Synopsis of biological data on the cobia *Rachycentron canadum*
(Pisces: Rachycentridae)

Rosalie Vaught Shaffer and Eugene L. Nakamura
1989

SEDAR58-RD16

30 January 2018

SEDAR28-RD20

NOAA Technical Report NMFS 82 December 1989

Synopsis of Biological Data on the Cobia *Rachycentron canadum* (Pisces: Rachycentridae)

Rosalie Vaught Shaffer
Eugene L. Nakamura

FAO Fisheries
Synopsis 153

NMFS/S 153

SAST—*Rachycentron canadum* 1,70(22),221,01

U.S. Department of Commerce

NOAA TECHNICAL REPORT NMFS

NOAA Technical Report NMFS 82
FAO Fisheries Synopsis 153

Synopsis of Biological Data on the Cobia *Rachycentron canadum* (Pisces: Rachycentridae)

Rosalie Vaught Shaffer
Eugene L. Nakamura

December 1989

U.S. DEPARTMENT OF COMMERCE
Robert Mosbacher, Secretary
National Oceanic and Atmospheric Administration
John A. Knauss, Under Secretary for Oceans and Atmosphere
National Marine Fisheries Service
James Brennan, Assistant Administrator for Fisheries

CONTENTS

*No information available

Acknowledgments

We thank all the contributors of personal communications, as acknowledged in the text. We also thank Bruce B. Collette, NMFS Systematics Laboratory, Washington, D.C., and James Franks, Gulf Coast Research Laboratory, Ocean Springs, Mississippi, for their manuscript reviews and helpful suggestions, and Karen Burns of the Mote Marine Laboratory, Sarasota, Florida, for additional references. Special thanks go to Robin M. Overstreet of the Gulf Coast Research Laboratory and Roger F. Cressey, National Museum of Natural History, Washington, D.C., for their assistance with the parasite section.

Synopsis of Biological Data on the Cobia *Rachycentron canadum* (Pisces: Rachycentridae)

ROSALIE VAUGHT SHAFFER
EUGENE L. NAKAMURA
Panama City Laboratory
Southeast Fisheries Center
National Marine Fisheries Service, NOAA
3500 Delwood Beach Road
Panama City, Florida 32408

ABSTRACT

Information on the biology and fisheries of cobia, *Rachycentron canadum*, is compiled and reviewed in the FAO species synopsis style. Topics include taxonomy, morphology, distribution, reproduction, pre-adult and adult stages, food, growth, migration, population characteristics, and various aspects of exploitation. Data and information were obtained from unpublished as well as published sources.

Cobia, the only species in the family Rachycentridae, is a migratory pelagic fish that occurs in tropical and subtropical seas of the world, except in the central and eastern Pacific Ocean. In the western Atlantic Ocean, spawning occurs during the warm months. Eggs and larvae are planktonic. Females grow faster than males: at 1 year, females are 36 cm FL and 0.4 kg; at 4 years, 99 cm and 11 kg; and at 8 years, 137 cm and 31 kg. Comparable data for males are: at 1 year, 31 cm and 0.3 kg; 4 years, 82 cm and 6 kg; and 8 years, 108 cm and 15 kg. Sexual maturity is attained by males at about 52 cm FL in their second year and by females at about 70 cm in their third year. Fecundity for females 100–125 cm FL varies from 1.9 to 5.4 million eggs. Cobia favor crustaceans for food, but will feed on other invertebrates and fishes as well. They attain a maximum size of over 60 kg. Cobia are fished both commercially and recreationally. Commercially, they are usually caught incidentally in both hook-and-line and net fisheries. In the United States, which ranks behind Pakistan, Mexico, and the Philippines in commercial production of cobia, recreational landings exceed commercial landings by more than ten-fold.

1 IDENTITY

1.1 Nomenclature

1.11 Valid name

Rachycentron canadum (Linnaeus 1766) (Fig. 1): Originally described by Linnaeus as *Gasterosteus canadus* in 1766. The type locality was listed as Carolina (Linnaeus 1766; Systema Natura, p. 491).

1.12 Synonymy

The following synonymy is based on the work of Gill (1895), Jordan (1905), and Jordan and Evermann (1896):

Gasterosteus canadus Linnaeus 1766 (type locality, Carolinas)

Scomber niger Bloch 1793

Centronotus gardenii Lacépède 1802 (Carolinas)

Centronotus spinosus Mitchill 1815 (New York)

Rachycentron typus Kaup 1826

Elacate atlantica Cuvier and Valenciennes 1831 (Brazil)

Elacate bivittata Cuvier and Valenciennes 1831 (Molucca)

Elacate malabarica Cuvier and Valenciennes 1831 (Malabar)

Elacate motta Cuvier and Valenciennes 1831 (Orixa)

Elacate pondiceriana Cuvier and Valenciennes 1831 (Pondicherry)

Meladerma nigerrima Swainson 1839

Naucrates niger Swainson 1839

Elacatc canada DeKay 1842 (New York)

Elacate falcipinnis Gosse 1851 (Jamaica)

Elacate nigra Günther 1860

Rachycentron canadus Jordan and Evermann 1896

Rachycentron pondicerrianum (*sic*) Jordan 1905

Rachycentron canadum Jordan 1905

1.2 Taxonomy

1.21 Affinities

Suprageneric

- Phylum Chordata
  - Subphylum Vertebrata
    - Superclass Gnathostomata
      - Class Osteichthyes
        - Superorder Acanthopterygii
          - Order Perciformes
            - Suborder Percoidei
              - Family Rachycentridae

Generic

Genus *Rachycentron* Kaup 1826. Monotypic genus, see 1.22 and 1.3.

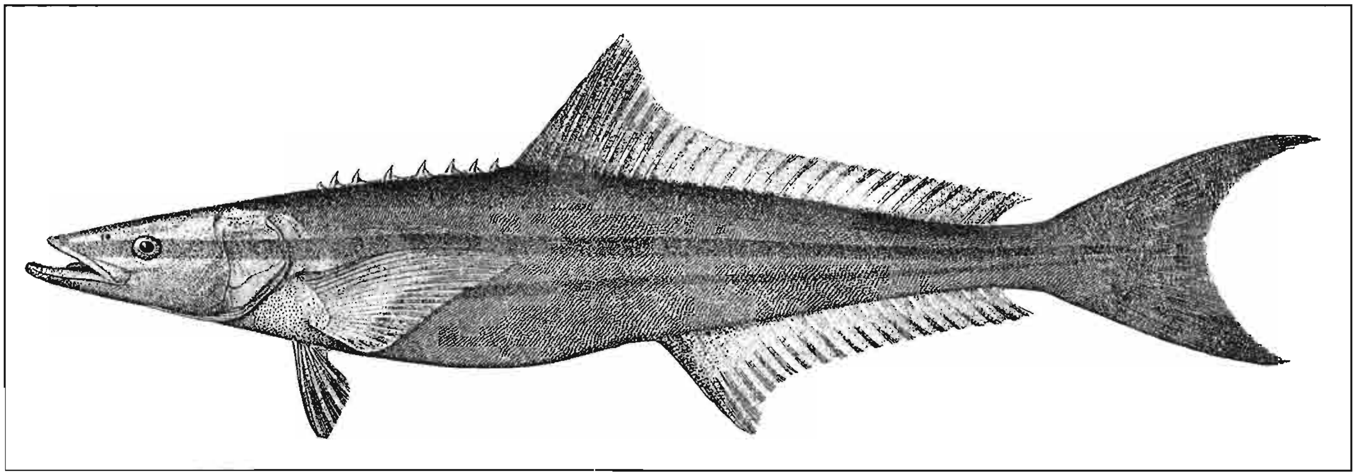

Figure 1
The Cobia, *Rachycentron canadum* (Goode 1884, plate 174).

Specific The following diagnosis of *Rachycentron canadum* is from Collette (1978): "Body elongate, subcylindrical; head broad and depressed. Mouth large, terminal, with projecting lower jaw; villiform teeth in jaws and on roof of mouth and tongue. First dorsal fin with 7–9 (usually 8) short but strong isolated spines, not connected by a membrane; second dorsal fin long, anterior rays somewhat elevated in adults; pectoral fins pointed, becoming more falcate with age; anal fin similar to dorsal, but shorter; caudal fin lunate in adults, upper lobe longer than lower (caudal fin rounded in young, the central rays much prolonged). Scales small, embedded in thick skin; lateral line slightly wavy anteriorly."

1.22 Taxonomic status

Rachycentron canadum is the only species in the family Rachycentridae.

Affinities based on morphology of early life stages as well as adults of species in the families Nematistiidae, Carangidae, Coryphaenidae, Rachycentridae, and Echeneididae are discussed by Johnson (1984). He states that *Rachycentron* and echeneidids have been assumed to be closely related (sister groups) based on similarities in form, color, and fin shape of juveniles of *Rachycentron* and *Echeneis naucrates*, but that osteological examinations reveal a greater likelihood of sister groups between *Rachycentron* and *Coryphaena*. This latter affinity is especially shown in larval morphology of the two genera. He also states, "Three synapomorphies unite the Carangidae, Coryphaenidae, Rachycentridae, and Echeneididae as a monophyletic group. . . Within the carangoids, the Coryphaenidae, Rachycentridae, and Echeneididae form a monophyletic group."

1.23 Subspecies

No subspecies are recognized.

1.24 Standard common names, vernacular names

The accepted common name for *Rachycentron canadum* in the United States is cobia (Robins et al. 1980). The standard FAO common names are: English, cobia; French, mafou; Spanish, cobie (Collette 1978). Other names appearing in the literature are:

United States Ling, sergeant fish, bonito, coalfish (Goode 1884); cabio, crabeater (La Monte 1952); lemonfish (Manooch 1984); black bonito (Hildebrand and Schroeder 1928); lingcod, black salmon (Moe 1970); cubby-yew, flathead (Burgess 1983)

Argentina Bonito negro (Menni et al. 1984)

Australia and India Black kingfish (La Monte 1952, Pillai 1982)

Brazil Bijupirá (Figueiredo and Meneses 1980); ceixupira (Duarte-Bello and Buesa 1973)

Colombia Bacalao (Menni et al. 1984)

Cuba Bacalao (Menni et al. 1984); medregal (Duarte-Bello and Buesa 1973)

Guyanas Cabilo (Org. Econ. Coop. Develop. 1978)

Japan Sugi (Ueno 1965)

Madagascar Sao ambina; poisson-sergent (Fourmanoir 1957)

Mexico Bacalao (La Monte 1952); bonito (Duarte-Bello and Buesa 1973); esmedregal (Sec. Ind. Comer. Mex. 1976)

Pakistan Black kingfish; sanghra; sanglor (Bianchi 1985)

Persian Gulf Sikin (Kuronuma and Abe 1972)

Puerto Rico Bacalao (La Monte 1952, Erdman 1956)

Senegal and Gambia Warangall (Menni et al. 1984)

South Africa Runner; prodigal son (Smith 1965)

Tanzania Runner; songoro (Hatchell 1954)

U.S.S.R. Kobievye; serzhant-ryby (Lindberg and Krasyukova 1971)

Uruguay Bonito; bonito negro (Menni et al. 1984)

Venezuela Bacallao (Menni et al. 1984, Cervigón 1966)

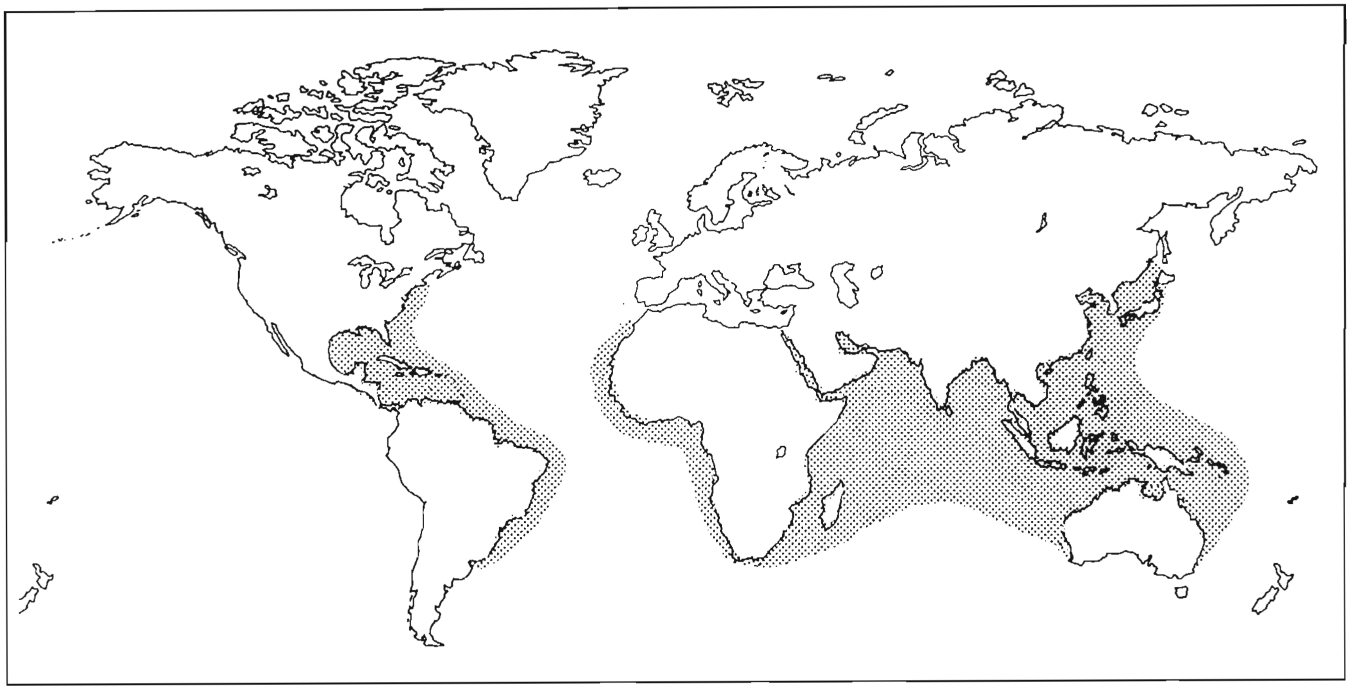

Figure 2
Range of the cobia, *Rachycentron canadum*.

1.3 Morphology

1.31 External morphology

Body elongate, fusiform; head very long, depressed; eye small, interorbital wide, no adipose lid; snout broad, its length 2.45–2.85 in head, eye 4.85–6.35 in head; head 4.05–5.3 in standard length (SL), depth 5.55–8.1; dorsal spines 7–9, each depressible into a groove; dorsal rays 28–33; anal fin with 1–3 spines, 23–27 rays; mouth moderate, lower jaw projecting; maxillary reaching anterior margin of the eye, 2.3–2.6 in head; premaxillaries not protractile; gillrakers short, 7–9 on lower limb of first arch; branchiostegals 7; preopercle and opercle finely serrate marginally; vertebrae 11–14; caudal vertebrae 13 or 14; no air bladder; pyloric appendages branched (Briggs 1974, Fowler 1936, Hardy 1978, Kuronuma and Abe 1972). A detailed study of the cobia lateral-line canal system may be found in Siming and Hongxi (1986). Ueno (1965) gives morphometric data from a Japanese specimen.

Color dark-brown above, a paler brown on sides and below; a black lateral band, as wide as the eye, extending from snout to base of caudal, bordered above and below by paler bands; below this is a narrower dark band. The black lateral band is very pronounced in the juvenile, but tends to become obscured in the adult. Fins mostly all deep or dusky brown; anal and pelvics pale with gray or dusky markings; ventral surface grayish white to silvery (Briggs 1974, Fowler 1936, Hardy 1978, Smith 1907).

2 DISTRIBUTION

2.1 Total area

Cobia are widely distributed, occurring nearly worldwide in tropical, subtropical, and warm temperate waters (Fig. 2). In the western Atlantic, they occur from Massachusetts and Bermuda to the Rio de la Plata, Argentina (Briggs 1958, Menni et al. 1984, Nichols and Breder 1926), with the northern range record of a 42.7-mm SL specimen collected from the Scotian Shelf in Canada (Markle et al. 1980).

In the eastern Atlantic, cobia range from the Atlantic coast of Morocco to South Africa (Monod 1973, Smith 1965). They do not occur in the Mediterranean, except for possible strays from the Red Sea through the Suez Canal (Golani and Ben-Tuvia 1986). Cobia range throughout the Indian Ocean, and in the western Pacific they are reported from Hokkaido, Japan to Australia and the East Indies (Bianchi 1985, Fourmanoir 1957, Grant 1972, Hatchell 1954, Jordan and Seale 1906, La Monte 1952, Lindberg and Krasyukova 1971, Relyea 1981, Ueno 1965). Cobia do not occur in the eastern Pacific.

2.2 Differential distribution

2.21 Spawn, larvae, and juveniles

Most cobia eggs and larvae are found in offshore waters (see 3.16). Early juveniles move inshore and inhabit coastal areas, near beaches, river mouths, barrier islands, lower reaches of bays and inlets, or bays of relatively high salinities (Benson 1982, Hoese and Moore 1977, McClane 1974, Swingle

Table 1
Environmental data from cobia collections.

Location	Date	N	Length/wt.	Water temp. (°C)	Salinity (ppt)	References
Western Atlantic						
New Jersey	Aug.*	2	49 mm TL; 51 mm TL	16.8	30.0	Milstein and Thomas 1976
North Carolina–Florida	Sept. 1969–May 1972	10	22–126 cm TL	19.6–25.2	32.0–36.4	Wilk and Silverman 1976
Jupiter Inlet, Florida	Aug. 1960	1	22 cm SL	>30.0	22.5	Christensen 1965
Gulf of Mexico						
Gulf of Mexico	Nov. 1950–Dec. 1952	—	—	23.0–25.0**	—	Springer and Bullis 1956
Buttonwood Canal, Florida	July 1963	2	132 mm TL; 166 mm TL	29.8	44.5	Roessler 1967
Tampa Bay, Florida	July 1958	1	77.0 mm SL	28.0	33.3	Springer and Woodburn 1960
Cedar Key, Florida	Aug. 1950	2	7 kg; 14 kg	28.9	24.6	Reid 1954
Dog Keys Pass, Mississippi	June and July 1967; June 1968	10	12.6–27 mm SL	25.9–32.0	28.9–37.7	Dawson 1971
Eastern Atlantic						
Ivory Coast	Jan. 1983	1	3.8 kg	22.5	35.4	Lhomme 1983

*1972, 1973, or 1974
**Bottom temperatures, trawl-caught samples

1971). Dawson (1971) indicated that small juveniles (13–15 mm) were taken offshore in the Gulf of Mexico, whereas larger specimens (45–140 mm) were most frequently collected from inshore locations.

2.22 Adults

Adult cobia are coastal and continental shelf fish, occasionally entering estuaries (Benson 1982, Collette 1978, Robins and Ray 1986). They are pelagic, but may occur throughout the water column (Freeman and Walford 1976), and have been taken at depths of 50 m, and over waters as deep as 1200 m (Springer and Bullis 1956). They are found in a variety of habitats: Over mud, rock, sand and gravel bottoms; over coral reefs and in mangrove sloughs; inshore around pilings and buoys, and offshore around drifting and stationary objects (Freeman and Walford 1976, Goodson 1985, Hoese and Moore 1977, Relyea 1981, Sonnier et al. 1976, Springer and Bullis 1956).

2.3 Determinants of distribution changes

Temperature The distribution of cobia is greatly affected by temperature. Generally, cobia occur in the cooler portion of their range only during the warm months of the year. Cobia either migrate to warmer waters, or move offshore to deeper waters during the colder months (see 3.51). They have been collected from waters of 16.8–32.0°C (Table 1). Hassler and Rainville (1975) reported 37.7°C to be lethal to juveniles. The juveniles tolerated temperatures down to 17.7°C, although they ceased feeding entirely at 18.3°C. According to Richards (1967), cobia do not appear in the Chesapeake Bay until water temperatures exceed 19°C.

Salinity Cobia generally occur in areas of oceanic or near-oceanic salinities, and can tolerate fairly hypersaline conditions. They have been taken from waters with salinities ranging from 22.5 to 44.5 ppt (Table 1), but they may be able to acclimate to slightly lower salinities. Hassler and Rainville (1975) were able to rear cobia larvae successfully in salinities as low as 19 ppt.

Food Cobia are known to move to areas of high food abundance, particularly abundances of crabs and other crustaceans (Darracott 1977).

2.4 Hybridization

No hybrids of cobia are known (Schwartz 1972, 1981).

3 BIONOMICS AND LIFE HISTORY

3.1 Reproduction

3.11 Sexuality

Cobia are gonochoristic. No external sexual dimorphism has been reported.

3.12 Maturity

Male cobia mature at a smaller size than females. Richards (1967) reported that male cobia from the Chesapeake Bay reached earliest maturity in their second year, at 51.8 cm FL and 1.14 kg. Females reached earliest maturity in their third year, at 69.6 cm FL and 3.27 kg.

Table 2
Fecundity estimates of cobia collected from Windmill Point and York Spit, Chesapeake Bay (Richards 1967). Ova measured 0.50–0.90 mm diameter.

Fork length (inches)	Wt. (lbs)	Date (July 1963)	Ovary condition	Total ovarian tissue (g)	Egg count (avg./g)	Estimated total fecundity (10^3 eggs)
49.1	57.75	17	Full	2113	2574	5439
48.8	54.75	17	Full	1877	2316	4347
46.5*	45.50	6**	Partly spent	1121	2497	2799
39.2	26.25	17	Full	506	3825	1935
47.0	45.25	17	Partly spent	769	2866	2204
41.8	33.00	18	Full	1083	2464	2669

*Collected only at York Spit.
**1962

Cobia in other parts of the world may mature earlier. In Indian waters, Rajan et al. (1968) collected a 42.6-cm TL female with ovaries in the third stage of maturity.

3.13 Mating

Cobia form spawning aggregations (Richards 1967).

3.14 Fertilization

Fertilization is probably external, with both eggs and sperm released simultaneously.

3.15 Gonads

Fecundity In the Chesapeake Bay area, Richards (1967) reported that fecundity ranged from 1.9 to 5.4 million eggs for six cobia (Table 2). Richards also gave the relation between fecundity (F), in 10^4 ova, and the body weight (wt) in pounds of four fully-gravid females as $F = 0.98\ (wt) - 6.39$.

3.16 Spawning

Western North Atlantic The presence of gravid females and appearance of cobia eggs in plankton collections indicated that spawning occurs between mid-June and mid-August in the Atlantic Ocean adjacent to the mouth of the Chesapeake Bay (Joseph et al. 1964). Richards (1967) indicated that cobia spawn from late June through mid-August off Virginia, and that multiple spawning may occur.

Spawning may occur earlier in North Carolina waters. Hassler and Rainville (1975) collected nearly 2000 cobia eggs from 23 May to the end of their sampling period on 28 June in Gulf Stream waters 25–50 km from the coast. Spawning appeared to peak between 10 and 17 June. Off South Carolina, spawning has been recorded as early as mid-May, extending to the end of August in offshore waters, approximately 80 km from the coast (Donald Hammond, S.C. Dep. Wildl. Mar. Resour., P.O. Box 12559, Charleston, SC 29412, pers. commun., 8 Apr. 1987).

Table 3
Cobia larvae collected from Gulf of Mexico waters off the coast of Texas (adapted from Finucane et al. 1978a).

Date	Stn. no.	*N*	Size (mm)	Water depth (m)	Km from coast (est.)
7/6/77	II-3	2	3.8	135	90
9/7/77	IV-3	3	4.0	90	80
9/8/77	III-2	4	6.8	~70	50
9/10/77	I-3	3	5.1	135	85

Gulf of Mexico Finucane et al. (1978a) implied cobia spawning in the Gulf of Mexico from the collection of small larvae (3.8–6.8 mm) off the Texas coast in July and September (Table 3). In an additional study, Finucane et al. (1978b) collected six larvae (5.9–23.0 mm) off the coast of Texas in July. Dawson (1971) reported that cobia less than 30 mm SL were taken from gulf coastal waters between 31 May and 12 July; the smallest specimens (16–19 mm SL) were collected on 5 June. He also noted that the occurrence of small specimens follows the appearance of adults in northern gulf waters in March and April. Baughman (1950) indicated that young cobia were common off Texas in May, June, and July. Observations of what was believed to be spawning by cobia have been made by James M. Barkuloo (U.S. Fish Wildl. Serv., Panama City, FL, pers. commun., 23 March 1988). On 8 and 10 August 1974, while on an oil drilling ship in the Gulf of Mexico about 30 miles southwest of Panama City, Florida, Barkuloo saw as many as nine cobia ranging from 30 to 50 pounds each. The cobia separated into groups of two or more and released eggs (''bubble-like'') and sperm (''white cloud'') while undergoing changes in body color from uniform brown to a light horizontal-striped pattern on their lateral surfaces.

Caribbean Sea Erdman (1968) indicated that August was the peak month of spawning for cobia in Puerto Rican waters.

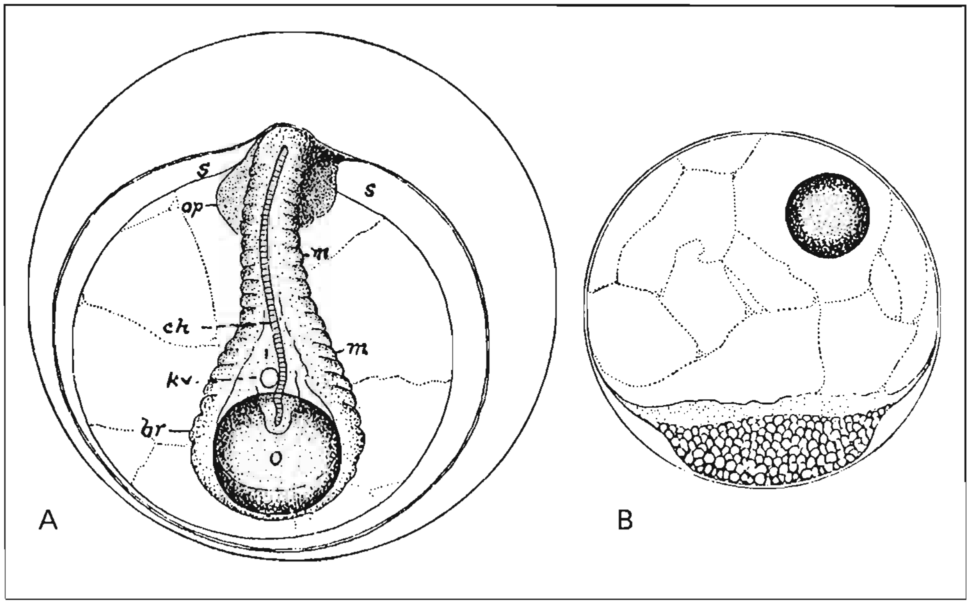

Figure 3

Development of cobia eggs (from Ryder 1887, plate 3): A) Developing egg of *Rachycentron canadum*, showing the spacious cleavage cavit (s), Kupffer's vesicle (kv), the chorda (ch), segments (m) of the embryo, the limbs (br) of the concrescing blastophore, the oil drop (o), and the optic vesicles (op); and B) an earlier phase of the developing egg.

Indian Ocean Little is known regarding cobia spawning in waters other than the western Atlantic. Darracott (1977) indicated that cobia eggs have not yet been recorded from the Indian Ocean, although ripe fish are found year-round. She also indicated that cobia may migrate from the southern Indian Ocean to spawn off coastal areas of the Arabian Sea. Rajan et al. (1968) collected two small juveniles (7 mm TL) in a lagoon of the Bay of Bengal, India, on 25 March 1960. Day (1967) took a ripe female from Indian waters in March. In Pakistan waters, ripe cobia are found in March and April along the Baluchistan coast (Bianchi 1985). A female with maturing eggs was collected from Madagascar waters in October 1964 (Richards 1967).

3.17 Spawn

Unfertilized eggs from female cobia were described by Richards (1967) as having three stages:

Immature Clear, nucleated cells, 0.10-0.30 mm in diameter

Maturing Eggs with a clouded appearance and the oil globule vaguely discernible, 0.36-0.66 mm in diameter

Mature Eggs clear or transparent, 1.09-1.31 mm in diameter (average 1.20 mm), with an oil globule 0.29-0.44 mm in diameter (average 0.37)

Fertilized cobia eggs are pelagic, and can be identified by the distinctively large oil globule. The yolk is segmented. Both the oil globule and the embryo are yellow and mottled with melanin pigment (Hassler and Rainville 1975). Joseph et al. (1964) collected fertilized cobia eggs and described them as ranging from 1.16 to 1.42 mm in diameter (mean 1.27 mm), with a single oil globule ranging from 0.34 to 0.44 mm in diameter (mean 0.38).

3.2 Preadult phase

The preadult phase has been summarized by Hardy (1978).

3.21 Embryonic phase

The development of cobia eggs in the laboratory has been described by Ryder (1887) (Fig. 3). He reported a rapid growth of the blastoderm; within 8 hours from fertilization, the entire vitellus was included and covered by the blastoderm's epibolic growth. Eggs hatched within approximately 36 hours from fertilization (temperature unspecified).

Hassler and Rainville (1975) collected naturally spawned cobia eggs, and found the highest hatching rates to occur in tank water salinities of 33–35 ppt, with a water temperature of approximately 26.5°C.

3.22 Larval and early juvenile phase

The following descriptions were taken from Hassler and Rainville (1975):

Day 1 The 1-day-old larvae are approximately 3 mm long and colorless. Only a light-green tint is to be noted in the area of the developing eye. The larvae have not yet begun to feed actively and the yolksac is large and conspicuous. A single fin extends dorsally from the head and ventrally from the yolksac to the posterior, where it extends around the caudal tip of the body.

Table 4
Measurements (mm) of selected characters of prejuvenile and juvenile *Rachycentron canadum* from the Gulf of Mexico (Dawson 1971).*

Cat. No.	4355	4354	4356	4356	4355	4353	4353	2359	4352	373	373
Standard length	12.6	12.9	13.6	13.7	15.3	16.6	18.2	23.5	27.0	44.3	55.0
Caudal fin length	3.1	2.6	3.0	3.3	3.7	4.3	5.1	7.1	9.3	15.0	16.8
Least caudal peduncle depth	0.7	0.8	0.8	0.8	0.9	0.9	1.0	1.2	1.4	2.4	2.8
Depth at anal fin origin	1.1	1.4	1.4	1.3	1.5	1.6	1.6	2.1	2.7	4.6	5.4
Pectoral fin length	1.6	1.3	1.4	1.6	1.8	2.1	2.4	2.8	4.0	6.1	9.4
Pelvic fin length	0.7	0.7	0.9	1.0	0.7	1.4	1.8	3.1	4.5	8.7	10.1
Pelvic fin insertion to anal fin origin	3.5	3.9	4.1	4.1	4.7	4.5	4.9	6.2	7.3	12.3	15.3
Head length	3.6	3.5	3.8	3.8	—	4.7	—	—	—	—	13.7
Snout length	1.0	0.9	1.1	1.0	—	1.5	—	—	—	—	4.4
Eye diameter	1.1	1.0	1.1	1.1	1.2	1.3	1.5	1.6	1.8	3.1	3.5
Postorbital length	1.5	1.6	1.6	1.7	1.8	1.9	2.1	2.5	2.8	4.8	5.8
Interorbital width	—	0.6	—	0.9	—	1.0	1.1	1.5	1.5	3.2	4.5
Maxillary length	1.3	1.5	1.5	1.4	—	1.6	—	—	—	—	5.2

*All specimens are from the Museum of the Gulf Coast Laboratory, Ocean Springs, MS, except for Cat. no. 2359 collected by the Florida Department of Natural Resources, St. Petersburg, FL.

Day 5 After 5 days, the larvae are 4–5 mm long. Eyes are dark-brown and prominent. The yolksac is absorbed, and development of the eye and mouth permits active feeding. A faint yellow streak extends the length of the body, and scattered blotches of melanin are evident. The fin structure is the same as the day-1 larvae; however, limited swimming is now possible.

Day 10 By the tenth day, definite changes can be noted in the larvae. The mouth, head, and eye are fully developed. Musculature is now apparent throughout the body, permitting prolonged, active swimming. The single finfold persists, and fin rays begin to appear in some areas. Pectoral fins are now present. The larvae are light-brown and 5–10 mm in length.

Day 30 The day-30 juvenile has begun to take on the appearance of the adult fish. Distinct dorsal, anal, caudal, pectoral, and pelvic fins develop. The dorsal fin extends from midbody to a point just anterior to the caudal fin. The [anal] fin also ends just before the caudal fin and begins just behind the anus. The caudal fin is large and fan-shaped. Eight short spines develop just anterior to the dorsal fin. Two color bands run from the head to the posterior tip of the 30-day-old juvenile. The white-to-yellow dorsal band and the black ventral band meet along the lateral line of the juvenile.

Day 59 After 59 days, the juveniles have grown considerably, but their general appearance is similar to the 30-day cobia. The most striking change has occurred in the banding of the fish, which now appears to be black with dorsolateral and ventrolateral gold or white bands. The dorsolateral bands extend anteriorly over the head, just above the eye, and posteriorly to the caudal fin. The ventrolateral band is not as distinct, and extends from under the mouth to the caudal fin. The dorsal, anal, and caudal fins are black with light-yellow tips.

Dawson (1971) gave detailed descriptions of prejuvenile and juvenile cobia, 12.6–55.0 mm SL. His measurements of selected characters are given in Table 4. Illustrations of larval and juvenile cobia are given in Figures 4 and 5.

3.23 Juvenile phase

Joseph et al. (1964) described two juvenile cobia, 108 and 120 mm TL, collected from the mouth of the York River, Virginia. These juveniles differed from adults most notably in color pattern. They displayed a prominent black longitudinal band, extending the full length of the body, bordered above and below by white stripes. The paired fins were black, except for an inconspicuous margin on the pectorals. Dorsal and anal fins were marked with white margins on the anterior portions. The caudal fin was broadly rounded, with white margins on the dorsal and ventral edges (Fig. 6). Hildebrand and Schroeder (1928) indicated that juveniles differ markedly from adults in having a ''more elongate body, less strongly depressed head, in having the caudal fin truncate instead of forked, and in being somewhat lighter in color and having a black lateral band, which extends from the snout, through the eye, to the base of the caudal.''

Wang and Kernehan (1979) described juvenile cobia 50 mm and larger as resembling the adult, but having a truncate-to-broadly-rounded caudal fin rather than the lunate caudal of the adult. They gave the following characteristics: Head, long and depressed; lower jaw projecting out farther than the upper jaw; all fin rays and spines developed (dorsal fin with 8–9 spines, 30 rays; anal fin with 1 spine, 23 rays); dorsal, pectoral, and anal fins elongate; dark horizontal band extending from tip of snout to base of caudal fin; dorsum, ventrum, and fins darkly pigmented (Fig. 7).

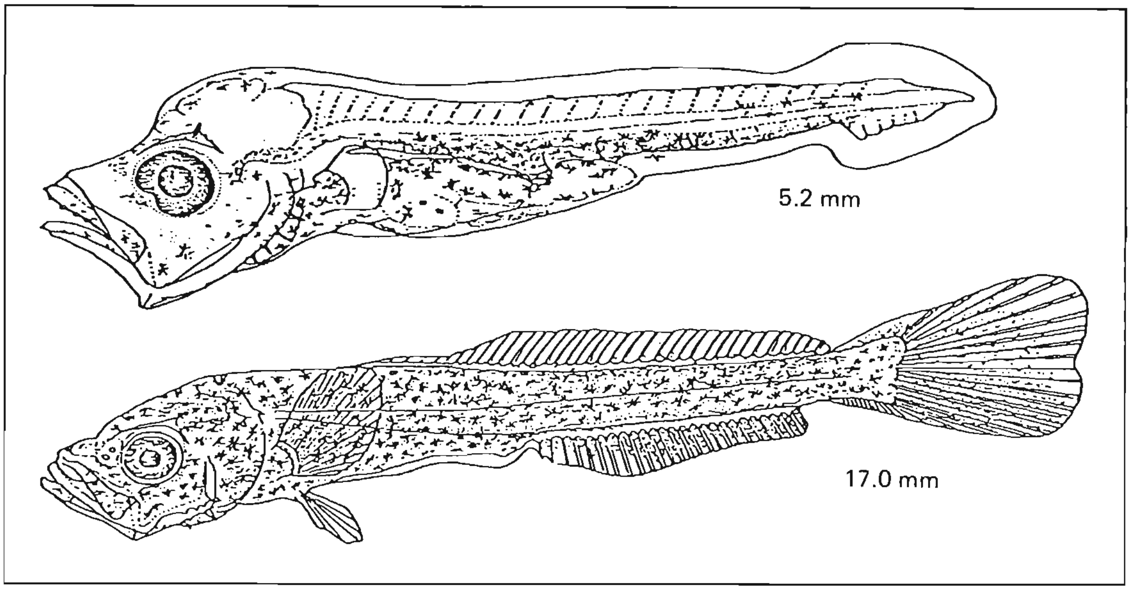

Figure 4
Larval development stages of cobia collected off the Texas outer continental shelf (Finucane et al. 1978a, fig. 146).

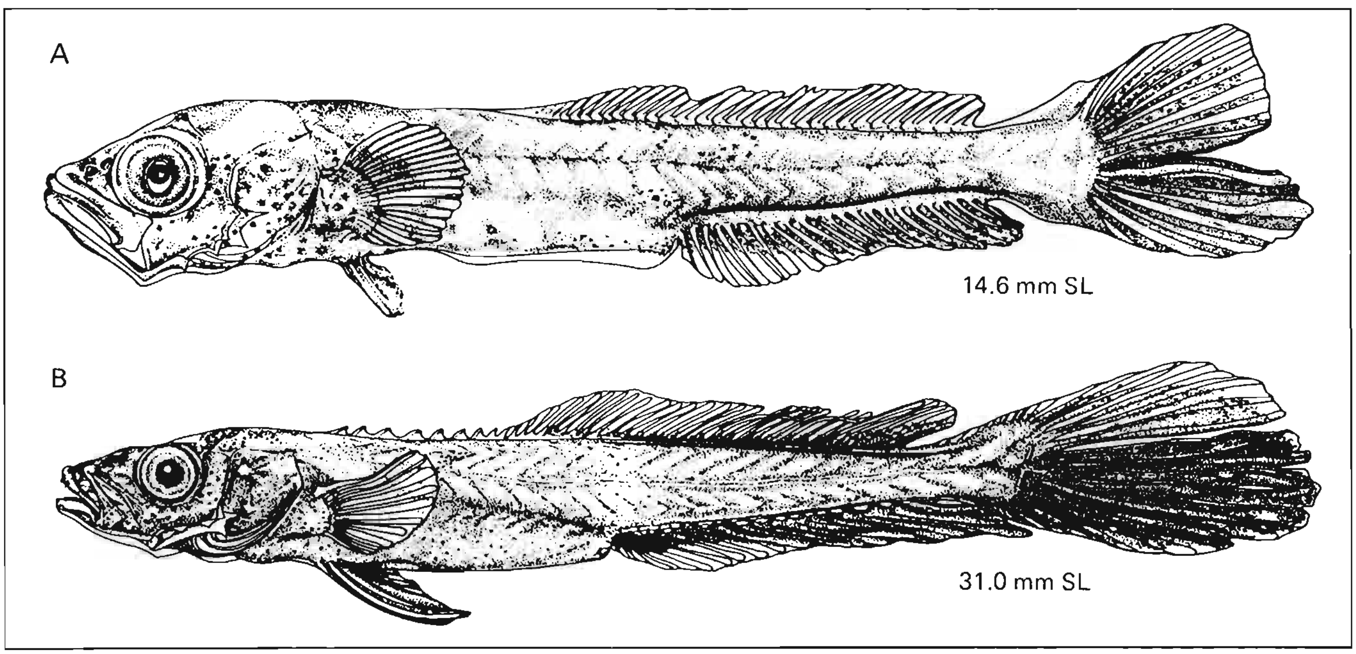

Figure 5
Late larva and juvenile cobia (Hardy 1978, fig. 226): A) Late larva, preopercular spines prominent, preanal finfold still evident; and B) juvenile.

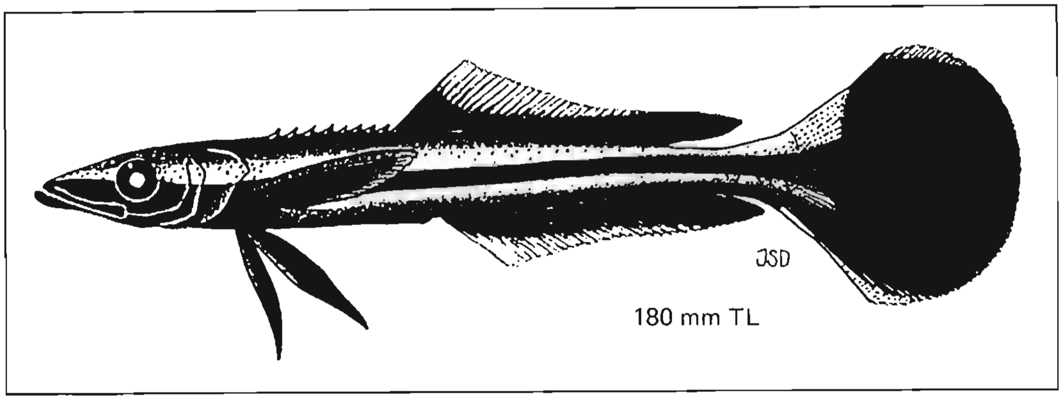

Figure 6
Composite drawing of a juvenile cobia (Joseph et al. 1964, fig. 3).

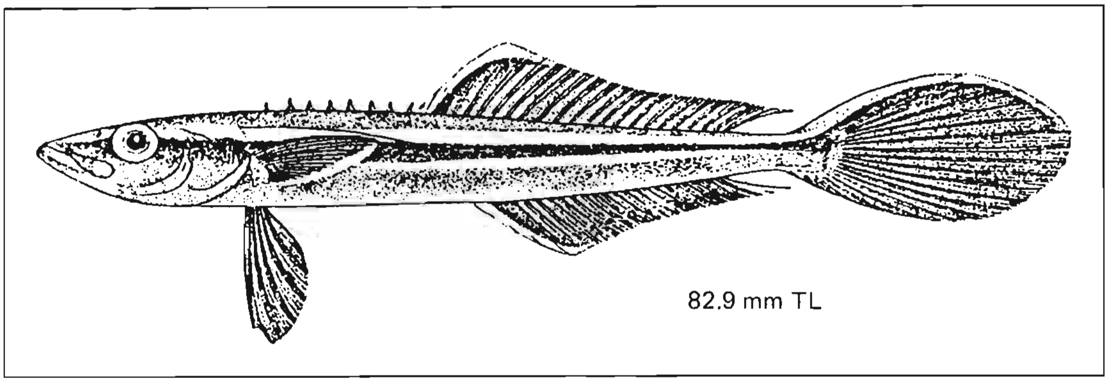

Figure 7
A juvenile cobia (Wang and Kernehan 1979, fig. 75).

3.3 Adult phase

3.31 Longevity

Cobia may reach a length of 2 m (Cadenat 1950). The world hook-and-line weight record for cobia is a 61.5-kg fish from Australian waters in 1985 (Int. Game Fish Assoc. 1988). According to Wheeler (1975), cobia weighing 68 kg have been reported.

Cobia are known to live at least 10 yrs (Richards 1967), and may reach an age of 15 yrs or more (Gulf Mex. S. Atl. Fish. Manage. Counc. 1985).

3.32 Hardiness

Cobia are relatively adaptable to their environment and are able to utilize a variety of habitats and food sources (see 2.2, 2.3, 3.35, 3.42).

3.33 Competitors

No studies have been done regarding the competitors of cobia, but given the wide range of the cobia's habitats and prey species, competition is probably not an important factor in their survival.

3.34 Predators

No studies have been done regarding the predators of cobia, but they are presumably eaten by larger pelagic fishes. Dolphin (*Coryphaena hippurus*) have been reported to prey upon small cobia (Rose 1965).

3.35 Parasites, diseases, and abnormalities

Parasites of cobia include trematodes, monogeneans, cestodes, nematodes, acanthocephalans, and copepods (Table 5). Infections by some parasites appear to be heavy on occasion. Madhavi (1976) reported 30 specimens of the trematode *Stephanostomum pseudoditrematis* from a cobia intestine. Intestinal damage from acanthocephalid worms was severe in cobia examined by George and Nadakal (1981). Rasheed (1965) and Overstreet (Robin Overstreet, Gulf Coast Res. Lab., P.O. Box 7000, Ocean Springs, MS 39564-7000, pers. commun., 12 Aug. 1987) noted that whenever a cobia was dissected for study, the stomach was found to be heavily infected with the nematode *Iheringascaris inquies*.

Some parasites of cobia demonstrate a high degree of host-specificity. The monogenean *Dionchus rachycentris* is reported only from the cobia (Hargis 1957). The closely

Table 5
A partial list of parasites of cobia.

Parasite	Geographic region	Site on host	Reference
Monogeneans			
Dionchus rachycentris	Gulf of Mexico–Texas	Gills	Koratha 1955
(syn. *D. hopkinsi*)	Gulf of Mexico–Florida	—	Hargis 1957
	SW Pacific–Australia	—	Young 1970
Dionchus sp.	SW Pacific–Australia	Gills	Rohde 1978
Digenetic trematodes			
Laruea straightum	Arabian Sea–Pakistan	Intestine	Jahan 1973
Lecithocladium jagannathi	Bay of Bengal–India	Stomach	Ahmad 1981
Sclerodistomum rachycentri	Indian Ocean	—	Parukhin 1978
Stephanostomum cloacum	Bay of Bengal–India	Intestine	Hafeezullah 1978
S. dentatum	NW Atlantic–North Carolina	—	Linton 1905
(syn. *Distomum dentatum*)			
S. imparaspine	Gulf of Mexico–Florida	Rectum	Sogandares-Bernal and Hutton 1959
(syn. *Distomum imparispine*)			
S. microsomum	Bay of Bengal–India	Intestine	Madhavi 1976
S. pseudoditrematis	Bay of Bengal–India	Intestine	Madhavi 1976
Sterrhurus monticelli	NW Atlantic–North Carolina	—	Linton 1905
(syn. *Distomum monticellii*)			
Tormopsolus filiformis	Gulf of Mexico–Florida	Rectum	Sogandares-Bernal and Hutton 1959
	Bay of Bengal–India	Intestine	Madhavi 1976
T. spatulum	Bay of Bengal–India	Intestine	Hafeezullah 1978
Cestodes (metacestode stage)			
Rhinebothrium sp.	NW Atlantic–North Carolina	Alimentary canal	Linton 1905
Rhynchobothrium sp.	NW Atlantic–North Carolina	—	Linton 1905
Scolex polymorphus	NW Atlantic–North Carolina	—	Linton 1905
Tetrarhynchus bisulcatus	NW Atlantic–North Carolina	Stomach wall	Linton 1905
Nematodes			
Goezia pelagia	Gulf of Mexico	Stomach	Deardorff and Overstreet 1980
Iheringascaris inguies	NW Atlantic–North Carolina	—	Linton 1905
(syn. *Ascaris inguies*,	Arabian Sea–Pakistan	Stomach	Rasheed 1965
Thynnascaris inguies,	Arabian Sea–Pakiston	Alimentary canal	Khan and Begum 1971
Neogeozia elacateidae,	Gulf of Mexico	Stomach and pyloric caeca	Overstreet 1978
Contracaecum inguies,	Various	Stomach and pyloric caeca	Deardorff and Overstreet 1981
I. iheringascaris)			
Acanthocephalans			
Serrasentis nadakali	Arabian Sea–India	Intestine and pyloric caeca	George and Nadakal 1981
S. sagittifer	NW Atlantic–North Carolina	Intestine	Linton 1905
(syn. *Echinorhynchus sagittifer*,	E. Atlantic–Senegal	Intestine	Golvan 1956
S. socialis)	Gulf of Mexico	Intestine and pyloric caeca	Overstreet 1978
	Arabian Sea–India	Intestine	Soota and Bhattacharya 1981
Copepods			
Euryphorus nympha	Gulf of Mexico–Texas	—	Causey 1953
(syn. *E. coryphaenae*)			
Lernaeenicus longiventris	Gulf of Mexico–Texas	Fin surface	Causey 1953
Lernaeolophus hemiramphi	Gulf of Mexico–Texas	—	Causey 1953
L. sultanus	Gulf of Mexico–Mississippi	Body surface	Dawson 1969
Parapetalus gunteri	Gulf of Mexico–Texas	Gills	Pearse 1952
	SW Pacific–Australia	Gills	Kabata 1967
	Indian Ocean–India (Trivandrum)	Gills	Pillai 1962
P. occidentalis	NW Atlantic–North Carolina	Inside surface of operculum	Wilson 1908
	Gulf of Mexico	Body surface	Causey 1955
	Indian Ocean–India (Trivandrum)	Gills and inner surface of operculum	Pillai 1962
Tuxophorus caligodes	NW Atlantic–North Carolina	Body surface	Wilson 1908
	Gulf of Mexico–Texas	Body surface	Causey 1953

related *D. remorae* is specific to some remoras. This similarity has been suggested as an indicator of a close phylogenetic relationship between the two fishes (Hargis 1957, Koratha 1955). The adult nematode *Iheringascaris inquies* appears to be restricted to cobia (Deardorff and Overstreet 1981).

A barnacle (*Conchoderma virgatum*) has been found on a cobia from Mississippi waters. It was not attached directly to the fish, but to the parasitic copepod *Lernaeolophus sultanus*, embedded just posterior to the last dorsal fin ray (Dawson 1969).

There is little information in the literature regarding diseases of cobia. Heart abnormalities have been reported. Several cobia hearts examined by Howse et al. (1975) revealed pericardial adhesions, probably resulting from pericarditis. Also, the cobia is reported to be one of the fishes affected by red tide organisms (Galtsoff 1954).

3.36 Chemical composition

The composition of cobia (raw muscle tissue) was reported by Sidwell (1981): Moisture 74.9%, protein 18.9%, fat 5.4%, ash 1.3%, carbohydrates 0%. The caloric content was 124 calories per 100 g.

Moderately high levels of mercury have been found in cobia from Texas offshore waters. Bright and Pequegnat (1974) reported a concentration of 0.71 parts per million of mercury in cobia muscle tissue.

3.4 Nutrition and growth

3.41 Feeding

Cobia are known to be voracious feeders, often engulfing whole prey. Darracott (1977) reported undamaged crustaceans in cobia stomachs. Fisher (1891) compared cobia's feeding with that of the pike. To a large extent, cobia feed near the bottom; however, the presence of pelagic fish in some samples indicates that they also take prey near the surface (Knapp 1951).

Cobia exhibit some degree of commensalism. They are known to associate with rays, sharks, and other large fish, and have been observed in captivity to take in a larger fish's rejected food scraps (Takamatsu 1967, Smith and Merriner 1982). The rays may also stir up benthos upon which the cobia feed (Smith and Merriner 1982).

Feeding appears to decrease with lowered temperatures. Hassler and Rainville (1975) observed that 90-day-old laboratory-reared juvenile cobia ceased feeding when water temperatures were lowered to 18.3°C. Also, cobia may cease feeding during spawning (Richards 1967). No studies have been done regarding the cobia's diurnal feeding habits. Cobia may time their migrations with the availability of important prey species, such as crustaceans (Darracott 1977).

3.42 Food

Cobia are carnivorous, feeding extensively on crabs, other benthic invertebrates, and fish. They have been called the "crabeater" due to the prevalence of this food item in their diet (Randall 1983). Knapp (1951) found a 42% frequency of occurrence of *Callinectes*, and a 46% frequency of occurrence of penaeid shrimp in cobia stomachs. Crustaceans occurred in 100% of the cobia stomachs examined by Darracott (1977). Out of a total of 40 organisms found in cobia stomachs by Miles (1949), 29 were crabs.

Donald Hammond raised cobia from 30 days to 1 yr of age, and found that they did not thrive unless they received crustaceans in their diet (S.C. Dep. Wildl. Mar. Resour., P.O. Box 12559, Charleston, SC 29412, pers. commun., 8 Apr. 1987). Cobia also feed upon squid and a variety of small, particularly demersal fish, such as eels, sea catfish, and sciaenids. Cobia food habit studies are summarized in Table 6.

Little is known regarding the food habits of larval and young juvenile cobia. Hassler and Rainville (1975) successfully fed laboratory-raised cobia a diet of wild zooplankton, dominated by copepods.

3.43 Growth rate

Cobia appear to grow rapidly and have a moderately long life span. Richards (1967, 1977) studied the growth of cobia from the Chesapeake Bay and found that scale annuli were formed in midsummer. His age, length, and weight data are given in Table 7. His growth equations for male and female cobia were:

Males	Females
$FL = 121\ (1-e^{-028(t+0.06)})$	$FL = 164(1-e^{-0.226(t+0.08)})$
$W = 21.3(1-e^{-0.28t})^{3.088}$	$W = 54.5(1-e^{-0.225t})^{3.088}$

where FL = fork length in centimeters, W = weight in kilograms, and t = time in years. Solutions for these equations for 1–8 years are given in Table 8 (Richards 1977). Female cobia appear to grow more rapidly and attain greater size than males (Richards 1967, 1977).

The length-weight relationship for cobia was calculated by Richards (1967) to be: Log $W = (3.088 \log L) - 3.506$, where W = weight in pounds, and L = fork length in inches. The curvilinear relationship was the same for males and females (Fig. 8). Darracott (1977) reported the length-weight relationship of cobia from the Tanzanian area of the Indian Ocean as:

Female $W = -4.57\ L^{2.79}$ (n=9, r=0.97)

Male $W = -5.19\ L^{3.15}$ (n=9, r=0.99)

Total $W = -4.58\ L^{2.83}$ (n=48, r=0.96)
(18 could be sexed)

where W = weight in kilograms, and L = length in centimeters.

As scaling parameters in the negative range are unreasonable, it is likely that Darracott (1977) substituted the log parameter values into the non-log form of the equation. Therefore, the correct equations should read:

Table 6
Organisms found in cobia stomachs by various authors.

	Gulf of Mexico					Atlantic Ocean			Indian Ocean	
	Boschung (1957)	Christmas et al. (1974)	Knapp (1951)	Miles (1949)	Reid (1954)	Briggs et al. (1979)	Linton (1905)	Randall (1967)	Chacko (1949)	Darracott (1977)
	Waters of									
	Alabama	Mississippi	Texas	Texas	Florida	New York	North Carolina	West Indies	India	Tanzania
	No. of samples									
Taxonomic group	4	11	24	13	2	1	8	1	1	22
Annelida							x			
Arthropoda	x	x	x	x			x		x	x
Crustacea	x	x	x	x			x		x	x
Penaeidae		x	x	x						
Palinuridae										x
Portunidae	x	x	x	x					x	x
Stomatopoda			x							x
Mollusca			x	x						x
Gastropoda				x						
Cephalopoda			x							x
Chordata	x	x	x	x	x	x	x	x		x
Tunicata			x							
Vertebrata	x	x	x	x	x	x	x	x		x
Pisces	x	x	x	x	x	x	x	x		x
Squaliformes			x							
Anguillidae	x	x	x							x
Synodontidae				x						
Arridae			x	x	x					
Atherinidae						x				
Serranidae			x							
Sciaenidae	x	x	x							
Scombridae			x							
Stromateidae				x						
Triglidae		x								
Bothidae		x								
Cynoglossidae	x									
Ostraciidae					x			x		

Female $\text{Log } W = 2.79 \text{ Log } L - 4.57$

Male $\text{Log } W = 3.15 \text{ Log } L - 5.19$

Total $\text{Log } W = 2.83 \text{ Log } L - 4.58$

(J. Jeffery Isely, Panama City Lab., Southeast Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Panama City, FL 32408, pers. commun., 28 Sept. 1989).

Hassler and Rainville (1975) described exponential weight and length increases in cobia larvae and juveniles older than 10 days with the equations:

$$\text{Log } W = 4.360 \text{ Log } X - 4.318,$$

where W = weight in mg, and X = age in days.

$$\text{Log } L = 1.425 \text{ Log } X - 0.587,$$

where L = length in mm, and X = age in days.

Hassler and Rainville (1975) also described the length-weight relationship of larval and juvenile cobia with the exponential equation: $\text{Log } W = 2.4035 \text{ Log } L - 1.3007$. Table 9 provides the average weight and length-at-age of cobia to 131 days of age.

Table 7

Calculated fork lengths and average length-weight data for cobia samples from catches within Chesapeake Bay, 1960–64 (Richards 1967).

Age	Sample size	Mean capture weight (lbs)	No. of fish	Mean capture length (in.)	Calculated lengths (inches) at successive annuli 1	2	3	4	5	6	7	8	9	10
Males														
I	3	3.3	4	21.4	15.1									
II	32	8.3	37	28.1	14.1	24.6								
III	16	16.7	18	33.2	13.9	22.9	30.1							
IV	9	21.2	10	37.1	13.9	23.6	30.2	34.8						
V	12	26.3	13	39.7	13.9	23.7	30.1	34.7	38.0					
VI	9	30.3	12	40.9	13.4	20.2	27.0	32.3	36.3	39.3				
VII	4	32.0	4	41.4	12.8	19.1	25.4	29.8	33.4	36.8	39.7			
VIII	0	—	0	—										
IX	2	39.1	2	43.0	10.6	16.2	20.5	24.0	29.6	34.0	36.4	39.2	41.6	
X	1	41.8	1	47.0	11.8	20.2	23.7	27.1	32.5	38.2	40.5	42.4	44.3	45.9
Total	88		101	Grand average	13.8	23.1	28.8	32.9	36.2	38.3	39.1	40.3	42.5	45.9
Females														
I	6	4.0	6	22.9	15.3									
II	11	10.2	15	30.7	14.3	25.0								
III	25	24.5	30	37.5	14.0	24.5	34.4							
IV	17	29.2	20	41.0	13.9	23.3	31.6	38.1						
V	34	43.5	39	45.6	14.3	24.2	32.7	38.5	42.8					
VI	19	48.1	22	47.1	14.0	23.0	30.3	35.7	40.8	44.7				
VII	13	55.4	14	49.5	14.7	23.5	30.7	36.2	40.6	44.2	47.4			
VIII	7	62.7	7	51.3	14.2	22.3	28.6	33.5	38.4	42.8	45.8	49.2		
IX	3	67.3	3	52.5	13.3	22.8	31.0	34.5	39.2	42.2	44.6	47.7	50.3	
Total	135		156	Grand average	14.2	23.8	32.0	37.0	41.4	44.1	46.6	48.7	50.3	

Table 8

Length and weight solutions for cobia growth equations (Richards 1977).

t (years)	Females Fork length in.	cm	Weight lbs	kg	Males Fork length in.	cm	Weight lbs	kg
1	14.0	36	0.85	0.4	12.2	31	0.6	0.3
2	24.2	61	5.2	2.4	20.8	53	3.4	1.5
3	32.3	82	13.3	6.0	27.3	69	8.2	3.7
4	38.8	99	24.0	10.9	32.3	82	13.9	6.3
5	44.0	112	35.7	16.2	36.0	91	19.6	8.9
6	48.1	122	47.5	21.5	38.8	99	24.8	11.2
7	51.4	131	58.6	26.6	40.9	104	29.3	13.3
8	54.0	137	68.7	31.2	42.5	108	33.1	15.0

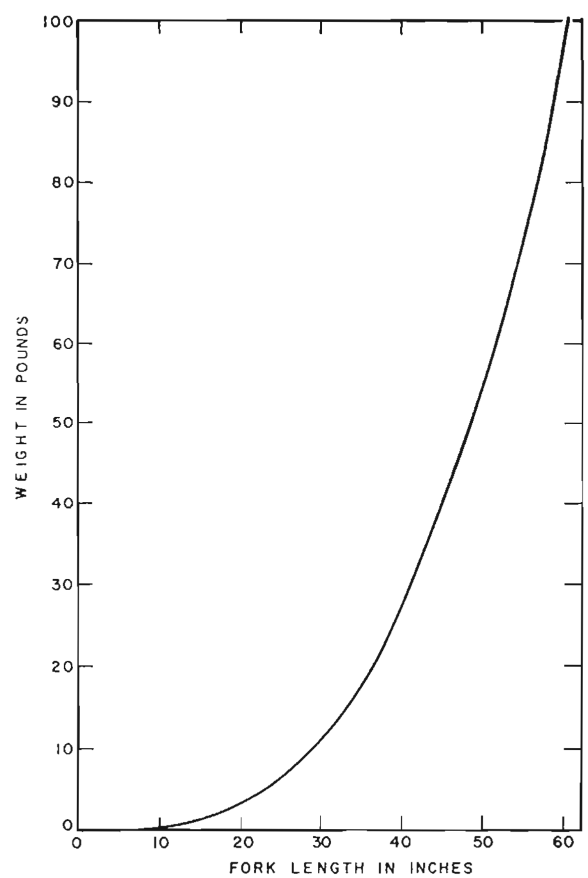

Figure 8
Length-weight relationship for cobia collected from Virginia waters (Richards 1967, fig. 2).

Table 9
Age and average weight and length data of larval and juvenile cobia (modified from Hassler and Rainville 1975).

Age (days)	No. of specimens	Weight (mg) Avg.	Weight (mg) Range	Length (mm) Avg.	Length (mm) Range
1	5	1.0	-	3.0	-
2	5	2.2	2-3	3.6	3.0-4.0
3*	3	1.0	-	3.7	-
4*	3	2.7	2-3	3.7	3.5-4.0
5	3	8.7	8-9	4.7	4.5-5.0
6*	4	9.2	9-10	4.9	4.5-5.0
7*	3	8.0	7-10	4.8	4.5-5.0
8*	3	1.0	-	5.3	5.0-5.5
9	2	7.0	6-8	6.5	6.0-7.0
10	1	10.0	-	9.0	-
10*	1	4.0	-	6.0	-
12*	3	4.0	-	6.7	-
13*	1	9.0	-	9.0	-
14	1	30.0	-	16.0	-
15*	1	8.0	-	9.5	-
18	1	30.0	-	19.0	-
19	7	11.4	20-10	12.1	10.0-15.5
20	1	20.0	-	16.0	-
22	11	42.7	20-90	24.2	16.0-30.0
23	3	41.7	35-50	23.1	22.5-24.0
24	13	46.9	20-120	24.2	19.0-33.0
25	1	90	-	24.5	-
28	1	60	-	29.0	-
30	1	90	-	29.0	-
36	1	920	-	65.0	-
43	1	130	-	34.0	-
51	1	3,750	-	93.0	-
59	8	4,140	1,350- 7,500	98.2	69-120
71	2	19.745	6,900-12,590	138	128-149
73	1	12,480	-	141	-
83	4	10,425	8,900-12,520	142	134-148
88	2	22,865	22,390-23,340	166	165-166
99	1	25,350	-	183	-
102	1	33,610	-	196	-
107	1	43,200	-	201	-
109	1	34,300	-	187	-
110	1	12,000	-	127	-
111	1	25,000	-	178	-
112	1	71.000	-	205	-
120	1	64,000	-	210	-
124	1	74,000	-	225	-
131	1	80,000	-	231	-

*Larvae were reared on *Brachionus plicatilis* and *Artemia salina*.

3.5 Behavior

3.51 Migrations

Western North Atlantic Cobia make seasonal migrations in connection with changes in water temperature and with spawning. In the Chesapeake Bay, cobia were found to enter the bay in late May or early June, and leave by mid-October (Richards 1977). Tagging studies indicated that there was a distinct group that returned to the bay every summer (Richards 1977).

Cobia have long been reported to have a north-south/ spring-fall movement pattern along the southeastern United States (Smith 1907, Hardy 1978), and fishermen have been known to track their spring run from Florida to South Carolina (McNally 1985). Recent tagging studies, however, show an inshore-offshore/spring-fall movement by the cobia population off the coast of South Carolina (Donald Hammond, S.C. Dep. Wildl. Mar. Resour., P.O. Box 12559, Charleston, SC 29412, pers. commun., 8 Apr. 1987). A record of extensive migration resulted from that study: A cobia tagged off Charleston in June 1984 was recovered in April 1986 off Biloxi, Mississippi.

Gulf of Mexico In Gulf of Mexico waters, cobia winter in the Florida Keys, and move north and west along the gulf coast in the spring. Fish tagged in the Florida Keys during the winter of 1974 were recovered during the spring and summer of subsequent years from locations ranging from St. Petersburg, Florida, to the Texas-Louisiana border. The following winter, four were recaptured from the original tagging locations (Donald Hammond, pers. commun., see above). More recently, a cobia tagged off Galveston, Texas, in July 1987 was recovered off Sisal, Yucatan, Mexico, in January 1988 (Steve Qualia, P.O. Box 4746, Corpus Christi, TX 78469, pers. commun., 9 Feb. 1988).

Indian Ocean Little information is available on movements of cobia in other parts of the world. Darracott (1977) indicated that cobia from southern Indian Ocean waters may move north to spawn off the coast of Arabia. Smith and Heemstra (1986) reported that cobia migrate to South African waters during the austral summer, occasionally reaching False Bay.

Eastern Atlantic In June, cobia move north along the African coast from the Senegal-Guinea area, returning there in December (Champagnat and Domain 1978).

3.52 Schooling

Cobia may be solitary or travel in small groups or "pods" of 2-8 or more fish (Benson 1982, Burgess 1983, Moe 1970). They form aggregations during the spawning season (Richards 1967).

Associations Cobia associate with larger fish, such as rays and sharks, and sea turtles (Baughman 1950). This behavior has been observed in captivity (Smith and Merriner 1982, Takamatsu 1967) as well as at sea. It is so well known that fishermen often consider schools of large rays to be indicators of cobia (McNally 1985, Moe 1970). In South Africa, cobia are often observed with groups of remoras (Smith and Heemstra 1986). Explanations for the cobia's associations have been proposed, e.g., the increased availability of food (Smith and Merriner 1982, Takamatsu 1967), and as part of the cobia's generalized sheltering behavior (Carr 1987) (see also 3.53).

3.53 Responses to stimuli

Cobia are known to be attracted to inanimate objects in the sea. According to Baughman (1950), "They are found around buoys, under floating debris, around large fish and under sea turtles, to name only a few of the many items with which they have been observed associating." They are also found around pilings, wrecks, and other artificial structures (Hardy 1978, Wickham et al. 1973). Cobia show a strong tendency to lie in the shadow of a boat (Joseph et al. 1964). They appear to be attracted to noise (Goodson 1985, Sasser 1984).

Cobia are a favorite with sport fishermen due to their fighting ability, strength and speed (Henshall 1895, McClane 1974). They are known to make determined runs and leaps when hooked (Grant 1972, Smith 1965).

4 POPULATION

4.1 Structure

4.11 Sex ratio

Richards (1967) found a female-to-male ratio of 1.54:1 for 257 cobia from the Chesapeake Bay region. Of 48 cobia from Tanzanian waters, 9 were identified as male and 9 as female (Darracott 1977). Out of 301 cobia from southeastern U.S. and Gulf of Mexico waters, the female-to-male ratio was 1.20:1 (L. Alan Collins, Panama City Lab., Southeast Fish. Cent., Natl. Mar. Fish. Serv., NOAA, Panama City, FL 32408, pers. commun., 10 Nov. 1987).

4.12 Age composition

The only study on age composition of cobia is that of Richards (1967). He examined 257 fish from Chesapeake Bay area landings, 1960–64, and showed that for males, age-II fish were the most abundant, whereas for females, age-V fish predominated, followed closely by age-III fish (Table 7).

4.13 Size composition

Darracott (1977) reported that the modal length of 48 cobia caught off Tanzania was 75–85 cm FL, and the modal weight was 5–10 kg. Richards (1967) found that females attain greater size than males; the most abundant size range for females was 95–120 cm FL, and 70–85 cm FL for males (Table 7).

4.14 Subpopulations

From tagging studies, Richards (1977) concluded that "Chesapeake Bay cobia may be a distinct group or subpopulation." A separate stock of cobia in the Gulf of Mexico has also been suggested (Jones et al. 1985, Gulf Mex. S. Atl. Fish. Manage. Counc. 1985).

4.2 Abundance and density

Cobia is considered to have low abundance throughout its range. It has relatively higher abundance in the Arabian Sea and in the Gulf of Mexico. See section 5.43.

4.3 Natality and recruitment

4.31 Reproduction rates

See section 3.15.

4.32 Factors affecting reproduction

No studies have been done regarding factors affecting reproduction.

4.33 Recruitment

The rate of recruitment for cobia is considered to be low (Gulf Mex. S. Atl. Fish. Manage. Counc. 1985).

4.4 Mortality

Richards (1977) noted that the total mortality rate for cobia from the Chesapeake Bay area, including both commercial and sport fishing as well as natural mortality, could be excessive. From tagging studies, he calculated a sport fishing mortality for cobia of 0.30 ± 0.21, with a probability of 95%. From his data, an annual survival rate was calculated with 95% confidence limits: $S = 0.66 \pm 0.04$ (Gulf Mex. S. Atl. Fish. Manage. Counc. 1985).

5 EXPLOITATION

5.1 Fishing equipment

Commercial fishery Throughout most of its range, cobia is an incidental catch in the various fisheries. In Pakistan, the world's largest producer of cobia, fishermen catch them with handlines, bottom trawls, driftnets, and floating gillnets (Bianchi 1985). In India, they are usually taken with drift gill nets, handlines, and troll lines from the inshore coastal waters (Pillai 1982). In the Philippines, cobia are caught incidentally in the purse-seine and trawl fisheries (Aprieto 1985, Aprieto and Villoso 1979). In the Persian Gulf, cobia are a common bycatch of the shrimp fishery (Kuronuma and Abe 1972).

In the United States, cobia are caught commercially in pound nets, gill nets, and seines (Manooch 1984). They are also taken incidentally by shrimp trawlers in the Gulf of Mexico, and as a commercial supplement to the Texas charterboat fishery (Gulf Mex. S. Atl. Fish. Manage. Counc. 1985).

Recreational fishery Cobia are highly prized and sought by recreational fishermen, who angle for them from boats, beaches, piers, and jetties. According to McClane (1974), "The most popular tackle for cobia is heavy spinning gear designed to cast 15–25-pound test monofilament lines. Large plugs, similar to those used for striped bass in blue scale or silver-flash finishes, and 1½–3-ounce jigs with white or yellow skirts are standard baits. A 3-foot wire leader (No. 7–9) or a 60–80-pound test monofilament shock tippet is necessary." Other baits used for cobia include a variety of small, live fish, squid, cut bait, large shrimp, and artificial spoons (Daigle 1984, McClane 1974).

5.2 Fishing areas

Cobia are caught incidentally in commercial fisheries throughout their range, particularly in the Gulf of Mexico and the Arabian Sea. The primary recreational fishery for cobia is located in United States waters. They are also fished recreationally in Australia (Grant 1972), southeastern Africa (Hatchell 1954, Smith 1965), and the Caribbean (La Monte 1952). They are usually caught in shallow coastal waters, but have been taken in trawls from waters as deep as 50 m (Springer and Bullis 1956).

5.3 Fishing seasons

Since water temperature influences the movement of cobia, they are generally fished in the cooler portions of their range in the summer and the warmer portions during the winter. In the Chesapeake Bay region, cobia season extends from May to October, with a peak in July (Richards 1965). Along the east coast of the United States, sport fishermen can follow the northward movement of cobia from south Florida in January to the Carolinas in May (McNally 1987). In south Florida, cobia are fished mostly in the winter (Gulf Mex. S. Atl. Fish. Manage. Counc. 1985). In North Carolina waters, cobia are caught from May to August, with a peak in June (Manooch and Laws 1979). In South Carolina, cobia season extends from May to September (Bearden 1961). In the Gulf of Mexico (U.S. waters), cobia are fished in the spring and summer, with a strong "spring run" in the northern Gulf from mid-March to May (Burgess 1983, Gulf Mex. S. Atl. Fish. Manage. Counc. 1985).

In Tanzania, anglers catch cobia during August and September (Hatchell 1954), and in Australia from September to November (La Monte 1952).

5.4 Fishing operations and results

5.42 Selectivity

Cobia is generally an incidental catch of various commercial fisheries. Selectivity in the recreational fishery is probably limited to hook size.

5.43 Catches

Cobia is a highly prized food fish, generally sold fresh. It holds up well as a frozen product, and also makes a fine smoked product (Seafood Leader 1987).

Commercial landings of cobia are the highest in Pakistan, Mexico, and the Philippines (Table 10). India is also a major producer of cobia, reporting widely fluctuating landings; e.g., between 1969 and 1980, annual landings ranged from 200 to 880 metric tons (Pillai 1982). Most cobia landed in the United States are taken from Gulf of Mexico waters (Table 11).

Table 10

Commercial landings (metric tons) of cobia by country, 1980–86 (FAO 1983, 1988). (U.S. landings have been revised by NMFS data; see Table 11.)

Country	1980	1981	1982	1983	1984	1985	1986
Pakistan	606	1405	1971	1384	1134	887	769
Mexico	134	385	334	753	626	497	472
Philippines	395	334	298	412	741	378	629
United States	31	45	55	55	73	74	97
United Arab Emirates	—	70	30	36	36	30	30
Bahrain	19	39	44	42	22	19	16
Qatar	—	—	19	21	49	62	37
Saudi Arabia	—	—	—	—	—	—	74
Total	1185	2278	2751	2703	2681	1947	2124

Recreational landings of cobia are not well documented. An estimated 216,000 cobia (2,029,000 lbs or 920 mt) were landed in U.S. waters in 1965 (Deuel and Clark 1968), while 119,000 (900,000 lbs or 408 mt) were landed in 1970 (Deuel 1973). Recreational landings (Table 12) are substantially greater than commercial landings (Table 11) in the United States.

6 PROTECTION AND MANAGEMENT

6.1 Regulatory measures

In the United States, the cobia fishery is managed by the Gulf of Mexico and South Atlantic Fishery Management Councils, and is included in the fishery management plan for coastal migratory pelagic resources (Gulf Mex. S. Atl. Fish. Manage. Counc. 1985). The current regulation consists of a size limit (33 in. or 83.8 cm FL); no allocations or quotas are applied at this time.

7 CULTURE

Few studies have been done on the culture of cobia. However, Hassler and Rainville (1975), in a small-scale study, raised cobia from fertilized eggs to 131-day-old juveniles. They found them to be good potential aquaculture organisms due to their fast growth, ease of handling, and tolerance of variable environmental conditions.

7.1 Procurement of stocks

In May and June of 1974, Hassler and Rainville (1975) collected 1979 naturally spawned cobia eggs in plankton tows off Hatteras Village, North Carolina. Most of the eggs were hatched and larvae reared in 38-liter tanks, although some 76-liter tanks were also used. The seawater was filtered

Table 11

U.S. commercial cobia landings (pounds), 1978–87. (Data from NMFS Southeast and Northeast Fisheries Centers.)

State	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Atlantic										
Massachusetts	—	—	—	—	—	—	—	100	—	—
Maryland	—	—	—	—	100	—	—	100	—	—
Virginia	600	600	1,400	1,400	2,000	900	1,900	2,400	1,180	536
North Carolina	1,928	3,552	5,128	5,260	10,574	4,279	6,701	6,640	18,303	32,672
South Carolina	219	220	1,363	10,137	16,286	11,367	2,523	1,464	3,690	4,718
Georgia	—	168	497	1,126	2,304	1,497	2,570	611	2,561	2,705
East Florida	9,200	7,100	19,971	22,008	13,604	12,936	16,742	15,069	32,588	55,002
Subtotal	11,947	11,640	28,359	39,931	44,868	30,969	30,436	26,384	58,322	95,633
Gulf										
West Florida	40,200	36,900	29,900	42,400	51,300	69,400	103,300	104,895	89,546	99,336
Alabama	3,304	5,700	2,491	1,799	776	3,291	3,604	2,097	11,454	5,169
Mississippi	—	280	250	—	700	100	7,370	5,513	9,940	11,427
Louisiana	359	332	4,718	2,905	153	1,033	3,247	16,873	33,628	39,092
Texas	13,600	7,674	2,200	13,100	24,200	17,200	12,702	6,442	11,628	8,140
Subtotal	57,463	50,886	39,559	60,204	77,129	91,024	130,223	135,820	156,196	163,164
U.S. total										
(pounds)	69,410	62,526	67,918	100,135	121,997	121,993	160,659	162,204	214,518	258,797
(metric tons)	31.5	28.4	30.8	45.4	55.3	55.3	72.9	73.6	97.3	117.4

Table 12

U.S. recreational cobia landings (10^3 lbs) for the years 1981–87. (Data from Marine Recreational Fishing Statistics Survey, NMFS, Wash., D.C.)

Year	Atlantic	Gulf of Mexico	Total
1981	5	2632	2637
1982	336	1106	1442
1983	175	1637	1812
1984	896	778	1674
1985	655	600	1255
1986	542	1250	1792
1987	608	759	1367

before use. Water quality in the tanks was maintained by the use of algae, subgravel filters, and external filters. The tanks were continuously aerated and illuminated. Water exchanges were made when necessary. Most eggs hatched within 12 to 20 hrs after placement in tanks. The hatching percentage ranged from 24 to 76% per tank. Most mortality occurred in the first 10 days. Temperatures were generally held at 26.5°C, salinity at 35 ppt, pH at 8.3, dissolved oxygen above 5.5 mg/L, and nitrite levels below 1 ppm.

7.3 Spawning

Artificial spawning of cobia in the laboratory has not been recorded; however, R.E. Earll reportedly succeeded in artificially fertilizing cobia eggs in 1880 (Goode 1884).

7.4 Rearing

In the Hassler and Rainville (1975) study, cobia larvae were fed wild zooplankton collected from a saltmarsh creek, at the rate of 1.33 food organisms per cubic centimeter of tank capacity per day. The size of the zooplankters, dominated by copepods, was increased as the larvae grew. In three of the tanks, larvae were fed laboratory-raised rotifers (*Brachionus plicatilis*) and brine shrimp (*Artemia salina*) during day-1 to day-14. After eight days of growth, the larvae fed wild zooplankton showed a much greater growth rate, up to twice the growth of the larvae fed laboratory-raised food. After 40 days, juvenile cobia were fed a diet of small mosquito fish (*Gambusia affinis holbrookii*), supplemented by shrimp, cooked bluefish, and ground trout chow. Growth results were given in section 3.43.

Citations

Ahmad, J.
1981 Studies on digenetic trematodes from marine fishes from the Bay of Bengal, Part XVI. Riv. Parassitol. 42:403-413.

Aprieto, V.L.
1985 Catch composition and relative abundance of purse seine-caught fishes. Univ. Philipp. Visayas Fish. J. 1(1):23-31.

Aprieto, V.L., and E.P. Villoso
1979 Catch composition and relative abundance of trawl-caught fishes in the Visayan Sea. Fish. Res. J. Philipp. 4(1):9-18.

Baughman, J.L.
1950. Random notes on Texas fishes, Part II. Tex. J. Sci. 2(2): 242-263.

Bearden, C.M.
1961 Common marine fishes of South Carolina. Contrib. Bears Bluff Lab. 34, 47 p.

Benson, N.G. (editor)
1982 Life history requirements of selected finfish and shellfish in Mississippi Sound and adjacent areas. U.S. Fish Wildl. Serv. FWS/OBS-81/51, p. 49-50.

Bianchi, G.
1985. Field guide to the commercial marine and brackish-water species of Pakistan. FAO, Rome, 200 p.

Bloch, M.E.
1793 Ichthyologie, vol. 10, p. 48, pl. 337. Berlin.

Boschung, H.T., Jr.
1957 The fishes of Mobile Bay and the gulf coast of Alabama. Ph.D. Diss., Univ. Alabama, Tuscaloosa, AL 35486, 626 p.

Briggs, J.C.
1958 A list of Florida fishes and their distribution. Bull. Fla. State Mus., Biol. Sci. 2:221-318.
1974 Cobia, *Rachycentron canadum*. *In* McClane, A.J. (ed.), McClane's new standard fishing encyclopedia and international angling guide, p. 219. Holt, Rinehart & Winston, NY.

Briggs, P.T., C.S. Zawacki, and F.M. Mushacke
1979 Notes on fishes rare in the waters off the south shore of Long Island. N.Y. Fish Game J. 26(2):195-197.

Bright, T.J., and L.H. Pequegnat (editors)
1974 Biota of the West Flower Garden Bank. Gulf Publ. Co., Houston, TX, 435 p.

Burgess, B.
1983 Coping with cobia. Fla. Sportsman 14(4):26-29.

Cadenat, J.
1950 Poissons de mer du Sénégal. Inst. Francais d'Afrique Noire, Init. d'Africaines III, 345 p. [in French].

Carr, A.
1987 Thoughts brought on by cobias. Anim. Kingdom 90(3):48-50.

Causey, D.
1953 Parasitic Copepoda of Texas coastal fishes. Publ. Inst. Mar. Sci. Univ. Tex. 3:5-16.
1955 Parasitic Copepoda from Gulf of Mexico fish. La. State Univ., Occas. Pap. Mar. Lab. 9, 19 p.

Cervigón M., F.
1966 Los peces marinos de Venezuela, v. 1. Fund. La Salle Cienc. Nat., Caracas, Venezuela, 436 p. [in Spanish].

Chacko, P.I.
1949 Food and feeding habits of the fishes of the Gulf of Mannar. Proc. Indian Acad. Sci., Sect. B. 29:83-97.

Champagnat, C., and F. Domain
1978 Migrations des poissons démersaux le long des côtes ouest-africaines de 10 à 24° de latitude nord. Cah. ORSTOM, Sér. Océanogr. 16(3-4):239-261 [in French].

Christensen, R.F.
1965 An ichthyological survey of Jupiter Inlet and Loxahatchee River, Florida. M.S. Thesis, Fla. State Univ., Tallahassee, FL 32306, 318 p.

Christmas, J.Y., A. Perry, and R.S. Waller
1974 Investigations of coastal pelagic fishes. Completion rep., proj. 2-128-R, Gulf Coast Res. Lab., Ocean Springs, MS 39564, 105 p.

Collette, B.B.
1978 Rachycentridae. *In* Fischer, W. (ed.), FAO species identification sheets for fishery purposes, western central Atlantic (Fishing area 31), vol. 4. FAO, Rome, unpaginated.

Cuvier, G., and A. Valenciennes
1831 Histoire naturelle des poissons, vol. 8, p. 245. F.G. Levrault, Paris [in French].

Daigle, R.
1984 Division biologists complete inshore sportfish study. Coastlines Georgia 7(2):3-6.

Darracott, A.
1977 Availability, morphometrics, feeding and breeding activity in a multi-species, demersal fish stock of the western Indian Ocean. J. Fish. Biol. 10(1):1-16.

Dawson, C.E.
1969 Records of the barnacle *Conchoderma virgatum* from two Gulf of Mexico fishes. Proc. La. Acad. Sci. 32:58-62.
1971 Occurrence and description of prejuvenile and early juvenile Gulf of Mexico cobia, *Rachycentron canadum*. Copeia 1971(1):65-71.

Day, F.
1967 The fishes of India, vol. 1, p. 256-257. Today & Tomorrow's Book Agency, New Delhi, India.

Deardorff, T.L., and R.M. Overstreet
1980 Taxonomy and biology of North American species of *Goezia* (Nematoda: Anisakidae) from fishes, including three new species. Proc. Helminthol. Soc. Wash. 47(2):192-217.
1981 Review of *Hysterothylacium* and *Iheringascaris* (both previously = *Thynnascaris*) (Nematoda: Anisakidae) from the northern Gulf of Mexico. Proc. Biol. Soc. Wash. 93(4):1035-1079.

DeKay, J.E.
1842 Zoology of New York, or, the New York fauna: Fishes, pt. IV, p. 113. New York State Geol. Surv., Albany, NY.

Deuel, D.G.
1973 1970 salt-water angling survey. Curr. Fish. Stat. 6200, U.S. Dep. Commer., Natl. Mar. Fish. Serv., 54 p.

Deuel, D.G., and J.R. Clark
1968 The 1965 salt-water angling survey. U.S. Fish Wildl. Serv., Bur. Sport Fish. Wildl., Resour. Publ. 67, 51 p.

Duarte-Bello, P.P., and R.J. Buesa
1973 Catalogo de peces Cubanos (Primera rev.). Cienc. Ser. 8, Invest. Mar. (Havana) 3, p. 132 [in Spanish].

Erdman, D.S.
1956 Recent fish records from Puerto Rico. Bull. Mar. Sci. Gulf Caribb. 6(4):315-340.
1968 Spawning seasons of some game fishes around Puerto Rico. Proc. 12th Annu. Int. Game Fish Conf., p. 11-19. Int. Oceanogr. Found., Miami, FL.

FAO (Food and Agriculture Organization of the U.N.)
1983 Yearbook of fishery statistics, 1981. Vol. 52. FAO, Rome, 357 p.
1988 Yearbook of fishery statistics, 1986. Vol. 62. FAO, Rome, 479 p.

Figueiredo, F.L., and A. Meneses
1980 Manual de peixes marinhos do sudeste do Brasil. III. Teleostei (2). Museu de Zoologia, Univ. Sao Paulo, 90 p. [in Portuguese].

Finucane, J.H., L.A. Collins, and L.E. Barger
1978a Ichthyoplankton/mackerel eggs and larvae. Environmental studies of the south Texas outer continental shelf, 1977. Final rep. to Bur. Land Manage. by Natl. Mar. Fish. Serv., NOAA, Galveston, TX 77550, var. pagination.
1978b Determine the effects of discharges on seasonal abundance, distribution, and composition of ichthyoplankton in the oil field. Annu. rep. to EPA: Environmental assessment of an active oil field in the northwestern Gulf of Mexico, 1977-1978. Vol. II: Biological investigations. Natl. Mar. Fish. Serv., NOAA, Galveston TX, 77550, var. pagination.

Fisher, A.K.
1891 Notes on the occurrence of a young crab-eater (*Elacate canada*), from the lower Hudson Valley, New York. Proc. U.S. Natl. Mus. 13(811):195.

Fourmanoir, P.
1957 Poissons teleosteens des eaux malagaches du Canal de Mozambique. Mem. Inst. Rech. Sci. Madagascar ser. F Oceanogr., Tome 1, 316 p. [in French].

Fowler, H.W.
1936 The marine fishes of west Africa. Bull. Am. Mus. Nat. Hist. 70, pt. 2, 1493 p.

Freeman, B.L., and L.A. Walford
1976 Angler's guide to the United States Atlantic coast: Fish, fishing grounds & fishing facilities. Sect. VII: Altamaha Sound, Georgia to Fort Pierce Inlet, Florida. Natl. Mar. Fish. Serv., NOAA, Seattle, WA 98115-0070, 21 p.

Galtsoff, P.S.
1954 Red tide: Progress report on the investigations of the cause of the mortality of fish along the west coast of Florida conducted by the U.S. Fish and Wildlife Service and cooperating organizations. U.S. Fish Wildl. Serv. Spec. Sci. Rep. Fish. 46, 44 p.

George, P.V., and A.M. Nadakal
1981 Observations on the intestinal pathology of the marine fish, *Rachycentron canadus* (Günther) infected with the acanthocephalid worm, *Serrasentis nadakali* (George and Nadakal, 1978). Hydrobiologia 78:59-62.

Gill, T.
1895 The nomenclature of *Rachicentron* or *Elacate*, a genus of acanthopterygian fishes. Proc. U.S. Natl. Mus. 18(1059):217-219.

Golani, D., and A. Ben-Tuvia
1986 New records of fishes from the Mediterranean coast of Israel including Red Sea immigrants. Cybium 10(3):285-291.

Golvan, Y.J.
1956 Parasites de poissons de mer oest-africains récoltés par J. Cadenat. VIII. Acanthocéphales. Bull. Inst. Fondam. Afr. Noire, Ser. A Sci. Nat. 18(2):467-481 [in French].

Goode, G.B.
1884. The fisheries and fishery industries of the United States. Section I: Natural history of useful aquatic animals. Text. U.S. Comm. Fish Fish., Wash., D.C., 895 p.

Goodson, G.
1985 Fishes of the Atlantic coast. Stanford Univ. Press, Stanford, CA, 204 p.

Gosse, P.H.
1851 A naturalist's sojourn in Jamaica. London, 508 p.

Grant, E.M.
1972 Guide to fishes. Queensland Dep. Primary Industries, Brisbane, 472 p.

Gulf of Mexico and South Atlantic Fishery Management Councils
1985 Final amendment 1, fishery management plan and environmental impact statement for coastal pelagic resources (mackerels) in the Gulf of Mexico and south Atlantic region. Gulf Mex. Fish. Manage. Counc., Tampa, FL, var. pagination.

Günther, A.
1860 Catalogue of fishes of the British Museum, vol. 2, p. 375.

Hafeezullah, M.
1978 Acanthocolpid trematodes of marine fishes of India, with considerations on synonymies in the group. Bull. Zool. Surv. India 1:29-36.

Hardy, J.D., Jr.
1978 Development of fishes of the Mid-Atlantic Bight: An atlas of egg, larval and juvenile stages. Vol. III. Aphredoderidae through Rachycentridae. U.S. Fish Wildl. Serv., Biol. Serv. Prog., FWS/OBS-78/12, 394 p.

Hargis, W.J., Jr.
1957 The host specificity of monogenetic trematodes. Exp. Parasitol. 6(6):610-625.

Hassler, W.W., and R.P. Rainville
1975 Techniques for hatching and rearing cobia, *Rachycentron canadum*, through larval and juvenile stages. Publ. UNC-SG-75-30, Univ. N.C. Sea Grant Coll. Prog., Raleigh, NC 27650-8605, 26 p.

Hatchell, G.W.
1954 Sea-fishing on the Tanganyika coast. Tanganyika Notes and Records 37:1-39.

Henshall, J.A.
1895 Notes on fishes collected in Florida in 1892. Bull. U.S. Fish Comm. 14:209-221.

Hildebrand, S.F., and W.C. Schroeder
1928 Fishes of the Chesapeake Bay. Reprinted 1972, TFH Publ., Neptune City, NJ, 388 p.

Hoese, H.D., and R.H. Moore
1977 Fishes of the Gulf of Mexico; Texas, Louisiana, and adjacent waters. Texas A&M Univ. Press, College Station, TX, 327 p.

Howse, H.D., J.S. Franks, and R.F. Welford
1975 Pericardial adhesions in cobia *Rachycentron canadum* (Linnaeus). Gulf Res. Rep. 5(1):61-62.

International Game Fish Association
1988 World record game fishes, 1988. Int. Game Fish Assoc., Fort Lauderdale, FL 33316-1616, 320 p.

Jahan, I.
1973 A new trematode parasite *L. straightum* (n.sp.) from marine food fishes of Karachi coast. Rec. Zool. Surv. Pak. 5:49-50.

Johnson, G.D.
1984 Percoidei: development and relationships. *In* Moser, H.G., et al. (eds.), Ontogeny and systematics of fishes, p. 464-498. Spec. publ. 1, Am. Soc. Ichthyol. Herpetol. Allen Press, Lawrence, KS.

Jones, A.C., et al.
1985 Ocean habitat and fishery resources in Florida. *In* Seaman, W. Jr. (ed.), Florida aquatic habitat and fishery resources, p. 437-543. Fla. Chap. Am. Fish. Soc., Kissimmee, FL.

Jordan, D.S.
1905 A guide to the study of fishes, vol. 2, p. 282. Holt & Co., NY.

Jordan, D.S., and B.W. Evermann
1896 The fishes of North and middle America. Bull. U.S. Natl. Mus. 47, pt I, p. 948.

Jordan, D.S., and A. Seale
1906 The fishes of Samoa; description of the species found in the archipelago, with a provisional check-list of the fishes of Oceania. Bull. U.S. Bur. Fish. 25:173-455.

Joseph, E.B., J.J. Norcross, and W.H. Massmann
1964 Spawning of the cobia, *Rachycentron canadum*, in the Chesapeake Bay area, with observations of juvenile specimens. Chesapeake Sci. 5(1-2):67-71.

Kabata, Z.
1967 Copepoda parasitic on Australian fishes. VI. Some caligoid species. Ann. Mag. Nat. Hist. 13th Ser., 9:563-570.

Kaup, J.J.
1826 Beiträge zur Amphibiologie und Ichthyologie. Isis (Oken) 19:87-90 [in German].

Khan, D., and A. Begum
1971 Helminth parasites of fishes from west Pakistan. I. Nematodes. Bull. Dep. Zool. Univ. Panjab (new ser.) 1(art. 5):1-22.

Knapp, F.T.
1951 Food habits of the sergeantfish, *Rachycentron canadus*. Copeia 1951(1):101-102.

Koratha, K.J.
1955 Studies on the mongenetic trematodes of the Texas coast. II. Descriptions of species from marine fishes of Port Aransas. Publ. Inst. Mar. Sci. Univ. Tex. 4:251-278.

Kuronuma, K., and Y. Abe
1972 Fishes of Kuwait. Kuwait Inst. Sci. Res., Kuwait City, 123 p.

Lacépède, B.G.E.
1802 Histoire naturelle des poissons, vol. 3, p. 357. Mus. Hist. Nat., Paris [in French].

La Monte, F.
1952 Marine game fishes of the world. Doubleday & Co., NY, 190 p.
Lhomme, F.
1983 Campagnes *Chalci*: *Chalci* 83.01 du 11 au 19.01.1983, *Chalci* 83.02 du 10 au 18.03. 1983; résultats des chalutages. Arch. Sci. Cent. Rech. Océanogr. Abidjan 9(4):1-102 [in French].
Lindberg, G.U., and Z.V. Krasyukova
1971 Fishes of the Sea of Japan and the adjacent areas of the Sea of Okhotsk and the Yellow Sea. Part 3. Teleostomi. XXIX. Perciformes. [Engl. transl., Israel Prog. Sci. Transl., Jerusalem, 498 p.]
Linnaeus, C.
1766 Systema natura, 12th ed., pt. 1, p. 491. Reprinted by Brit. Min. Nat. Hist., London.
Linton, E.
1905 Parasites of fishes of Beaufort, North Carolina. Bull. U.S. Bur. Fish. (1904) 24:321-428.
Madhavi, R.
1976 Digenetic trematodes from marine fishes of Waltair Coast, Bay of Bengal. Family Acanthocolpidae. Riv. Parassitol. 37:115-128.
Manooch, C.S., III
1984 Fisherman's guide; fishes of the southeastern United States. N.C. State Mus. Nat. Hist., Raleigh, NC, 362 p.
Manooch, C.S., III, and S.T. Laws
1979 Survey of the charter boat troll fishery in North Carolina, 1977. Mar. Fish. Rev. 41(4):15-27.
Markle, D.F., W.B. Scott, and A.C. Kohler
1980 New and rare records of Canadian fishes and the influence of hydrography on resident and nonresident Scotian Shelf ichthyofauna. Can. J. Fish. Aquat. Sci. 37(1):49-65.
McClane, A.J.
1974 McClane's new standard fishing encyclopedia and international angling guide. Holt, Rinehart & Winston, NY, 1156 p.
McNally, B.
1985 Run to the rays. Fla. Sportsman 16(6):33-36.
1987 Setting your sights on cobia. South. Outdoors Saltw. Mag. 1(2):44-47.
Menni, R.C., R.A. Ringuelet, and R.H. Aranburu
1984 Peces marinos de la Argentina y Uruguay. Edit. Hemisferio sur S.A., 359 p. [in Spanish].
Miles, D.W.
1949 A study of the food habits of the fishes of the Aransas Bay area. M.S. Thesis, Univ. Houston, Houston, TX 77004, 70 p.
Milstein, C.B., and D.L. Thomas
1976 Fishes new or uncommon to the New Jersey coast. Chesapeake Sci. 17(3):198-204.
Mitchill, S.L.
1815 The fishes of New York, described and arranged. Trans. Lit. Philos. Soc. N.Y. 1:355-492.
Moe, M.A., Jr.
1970 Florida's fishing grounds. Great Outdoors Publ. Co., St. Petersburg, FL, 80 p.
Monod, T.
1973 Rachycentridae. *In* Hureau, J.C., and T. Monod (eds.), Checklist of the fishes of the northern-eastern Atlantic and of the Mediterranean, vol. 1, p. 371-372. UNESCO, Paris.
Nichols, J.T., and C.M. Breder, Jr.
1926 The marine fishes of New York and southern New England. Zoologica (NY) 9(1), 192 p.
Organization for Economic Co-operation and Development
1978 Multilingual dictionary of fish and fish products. Fishing News Books, Ltd., Farnham, Surrey, England, 430 p.
Overstreet, R.M.
1978 Marine maladies? Worms, germs, and other symbionts from the northern Gulf of Mexico. Publ. MASGP-78-021, Miss.-Ala. Sea Grant Consort., Ocean Springs, MS 39564, 140 p.
Parukhin, A.M.
1978 A contribution to the study of trematode fauna of the Indian and Atlantic Oceans. Biol. Morya (Vladivost.) no. 45:90-99 [in Russ., Engl. summ.).
Pearse, A.S.
1952 Parasitic Crustacea from the Texas coast. Publ. Inst. Mar. Sci. Univ. Tex. 2(2), p. 5-42.
Pillai, N.K.
1962 A revision of the genera *Parapetalus* Steenstrup & Lutken and *Psudopetalus* nov. Crustaceana 3:285-303.
Pillai, P.K.M.
1982 Black kingfishes. Mar. Fish. Inf. Serv., Tech. Ext. Ser. (Cochin, India) no. 39, p. 12.
Rajan, S., S. Patnaink, and N.C. Basu
1968 New records of fishes from the Chilka Lake. J. Zool. Soc. India 20(1/2):80-93.
Randall, J.E.
1967 Food habits of reef fishes of the West Indies. Stud. Trop. Oceanogr. (Miami) 5:665-847.
1983 Caribbean reef fishes, rev. ed. TFH Publ., Neptune City, NJ, 350 p.
Rasheed, S.
1965 On a remarkable new nematode, *Lappetascaris lutjani* gen. et sp. nov. (Anisakidae: Ascaridoidea) from marine fishes of Karachi and an account of *Thynnascaris inquies* (Linton, 1901) n. comb. and *Goezia intermedia* n. sp. J. Helminthol. 39(4):313-342.
Reid, G.K., Jr.
1954 An ecological study of the Gulf of Mexico fishes, in the vicinity of Cedar Key, Florida. Bull. Mar. Sci. Gulf Caribb. 4(1):1-94.
Relyea, K.
1981 Inshore fishes of the Arabian Gulf. George Allen & Unwin, London, 149 p.
Richards, C.E.
1965 Availability patterns of marine fishes caught by charter boats operating off Virginia's eastern shore, 1955-1962. Chesapeake Sci. 6(2):96-108.
1967 Age, growth and fecundity of the cobia, *Rachycentron canadum*, from Chesapeake Bay and adjacent mid-Atlantic waters. Trans. Am. Fish. Soc. 96(3):343-350.
1977 Cobia (*Rachycentron canadum*) tagging within Chesapeake Bay and updating of growth equations. Chesapeake Sci. 18(3):310-311.
Robins, C.R., R.M. Bailey, C.E. Bond, J.R. Brooker, E.A. Lachner, R.N. Lea, and W.B. Scott
1980 A list of common and scientific names of fishes from the United States and Canada, 4th ed. Spec. Publ. 12, Am. Fish. Soc., Bethesda, MD, 174 p.
Robins, C.R., and G.C. Ray
1986 Field guide to Atlantic coast fishes of North America. Houghton Mifflin Co., Boston, MA, 354 p.
Roessler, M.
1967 Observations on the seasonal occurrence and life histories of fishes in Buttonwood Canal, Everglades National Park, Florida. Ph.D. Diss., Univ. Miami, Coral Gables, FL, 33124, 155 p.
Rohde, K.
1978 Monogenea of Australian marine fishes. The genera *Dionchus*, *Sibitrema* and *Hexostoma*. Publ. Seto Mar. Biol. Lab. 24(4/6): 349-367.
Rose, C.D.
1965 The biology and catch distribution of the dolphin, *Coryphaena hippurus* (Linnaeus), in North Carolina waters. Ph.D. Diss., N.C. State Univ., Raleigh, NC 27695, 153 p.
Ryder, J.A.
1887 On the development of osseus fishes, including marine and freshwater forms. U.S. Comm. Fish Fish., Rep. of the Commissioner for 1885, p. 489-604.
Sasser, R.
1984 Ring-a-ling. Salt Water Sportsman 45(4):56-60.

Schwartz, F.J.
1972 World literature to fish hybrids with an analysis by family, species, and hybrid. Publ. Gulf Coast Res. Lab. Mus. 3, 328 p.
1981 World literature to fish hybrids with an analysis by family, species, and hybrid: supplement 1. NOAA Tech. Rep. NMFS SSRF-750, Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Seattle, WA 98115-0070, 507 p.

Seafood Leader
1987 Seafood buyer's guide: Cobia. Seafood Leader 7(1):60–62.

Secretaria de Industria y Comercio, Mexico
1976 Catalogo de peces marinos Mexicanos. Inst. Nac. Pesca, Mexico, 462 p. [in Spanish].

Sidwell, V.D.
1981 Chemical and nutritional composition of finfishes, whales, crustaceans, mollusks, and their products. NOAA Tech. Memo. NMFS F/SEC-11, Southeast Fish. Cent., Natl. Mar. Fish. Serv., Miami, FL 33149, 432 p.

Siming, D., and Z. Hongxi
1986 Comparative studies of the lateral line canal system of families to be related with the Carangidae. *In* Uyeno, R.A., T. Taniuchi, and K. Matsuura (eds.), Indo-Pacific Biology: Proceedings of the 2nd Int. Conf. on Indo-Pacific Fishes, p. 561–569. Ichthyol. Soc. Japan, Tokyo.

Smith, H.M.
1907 The fishes of North Carolina. N.C. Econ. Geol. Surv. 2, 453 p.

Smith, J.L.B.
1965 The sea fishes of southern Africa. Central News Agency, Ltd., South Africa, 580 p.

Smith, J.W., and J.V. Merriner
1982 Association of cobia, *Rachycentron canadum*, with cownose ray, *Rhinoptera bonasus*. Estuaries 5(3):240–242.

Smith, M.M., and P.C. Heemstra (editors)
1986 Smiths' sea fishes. Springer-Verlag, Berlin, 1047 p.

Sogandares-Bernal, F., and R.F. Hutton
1959 Studies on helminth parasites from the coast of Florida. IV. Digenetic trematodes of marine fishes of Tampa, Boca Ciega Bays, and the Gulf of Mexico. Q. J. Fla. Acad. Sci. 21 (3):259–273.

Sonnier, F., J. Teerling, and H.D. Hoese
1976 Observations on the offshore reef and platform fish fauna of Louisiana. Copeia 1976(1):105–111.

Soota, T.D., and S.B. Bhattacharya
1981 On some acanthocephalans from Indian marine fishes. Bull. Zool. Surv. India 3(3):227–233.

Springer, S., and H.R. Bullis, Jr.
1956 Collections by the *Oregon* in the Gulf of Mexico. U.S. Dep. Inter. Bur. Commer. Fish., Spec. Sci. Rep. Fish. 196, 134 p.

Springer, V.G., and K.D. Woodburn
1960 An ecological study of the fishes of the Tampa Bay area. Prof. Pap. Ser. 1, Fla. Board Conserv. Mar. Res. Lab., 104 p.

Swainson, W.
1839 The natural history and classification of fishes, amphibians and reptiles, or monocardian animals, vol. 2, p. 243–245. London.

Swingle, H.A.
1971 Biology of Alabama estuarine areas—Cooperative Gulf of Mexico Estuarine Inventory. Ala. Mar. Resour. Bull. 5, 123 p.

Takamatsu, S.
1967 On the habit of cobia, *Rachycentron canadum* (Linnaeus), associating with sting ray, *Dasyatis maculatus* Miyoshi. Jpn. J. Ichthyol. 14(4/6):183–186.

Ueno, T.
1965 On two rare pelagic fishes, *Luvarus imperialis* and *Rachycentron canadum*, recently captured at Yoichi, Hokkaido, Japan. Jpn. J. Ichthyol. 12(3/6):99–103.

Wang, J.C.S., and R.J. Kernehan
1979 Fishes of the Delaware estuaries: A guide to the early life histories. E.A. Communications, Towson, MD, 410 p.

Wheeler, A.
1975 Fishes of the world. Macmillan Publ. Co., NY, 366 p.

Wickham, D.A., J.W. Watson, Jr., and L.H. Ogren
1973 The efficacy of midwater artificial structures for attracting pelagic sport fish. Trans. Am. Fish. Soc. 102(3):563–572.

Wilk, S.J., and M.J. Silverman
1976 Fish and hydrographic collections made by the research vessels *Dolphin* and *Delaware II* during 1968–72 from New York to Florida. NOAA Tech. Rep. NMFS SSRF-697, Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Seattle, WA 98115-0070, 159 p.

Wilson, C.B.
1908 North American parasitic copepods: new genera and species of Caliginae. Proc. U.S. Natl. Mus. 33(1580):593–627.

Young, P.C.
1970 The species of Monogenoidea recorded from Australian fishes and notes on their zoogeography. An. Inst. Biol. Univ. Nac. Auton. Mex. Ser. Zool. 41(1):163–176.

NOAA TECHNICAL REPORT NMFS

Guidelines for Contributors

FORM OF MANUSCRIPT

Authors are encouraged to retain manuscripts on word-processing storage media (diskettes, floppy disks) and submit a double-spaced hardcopy run from the storage media. The document should be in the following sequence: Title page (incl. authors' full names and complete mailing addresses), Contents, Acknowledgments. Abstract, Text, Citations, Text footnotes, Appendices, Tables, Figure legends, and Figures.

Disks Submit disks as MS-DOS "print" or "non-document" files (often called "ASCII files"). If a disk cannot be converted to an ASCII file, the author should indicate on the disk the source computer and software language (e.g., Word Star, Word Perfect) along with the file name. Either 5¼-inch or 3½-inch disks from IBM-compatible or Apple/MacIntosh systems (non-graphics only) can be submitted, double-sided/double-density or high-density, limiting each file to 300 kilobytes. All 8-inch word-processing disks (e.g., Wang or NBI) must be converted onto 5¼- or 3½-inch MS-DOS print disks.

CONTENTS OF MANUSCRIPT

Acknowledgments Gather all acknowledgments into a brief statement at the beginning of the text. Give credit only for exceptional contributions and not to those whose contributions are part of their normal duties.

Abstract Not to exceed one double-spaced typed page. Should include a sentence or two explaining to the general reader why the research was undertaken and why the results should be viewed as important. Abstract should convey the main point of the paper and outline the results or conclusions. No footnotes or references.

Text A brief introduction should portray the broad significance of the paper. The entire text should be intelligible to readers from different disciplines. All technical terms should be defined. Follow the *U.S. Government Printing Office Style Manual*, 1984 ed., and the *CBE Style Manual*, 5th ed. Fishery nomenclature should follow the American Fisheries Society Special Publication 12, *A List of Common and Scientific Names of Fishes from the United States and Canada*, 4th ed.

Abbreviations and symbols Define all abbreviations, acronyms, and symbols in text, equations, and formulae. Abbreviate units of measure only when used with numerals or in tables and figures to conserve space.

Measurements should be expressed in metric units. Other equivalent units may be given in parentheses.

Text footnotes should be numbered in Arabic numerals and typed on a separate sheet from the text. Footnotes are not used for reference material or personal communications, but rather to explain or define terms in the text and for contribution numbers.

Personal communications are noted parenthetically in the text (full name, affiliation, brief address including zip code, month and year).

Citations All written sources should be listed in the Citations section, including unpublished and processed material. In text, cite as Smith and Jones (1977) or (Smith and Jones 1977); if more than one citation, list chronologically (Smith 1936, Jones 1975, Doe 1977). All sources cited in the text should be listed alphabetically by the senior authors' surname under the heading CITATIONS. Abbreviations of periodicals and serials should conform to the Biosis Data Base™. Indicate whether sources are in a language other than English. For informal literature, include address of author or publisher. Authors are responsible for the accuracy of all citations.

Tables should supplement, not duplicate, the text. Each table should be numbered and cited consecutively, with headings short but amply descriptive so that the reader need not refer to the text. For values less than one, zeros should precede all decimal points. Indicate units of measure in column headings; do not deviate from the unit of measure within a column. Table footnotes should be noted consecutively in Roman letters across the page from left to right and then down. Since all tables are typeset, they need not be submitted camera-ready.

Figures Photographs and line drawings should be of professional quality—clear and concise—and reducible to 42 picas for full-page width or to 20 picas for a single-column width, and a maximum of 57 picas high. All graphic elements in illustrations must be proportioned to insure legibility when reduced to fit the page format. Line weight and lettering should be sharp and even. Lettering should be upper and lower case, and vertical lettering should be avoided whenever possible (except for vertical, y, axis). Zeros should precede all decimal points for values less than one. Reproductions of line artwork are accepted in the form of high-quality photographic prints from negatives or photomechanical transfer (PMT). Halftones should be sharply focused with good contrast. Micron rules should be inserted on electron micrographs, even when magnification is included in the figure legend. There should be clear distinction between identifying letters (press-on or overlays) and background of photograph. Label each figure in pencil on the back. Send only xerox copies of figures to the Scientific Editor; originals or photographic prints will be requested later when the manuscript is accepted for publication.

Copies of published reports For single monographs, the senior author and his/her organization each receive 50 copies free-of-charge. For collections of papers, the senior author and his/her organization each receive 50 separates and one cover free-of-charge. Additional copies may be purchased in lots of 100.

Copyright Government publications are in the public domain, i.e., they are not protected by copyright.

SUBMISSION OF MANUSCRIPTS

Send original hardcopy and two duplicated copies to:

Dr. Linda L. Jones, Scientific Editor
National Marine Mammal Laboratory, F/AKC3
National Marine Fisheries Service, NOAA
7600 Sand Point Way N.E.
Seattle, WA 98115-0070

Indicate whether word processing storage media are available, but do not forward disks until requested by Scientific Publications Office.

Questions regarding editorial policy and procedures or disk specifications may be forwarded to:

Nancy Peacock, Managing Editor
NOAA Technical Reports NMFS
National Marine Fisheries Service, NOAA
Scientific Publications Office, F/NWR1
7600 Sand Point Way N.E.
Seattle, WA 98115-0070

FISHERIES SYNOPSES

This series of documents, issued by FAO, CSIRO, INP, and NMFS, contains comprehensive reviews of present knowledge on species and stocks of aquatic organisms of present or potential economic interest. The Fishery Resources and Environment Division of FAO is responsible for the overall coordination of the series. The primary purpose of this series is to make existing information readily available to fishery scientists according to a standard pattern, and by so doing also to draw attention to gaps in knowledge. It is hoped that synopses in this series will be useful to other scientists initiating investigations of the species concerned or of related ones, as a means of exchange of knowledge among those already working on the species, and as the basis for comparative study of fisheries resources. They will be brought up to date from time to time as further information becomes available.

The documents of this series are issued under the following titles:

		Symbol
FAO	**Fisheries Synopsis No.**	**FIR/S**
CSIRO	**Fisheries Synopsis No.**	**DFO/S**
INP	**Sinopsis sobre la Pesca No.**	**INP/S**
NMFS	**Fisheries Synopsis No.**	**NMFS/S**

Synopses in this series are compiled according to a standard outline described in FIb/S1 Rev. 1 (1965). FAO, CSIRO, INP, and NMFS are working to secure the cooperation of other organizations and of individual scientists in drafting synopses on species about which they have knowledge, and welcome offers of help in this task. Additions and corrections to synopses already issued will also be most welcome. Comments on individual synopses and requests for information should be addressed to the coordinators and editors of the issuing organizations, and suggestions regarding the expansion or modification of the outline to FAO:

FAO:

Fishery Resources and Environment Division
Aquatic Resources Survey and Evaluation Service
Food and Agriculture Organization of the United Nations
Via delle Terme di Caracalla
00100 Rome, Italy

CSIRO:

CSIRO Division of Fisheries and Oceanography
Box 21
Cronulla, N.S.W. 2230
Australia

INP:

Instituto Nacional de Pesca
Subsecretaria de Pesca
Secretaria de Pesca
Secretaria de Industria y Comercio
Carmona Y Valle 101-403
Mexico 7, D.F.

NMFS:

Scientific Editor
National Marine Mammal Laboratory
National Marine Fisheries Service, NOAA
7600 Sand Point Way N.E.
Seattle, WA 98115-0070
U.S.A.

Consolidated lists of species or groups covered by synopses issued to date or in preparation will be issued from time to time. Requests for copies of synopses should be addressed to the issuing organization; except for NMFS/S copies, these can be purchased from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151.

The following synopses in this series have been issued since January 1983:

NMFS/S 133	Synopsis of biological data on the grunts *Haemulon aurolineatum* and *H. plumieri* (Pisces: Haemulidae)	February 1983
NMFS/S 134	Synopsis of biological data on the pigfish, *Orthopristis chrysoptera* (Pisces: Haemulidae)	March 1983
NMFS/S 136	Synopsis of biological data on skipjack tuna, *Katsuwonus pelamis*	January 1984
NMFS/S 138	Synopsis of biological data on the blue crab, *Callinectes sapidus* Rathbun	March 1984
NMFS/S 140	Synopsis of biological data on shortnose sturgeon, *Acipenser brevirostrum* LeSueur 1818	October 1984
NMFS/S 141	Synopsis of biological data on the pinfish, *Lagodon rhomboides* (Pisces: Sparidae)	February 1985
NMFS/S 142	Synopsis of biological data on the spottail pinfish, *Diplodus holbrooki* (Pisces: Sparidae)	January 1985
NMFS/S 143	Synopsis of biological data on the sand perch, *Diplectrum formosum* (Pisces: Serranidae)	March 1985
NMFS/S 144	Synopsis of biological data on the pink shrimp, *Pandalus borealis* Krøyer 1838	May 1985
NMFS/S 148	Synopsis of biological data on the porgies, *Calamus arctifrons* and *C. proridens* (Pisces:Sparidae)	September 1986

UNITED STATES
DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
SCIENTIFIC PUBLICATIONS OFFICE
BIN C15700
SEATTLE, WA 98115
OFFICIAL BUSINESS

Penalty for Private Use, $300

BULK RATE
POSTAGE & FEES PAID
U.S. Department of Commerce
Permit No. G-19

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 13, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS—Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS—Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS—Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS—Reports containing data, observations, instructions, etc. A partial listing includes data serials; predictions and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS—Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS—Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.

Information on availability of NOAA publications can be obtained from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161