Distribution and life history of two diminutive flatfishes, *Citharichthys gymnorhinus* and *C. cornutus* (Pleuronectiformes: Paralichthyidae), in the western North Atlantic

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Abstract—*Citharichthys cornutus* and *C. gymnorhinus*, diminutive flatfishes inhabiting continental shelves in the western Atlantic Ocean, are infrequently reported and poorly known. We identified 594 *C. cornutus* in 56 different field collections (68–287 m; most between 101–200 m) off the eastern United States, Bahamas, and eastern Caribbean Sea. Historical records and recently captured specimens document the northern geographic range of adults on the shelf off New Jersey (40°N, 70°W). *Citharichthys cornutus* measured 17.2–81.3 mm standard length (SL); males (20.0–79.1 mm SL) and females (28.0–81.3 mm SL) attain similar sizes (sex could not be determined for fish <20 mm SL). Males reach nearly 100% maturity at ≥60 mm SL. The smallest mature females are 41.5 mm SL, and by 55.1 mm SL virtually all are mature. Juveniles are found with adults on the outer shelf. Only 214 *C. gymnorhinus* were located in 42 different field collections (35–201 m, with 90% between 61 and 120 m) off the east coast of the United States, Bahamas, and eastern Caribbean Sea. Adults are found as far north as the shelf off Cape Hatteras, NC (35°N, 75°W). This diminutive species (to 52.4 mm SL) is among the smallest flatfishes but males (n=131; 20.3–52.4 mm SL) attain a slightly larger maximum size than that of females (n=58; 26.2–48.0 mm SL). Males begin to mature between 29 and 35 mm SL and reach 100% maturity by 35–40 mm SL. Some females are mature at 29 mm SL, and all females >35.1 mm SL are mature. Overlooked specimens in museum collections and literature enabled us to correct long-standing inaccuracies in northern distributional limits that appear in contemporary literature and electronic data bases for these species. Associated locality-data for these specimens allow for proper evaluation of distributional information for these species in relation to hypotheses regarding shifts in species ranges due to climate change effects.

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Citharichthys cornutus (Günther, 1880), the horned whiff, and *C. gymnorhinus* Gutherz and Blackman, 1970, the anglefin whiff, are small-size, poorly known flatfishes inhabiting substrata located on the middle and outer continental shelves— primarily in subtropical and tropical waters of the western Atlantic Ocean (Gutherz, 1967; Gutherz and Blackman, 1970; Topp and Hoff, 1972; Figueiredo and Menezes, 2000; 2003). Larvae of both species have been collected off Nova Scotia, Canada, but these were considered strays from more southern localities (Scott and Scott, 1988). These two species are morphologically similar and, although broadly sympatric in the western North Atlantic Ocean, are seldom taken together in the same collections. Their relatively small size (maximum to 55 mm standard length [SL] in *C. gymnorhinus* and 91 mm SL in *C. cornutus*), lack of commercial importance, infrequency of capture, and the probable low abundance of both species have resulted in their largely being ignored.

Published, detailed life history information for *C. cornutus* is sparse. Consequently, our knowledge of the biology, ecology, and geographic distribution of this species is limited to relatively few observations on maximum size (Parr, 1931; Longley and Hildebrand, 1941; Gutherz, 1967), size at maturity (Parr, 1931 [in part]; Longley and Hildebrand, 1941), reports of hermaphrodites (Gutherz, 1969), and general descriptions of geographic and bathymetric distributions (Parr, 1931 [in part]; Longley and Hildebrand, 1941; Gutherz, 1967; Topp and Hoff, 1972). *Citharichthys cornutus* is found from temperate regions of the North Atlantic Ocean off New Jersey (Goode, 1880; reported as *Citharichthys unicornis*, now considered a junior synonym of *C. cornutus*, see Norman, 1934; Fowler, 1952; Steves et al., 1999) and Hudson Submarine Canyon (Fahay, 2007) to subtropical waters off southern Brazil (Günther, 1880) and Uruguay (Figueiredo and Menezes, 2000; 2003). From the limited data, it appears that *C. cornutus* reaches sizes to about 89 mm SL (Gutherz, 1967), and although this species is known from depths ranging from 20 to 408 m (Gutherz, 1967; Topp and Hoff, 1972), it has been captured most frequently between 130 and 370 m (Gutherz, 1967).

Most published sources commonly cited for distributional information on *C. cornutus* are inaccurate. Data in Gutherz (1967) are the basis for the geographic range most frequently

reported for adult *C. cornutus* (Robins and Ray, 1986; Munroe, 2003; McEachran and Fechhelm, 2005). Gutherz (1967) described the range as the continental shelf from off Georgia throughout warm-temperate and tropical regions of the western Atlantic to Brazil. Several earlier reports (Goode, 1880; Goode and Bean, 1895; Fowler, 1952), however, had already documented occurrences of *C. cornutus* (as *C. unicornis*) from more northern localities including those as far north as the outer continental shelf off New Jersey (see also Fahay, 2007). These earlier reports of *C. unicornis* (=*C. cornutus*) from more northern locales were overlooked in most recent studies where information has been compiled for this species (with exception of Fahay, 2007).

More information is available on the life history and distribution of *C. gymnorhinus*, which reportedly reaches a maximum size of about 55 mm SL (Gutherz and Blackman, 1970; Topp and Hoff, 1972). *Citharichthys gymnorhinus* is one of the smallest species of the genus and is also among the smallest of flatfishes (Munroe, 2005). It is found on the mid- to outer continental shelf at depths of 35–201 m, but has been collected most frequently between 30 and 90 m (Gutherz and Blackman, 1970; Topp and Hoff, 1972; Walsh et al., 2006). *Citharichthys gymnorhinus* inhabits subtropical and tropical regions of the western North Atlantic Ocean (Gutherz and Blackman, 1970; Topp and Hoff, 1972) from North Carolina (Quattrini and Ross, 2006) to Guyana (Topp and Hoff, 1972).

Although not rare, *C. gymnorhinus* has been captured less frequently than *C. cornutus*, and seldom has it been taken in abundance, especially on the continental shelf off the eastern United States. No summaries of biological information exist for *C. gymnorhinus* found off the east coast of the United States, and information from this region is restricted to limited geographic and bathymetric data based on few specimens—the data appearing in tables and appendices of various reports (see below). Most biological and ecological data for this species, including observations on habitat, depth of occurrence, size, size at maturity, and geographical distribution, are based on 47 specimens collected from the Florida Keys to Guyana, and the majority of these specimens were taken on the west Florida shelf during cruises of the RV *Hourglass* (Topp and Hoff, 1972). Recent summaries of information on adult *C. gymnorhinus* are based almost entirely on data originally presented in Gutherz and Blackman (1970) and Topp and Hoff (1972) and indicate a northernmost geographical limit for adults, either as the Bahamas (Robins and Ray, 1986; McEachran and Fechhelm, 2005; Lyczkowski-Shultz and Bond, 2006), Florida (Fahay, 2007), the Florida Keys (Robins and Ray, 1986; McEachran and Fechhelm, 2005), or perhaps the continental shelf as far north as off North Carolina (Munroe, 2003). Assessment of distributional information in these recent reviews indicated that the northernmost limits in the geographic range reported for *C. gymnorhinus* were inaccurate. Earlier published records of adult *C. gymnorhinus* from waters north of the Florida Keys and Bahamas, including those from off Georgia (Tucker, 1982) and South Carolina (Wenner et al., 1979a), were overlooked in these recent summaries. Recently, Walsh et al. (2006) again collected juveniles and adults of this species off Georgia, and Quattrini and Ross (2006) reported catching adults on the continental shelf off North Carolina, thereby documenting the northernmost latitude known for adult *C. gymnorhinus*. Although the captures in Quattrini and Ross (2006) are the first published records for *C. gymnorhinus* as far north as North Carolina, our examination of museum lots uncovered a specimen taken off North Carolina during the first part of the 20th century (see below).

The objectives of this study are to update and augment biological and distributional information for these two diminutive flatfish species. Data were gleaned from three sources: 1) specimens in fish collections, including specimens for which some information may have already appeared in published and gray literature, and including some specimens that we re-identified; 2) specimens in fish collections not previously reported; and 3) from recently collected specimens of both species captured off the southeastern United States. Additional information from other specimens reported in the literature, although not examined by us but where identifications were deemed reliable, is also included in the data summaries. The cumulative contributions of information from the above sources allowed us to note obscure distributional records for both species and also to compile more accurate summaries of life history, and ecological and distributional information for these flatfishes. In summarizing such data, we were able to correct long-standing inaccuracies in the reported distributions of these species and to evaluate this new distributional information in relation to contemporary hypotheses regarding shifts in ranges of continental shelf fishes due to effects of climate change.

Materials and methods

This study was initiated with the collection of both *C. gymnorhinus* and *C. cornutus* from the continental shelf off North Carolina (Quattrini and Ross, 2006; Ross, unpubl. data). Recognizing that captures of both species off North Carolina represent significant contributions to our knowledge of the distribution and ecology of these species, we initiated a complete review of available information on these fishes. Pertinent literature was examined to identify and validate published records of both *C. gymnorhinus* and *C. cornutus* (including records for type specimens of *C. unicornis* Goode, a junior subjective synonym of *C. cornutus*; see Norman, 1934) from localities off the eastern United States and adjacent areas in the Bahamas and northeastern Caribbean Sea. Major fish collections likely to have holdings of these species from this region were also surveyed and specimens were examined (Appendices 1 and 2), or data were taken from internet databases where identifications were deemed reliable. Details for institutional fish collections

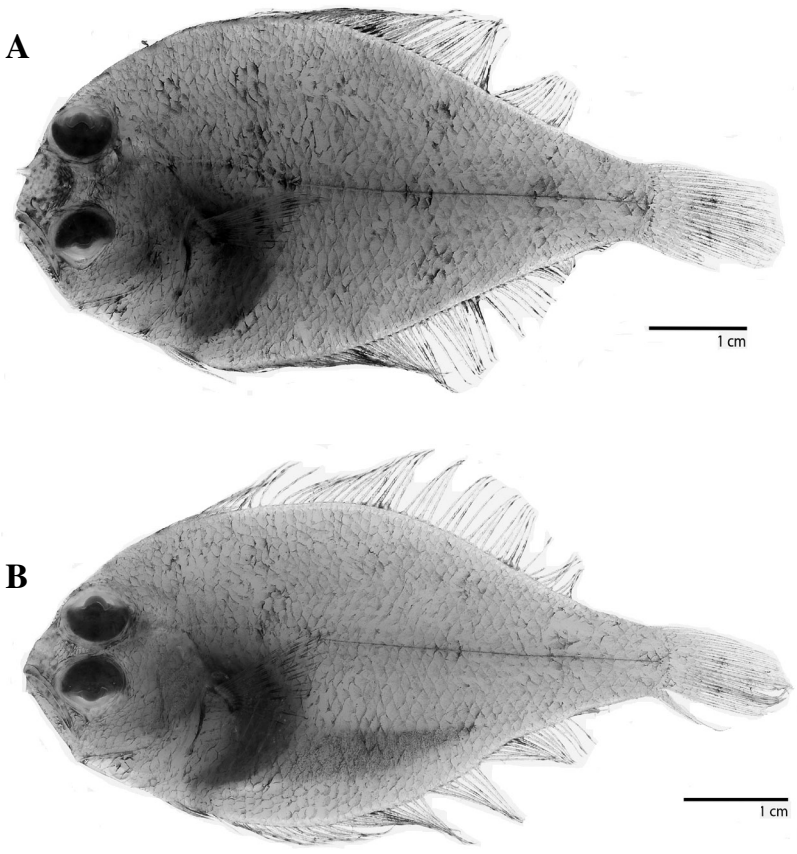

Figure 1

Adult *Citharichthys cornutus* from the western North Atlantic Ocean. (**A**) Male; North Carolina State Museum (NCSM) 47664; 65.1 mm standard length (SL); featuring secondary sexual dimorphisms in cephalic spination and wide interorbital space. (**B**) Female (NCSM 47664; 62.1 mm SL) with no cephalic spination and narrower interorbital space. Note also the elongate, pigmented ovary.

designated by acronyms in this study can be found at http://www.asih.org/codons.pdf. Additionally, specimens of both species were identified from materials collected during recent NMFS-Northeast Fishery Science Center (NEFSC) groundfish surveys, and data associated with these specimens were also included in this study.

All benthic specimens examined or noted through literature and museum searches were collected primarily by various types of bottom trawl, and a few specimens were also taken in benthic dredges. Descriptive geographic locations of collections taken on the continental shelf along the southeastern United States designated in Appendices 1 and 2 and elsewhere were based on their latitudinal positions in relation to terrestrial state boundaries, which may not necessarily coincide with the state boundaries on the continental shelf.

Fishes examined were identified, enumerated, and measured to the nearest mm SL, unless otherwise noted. Species were identified according to characters outlined in Gutherz and Blackman (1970). *Citharichthys cornutus* (Fig. 1, A and B) is distinguished from *C. gymnorhinus* (Fig. 2, A and B) in having scales on the snout (absent in *C. gymnorhinus*), 6 ocular-side pelvic fin rays (vs. 5), 40 or more lateral-line scales (vs. <40 scales in lateral line), and a dark spot in the axil of the ocular-side pectoral fin (vs. no dark spot in axil of pectoral fin). Male *C. cornutus* do not have large black spots in the middle of their dorsal and anal fins that are characteristic of male *C. gymnorhinus* (compare Figs. 1A and 2A), and male *C. cornutus* also have a much larger interorbital space compared with that of male *C. gymnorhinus*.

Sex and maturity of individuals were determined (where possible) by examining external sexually dimorphic characters and by macroscopic examination of gonads with light transmitted through the abdominal

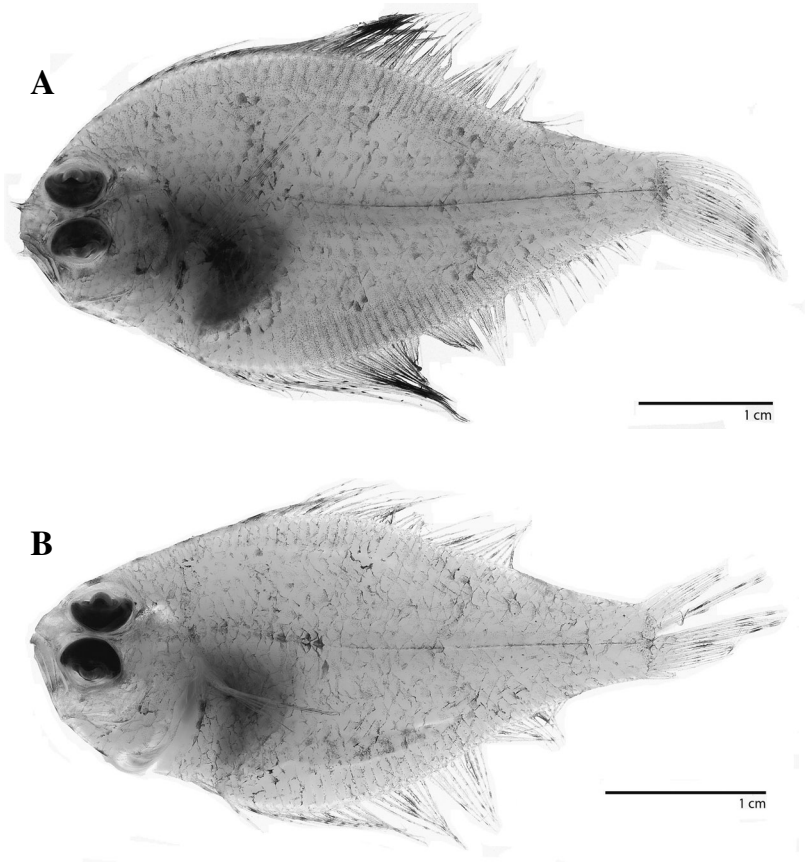

Figure 2

Adult *Citharichthys gymnorhinus* from the western North Atlantic Ocean. (**A**) Male; North Carolina State Museum (NCSM) 47657; 49.5 mm standard length (SL); featuring secondary sexual dimorphisms in cephalic spination, wider interorbital space and black blotches on dorsal and anal fins. (**B**) Female (NCSM 47662; 39.3 mm SL) lacking cephalic spination or black spots on dorsal and anal fins, and with narrower interorbital space. Note also the elongate, pigmented ovary.

region of the body. Adult *C. gymnorhinus* (Gutherz and Blackman, 1970; Topp and Hoff, 1972; this study) and *C. cornutus* (Parr, 1931; Gutherz and Blackman, 1970; this study) feature distinct sexual dimorphisms that facilitate macroscopic determination of sex of maturing and mature individuals of both sexes. Female *C. cornutus* lack dimorphic sexual features characteristic of male *C. cornutus* (compare Fig. 1, A and B), including the absence of rostral and cephalic spines, in having a much narrower interorbital space (usually <eye diameter), and females lack the dusky blind-side pigmentation observed in recently captured males (taken off North Carolina). Females also have a different size, shape, and extent of posterior elongation of the gonad compared with that of males. In mature females, the ovary is broadly triangular anteriorly, extends posteriorly for more than one-half the standard length of the specimen (see mature ovary in females in Figs. 1B and 2B), and is easily seen through the abdominal wall (vs. males with much smaller, rounded testes that do not undergo posterior elongation). For male *C. gymnorhinus* (Fig. 2A), secondary sexual characters include rostral and cephalic spination, conspicuous black blotches on dorsal and anal fins, dusky blind-side pigmentation (best observed in recently caught males), an elongate, fragile first fin ray (often broken) in the ocular-side pectoral fin, and small, rounded testes without posterior elongation. These features become conspicuous in some males between 29 and 35 mm SL and are well developed in all males ≥42 mm SL. In contrast, female *C. gymnorhinus* (Fig. 2B) lack cephalic spination, black pigmented blotches on dorsal and anal fins, and the dusky blind-side pigmentation characteristic of males. Also, with the onset of maturity, the ovaries undergo a conspicuous extensive posterior elongation (easily observed with light transmitted through the body), which,

as also occurs in *C. cornutus*, may extend for more than one-half of the standard length of the individual. Immature females of both species are identified by their shorter, more triangularly shaped ovaries that have either not yet begun to elongate, or that are only in the earliest stages of posterior elongation.

Results and discussion

Biological and ecological information from 594 *C. cornutus* (Appendix 1) and 214 *C. gymnorhinus* (Appendix 2) were included in this study. Of the 594 *C. cornutus,* size data were available for 566 individuals. Sizes were not available or were not taken for 28 of the *C. cornutus*; however, geographic and bathymetric data associated with these individuals were included in appropriate summaries. Size information was taken from 196 of the 214 *C. gymnorhinus* included in the study. One individual (a mature male) had a regenerated caudal region, and therefore it could not be measured accurately, and size data from this specimen were excluded. Depth of capture information was known for 578 of the 594 *C. cornutus* and for all 214 of the *C. gymnorhinus* included in the study.

Sex and maturity information was compiled from 430 of 566 *C. cornutus* that were measured. Sex could not be determined macroscopically for *C. cornutus* smaller than 20.0 mm. For 135 *C. cornutus*, although size information was available, no information was provided to determine the sex of these fishes. One specimen was damaged during collection and its sex could not be determined. Sex could not be determined for another individual of 68 mm because the gonad appeared to be undeveloped (macroscopic appearance was neither that of a typical testes or ovary) and although this individual is well within the size range for adults (see below), it does not feature any external sexually dimorphic characters typical of adult males, which also precluded macroscopic determination of its sex. Sex and maturity were determined for 190 of 214 *C. gymnorhinus*. We did not examine 25 *C. gymnorhinus*, including seven for which size data were available (8–38 mm); thus no information on their sex or maturity was available.

Citharichthys cornutus (Günther 1880)

Taxonomic note

Günther (1880) described *Rhomboidichthys cornutus* from specimens taken on the continental shelf in the western South Atlantic off Brazil. Later that year, Goode (1880) provided a description of *Citharichthys unicornis* based on three specimens (USNM 26003: 3 syntypes) collected on the outer continental shelf off southern New England (actually at a latitude off New Jersey; see Fowler, 1952). Norman (1934) first considered these two nominal species to be conspecific and this decision has been followed by subsequent authors, but the status of these nominal species is in need of further study. During the interim between Goode's (1880) description of *C. unicornis* and Norman's (1934) placement of this species in the synonymy of *C. cornutus*, several studies were published in which this species was listed or in which ecological, distributional, and systematic information was reported under the name *C. unicornis*. These earliest reports of *C. cornutus* from the western North Atlantic (Jordan and Gilbert, 1883; Günther, 1887; Jordan and Goss, 1889; Goode and Bean, 1895; Jordan and Evermann, 1898; Evermann and Marsh, 1902; Parr, 1931) were overlooked in nearly all contemporary compilations of information on the species, in part because *C. unicornis* Goode was not recognized as a junior synonym for *C. cornutus* (Günther).

The series of specimens reported in Goode and Bean (1895) comprises at least two species, including *C. unicornis* (=*cornutus*) and *C. gymnorhinus* (see below). Parr's study (1931) may also have contained a mixture of both species, but because he did not list any specific collection data for the 68 specimens from the USNM and MCZ identified as *C. unicornis* in his study, the possibility that two species were intermingled cannot be proven definitively. The majority of specimens of *C. unicornis* available to Parr from the USNM fish collection were those collected earlier during cruises of the RV *Albatross* and reported in Goode and Bean (1895). Several of these lots comprise mostly specimens of *C. gymnorhinus*; therefore, if these were the same specimens examined by Parr, it seems likely that his data set was compromised because it would have contained a mixture of at least two species.

Geographic distribution

Fifty-six different field collections (Appendix 1) containing juvenile and adult specimens of *C. cornutus* encompassed the geographic range from the outer continental shelf off New Jersey to the continental shelves off the northern coasts of the Bahamas, Cuba, Puerto Rico, and the Lesser Antilles (Fig. 3). All but five collections occurred south of 35°N latitude. Among collections examined were four from off New Jersey (we could not find specimens from the second location off NJ reported by Goode, 1880), seven from off North Carolina, 22 off South Carolina, three off Georgia, nine off Florida, five from the Bahamas, one off Cuba, two off Puerto Rico, and three others from the eastern Caribbean Sea. One early record (USNM 111520) purportedly of this species from off North Carolina was misidentified as *Citharichthys unicornis* (=*C. cornutus*) by Hildebrand (1941). This 56-mm total length (TL) male, taken on 13 September 1914, off Cape Lookout by the RV *Fish Hawk* at a depth of about 92 m (50 fm) is actually *C. gymnorhinus*, and the significance of this specimen is discussed under the account for that species.

Our knowledge concerning the geographic occurrence of *C. cornutus* in the western North Atlantic Ocean is now improved through the inclusion of previously published distributional data, by highlighting data for specimens previously listed only in published tables

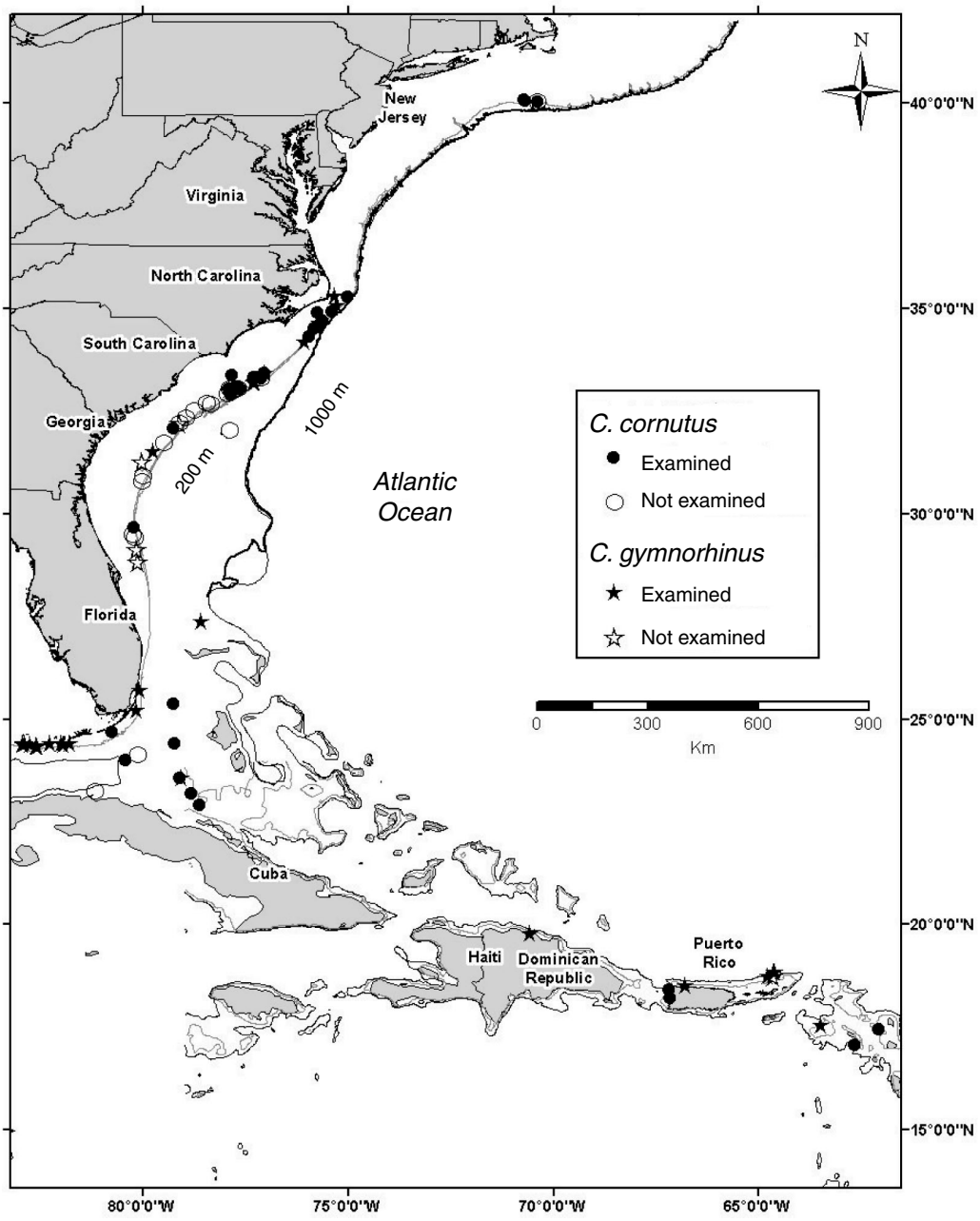

Figure 3

Capture locations of specimens examined, or, of specimens cited in literature for which there are reliable identifications, for *Citharichthys cornutus* (n=594) and *C. gymnorhinus* (n=214). Points may indicate more than one fish and more than a single capture. Capture records for other specimens of *C. cornutus* from the Dry Tortugas Islands Region based on Longley and Hildebrand (1941) are not plotted because precise locality data were not provided for these specimens.

or appendices, and by inclusion of unpublished information associated with museum specimens and other uncatalogued specimens (Appendix 1). Based on these sources, the range of adult *C. cornutus* extends from the outer continental shelf off New Jersey (40°05.593′N, 70°42.75′W) and New York southward along the outer shelf of the eastern United States to Texas, and perhaps Yucatan, Mexico (Castro-Aguirre et al., 1999), the Bahamas, the Greater Antilles (Puerto Rico and Cuba), and Lesser Antilles (off Virgin Islands, St. Kitts Island), on the outer continental shelf throughout the Caribbean Sea, and off the Atlantic coast of South America to Uruguay. Larvae are known from Canadian Atlantic waters; several individuals have been collected

at 41°33′N, 54°55′W (MCZ 77935) and 41°05′N, 66°31′W (Scott and Scott, 1988; Fahay, 2007).

The geographical distribution reported here is largely consistent with that known for the species as reported in Fahay (2007), but it is different from range information contained in literature accounts published during the last half of the 20th century. Goode (1880) first reported *C. cornutus* (as *C. unicornis*) from the western North Atlantic from two stations located on the outer continental shelf south of Rhode Island (40°02′54″N, 70°23′40″W and 40°02′36″N, 70°22′58″W). This capture site, actually off New Jersey (Fowler, 1952), is located on the shelf between the head of Alvin Submarine Canyon (40°00′N, 70°30′W) and a feature called "The Mud Patch" located just to the northwest of the canyon. The same distributional information for the species (deep waters of the Gulf Stream off Rhode Island) was reported by Jordan and Gilbert (1883) and Jordan and Goss (1889) from the data presented in the original description of the species by Goode (1880). Günther (1887) also listed this locality for *C. unicornis* on the basis of Goode's specimens. Fowler (1952) again listed *C. cornutus* among fishes of New Jersey on the basis of "offshore records" that most likely refer to specimens contained in Goode's (1880) original description of *C. unicornis*, because no other specimens were listed to indicate otherwise. In their treatise on deep-sea fishes, Goode and Bean (1895) again repeated the same distributional information for the syntypes of *C. unicornis* captured on the outer shelf off northern New Jersey, but they also provided data for additional specimens taken off South Carolina (33°18′N, 77°07′W) and in the Gulf of Mexico (28′36–38′N, 85°52–53′W). These new specimens increased the knowledge about the geographic distribution of this species along the southeast continental shelf of the United States. Although Goode and Bean also reported *C. unicornis* from the Straits of Florida off the Florida Keys (24°25′45″N, 81′46′W), re–examination of these specimens from *RV Albatross* station 2318 (USNM 45610; USNM 45677; USNM 143120) and RV *Albatross* station 2316 (USNM 129946) revealed they are not *C. cornutus*, but rather are *C. gymnorhinus* (see data summaries below for that species).

Scott and Scott (1988) considered their record of a larval *C. cornutus*, taken at 41°05′N, 66°31′W in 1982, to represent the northernmost point of the range of the species. They also considered that larvae of this species reported from the vicinity of the Canadian Atlantic are most likely strays from more southern locales. They missed earlier references documenting adults from the outer shelf region at 40°N and cited Georgia as the northern limit for the species following information in Tucker (1982). Other larval *C. cornutus* known from this general area (MCZ fish collection), including Georges Bank (Fahay, 2007), indicate the possibility that larvae caught in this region could also be produced by more localized spawning of *C. cornutus*. FishBase (Froese and Pauly, 2010; www.fishbase.org) also shows the western North Atlantic distribution of this species as Canada to Georgia based on the larva reported in Scott and Scott (1988).

Additional records of this species from off the southeastern coast of the United States and nearby areas include those in an unpublished dissertation by Staiger (1970), who detailed distribution of this species in the Straits of Florida region based on 143 specimens. He reported that *C. cornutus* occurs along the continental margin of the Straits from off the Dry Tortugas to Miami, also in the central Straits near the Cay Sal Bank, and along the insular margin of the Straits from the Santaren Channel to the Little Bahama Bank. Quattrini and Ross (2006) caught this species on the continental shelf off North Carolina but provided no further comments on the distribution of the species (because their specimens are included in the present study). Eight specimens of *C. cornutus* have also been taken at two locations off Puerto Rico (Evermann and Marsh, 1902; this study) and off the northern coast of Cuba near Provincia de Matanzas (Vergara Rodriguez, 1974). Cervigón (1996) recorded the species from off Venezuela but indicated that it is poorly documented from this area.

Other studies published during the last century contained more general, and often vague, information or commentary on the distribution of this species. For example, Jordan and Evermann (1898) listed it as occurring in deep waters of the Gulf Stream. Parr (1931) did not report any specific capture information for the approximately 68 specimens (largest series examined to that date) in his study. Instead, he mentioned that although very little was known about the distribution of *C. cornutus*, it was generally regarded as occurring in deep waters of the Gulf Stream. Norman (1934) considered *C. cornutus* to have a disjunct distribution with a northern range in deep waters of the Gulf Stream and a southern distribution off the coast of Brazil. Longley and Hildebrand (1941) reported the species as occurring in the Gulf Stream from the Dry Tortugas to at least off the southeast coast of New England (presumably from earlier literature records off New Jersey). Topp and Hoff (1972) listed this as a deepwater species in the Gulf of Mexico. Lyczkowski-Shultz and Bond (2006) described the range of *C. cornutus* as the Atlantic and Gulf coasts of the United States, without specifying any geographic limits. In a summary of distributional information for *C. cornutus*, Gutherz (1967) reported that its geographic range included the outer continental shelf along the Atlantic and Gulf coasts of the United States from Georgia to Texas, the Bahamas, the Greater Antilles, off Yucatan, Mexico, throughout the Caribbean, and off the Atlantic coast of South America to Brazil. Although Gutherz (1967) adequately summarized capture locations for the species in the middle portions (extreme southeastern United States, Gulf of Mexico, and Caribbean Sea) of its geographic range, he did not mention previous captures of the species from north of Georgia.

Beginning with Gutherz (1967), captures of adult *C. cornutus* from off New Jersey (Goode, 1880; and cited

in other studies) and South Carolina (Goode and Bean, 1895; Wenner et al., 1979a; 1979c; 1979d; 1980) were overlooked in nearly all subsequent contemporary literature, and misinformation regarding the northern limits of distribution for *C. cornutus* was perpetuated. For example, Hoese and Moore (1977) reported the distribution of *C. cornutus* as the northwestern Gulf of Mexico, and from Georgia throughout the Caribbean to Brazil, later (Hoese and Moore, 1998) adding the Bahamas to this distribution. Tucker (1982: Table 1) also listed the geographic range for adults as Georgia to Brazil (although he illustrated in a map that larvae were known from areas north of Georgia at about Cape Fear, NC). Robins and Ray (1986) and Boschung (1992) repeated the same distributional information for the northern point of the geographic range (Georgia) for *C. cornutus* as that appearing in Gutherz (1967). Cervigón (1996) listed the geographic distribution as the eastern United States, Bahamas, and northern Gulf of Mexico to Brazil. Castro-Aguirre et al. (1999) tentatively listed the species from the Veracruz, Mexico, region on the basis of a study by Lozano-Vilano et al. (1993), and reported the geographic distribution of the species from Georgia, Florida, and Gulf of Mexico to Brazil, including the Bahamas and Antilles. Figueiredo and Menezes (2000; 2003) also listed the northern limit of the geographic range of *C. cornutus* as Georgia, as did Saavedra-Díaz et al. (2000). Munroe (2003) reported the distribution as the continental shelf off the Atlantic and Gulf coasts of the United States from North Carolina to Texas, which distribution is essentially the same as that given in McEachran and Fechhelm (2005). Historical captures of *C. cornutus* from off New Jersey were also overlooked (J. A. Moore and K. E. Hartel, personal commun.[1]) by Moore et al. (2003) and Hartel et al. (2008) in checklists of the deepwater (≥200 m) resident fishes from the Mid-Atlantic Bight area south of New England.

Among contemporary literature, only Fahay (2007) has provided a more accurate assessment of the northernmost occurrences of *C. cornutus*. Although he notes that the geographic range usually reported in the literature is from Georgia to Brazil, including the Gulf of Mexico and Caribbean Sea, he also has observed that adults are fairly common as far north as Cape Hatteras and Hudson Canyon and that larvae are collected as far north as Georges Bank. A recent capture of one specimen of *C. cornutus* from off New York is reported by Steves et al. (1999: their Table 3) and a photograph provided by M. Fahay (personal commun.[2]) indicates that at least five other specimens were taken recently on the continental shelf off New Jersey.

[1] Moore, Jon A., and Karsten E. Hartel. 2008. Honors College, Florida Atlantic University, Jupiter, FL 33458 and Museum of Comparative Zoology, Harvard Univ., 26 Oxford Street, Cambridge, MA 02138.

[2] Fahay, Michael. 2006. (Retired.) James J. Howard Marine Sciences Laboratory at Sandy Hook, Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 74 Magruder Road, Highlands, NJ 07732.

Bathymetric distribution

Overall, the 578 specimens for which information on depth of capture was available were captured at depths ranging from 68 to 287 m (Appendix 1). The majority of specimens (496 of 578=85%) were taken between 101–200 m (Fig. 4A). Only 31 (5.3%) *C. cornutus* in this study were taken shallower than 100 m, and only 61 (10.5%) specimens were collected deeper than 200 m (Fig. 4A).

Specimens examined in this study were collected within the bathymetric range generally reported for this species; however, our specimens did not represent the depth extremes reported for this species. This species is usually reported from outer shelf depths where these fishes are associated with soft bottoms, including sand-mud substrata (Staiger, 1970; McEachran and Fechhelm, 2005; Fahay, 2007). For example, Goode and Bean (1895) reported that their specimens were taken between about 83 and 285 m; however, their study included both *C. cornutus* and *C. gymnorhinus*. The depth range for specimens of *C. cornutus* in Goode and Bean is actually 174–285 m. Off the Dry Tortugas, Longley and Hildebrand (1941) reported the distribution of *C. cornutus* as benthic habitats in the Gulf Stream at depths of about 81 to somewhat less than 185 m, and that abundance was highest near 120 m. Staiger (1970) reported a depth range for the species in the Florida Straits region from 83 to 260 m. Gutherz (1967) listed the depth range for *C. cornutus* throughout its geographic range as 27–366 m and that captures generally exceeded 137 m; this range was repeated in several publications (Tucker, 1982; McEachran and Fechhelm, 2005; and Fahay, 2007). Topp and Hoff (1972) reported that off West Florida this species is known from the outer shelf or shelf edge; those in the Gulf of Mexico can be found at depths exceeding 350 m (5 out of 38 of their specimens were collected at these depths), and in the Caribbean it is usually found deeper than 137 m. Boschung (1992) listed the depth range for *C. cornutus* off Alabama as 24–172 m. Robins and Ray (1986) indicated a depth range of 30–400 m, usually deeper than 140 m for the species. Cervigón (1996) reported that this species inhabits depths between 30 and 400 m, but generally less than 300 m. Hoese and Moore (1977; 1998) considered this to be a deepwater species ranging from about 28–368 m, generally >138 m. Saavedra-Díaz et al. (2000) reported a depth range of 24–400 m. Munroe (2003) and Lyczkowski-Shultz and Bond (2006) reported this species at depths of 20–370 m, but generally deeper than 130 m. Off southern Brazil, Figueiredo and Menezes (2000) noted that *C. cornutus* is captured in fisheries conducted at depths of 20–192 m, and a maximum depth record of 365 m has been documented for this species in this region.

Size

Our specimens ranged in size from 17.2 to 81.3 mm SL (Fig. 5A). Overall, approximately 48% (272 of 566) of

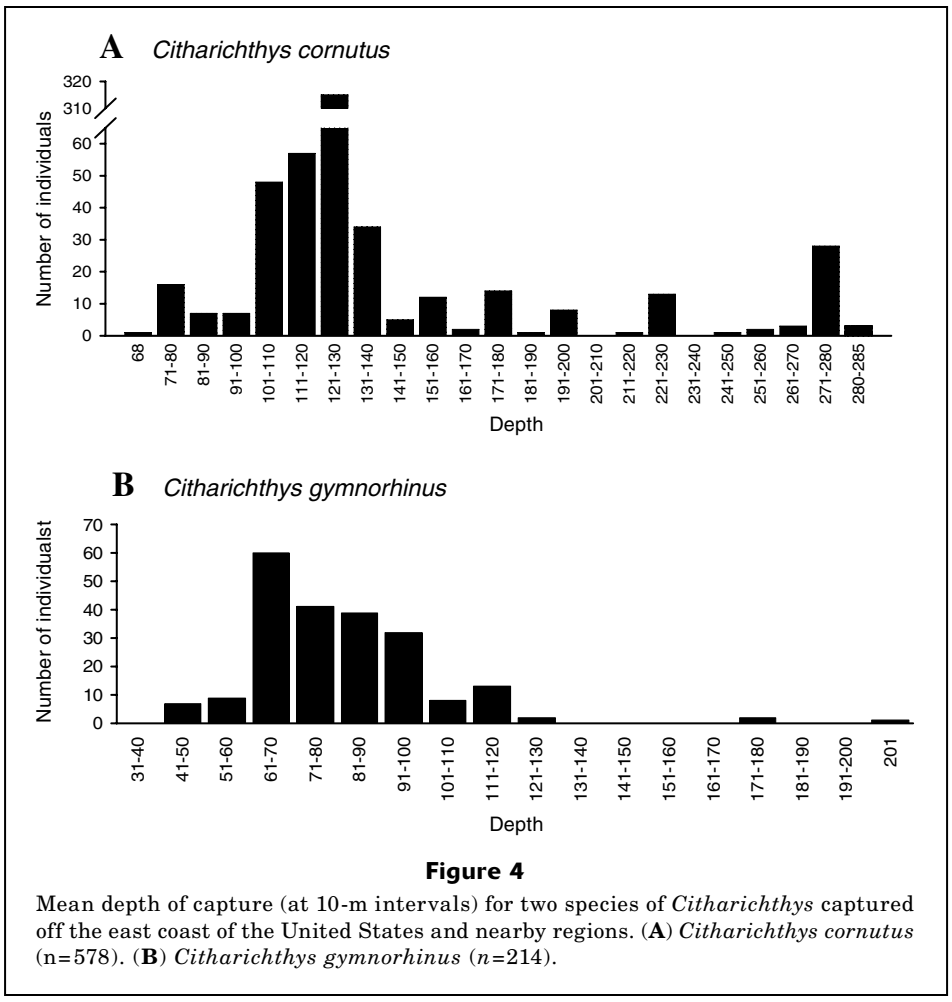

Figure 4

Mean depth of capture (at 10-m intervals) for two species of *Citharichthys* captured off the east coast of the United States and nearby regions. (**A**) *Citharichthys cornutus* (n=578). (**B**) *Citharichthys gymnorhinus* (*n*=214).

the specimens measured 60 mm or larger; but only 27 (4.7%) exceeded 70 mm. Males (259 of 430, ca. 60% of total fish for which sex was determined) ranged in size from 20.2 to 79.1 mm (Fig. 6A). Females (171 of 430=ca. 40% of total fish for which sex was determined) attained similar sizes (28.0–81.3 mm) to those recorded for males (Fig. 6B). Despite attaining nearly the same maximum size, males overall were usually larger than females and slightly more than twice as many males (169 or 39.3% of 430 fish for which sex was determined) reached 60 mm or larger than did females (48 or 11% of total fish for which sex was determined).

Size distributions in our samples are similar to those recorded for the species in other studies, but are slightly smaller than the maximum size (about 91 mm SL) reported for the species (Longley and Hildebrand, 1941; Gutherz, 1967; Cervigón, 1996). From a size range of 32–68 mm SL (*n*=68), Parr (1931) concluded that *C. cornutus* is a small species reaching only about 70 mm SL. But, as noted above, his results were likely based on a mixture of both *C. cornutus* and *C. gymnorhinus*. Norman (1934) reported sizes of 47–87 mm SL for six males, and 58 mm SL for one female. For *C. cornutus* collected off the Dry Tortugas, the largest size obtained by Longley and Hildebrand (1941) was slightly larger than 90 mm (TL?). Gutherz (1967) illustrated a male measuring 89 mm SL, but later (Gutherz, 1969), reported a maximum length for *C. cornutus* of only about 75 mm SL. Staiger (1970:64) examined 85 males and 35 females from the Straits of Florida that ranged in size between 26 and 70 mm SL. Topp and Hoff (1972) measured 38 specimens between 47.5 and 74.1 mm SL. Cervigón (1996) listed a maximum size of 91 mm SL for the species. Saavedra-Díaz et al. (2000) reported sizes for seven specimens taken off Colombia ranging from 46.7 to 61.8 mm SL. In other studies (Robins and Ray, 1986; Munroe, 2003; McEachran and Fechhelm, 2005), a maximum size of 100 mm TL was recorded (apparently rounded upward on the basis of other literature).

Size at maturity

Sex was determined for 430 of the 566 (ca. 76%) individuals measured. Among males (Fig. 6A), 32 of 259 (about 12%), ranging from 20.0 to 71.4 mm, are immature; whereas, 227 (87%), measuring 36.5–79.1 mm, are mature. All nine males ≤ 35.0 mm are immature, and 3 of 4 males between 35 and 40 mm are also immature.

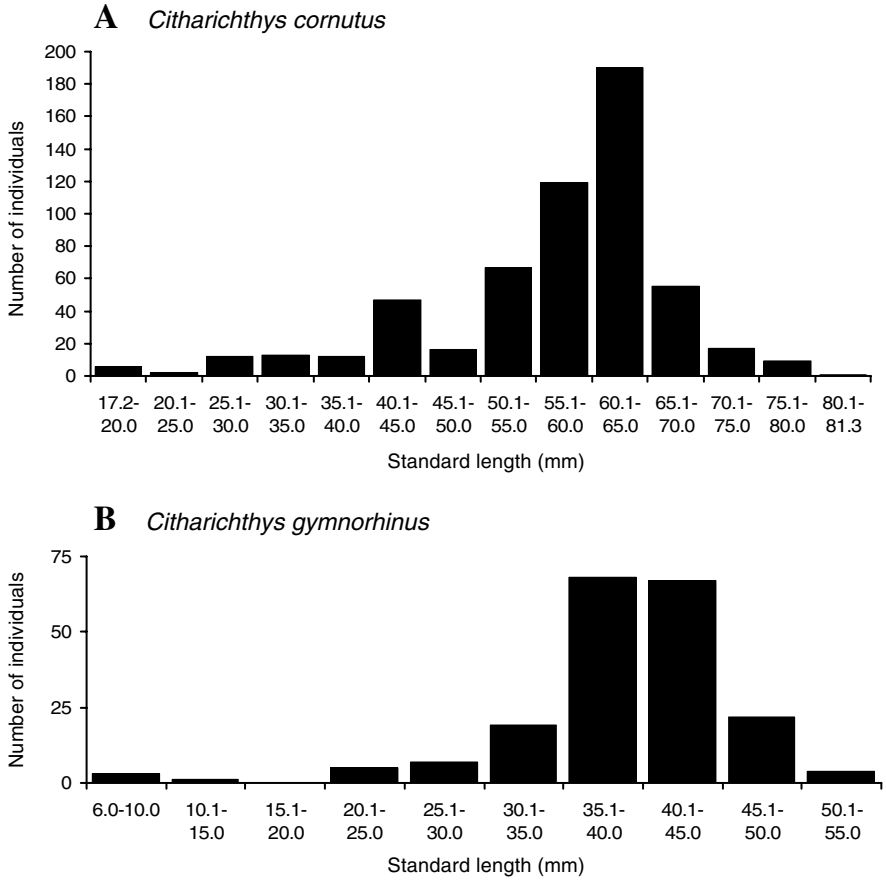

Figure 5

Size distribution (standard length) for two species of *Citharichthys* captured off the east coast of the United States and nearby regions. (**A**) *Citharichthys cornutus* (n=566). (**B**) *Citharichthys gymnorhinus* (*n*=196).

Between 40 and 45 mm, 7 of 10 males are mature, but in the next size category (45–50 mm) only 4 of 9 males are mature. Between 50 and 55 mm, 90% of the males are mature, and between 55 and 65 mm, 95–98% of the males (42 of 44 and 126 of 129, respectively) are mature. Nearly all males (*n*=38 of 40) ≥65.1 mm are mature.

Among the 171 females examined (Fig. 6B), 18 (28.0–55.1 mm) are immature, whereas mature females (*n*=153) range in size between 41.5 and 81.3 mm. Among the smallest females, 14 of 15 (93%) ranging between 28.0 and 45.0 mm are immature. Between 45.1 and 50.0 mm, only 1 of 3 females are immature, and among females ≥50 mm, only three (51.1, 51.8, and 55.1 mm) are immature. Of mature females, 2 of 3 females between 45.1 and 50.0 mm are mature, whereas between 50.1 and 55.0 mm about 93% (28 of 30) of the females are mature, and all but one female ≥ 55.1 mm are mature.

The largest collection of *C. cornutus* from off the eastern seaboard of the United States (NCSM 47664) contains 314 fish ranging in size from 20.0 to 68.0 mm. The sample comprises 177 males (20–68 mm), 136 females (28–64 mm), and 1 individual (68 mm) of unknown sex. The sex ratio for this sample is 1.3:1.0 males to females. Among males, 164 are mature (48–68 mm), and 13 others (20–49 mm) are immature. Most of the 136 females (*n*=121, 47–64 mm) are mature and only 15 (28–46 mm) are immature. Co-occurrence of juveniles and adult males and females in the same collection indicates that both sexes and both life stages occupy similar depths and probably occur in the same microhabitat(s).

Before this study, little information was available regarding size at maturity for *C. cornutus*. Earlier literature on *C. cornutus* emphasized the sexual dimorphisms exhibited by this species and the relative sizes when these dimorphic features become evident. Parr (1931:17) provided the most detailed account on size, morphological features, and striking sexual dimorphism exhibited in this species (as *C. unicornis*) based on at least 37 males and 31 females ranging from 32 to 68 mm SL (note again that his specimens may have been a mixture of *C. cornutus* and *C. gymnorhinus*). Norman

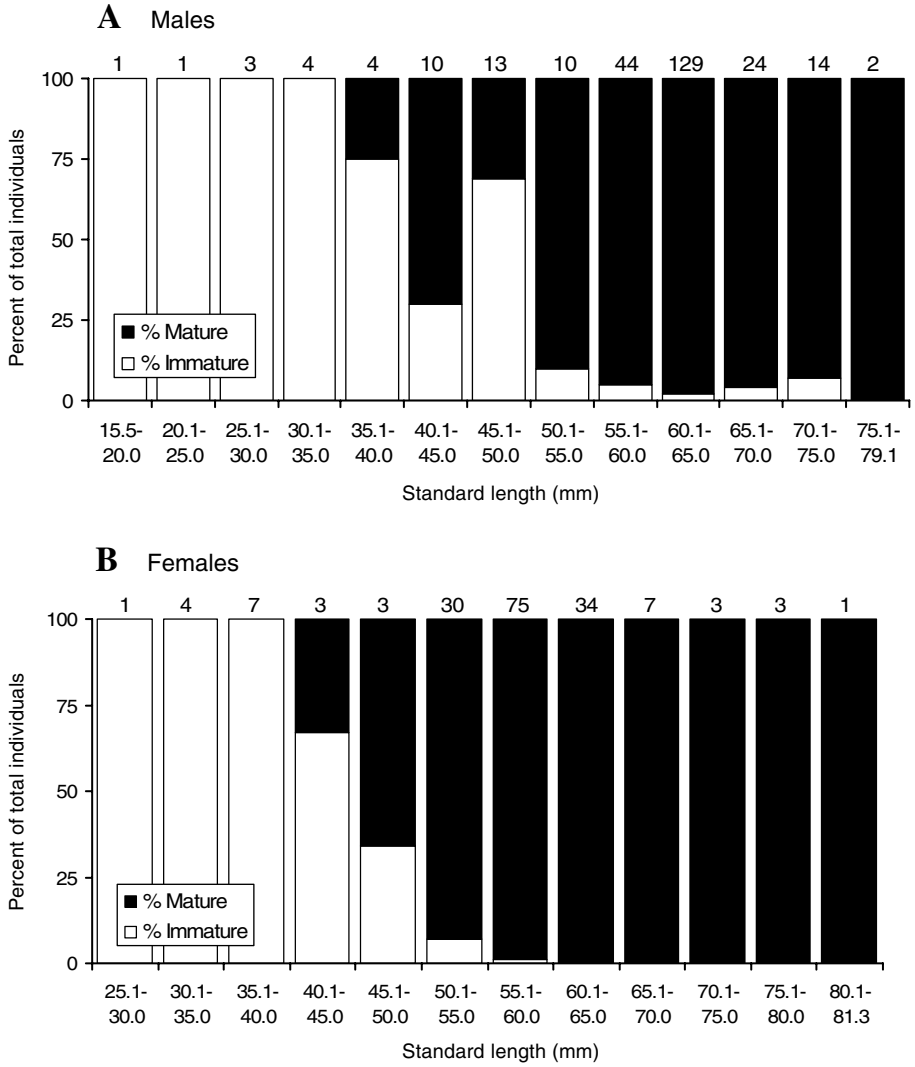

Figure 6

Size (standard length) and maturity information for 430 *Citharichthys cornutus* captured off the east coast of the United States and nearby regions. (**A**) Males (n=259). (**B**) Females (*n*=171). Number above each column is the number of individuals examined in that size range.

(1934:153) examined seven specimens of *C. cornutus* (including types of *Rhomboidichthys cornutus* and several USNM specimens), noted sexual dimorphisms of this species, and also commented that a more complete description of these dimorphic differences was available in Parr (1931). Longley and Hildebrand (1941:43) provided descriptive information on sexual dimorphism, as did Gutherz (1969), who also reported the capture of two adult hermaphroditic specimens from off Nicaragua. Longley and Hildebrand (1941) further commented that the sexes were easily distinguished at sizes of 55 mm (TL?) and greater because the posterior elongation of the ovaries was easily observed through the body wall of females. We also found that all females but one taken off the east coast of the United States that are ≥55 mm are sexually mature.

Abundance

Overall, the majority of specimens examined were taken on the outer continental shelf of the South Atlantic Bight. Ten different collections of *C. cornutus* from this region contained solitary individuals (Appendix 1), and another nine collections contained two or three specimens. The largest collections of *C. cornutus* from the east coast of the United States are all from North Carolina and southwards, including one collection off North Carolina with 12 specimens, seven off South Carolina (two with

12, one each with 15, 24, 26, and 30 individuals), and the single largest collection (314 individuals) of *C. cornutus* from this region (NCSM 47664) from off South Carolina (at 33°25.389′N, 77°02.234′W). Other notable collections are those of 16 specimens from the Dry Tortugas region, and another collection containing 24 specimens (USNM 282789) made off the Bahamas.

Citharichthys cornutus is found in relatively high densities in the Dry Tortugas region (Longley and Hildebrand, 1941). Although it is unclear how many specimens they encountered, Longley and Hildebrand (1941:43) noted that *C. cornutus* was "rather common" in this area, with sometimes 50 or more individuals taken together. Other significant collections of *C. cornutus* from the eastern Gulf of Mexico containing 43, 47, 63, 100, 103, 172, and 321 specimens are curated in the AMNH fish collection (see *Additional material* section).

Citharichthys gymnorhinus

Geographic distribution

We identified 214 juvenile and adult *C. gymnorhinus* in a total of 42 different field collections from the continental shelf off North Carolina to the Dominican Republic, Virgin Islands, and Puerto Rico (Fig. 3; Appendix 2). Of collections containing *C. gymnorhinus*, five are from the shelf off North Carolina, including the northernmost capture of the species made off Cape Hatteras (35°05.51′N). Nine were made on the continental shelf off South Carolina, and at least two collections were made off Georgia. Most (n=17) collections of *C. gymnorhinus* are from the continental shelf off Florida, including the Straits of Florida and the Dry Tortugas regions. *Citharichthys gymnorhinus* not only was less frequently captured at insular regions in the eastern Caribbean Sea than off the southeastern United States, but it is also known from relatively few specimens per collection at these Caribbean locations (e.g., five collections from Virgin Islands yielded only 21 specimens). Only two collections (n=3 specimens) from off the Bahamas were found, and we note single captures of this species from off the northern coasts of Puerto Rico and the Dominican Republic.

The northernmost records for juvenile and adult *C. gymnorhinus* are those from the continental shelf just south of Cape Hatteras, NC (NMFS Survey specimens; NCSM records; Quattrini and Ross, 2006). Larval *C. gymnorhinus* have been collected from sites much farther north than those reported for adults. For example, Scott and Scott (1988) reported that a 13-mm larva of *C. gymnorhinus*, collected in 1982 at 41°21′N, 66°14′W, represented the first record for this species from Canadian waters and also was the northernmost record of occurrence for the species. Other captures of larval *C. gymnorhinus* from this general region include at least three lots (one taken at 41°35′28″N, 66°24′75″W; the others at 33°24′07″N and 32°58′37″N) curated in the Atlantic Reference Center (ARC) fish collection and one lot curated in the MCZ collection (MCZ 77935) taken at 41°33′N, 54°55′W. Scott and Scott (1988) considered that larval *C. gymnorhinus* occurring in Canadian waters were strays from more southern locations. Museum records at ARC and MCZ document captures of larval *C. gymnorhinus* at or just beyond 41′N latitude over the course of several years, indicating that larval *C. gymnorhinus* at this latitude may be found more frequently than previously recognized. The record of *C. gymnorhinus* from off New Jersey (Able, 1992) is also based on larvae. Absence of adults in areas north of North Carolina may indicate that suitable habitat or appropriate environmental conditions are not available for juvenile settlement or for adult survival in these areas.

Earlier occurrences of larval *C. gymnorhinus* in the South Atlantic Bight were detailed by Tucker (1982), who reported the northern range for larval *C. gymnorhinus* at about Cape Fear, NC. More recently, Powell et al. (2000) and Grothues et al. (2002) also listed this species among the larval fish assemblages off Cape Hatteras, NC, and Fahay (2007) reported collecting larvae in the area north of Cape Hatteras from January to November, with peak occurrence from August through September. Powell et al. (2000) considered that larval *C. gymnorhinus* in Onslow Bay, NC, were most likely produced either by adults spawning in outer-shelf waters (55–185 m) nearby or were larvae produced by fishes spawning south of their study area. Off Georgia, *C. gymnorhinus* is only a minor component of the larval fish assemblage in these waters (Marancik et al., 2005).

Before the work of Quattrini and Ross (2006), studies of fishes off North Carolina did not list adult or juvenile *C. gymnorhinus* among species occurring there. Although specimens cited in Quattrini and Ross (2006) represent the first published record of adult *C. gymnorhinus* taken on the continental shelf off North Carolina, these are not the first specimens known from the area. Examination of catalogued museum lots and uncatalogued specimens from NMFS-NEFSC groundfish surveys (USNM uncat., see Appendix 2) reveals that other specimens had been captured off North Carolina before the Quattrini and Ross (2006) study. The earliest collection of *C. gymnorhinus* from off North Carolina that we can document is that of a 45.4-mm male (USNM 111520) taken 13 September 1914, off Cape Lookout by the RV *Fish Hawk*, at a depth of about 92 m. Collection of this specimen pre-dates recognition and formal description of the species by Gutherz and Blackman (1970). Originally, Hildebrand (1941) misidentified this specimen as *Citharichthys unicornis* (=*C. cornutus*; see Norman, 1934); however, meristic features and color pattern, including dark pigment blotches on its dorsal and anal fins, reveal that it is an adult (45.4 mm SL) male *C. gymnorhinus*.

One of the earliest reports of this species off South Carolina is that of Wenner et al. (1979a), who recorded a single specimen of *C. gymnorhinus* taken at 86 m during the 1973 fall trawl survey. Other specimens taken off South Carolina during the 1970s are curated in several fish collections (AMNH, GMBL, UF; see Appendix 2). In his article describing larval develop-

ment of *C. gymnorhinus*, Tucker (1982) described the northern limit for adult *C. gymnorhinus* as off Georgia (however, his Table 1 noted the geographic range as Florida to Guyana). More recently, Walsh et al. (2006) have collected five small specimens of this species between 35 and 48 m on the inner continental shelf off Georgia. Gutherz and Blackman (1970) documented occurrence, based on 34 specimens, of *C. gymnorhinus* off the Florida Keys, the Antilles, off northern and western Bahamas, northern Hispaniola, northern Puerto Rico, Tobago, and the Caribbean Sea off Colombia, Panama, and Nicaragua. An additional record of *C. gymnorhinus* (as an undescribed *Citharichthys* species) was included by Starck (1968) from off Alligator Reef, Florida. Topp and Hoff (1972) recorded the species from several additional locations, including the continental shelf off west Florida, and also at sites off northern Cuba, the Virgin Islands, Venezuela, and Guyana. Boschung (1992) listed the geographic range as the northern Gulf of Mexico, and Bahamas to the western Caribbean and northern South America.

Recent literature and an on-line database synthesizing information on *C. gymnorhinus* have perpetuated misinformation concerning the northern limits of distribution for this species. Robins and Ray (1986), Cervigón (1996), Saavedra-Díaz et al. (2000), Munroe (2003), McEachran and Fechhelm (2005), Lyczkowski-Shultz and Bond (2006), Fahay (2007), and Froese and Pauly (2010) indicate a northernmost geographical limit for adult *C. gymnorhinus* as the Bahamas or the Florida Keys, which is essentially the same distribution reported in Gutherz and Blackman (1970) and Topp and Hoff (1972). Earlier records of adult *C. gymnorhinus* north of the Florida Keys and the Bahamas published after studies by Gutherz and Blackman (1970) and Topp and Hoff (1972) were overlooked owing to a lack of thorough investigation. Perhaps these oversights resulted because citations of *C. gymnorhinus* from this area are infrequent and scattered among species lists that are included only in tables or appendices of regional studies (e.g., Wenner et al., 1979a; 1979b; 1979c; 1980) or because some records are not vouchered by specimens and are difficult to verify. For other studies (i.e., Tucker, 1982), conflicting information reported within the same work regarding the distribution of this species is confusing.

Bathymetric distribution

Citharichthys gymnorhinus examined in the present study were collected over a depth range from 35 to 201 m (Appendix 2; Fig. 4B). Approximately 90% (193 of 214) of these fish were taken at depths averaging 61–120 m. Only 16 individuals were captured shallower than 60 m, with the shallowest depths recorded (Walsh et al., 2006) for five individuals taken between 35 and 48 m off Georgia (specimens not examined by us).

Capture locations for 48 *C. gymnorhinus* collected at depths averaging 100 m or more occurred in a variety of areas including those off North Carolina and South Carolina, in the Straits of Florida, and at the Bahamas. Only five individuals (2.3% of the total) examined in the present study were collected at depths averaging deeper than 120 m, and except for single specimens of *C. gymnorhinus* taken at 130 m and 123–127 m off North Carolina and South Carolina, respectively, the other three specimens were taken at insular locations off the Bahamas (two between 166–193 and one at 201 m). In fact, of examined specimens taken at insular locations in this region (n=26), all but five were collected at or beyond 70 m, and usually much deeper (Appendix 2).

The depth range summarized in the present study is similar to that reported previously for this species. For example, Gutherz and Blackman (1970) noted captures of *C. gymnorhinus* in depths of 37–92 m, and one specimen (USNM 203602), their deepest, was collected from about 201 m off the Bahamas (27°23′N, 78°35′W) (this specimen also represents our deepest record). Topp and Hoff (1972) reported that off west Florida this species is found at moderate depths on the continental shelf; 23 of 35 of their specimens were found at their deepest station (73 m), and all of their specimens were found deeper than 55 m. Tucker (1982: Table 1) listed a depth range of 37–201 m for adult *C. gymnorhinus* based on data from Gutherz and Blackman (1970). Saavedra-Díaz et al. (2000) reported that this species is found between 20 and 40 m in Colombian waters and between 37 and 139 m elsewhere. In nearly all other recent studies where information has been compiled for this species (Robins and Ray, 1986; Cervigón, 1996; Munroe, 2003; McEachran and Fechhelm, 2005; Lyczkowski-Shultz and Bond, 2006; Fahay, 2007), *C. gymnorhinus* are reported to be found on the continental shelf to depths of 200 m but more commonly taken in the shallower portion of this depth range (usually between 30 and 90 m).

Size

The largest *C. gymnorhinus* measured in this study are males of 52.4 and 52.1 mm (Fig. 7A), which is close to the reported maximum size (about 55 mm SL) observed for the species. A total of 131 males ranged from 20.3 to 52.4 mm (Fig. 7A), whereas females (n=58) were 26.2–48.0 mm (Fig. 7B). Most males (122 of 131, 93%) were 30–50 mm, and only four were larger than 50 mm. For females, most (42 of 58, 74%) were 35–45 mm, and only one (48.0 mm) exceeded 45 mm.

The size ranges for *C. gymnorhinus* taken along the eastern United States and nearby regions are comparable to those reported for this species from other parts of its geographic range. For example, Gutherz and Blackman (1970), who reported that *C. gymnorhinus* is the smallest species of *Citharichthys,* stated that maximum size for specimens they examined did not exceed 60 mm SL, when actually the largest of 34 specimens measured in their study (male, 52.5 mm SL) was smaller than this stated maximum size. Ten males examined in their study ranged in size from 41.9 to 52.5 mm SL, whereas four females were 32.9–41.8 mm SL. The largest of 47 individuals examined by Topp and Hoff (1972) was a

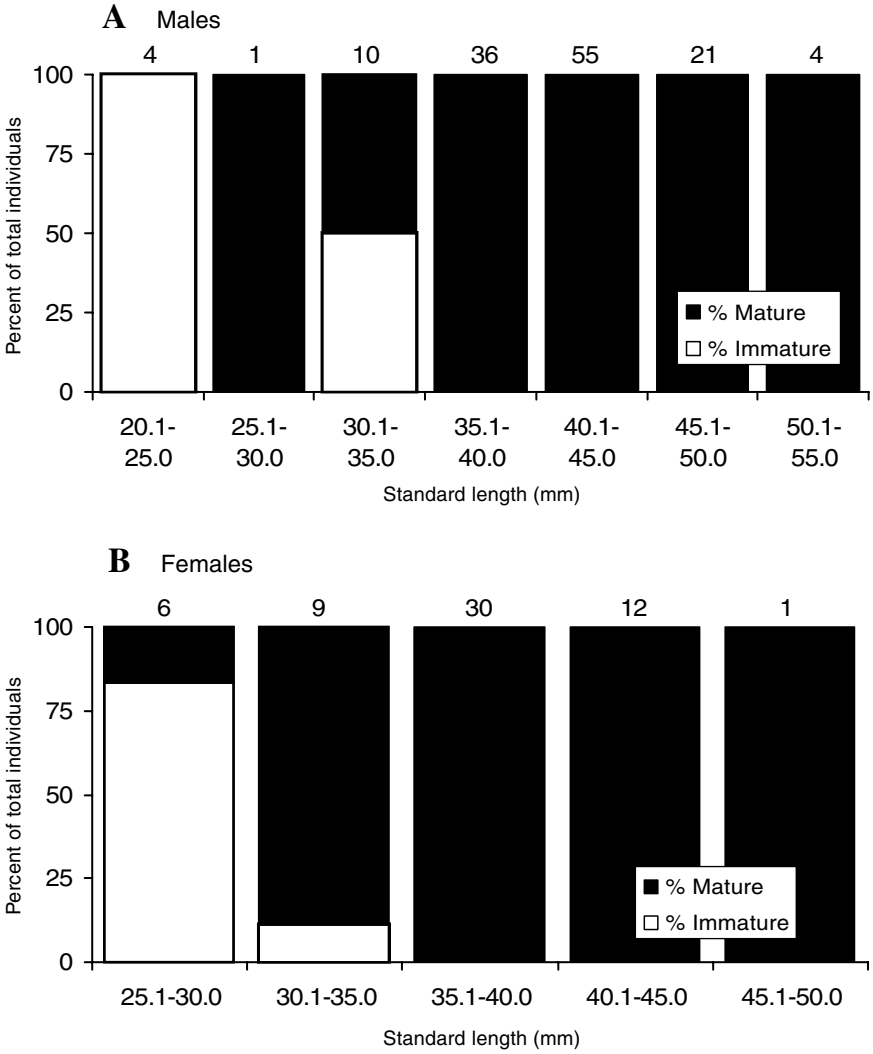

Figure 7

Size (standard length) and maturity information for 189 *Citharichthys gymnorhinus* captured off the east coast of the United States and nearby regions. (**A**) Males (n=131). (**B**) Females (n=58). Number above each column equals the number of individuals examined in that size range.

male of 53.7 mm SL, and they indicated a maximum size for *C. gymnorhinus* of less than 55 mm SL. Topp and Hoff (1972) did not provide a complete size breakdown for all specimens they examined but did give size ranges for these specimens. Males (n=25) ranged in size from 24.9 to 53.7 mm SL; females (n=6) were 36.1–47.0 mm SL. Cervigón (1996) reported that 55 mm SL was the maximum size observed for *C. gymnorhinus* taken off Venezuela. Fahay (2007) also considered *C. gymnorhinus* to be a dwarf species that seldom exceeds 55 mm SL in length.

Other literature reporting sizes for *C. gymnorhinus* larger than the maximum size observed in our study and the studies listed immediately above based their maximum sizes on an estimated value of 60 mm SL following that listed in Gutherz and Blackman (1970). These reports include those of Munroe (2003), McEachran and Fechhelm (2005), Robins and Ray (1986), and also FishBase (Froese and Pauly, 2010), which report a maximum size for *C. gymnorhinus* of 75 mm TL. This estimate of total length, corresponding to approximately 60 mm SL, is an overestimate of actual observations of maximum sizes recorded for the species from throughout its range.

Size at maturity

In other literature (where sizes of *C. gymnorhinus* are larger than the maximum size observed in our study and in the studies listed immediately above), maximum

length was estimated at 60 mm SL as listed in Gutherz and Blackman (1970). Of 131 males examined in the present study, all but nine are mature with obvious discernible dimorphic characters typical of sexually mature individuals (Fig. 2A; and discussed above). All four males ≤25.0 mm are immature. The only male (29.0 mm) in the next larger size class is the smallest mature male in the study (Fig. 7A). Between 30 and 35 mm, half (5 of 10) of the males examined are immature, whereas five others are mature and display external features characteristic of adult males. At 35.1 mm and larger, all males examined are mature. Of 58 female *C. gymnorhinus* examined, all but six (26.2, 26.5, 27.5, 27.6, 28.0, and 30.1 mm) are mature (Fig. 7B). The smallest mature female was 30 mm, and eight others smaller than 35 mm are also mature. At sizes ≥35.1 mm SL, all females are mature.

No published information on maturity schedules or size at maturity based on microscopic staging of gonads is available for *C. gymnorhinus*. Information on size at maturity for this species is based only on examination of external sexual dimorphisms for males and external examination of ovaries of females. For example, Gutherz and Blackman (1970) noted that the smallest mature male in their study was 42 mm SL. Small size at maturity compared to that of congeners was also noted for *C. gymnorhinus* in specimens taken in the eastern Gulf of Mexico off the west Florida shelf (Topp and Hoff, 1972). Among the six females examined by Topp and Hoff, ovaries of a 21.0-mm-SL female were maturing (observed macroscopically), whereas ovaries of a 30.2-mm-SL female were filled with ripe, spherical eggs. They also observed that males of the same size had sexually dimorphic features, indicating they were mature at sizes similar to those at which females reach maturity.

Abundance

Of 42 field collections containing *C. gymnorhinus* (Appendix 2), 16 comprised solitary specimens, 11 consisted of two or three specimens each, and 15 collections contained four or more specimens. The largest collections of *C. gymnorhinus* comprised 36 and 23 specimens taken in the Straits of Florida off Key West and off South Carolina, respectively. Other significant collections of this species are those containing 19, 16, and 15 specimens taken in single trawls in the Straits of Florida, off the eastern side of the Florida Peninsula, and South Carolina, respectively. Three other trawls made off North Carolina, South Carolina, and the British Virgin Islands contained eight, nine, and eight individuals, respectively.

From the collections we examined and those listed in previous studies that provide detailed information on *C. gymnorhinus* (Gutherz and Blackman, 1970; Topp and Hoff, 1972), we believe that this species apparently is not taken anywhere in its geographic range in such large numbers as is *C. cornutus* (see above). The largest collections reported in Gutherz and Blackman (1970) and Topp and Hoff (1972) contained only 10 and 11 individuals, respectively, for trawl catches made in the Straits of Florida and off Venezuela, but most of their collections of *C. gymnorhinus* contained only five or fewer specimens. Wenner et al. (1979b; 1979c) listed collections of 15 and 12 specimens taken off the east coast of Florida (28°50.3′N, 80°07′W and 29°50.3′N, 80°07′W, respectively).

General discussion

These data represent the most comprehensive assessments of biological, ecological, and distributional information for *C. cornutus* and *C. gymnorhinus*. Data on geographic occurrences, bathymetric distributions, maximum sizes, sizes at maturity, and depth of occurrence are provided for the majority of known specimens of both species that have been collected off the eastern United States. The combined information gleaned from a variety of mostly small collections of these species from this region, including data from specimens reported on in previously published studies and data associated with specimens vouchered in museum collections but for which no previously published information has been available, provides considerable insights into, and comprehensive documentation of, the occurrence, distribution, and natural history of these interesting flatfishes. This updated information, in turn, provides a baseline for evaluating any changes observed in their geographic and bathymetric distributions along the continental shelf off the eastern United States.

In prevailing literature since the late 1960s, the northern extent of the geographic ranges for adult *C. cornutus* and *C. gymnorhinus* has been misreported, resulting in a long history of inaccurate distribution data for these species. Both species are residents on the continental shelf off the southeastern United States off North Carolina and South Carolina, and their persistent presence in this region is documented from nearly a century (*C. gymnorhinus*) to more than a century ago (*C. cornutus*). Occurrences of *C. cornutus* north of North Carolina appear to be irregular, based on the absence of this species in many of the fish community studies conducted in this region (e.g., Grosslein and Azarovitz, 1982; Colvocoresses and Musick, 1984), and based on its generally low frequency of occurrence in the NMFS-NEFSC groundfish surveys conducted annually in this area (J. Galbraith, personal commun.[3]). Gear selectivity in most trawl surveys influences the frequency of occurrence of small-size species in their catches, and many small-size flatfishes, including *C. cornutus* and *C. gymnorhinus*, have often escaped capture or have been misidentified or overlooked in earlier surveys. These factors also likely contributed to the infrequency of reports on these species.

[3] Galbraith, John. 2009. Woods Hole Laboratory, Northeast Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, 166 Water Street, Woods Hole, MA 02543.

Recent captures of these species—*C. cornutus* from off Hudson Canyon (Fahay, 2007) and the shelf off New York (Steves et al., 1999) and *C. gymnorhinus* from off North Carolina (Quattrini and Ross, 2006; this study) in areas north of their perceived adult geographic ranges—could have been misinterpreted as evidence for expanding geographic distributions (i.e., poleward range extensions) in response to global warming because some marine fishes respond to oceanic warming with shifts in their latitudinal range (for further discussion on this topic in relation to marine fishes see Perry et al., 2005; Nye et al., 2009). However, adult specimens captured nearly a century or more ago, as well as historical literature documenting occurrences of both adults and larvae of these species in these northern locations, prove that these species were present in these areas historically. Similarly, purported new records of reef fishes off North Carolina were probably mistakenly attributed to ocean warming (Parker and Dixon, 1998), when in fact many of those species were already known from the area (see comments in Quattrini and Ross, 2006). These examples clearly indicate a need for more careful research and the need for examination of historical data (published and unpublished) before invoking climate-change hypotheses to explain observed distributional patterns of marine organisms, especially for species that are less well known. Available data indicate only sporadic and infrequent occurrence of adult *C. cornutus* on the continental shelf north of North Carolina, and no records exist of adult *C. gymnorhinus* from north of North Carolina. Changes in the distributions of these diminutive flatfishes on the northwest Atlantic shelf in response to climatic factors may be signaled by northward extension in their geographic ranges, by increases in frequency of capture and prevalence within northern portions of their ranges, or by increases in their biomass in deeper areas within their ranges, as has been observed for other North Atlantic fish species (Dulvy et al., 2008; Nye et al., 2009). The updated baseline information contained herein on the frequencies of occurrences, relative abundances, and detailed examination of bathymetric and geographic ranges of both flatfish species provides the basis for comparison with future evaluations of the responses of these species to changes occurring on the continental shelf of the western North Atlantic Ocean.

Several factors likely contributed to inaccuracies in geographic distributions for these species appearing in recently published literature. Given that these flatfishes are not usually taken in abundance, nor are they commercially important, significant captures could be overlooked in studies of fish communities or commercial fisheries. Important distributional information for both species also have escaped notice because incidental captures of these diminutive flatfishes were often buried in tables or appendices and the significance of these records was not emphasized in the works documenting these captures. Confusion in identifying these species also occurs (e.g., Goode and Bean, 1895; Hildebrand, 1941) and misidentifications in the literature and in museum collections and databases have contributed to oversights of important specimens. Furthermore, studies in which the ecology or distribution of these species was summarized (Gutherz, 1967; Robins and Ray, 1986; Munroe, 2003; McEachran and Fechhelm, 2005; Lyczkowski-Shultz and Bond, 2006; and others) did not contain earlier published records. Unfortunately, the incomplete, and sometimes inaccurate, information contained in these synthetic studies has subsequently been perpetuated in other publications. As biology and ecology disciplines increase the use and reliance on web-based and web-available references, historically important, but less available, less popular, or more obscure literature will be increasingly overlooked. We caution that sole reliance on popular citation sources for historical information, in many cases, is a poor substitute for first-hand examination of all of the pertinent original literature related to a subject. Additionally, regardless of what popularly cited literature sources report, or even what museum databases indicate on their websites, these are no substitutes for actually examining specimens and analyzing collection data associated with them. In our study, nine different references noted the occurrence of *C. cornutus* on the continental shelf south of Rhode Island or off New Jersey and New York, yet all of these publications were disregarded in all but one contemporary literature source for this species.

Moreover, museum specimens represent important archived sources of geographic and bathymetric information. Museum lots of both *C. cornutus* and *C. gymnorhinus* collected over 100 and 92 years ago, respectively, voucher occurrences of adults of these species from the northernmost regions of their geographic ranges. These specimens, too, were overlooked by the same popularly cited studies mentioned above.

Accurate records of geographic occurrence and bathymetric distribution for species such as these two diminutive flatfishes are necessary and important because they provide the background information required to evaluate future changes in their distributions or occurrences in relation to large-scale changes in oceanic conditions on the continental shelf of the western North Atlantic. Changes in distributions of organisms are relevant for assessments of effects of climate change, and more information is needed on the regional dynamics of populations over time to better understand effects of various environmental conditions on their survival and persistence within an area (Nye et al., 2009; Tolan and Fisher, 2009; Wood et al., 2009). Changes in the spatiotemporal occurrences of small-size, noncommercial species often are overlooked or disregarded (Link, 2007). But changes in geographic and bathymetric distributions and relative abundances for such species may provide additional evidence of larger-scale environmental changes impacting biological communities that inhabit the continental shelf off the eastern United States and elsewhere. Without proper understanding of historical data describing distributional patterns, it will be impossible to accurately document any changes that

may occur, or be occurring, in the geographic or ecological distributions of such species that inhabit particular geographic regions.

While assembling this information, we updated identifications of museum specimens, located important specimens in a variety of fish collections, and corrected and updated incomplete geographic records for some museum specimens. For both *C. cornutus* and *C. gymnorhinus*, much still remains to be learned about their biology and distributions, especially for a population, or populations, on the continental shelf off the southeastern United States. Age and growth, reproduction, habitat preferences, and trophodynamics remain virtually unknown for these diminutive species. Sadly, this situation is also true for most of the small fishes or those that are not economically important, and as management agencies move toward ecosystem-based, rather than single-species management approaches, data on the whole community becomes even more critical. We urge agencies and academic communities to expand the scope of fishery studies to address this need.

Additional material not included in appendices 1–2

C. gymnorhinus. Larvae: ARC 24522, 32°58′37″N, 77°51′53″W; ARC 24538, 33°24′07″N, 76°42′33″W; MCZ 77935, 41°33′N, 54°55′W.

C. cornutus. Adults. AMNH 86095, n=103; AMNH 86160, n=43; AMNH 86101, n=100; AMNH 84815, n=63; AMNH 84857, n=47; AMNH 85590, n=172; AMNH 85529, n=321.

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Appendix 1

List of specimens, collection data, life history information, and associated ecological data for *Citharichthys cornutus* from the continental shelf off the eastern United States and nearby areas of the eastern Caribbean Sea. SL=standard length, *=not examined; **depth estimated from nautical chart; NA=not available N=number of specimens.

Catalogue number	Field number	N	Size range (mm SL)	Males (mature)	Females (mature)	Depth (m)	Latitude (N)	Longitude (W)	Location	Collection date
Uncatalogued	HB 2009-01 Sta. 162	1	72.0	1 (1)	0	132	40°05.593′	70°42.75′	NJ	23 Mar 2009
Uncatalogued	Alb 2006-02 Sta. 107	1	81.3	0	1 (1)	129	40°04.428′	70°40.428′	NJ	25 Feb 2006
Uncatalogued*	FH Sta. 871	1(?)	NA	NA	NA	212	40°02′54”	70°23′40”	NJ	4 Sep 1880
USNM 26003	FH Sta. 870	3	48.4–55.6	3 (3)	0	285	40°02′36”	70°22′58”	NJ	4 Sep 1880
Uncatalogued	HB 2009-05 Sta. 58	2	47.5–49.4	2 (1)	0	113	35°17.872′	70°42.75′		18 Sep 2009
VIMS 2539	Eastward E1-73	2	56.5–64.0	1 (1)	1 (1)	108	34°56.2′	75°23.0′	NC	18 Apr 1971
Uncatalogued	Alb 2007-03 Sta. 48	1	41	1 (1)	0	151–171	34°54′	75°43.4′	NC	12 Mar 2007
Uncatalogued	Alb 2008-01 Sta. 110	3	51.8–53.9	2 (2)	1 (1)	142	34°42.433′	75°35.974′	NC	23 Mar 2008
VIMS 1131	NA	2	51.9–59.6	1 (1)	1 (1)	230	34°36.06′	75°40.6′	NC	18 Apr 1971
Uncatalogued	HB 2009-05 Sta. 54	12	52.5–64.2	9 (8)	3 (3)	107	34°31.096′	75°48.917′	NC	18 Sep 2009
VIMS 11786	Alb 84-02 Sta. 29	1	37	1 (0)	0	158–165	34°19′	75°56′	NC	4 Mar 1984
NCSM 47664	DE-04-008	314	20.0–68.0	177 (164)	137 (121)	123–127	33°25.389′	77°02.234′	SC	18 Apr 2004
AMNH 76925	GMBL 78-135	24	22.0–68.4	NA	NA	117	33°22.5′	77°48.5′	SC	10 Sep 1978
NCSM 47663	SJ 03-007	3	36.5–51.9	3 (3)	0	140	33°20.354′	77°17.025′	SC	18 Aug 2003
USNM 45676	ALB 2417	1	54.7	0	1(1)	174	33°18′30”	77°07′	SC	2 Apr 1885
Uncatalogued*	MARMAP 75206	3	51.6–77.4	NA	NA	159	33°18′	77°08.5′	SC	1975
GMBL 2955	GMBL 73-324	3	64.7–67.0	2 (2)	0	157	33°04.5′	77°40′	SC	15 Nov 1973
Uncatalogued*	MARMAP 73432	4	60.2–68.8	NA	NA	155	33°04′	77°41′	SC	1973
Uncatalogued*	MARMAP 75092	30	17.2–70.2	NA	NA	115	33°03.7′	77°45′	SC	1974
USNM 151887	ALB III 21	1	71.2	1 (1)	0	179	33°03′30”	77°37′	SC	27 May 1949
GMBL 2957	GMBL 73-326	8	31.4–49.0	8 (6)	0	110	33°02.8′	77°53′	SC	16 Nov 1973
Uncatalogued*	MARMAP 75091	7	17.2–60.2	NA	NA	102	33°02.5′	77°53.7′	SC	1974
AMNH 220899*	AT-72-01 Sta. 160	2	NA	NA	NA	147**	32°59′	77°50′	SC	3 Dec 1972
GMBL 02958	GMBL 76-253	2	29.3–43.6	1 (2)	0	137	32°58′	77°52.3′	SC	3 Sep 1976
Uncatalogued*	MARMAP 75198	26	43.0–68.8	NA	NA	139	32°55′	77°57′	SC	1975
MCZ 59549	DE II 81-02 Sta. 56	1	79.1	1 (1)	0	193	32°54′	77° 51′	SC	25 Mar 1981
Uncatalogued*	MARMAP 75195	5	25.8–43.0	NA	NA	81	32°42.5′	78°26.5′	SC	1975
Uncatalogued*	MARMAP 75196	12	60.2–77.4	NA	NA	172	32°40′	78°21.5′	SC	1975
Uncatalogued*	MARMAP 75192	15	25.8–51.6	NA	NA	71	32°30.5′	78°45.3′	SC	1975
GMBL 2956*	GMBL 73-300	1	32	NA	NA	74–77	32°21′	78°58′	SC	9 Nov 1973

continued

Appendix 1 (continued)

Catalogue number	Field number	N	Size range (mm SL)	Males (mature)	Females (mature)	Depth (m)	Latitude (N)	Longitude (W)	Location	Collection date
AMNH 76428*	GMBL 73-298	1	37	NA	NA	86	32°13′	79°06′	SC	9 Nov 1973
USNM 156468	Pelican 182-6	1	60	1 (1)	0	110	32°06′	79°14′	SC	4 Feb 1940
Uncatalogued*	MARMAP 73434	12	25.8–51.6	NA	NA	110	32°02.5′	77°53′	SC	1973
Uncatalogued*	MARMAP 75115	6	60.2–68.8	NA	NA	95	31°44.5′	79°30′	GA	1974
Uncatalogued*	MARMAP 75111	1	43	NA	NA	68	30°54.5′	80°00′	GA	1974
Uncatalogued*	MARMAP 75110	1	60.2	NA	NA	137	30°48′	80°01′	GA	1974
FMNH 74497	SB 3442	2	68.0–70.5	2 (2)	0	155	29°40′	80°12′	central FL	24 Sep 1961
Uncatalogued*	MARMAP 73375	1	68.8	NA	NA	86	29°29.5′	80°15′	FL, Atlantic	1973
AMNH 76357*	GMBL 73-268	3	51.5–52.0	NA	NA	98–110	29°26′	80°12.3′	FL	30 Oct 1973
Uncatalogued*	MARMAP 73376	3	43.0–51.6	NA	NA	110	29°25.6′	80°12′	FL	26 May 1905
FMNH 74493	SB 2476	1	55.0	1 (1)	0	183	25°22′30″	79°14′30″	Northern Bahamas	8 Nov 1960
FMNH 74490	SB 2390	1	63.1	1 (1)	0	91	24°42′30″	80°44′	FL Keys	26 Oct 1960
FMNH 74492	SB 2470	4	51.8–64.6	2 (2)	2 (0)	229	24°25′	79°13′	Straits FL, off Keys	7 Nov 1960
UF 132882*	SB 2445	2	NA	NA	NA	254	24°08′	80°08′	Straits FL, near Bahamas	3 Nov 1960
USNM 282787	SB 2447	7	45.7–61.3	3 (1)	4 (4)	165–229	24°00′	80°25′	Straits FL	3 Nov 1960
USNM 117039	Longley coll.	1	61.5	1(1)	0	250–287	NA	NA	FL, Dry Tortugas	26 Jun 1932
USNM 117094	Longley coll.	16	50.2–65.3	13 (13)	2 (2)	NA	NA	NA	FL, Dry Tortugas	NA
USNM 282789	SB 2464	24	48.7–76.5	15 (6)	9 (8)	274	23°34′	79°05′	Bahamas	6 Nov 1960
Uncatalogued*		1	61.8	NA	NA	250	23°15′04″	81°10′08″	Cuba	19 Jun 1965
USNM 214325	OR II 10861	1	76.5	1 (1)	0	276	23°12′	78°49′	Bahamas	15 Dec 1969
GMBL 3001	GMBL 61-030;SB 3510	3	57.5–73.5	0	2 (2)	276	22°55′	78°36′	Bahamas	1961
USNM 282786; FMNH 74389	OR 2684; OR 2654	7	64.8–72.5	3 (3)	4 (4)	229	18°26′	67°11′	Puerto Rico	6 Oct 1959
USNM 126172	FH 6063	1	45.8	1 (0)	0	140	18°12′22″	67°08′20″	Puerto Rico	20 Jan 1899
USNM 282783	OR 6700	1	70.4	1 (1)	0	249–285	17°27′	62°04′	Caribbean, Antigua	19 May 1967
UF 142601	OR 5067	1	79.3	0	1 (1)	258–267	17°04′	62°39′	Caribbean, St. Kitts	30 Jul 1964
UF 142602	OR 5068	1	78.5	0	1 (1)	258–268	17°04′	62°39′	Caribbean, St. Kitts	31 Jul 1964

Appendix 2

List of specimens, collection data, life history information, and associated ecological data for *Citharichthys gymnorhinus* from the continental shelf off the eastern United States and nearby areas of the eastern Caribbean Sea. SL=standard length; NA=not available; *=not examined. N=number of species.

Catalogue number	Field number	N	Size range (mm SL)	Males (mature)	Females (mature)	Depth (m)	Latitude (N)	Longitude (W)	Location	Collection date
Uncatalogued	HB 2009-05 Sta. 47	1	44.3	1 (1)	0	74	35°05.51′	75°17.24′	NC	17 Sep 2009
Uncatalogued	ALB 1997-06 Sta. 50	6	35.0–46.0	6 (6)	0	59–76	34°39′	75°43′	NC	13 Sep 1997
Uncatalogued	ALB 2008-03 Sta. 109	1	Damaged	NA	NA	130	34°37.26′	75°40′59”	NC	23 Mar 2008
Uncatalogued	HB 2009-01 Sta. 45	8	40.5–48.5	5 (5)	3 (3)	72	34°31.99′	75°51.67′	NC	8 Mar 2009
USNM 111520	FH D8249	1	45.4	1 (1)	0	92	34°12	76°04′56”	NC	13 Sep 1914
NCSM 47657	DEII-04-008	1	49.5	1 (1)	0	123–127	33°25.389′	77°02.234′	SC	18 Apr 2004
NCSM 47661	SJ 2002-056	4	33.9–46.5	4 (3)	0	93–140	33°13.324′	77°16.568′	SC	25 Sep 2001
NCSM 47659	SJ 2001-058	9	36.8–46.9	4 (4)	5 (5)	90–133	33°13.240′	77°17.025′	SC	25 Sep 2001
NCSM 47660	SJ 2001-069	1	45.2	1 (1)	0	101–112	33°12.997′	77°16.649′	SC	26 Sep 2001
NCSM 47658	SJ 2001-068	3	32.4–44.6	3 (3)	0	106–113	33°12.507′	77°17.446′	SC	26 Sep 2001
NCSM 47662	SJ 2001-070	23	26.2–44.3	12 (9)	11 (8)	98–102	33°12.411′	77°18.136′	SC	26 Sep 2001
GMBL 4880	GMBL 78-136	16	20.4–44.2	10 (9)	6 (5)	77	33°05.8′	77°48.2′	SC	10 Sep 1978
GMBL 2960	GMBL 73-326	3	24.0–37.6	3 (2)	0	110	33°02.5	77°53′	SC	16 Nov 1973
AMNH 76430; Uncat. 73406*	GMBL 73-298	2	37.2–38.0	NA	NA	86	32°13′	79°06′	SC	9 Nov 1973
USNM 315696	SCMRRI 63800766	1	44.5	1 (1)	0	66	31°31′48″	79°44′24″	GA	12 Sep 1980
Uncatalogued*	NA	5	6.4–24.0	NA	NA	35–48	31°16′	80°01′	GA	28 Jun 2005
Uncatalogued*	MARMAP 74074	1	NA	NA	NA	71	29°09′	80°08.6′	FL	1974
Uncatalogued*	MARMAP 75252	15	NA	NA	NA	70	28°50.3′	80°07′	FL	1975
USNM 203602	SB 3469	1	39.3	0	1 (1)	201	27°23′	78°35′	Bahamas	25 Oct 1961
UF 215588	Gerda 282	1	35.2	0	1 (1)	70–88	25°43′	80°05′	FL Straits	1 Apr 1964
UF 220768	Gerda 752	2	39.2–42.2	0	2 (2)	87–96	25°14′	80°09′	FL Straits	14 Sep 1965
USNM 45610; USNM 45677; USNM 143120	ALB 2318	36	30.1–44.5	28 (26)	8 (7)	83	24°25′45″	81°46′	FL Straits, S. Key West	15 Jan 1885
USNM 129946	ALB 2316	2	41.9–44.7	2 (2)	0	92	24°25′30″	81°47′45″	FL Straits	15 Jan 1885
UF 111098	FFS 99-20	2	39.8–41.0	2 (2)	0	55	24°25′23.5″	82°52′53″	FL Straits	8 May 1999
UF 98623	GHB 92-20	7	43.4–47.1	7 (7)	0	67–71	24°25′05”	82°16′21″	FL Straits	26 Sep 1992
UF 230503; UF 217400	Gerda 566	19	29.0–52.4	9 (9)	10 (10)	64	24°25′	82°55′	FL Straits	12 Apr 1965
UF 36455	JTW 680-10	4	24.2–45.1	3 (2)	1 (1)	64	24°24.34′	81°58.26′	FL Straits	4 Jun 1980
USNM 158279	OR 1004	2	46.5–48.7	2 (2)	0	68	24°24′	82°55′	FL Straits	13 Apr 1954

continued

Appendix 2 (continued)

Catalogue number	Field number	N	Size range (mm SL)	Males (mature)	Females (mature)	Depth (m)	Latitude (N)	Longitude (W)	Location	Collection date
UF 32429	GHB 81-7	1	33.9	1 (1)	0	101–107	24°23′22″	81°55.54′	FL Straits	31 May 1981
UF 116711	GHB 00-04	1	51.6	1 (1)	0	61–62	24°22′47″	82°45′30.3″	FL Straits	10 May 2000
UF 109237	GHB 98-13	1	48.0	0	1 (1)	79–88	24°21′50″	82°36′55″	FL Straits	7 May 1998
UF 217664	Gerda 575	1	39.2	1 (1)	0	64	24°21′	82°34′	FL Straits	13 Apr 1965
UF 219281; UF 217403	Gerda 574	7	20.3–43.7	3 (2)	4 (3)	59	24°21′	82°35′	FL Straits	13 Apr 1965
ex. USNM 117039	Longley Coll.	1	44.5	1 (1)	0	NA	NA	NA	S. Tortugas, FL	26 Jun 1932
UF 19295	SB 2455	2	44.4–45.0	2 (2)	0	166–193	23°34′30″	79°03′	Bahamas	5 Nov 1960
USNM 203603	SB 5165	1	32.7	0	1 (1)	91	19°48′	70°35′	Dominican Republic	15 Oct 1963
FMNH 74443	OR 2616	8	31.7–38.6	7 (7)	1 (1)	75	18°50′30″	64°38′	N. Br. Virgin Islands	27 Sep 1959
FMNH 74442	OR 2615	5	35.7–39.7	4 (4)	1 (1)	73	18°50′30″	64°37′	N. Br. Virgin Islands	27 Sep 1959
FSBC 1559*	OR 2622	2	36.7–39.8	1 (2)	1 (2)	44	18°45′	64°40′	N. of Virgin Islands	28 Sep 1959
FMNH 74387	OR 2624	3	36.4–42.9	2 (1)	1 (1)	69	18°45′	64°47′	N. Br. Virgin Islands	28 Sep 1959
UF 207071	OR 2668	1	43.9	1 (1)	0	70	18°31′	66°47′	Puerto Rico	8 Oct 1959
FMNH 74386	OR 2632	3	48.5–52.1	3 (3)	0	91	17°34′	63°30′	S. Br. Virgin Islands	30 Sep 1959