current management of the southeastern U.S. snapper-grouper fisheries guarantees subjection of protected size classes to stress and trauma. However, it is conceivable that swim-bladder deflation techniques could improve the effectiveness of current regulations.

The data we have presented show that the effects of capture on sponge-coral reef fishes vary between species and gears. These are important considerations for studies of feeding biology. Additional data on fish species survivorship following releases, stratified by gear and depth, will allow fine-tuning of present snapper-grouper management policies.

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