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

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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 Data and information were obtained from unpublished as well as published sources.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

Elacate 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.

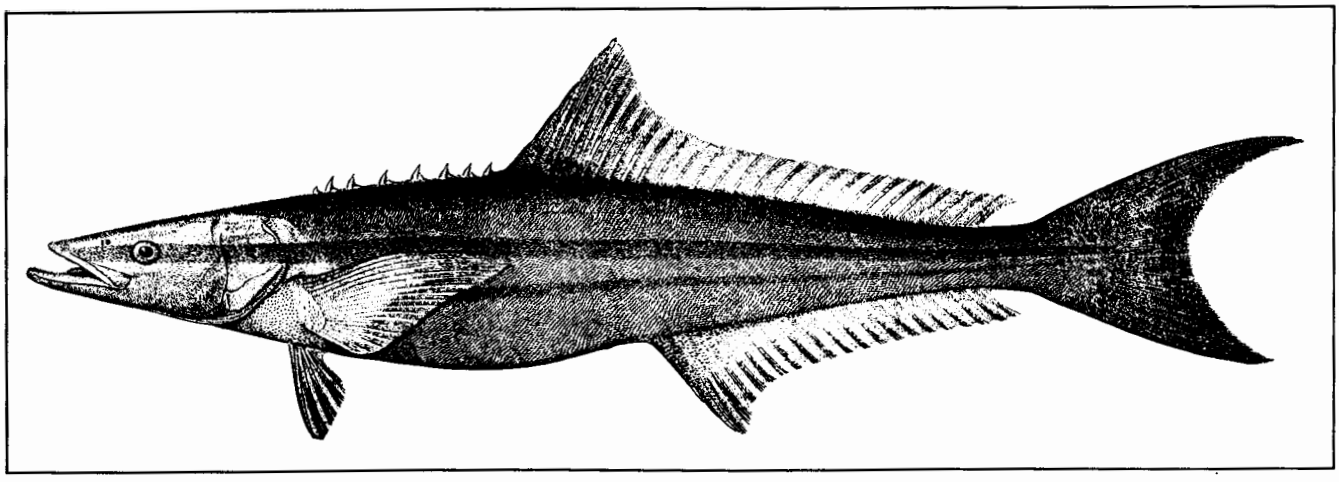

Figure 1
The Cobia, *Rachycentron canadum* (Goode 1884, plate 174).

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)

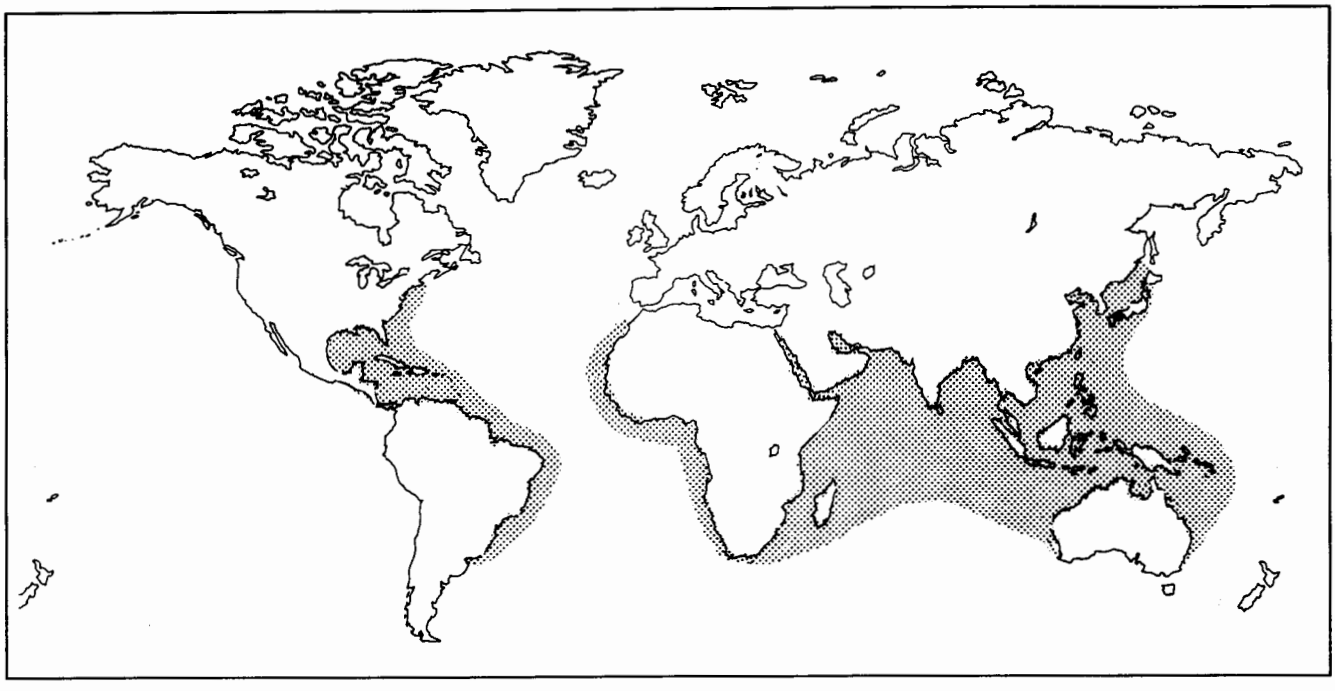

Figure 2
Range of the cobia, *Rachycentron canadum*.

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.

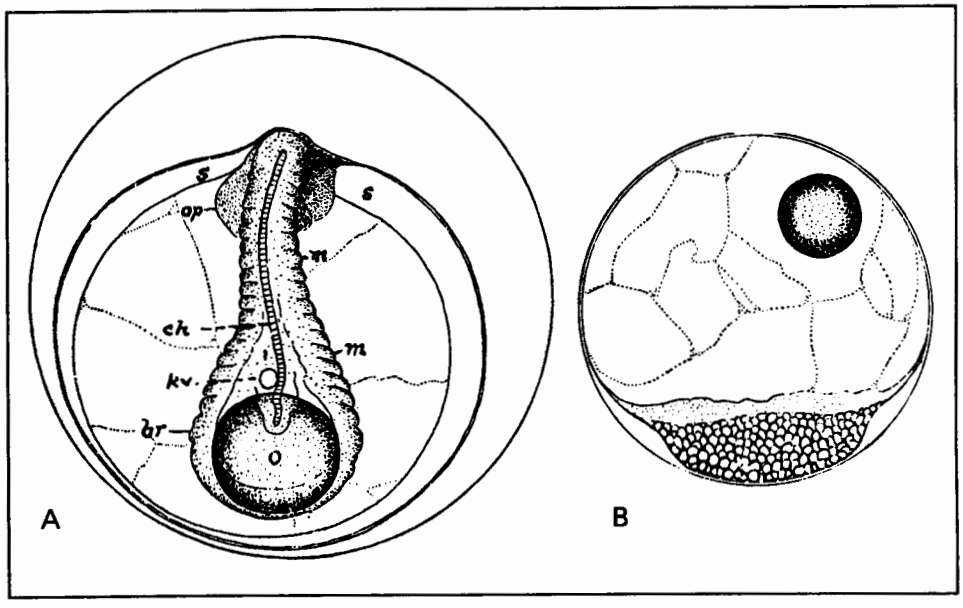

Figure 3

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).

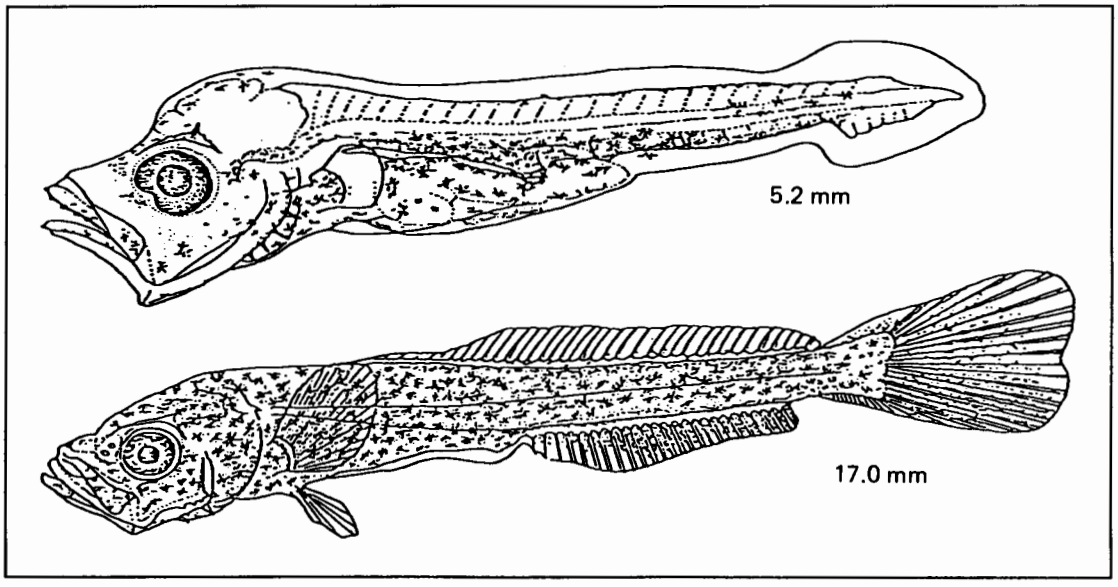

Figure 4

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

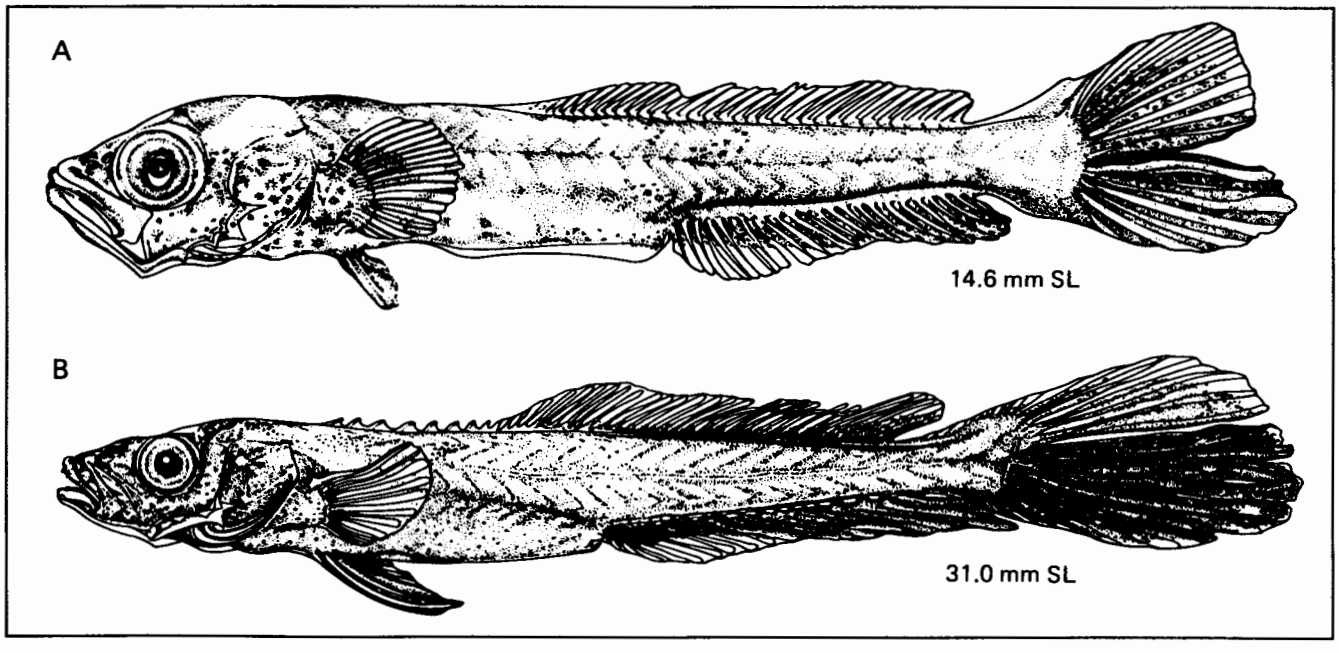

Figure 5

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

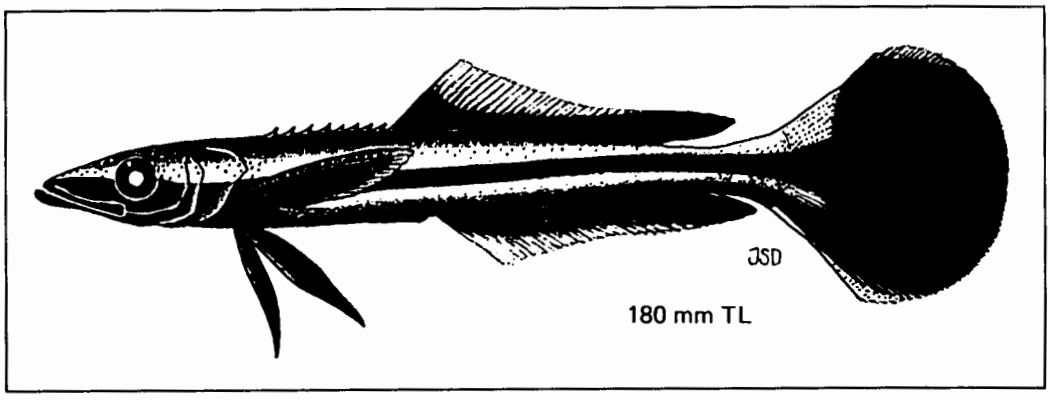

Figure 6
Composite drawing of a juvenile cobia (Joseph et al. 1964, fig. 3).

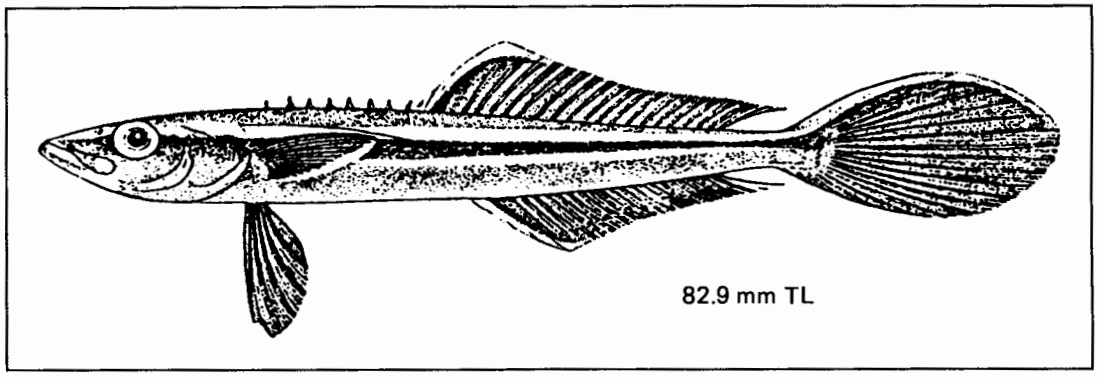

Figure 7
A juvenile cobia (Wang and Kernehan 1979, fig. 75).

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 inquies	NW Atlantic–North Carolina	—	Linton 1905
(syn. *Ascaris inquies*,	Arabian Sea–Pakistan	Stomach	Rasheed 1965
Thynnascaris inquies,	Arabian Sea–Pakiston	Alimentary canal	Khan and Begum 1971
Neogeozia elacateiae,	Gulf of Mexico	Stomach and pyloric caeca	Overstreet 1978
Contracaecum inquies,	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.

Taxonomic group	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									
	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						
Ariidae			x	x	x					
Atherinidae						x				
Serranidae			x							
Sciaenidae	x	x	x							
Scombridae			x							
Stromateidae				x						
Triglidae		x								
Bothidae		x								
Cynoglossidae	x									
Ostraciidae					x			x		

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

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

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

(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.	Females: Fork length cm	Females: Weight lbs	Females: Weight kg	Males: Fork length in.	Males: Fork length cm	Males: Weight lbs	Males: Weight 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

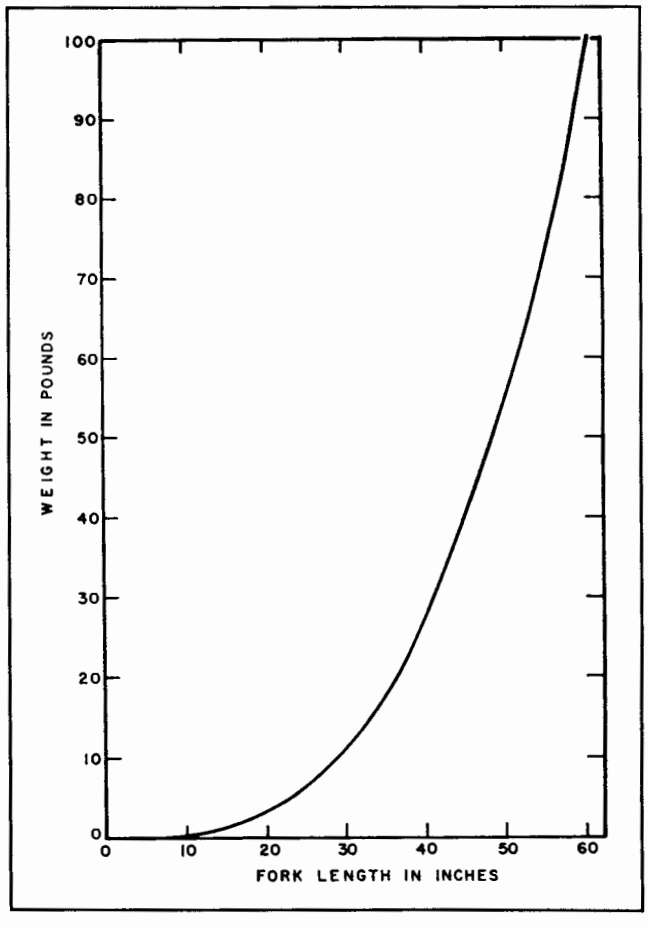

Figure 8
Length-weight relationship for cobia collected from Virginia waters (Richards 1967, fig. 2).

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.

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