

Fishes of Bermuda

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Abstract

Here we add a recently described species of *Hyporhamphus* (Hemiramphidae), recognize *Chromis bermudae* (Pomacentridae) as valid, and remove *Parasphyraenops atrimanus* (Serranidae) from the list of Bermuda endemics, changing the total number of Bermuda endemic fishes to seven species, eight if *Clepticus* sp. (Labridae) proves to be new, excluding from consideration several land-locked species of *Fundulus*. First Bermuda records are documented for 24 species but five others, *Carcharodon carcharias*, *Hyporhamphus unifasciatus*, *Rypticus subbifrenatus*, *Clepticus parrae* and *Eleotris pisonis*, based on misidentifications, are removed. Biological or distributional notes are included for 22 species and nomenclatural changes apply to another 12 species. Reproductions of recently discovered historical watercolors or pencil sketches by Colonel H. W. Drummond-Hay are provided for 14 species of Bermuda fishes.

Zusammenfassung

Wir fügen hier eine kürzlich beschriebene Art der Gattung *Hyporhamphus* (Hemiramphidae) hinzu, anerkennen *Chromis bermudae* (Pomacentridae) als gültig und entfernen *Parasphyraenops atrimanus* (Serranidae) aus der Liste der endemischen Arten Bermudas. Damit ändert sich die Zahl der endemischen Fische Bermudas zu sieben Arten oder acht, falls *Clepticus* sp. (Labridae) als neu anerkannt werden kann; einige ans Land gebundene *Fundulus*-Arten bleiben dabei außer Betracht. Erstnachweise für die Bermuda werden von 24 Arten dokumentiert, während fünf Arten wieder gestrichen werden, da ihre angeblichen Nachweise auf Fehlbestimmung beruhten, nämlich: *Carcharodon carcharias*, *Hyporhamphus unifasciatus*, *Rypticus subbifrenatus*, *Clepticus parrae* und *Eleotris pisonis*. Für 22 Arten werden Anmerkungen über Biologie und Verbreitung angefügt, zu weiteren 12 Arten sind Änderungen der Nomenklatur vermerkt. Außerdem werden kürzlich wiederentdeckte historische Aquarell- oder Bleistiftskizzen von Colonel H. W. Drummond-Hay zu 14 Bermuda-Fischarten wiedergegeben.

Résumé

Ici, nous ajoutons une espèce récemment décrite d'*Hyporhamphus* (Hemiramphidae), reconnaissons la validité de *Chromis bermudae* (Pomacentridae) et ôtons *Parasphyraenops atrimanus* (Serranidae) de la liste des endémiques des Bermudes, en portant le nombre total de poissons endémiques des Bermudes à sept espèces, huit si *Clepticus* sp. (Labridae) s'avère une espèce nouvelle, en ne tenant pas compte des espèces de *Fundulus* peuplant les terres. Les premiers relevés des Bermudes signalent 24 espèces, mais cinq autres, *Carcharodon carcharias*, *Hyporhamphus unifasciatus*, *Rypticus subbifrenatus*, *Clepticus parrae* et *Eleotris pisonis* sont écartées suite à des identifications erronées. Des notes sur la biologie et la distribution sont incluses pour 22 espèces et les modifications de nomenclature appliquées à 12 autres espèces. Des reproductions d'aquarelles historiques ou d'esquisses au crayon, récemment découvertes, du Colonel H. W. Drummond-Hay sont présentées et concernent 14 espèces de poissons des Bermudes.

Sommario

In questo articolo con l'aggiunta di una specie recentemente descritta di *Hyporhamphus* (Hemiramphidae), il riconoscimento di *Chromis bermudae* (Pomacentridae) come valida e la rimozione di *Parasphyraenops atrimanus* (Serranidae) dalla lista delle specie endemiche delle Bermuda, il numero totale di queste specie, escludendo dal conteggio quelle d'acqua dolce di *Fundulus*, viene portato a sette, eventualmente otto se *Clepticus* sp. (Labridae) si rivelerà come una nuova specie. È documentata per la prima volta la presenza di 24 specie, ma altre cinque, *Carcharodon carcharias*, *Hyporhamphus unifasciatus*, *Rypticus subbifrenatus*, *Clepticus parrae* e *Eleotris pisonis*, sulla base di errori di identificazione, vengono rimosse. Per 22 specie sono incluse note biologiche o di distribuzione, mentre cambiamenti della nomenclatura sono applicate ad altre 12 specie. Infine, sono presentate riproduzioni di schizzi a matita e acquerelli storici, recentemente ritrovati, di 14 specie di pesci delle Bermuda eseguiti dal colonnello H. W. Drummond-Hay.

INTRODUCTION

The purposes of this paper are to update our Fishes of Bermuda (Smith-Vaniz et al. 1999), to revalidate *Chromis bermudae* and to publish additional illustrations made by Col. Drummond-Hay recently discovered in an on-going inventory of ichthyological illustrations under way at the Smithsonian Institution by Lisa Palmer.

Unfortunately, a number of recent authors have failed to check distributions of some fishes against our book where we add new records, validate many previous records, and give reasons for not accepting some historical records of fishes from Bermuda. In a review of the recent FAO guide to western central Atlantic living marine resources (Carpenter 2003), Gilbert (2005) provided lists of species whose distributions differed from those given in our book and the FAO guide. He listed 32 species we verified as occurring in Bermuda that were not included on the FAO distribution maps. Another 19 species that we documented from Bermuda were not included in the FAO accounts. Four species undocumented from Bermuda and not shown on the FAO distribution maps were listed as occurring in Bermuda in the FAO accounts and three others with unverified Bermuda occurrences were indicated as present there on the FAO distribution maps. Five additional species were listed as occurring in Bermuda in the FAO accounts but are not considered to be present there.

METHODS AND MATERIALS

We present comments, corrections, and additions following the order used in our book. Addition of the Lampridae is given in phylogenetic order following Nelson (2006). Scientific names of taxa, authors and dates of original description follow recent on-line versions of the Catalog of Fishes (Eschmeyer 2013). Specimen lengths are given in mm as standard length (SL), fork length (FL) or total length (TL). Institution collection abbreviations are as follows: Academy of Natural Sciences, Philadelphia (ANSP); Bermuda Aquarium, Natural History Museum and Zoo (BAMZ); Museum of Comparative Zoology, Harvard University (MCZ); University of Michigan Museum of Zoology, Ann Arbor (UMMZ); National Museum of Natural History, Washington, D.C. (USNM); Humboldt-Universität, Museum für Naturkunde, Zoologisches Museum, Ichthyologie, Berlin (ZMB); and Zoological Museum, University of Copenhagen (ZMUC).

Newly discovered Drummond-Hay paintings:

Colonel Henry M. Drummond-Hay's unpublished notes and watercolors of Bermuda fishes (1847-51) have great scientific value as the first attempt to accurately document the fishes of Bermuda. Our book included the first color reproductions of Drummond-Hay paintings (Plates 1-9, depicting 41 species) and we documented (Table II) the existence of 76 of his whole-fish illustrations (excluding duplicates) of 70 species, housed at either the Smithsonian Institution or the Bermuda Government Archives. As we discussed in our original biographical notes (modified excerpts reproduced below with permission, courtesy of the American Society of Ichthyologists and Herpetologists), Drummond-Hay made a duplicate set of his 100 watercolors of Bermuda fishes but no list of these paintings has been located. Among the missing watercolors, is one of a beautiful 52.5 lb grouper (local name "Guinea chick hamlet") caught on the outer reef in 1851. G. Brown Goode and Tarleton H. Bean (both of whom independently visited the islands and made major contributions to Bermuda ichthyology) had an opportunity to examine that particular painting and were so impressed by it that they subsequently (Goode and Bean 1878) named the species *Epinephelus drummondhayi*. Unfortunately, this grouper is now listed as Critically Endangered throughout its range (Sadovy de Mitcheson et al. 2013). Although this painting has not been located, we here document the recent discovery of additional original watercolors (Figs 3-15) and two pencil sketches (Figs 4 and 16), now accounting for a total of 84 species of Bermuda fishes. As an example of the scientific value of these watercolors and sketches, see following accounts of *Haemulon macrostomum* under Haemulidae and *Masturus lanceolatus* under Molidae.

Henry Maurice Drummond-Hay (1814-1896): Colonel Drummond-Hay (Figs 1-2), son of Sir Adam Drummond, K. C. H., Admiral, R. N., and Lady Charlotte Murray, was born at Bath, England; family seat at Megginch Castle, Perthshire, Scotland. When he married Charlotte Elizabeth, only daughter of James Hay of Segginch, in October 1859, he changed his name to Drummond-Hay. He was educated by private tutor at Megginch and then boarded at Finchley Manor outside London but received no university instruction. In 1832 he also studied taxidermy for six months under Henry Linder, curator of the Museum at Geneva, and a leading authority on the ornithol-

ogy of Switzerland and the Alps. He joined the 42nd Royal Highlanders (the Black Watch) after the successful purchase of an ensigncy by his father in 1832. During his 20-year military career, Drummond-Hay was promoted to Lieutenant in 1837 and to Captain in 1842; he retired from active service in June 1852 and became a Lieutenant Colonel (1855-1870) of the volunteer Royal Perthshire Rifles, Scotland; he commanded the regiment during the Crimean war, retiring as a full colonel in 1872. His army postings included: Corfu in 1835; Glasgow and Dumbarton 1837-8; Ireland 1838-9; Corfu 1841-3; Malta 1843-7; Bermuda 1847-51; and Halifax, Nova Scotia 1851-2.

He was Commodore of the Royal Bermuda Yacht Club from 1849-1851. In addition to his artistic abilities, he was a keen naturalist and combined his enthusiasm for fishing and hunting with describing natural history. Drummond-Hay reportedly continued his drawings and notes on Bermuda fishes in Halifax, his next duty station after Bermuda. These appear to have been made in preparation for publication and were said to have filled two large manuscript volumes. Copies of original single page

species accounts that pertain to some of the Bermuda Archives' watercolor holdings are available, but the status of most of the Drummond-Hay ichthyological manuscript is unknown. Among his little known accomplishments is apparently having first pioneered the sport of fishing for needlefish with a fly rod. In his unpublished hand-written notes on *Tylosurus acus*, apparently intended to accompany his beautiful watercolor of the head of this large needlefish (our original Plate 2-27), he wrote:

"This large species of Garfish is very aptly named the Hound fish by the Bermudians, as they may incessantly be seen like a pack of hounds in chase of large schools of fry, which in their hurry and alarm jump out of the water skipping and scudding before their pursuers in a rolling mass over the smooth surface. Taking advantage of the Hound-fishes predatory habits, I used often to fish for them in the cut between Harrington Sound and the flats with a good strong salmon rod and tackle ...using a white fly sunk with a no. 1 shot a little below the surface, casting and working the fly much the same way as salmon fishing. This they took readily, affording splendid sport, especially if



Fig. 1. Henry Maurice Drummond-Hay (1814-1896), about 1838. Courtesy of Perth Museum & Gallery, Perth & Kinross Council, Scotland.

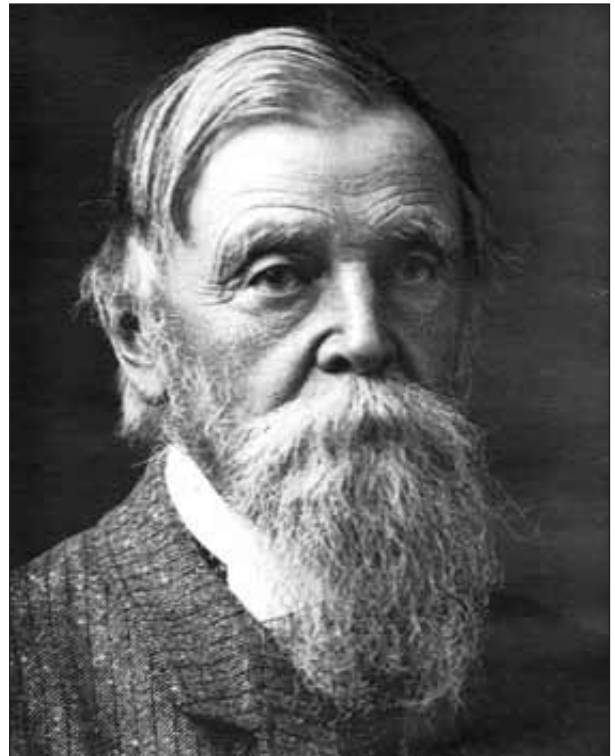


Fig. 2. Henry Maurice Drummond-Hay (1814-1896), about 1890. Courtesy of Perth Museum & Gallery, Perth & Kinross Council, Scotland.

a large one, which would run and dance out of the water like a clean run grilse reminding one of fishing on some rapid running salmon river in Scotland. I am told that following my example (the first who tried it) that rodfishing for them has since become quite a pastime for the officers of the garrison”.

Primarily interested in ornithology, Drummond-Hay also compiled notes on his observations of the Mediterranean avifauna, which were published in the *Annals & Magazine of Natural History* in 1843. A subsequent publication appeared following a month-long surveying trip to Tunis aboard “H.M.S. Beacon” in 1845. On his return to Europe in December 1852, Drummond-Hay observed a Great Auk on the edge of the Newfoundland banks at close range with his field glasses, and he was fond of relating that he believed he was the last person to have seen a living example of that great bird. Upon retirement from the army, he became the first president of the British Ornithological journal *The Ibis*. Drummond-Hay was also an active member of the Perthshire Society of Natural Science for 25 years, serving as its president for two terms, 1882-1884, and thereafter as Honorary Curator of the Society’s museum. For the last twenty years of his life his interests were focused on the natural history of Perthshire, and his contributions during that time were mostly published in the Society’s *Proceedings* or in the *Annals of the Scottish Naturalist*.

Notes on Bermuda fishes

Lamnidae

Carcharodon carcharias (Linnaeus 1758), White Shark. We reported the presence of the White Shark in Bermuda based on identification of a photograph (our Fig. 92) but admitted the possibility that it might have been a Shortfin Mako. Castro (2011:259), who we did not know was on the boat when the photograph was taken, identified a shark caught later that day a mile or so from where the photograph was taken as an unusually large Shortfin Mako; accordingly, there are no verified records of White Shark from Bermuda.

Isurus oxyrinchus Rafinesque 1810, Shortfin Mako. We reported several records of the Shortfin Mako from Bermuda and now correct the previous record of a White Shark as another Shortfin Mako record.

Dasyatidae

Dasyatis centroura (Mitchill 1815), Roughtail Stingray. A female Roughtail Stingray was found by Christopher Brown and Gunar Mayer at the

Hangover Hole dive site, 32°14'52.54"N, 64°48'58.40"W on April 22, 2013. They estimated that it was about 8-9 ft long from snout to tail tip with a wingspan of about 5-7 ft. We include one of several photographs (Fig. 17) taken by Gunar Mayer. Identification was confirmed by John McEachran. This is the first Bermuda record of this stingray which is found from Cape Cod to Argentina and also in the eastern Atlantic (McEachran & de Carvalho 2003).

Elopidae

Elops smithi McBride, Rocha, Ruiz-Carus, and Bowen 2010, Southern Ladyfish. Based on examination of a large number of leptocephalus larvae, Smith (1989) pointed out that there were two forms, probably different species, of *Elops* in the western Atlantic. A high-count morph (79-86 total myomeres) which he identified as *Elops saurus* and a low-count morph (74-78 total myomeres) which he felt probably represented an undescribed species. The single Bermuda specimen that we examined has 73 vertebrae and so now can be identified as *E. smithi* (McBride et al. 2010).

Ophichthidae

Ophichthus ophis (Linnaeus 1758), Spotted Snake Eel. This eel, which attains at least 192 cm TL, was first documented from Bermuda based on a Drummond-Hay watercolor of a “Panther eel” (our Pl. 1-21) collected in September 1849. The following two records are the first reports of adults of this eel in over 70 years. On September 23, 2009, a beachcomber reported a moribund and unusual spotted snake eel (Fig. 18) from Clearwater Beach in St. Davids during a prolonged fish kill event (S.R. Smith, pers. comm.). The 167 cm TL specimen has been catalogued as BAMZ 2009-265-013. Lucas (2012) also includes a photograph on this eel, discovered by Russell Whayman near Southwest Breaker, with its head partially protruding from the sand.

Bermuda individuals of this eel have unusually small body spots but agree in other characters of the species. John E. McCosker confirmed the identification. This large ophichthid is also known from North Carolina to Florida and isolated collections from the West Indies to southern Brazil, and the eastern Atlantic Ocean (McCosker et al. 1989).

Engraulidae

Anchoa choerostoma (Goode 1874), Bermuda Anchovy. Neighbor-joining trees based on both the control region and ITS1 sequences show that the endemic *Anchoa choerostoma* is more closely related

to *A. mitchilli*, whose range is restricted to the Atlantic and Gulf coasts of the United States than it is to *A. hepsetus*, whose range extends throughout the Caribbean (Johnson 2003).

Lampridae

Lampris guttatus (Brünnich 1788), Opah. Opahs (genus *Lampris*) are epi-mesopelagic fishes found in all oceans. Two species are currently recognized as valid: *Lampris immaculatus* Gilchrist 1904, an unspotted Indo-West Pacific species, and the spotted *L. guttatus*. The latter species is considered to have a circumtropical distribution but this is uncertain because there may be several spotted, cryptic species (Hawn & Collette 2012). We have examined three color photographs of spotted opahs from the vicinity of Bermuda, only one with collection data. That individual (Fig. 19), which weighed about 55 lbs was caught 29 April 2008 on a longline about 30 mi. north of Bermuda by commercial fisherman David Soares.

Synodontidae

A recent important paper on lizardfishes of the genus *Synodus* (Frable et al. 2013) describes one new species, resurrects another one from synonymy, and redescribes several easily misidentified Caribbean species. That publication does not alter the taxonomic concept or nomenclature of any of the Bermuda species.

Carapidae

Carapus bermudensis (Jones 1874), Pearlfish. The first specimen collected in Bermuda (Fig. 20) since its original description in 1874 came out of a sea cucumber, *Actinopyga agassizi* when it was cut open by Wolfgang Sterrer in February 2002 (Sterrer 2002a). This confirms Dr. Sterrer's prediction that the host of *Carapus*, at least in Bermuda, is the rare nocturnal *Actinopyga* rather than the more common *Isostichopus*. Two specimens are preserved at BAMZ, 2002-201-006 and 2002-203-007. In addition, three vexillifer larvae were collected near Bermuda by the Ocean Acre program and are catalogued as follows: USNM 218380 (1), Ocean Acre 12-34A; USNM 218381 (1), Ocean Acre 12-6M; USNM 218382 (1), Ocean Acre 12-1A.

Ophidiidae

Lamprogrammus brunswigi (Brauer 1906). A headless specimen was found floating at the surface. Based on the photograph, Drs. D. M. Cohen and J. Nielsen agree that it is one of the giant *Lamprogrammus* species, probably *L. brunswigi*. This is a circumtropical species (except absent from the eastern Pacific) usually found at depths of 800-

1,600 m but large individuals have been found floating at the surface a number of times (Cohen et al. 1991).

Bythitidae

Ogilbia cayorum Evermann & Kendall 1898, Key Brotula. A recent revision of *Ogilbia* by Møller et al. (2005) confirms that there is only one species of the genus in Bermuda.

Antennariidae

Col. Drummond-Hay illustrated two species of frogfishes of the genus *Antennarius*, *A. multiocellatus* (Valenciennes 1837) and *A. scaber* (Cuvier 1817), the latter considered by many to be a junior synonym of *A. striatus* (Shaw 1794). Frogfishes have a remarkable ability to alter their coloration to match the surrounding background. We incorrectly thought that Drummond-Hay had illustrated two color phases of *A. scaber* based on specimens caught on 28 Oct. and 8 Dec. 1847, respectively, which he referred to as the "orange" and "striped toad fish". However, in his unpublished notes (quoted on p. 160) he had correctly recognized that the "orange" and "black toad fish" are two color phases of the species now known as *A. multiocellatus*. Thus the legend for our color plate 2-23 should have been labeled as *A. multiocellatus*, not *A. scaber*.

Antennarius scaber (Cuvier 1817), Splitlure Frogfish. Since the illustrations by Col. Drummond-Hay were not of this species as noted above, a photograph (Fig. 21) of a recently collected specimen (BAMZ 2010-267-017) by Kimberly Holzer is of interest.

Antennatus bermudensis (Schultz 1957), Island Frogfish. In a recent molecular revision of the Antennariidae (Arnold & Pietsch 2012), this species was moved into the *A. nummifer* species group in the genus *Antennatus* Schultz 1957.

Fowlerichthys ocellatus (Bloch & Schneider 1801), Ocellated Frogfish. Arnold & Pietsch (2012) assigned *Antennarius ocellatus* to the genus *Fowlerichthys* Barbour 1941.

Mugilidae

Mugil curvidens Valenciennes 1836, Dwarf Mullet. In their appendix on p. 96 (Harrison et al. 2007) listed a single (180 mm SL) specimen: MCZ 17548 from "Bermuda, north Sargasso Sea, no collector or date". This record documents the fourth species of mullet in Bermuda. The Dwarf Mullet is also known from Ascension Island, the Bahamas, Antilles, and south to Rio de Janeiro, Brazil (Harrison 2003) so its occurrence in Bermuda is not surprising.

Belonidae

Tylosurus crocodilus (Peron & Lesueur 1821), Houndfish. Although all previous museum specimens from Bermuda identified as *T. crocodilus* were misidentifications of *T. acus acus*, we can now add *T. crocodilus* to the fauna of Bermuda based on the collection of two adults. John Galbraith collected one (USNM 385990) on hook and line at Non-such Island on Aug. 16, 1999. A second specimen (USNM 385891) was also caught on hook and line by James Liao on Aug. 14, 2001 off the rocks along the railroad trail just north of Whalebone Bay.

Hemiramphidae

Hyporhamphus collettei Banford, 2010, Collette's Halfbeak. The Bermuda population of *Hyporhamphus* has been considered to be conspecific with *Hyporhamphus unifasciatus* (Ranzani 1842) but is characterized by a more slender body, fewer pectoral fin rays (usually 10), dorsal fin rays (usually 14 or 15), and second arch gill rakers (usually 21-23). Sequence data for 800 bp of mtDNA Cyt *b* separates the Bermudan species from other species of the genus by a minimum genetic distance of 0.034 (Banford 2010).

Fundulidae

Sequence divergence in the mitochondrial Cyt *b* gene was assayed in four of the six extant Bermuda killifish populations (Grady et al. 2001). Two divergent (4.6%) haplotypes were detected; one is identical to the Georgia 2c haplotype of *Fundulus heteroclitus* and is fixed in three eastern populations: Lover's Lake (*F. relictus*), Mangrove Lake and Walsingham Pond (*F. bermudae*). The second is fixed and restricted to the westernmost population, Evan's Pond. Phylogenies and haplotype divergence indicate at least two Bermuda colonizations, the more recent involving transfer of the Georgia 2c haplotype. Discovery of killifish bones in peat deposits cored from Well Bay on Cooper's Island in St. David's in a layer of organic sediments formed over 1,500 years ago (Outerbridge et al. 2006) provides physical evidence that at least one species of killifish was living in Bermuda 1,000 years before humans arrived. Cyt_b sequences are uninformative as to the taxonomic status of the Bermuda endemics *F. bermudae* and *F. relictus*, but support recognition of the Evan's Pond population as an evolutionarily significant unit within the *F. heteroclitus* group. Genetic research on Bermuda's killifish indicates that each pond has a genetically unique population and that more endemic species may be recognized in the future. Thus, it is imper-

ative to keep fish from different ponds separated and manage the various ponds or threatened populations as discrete units. Accordingly, a recovery plan for Bermuda killifish has been proposed (Outerbridge & Sarkis 2012).

During an 18-month study in 2004-2005, researchers undertook surveys using a combination of direct observation and baited trapping to estimate abundance, size frequencies, and sex ratios among the isolated killifish populations (Outerbridge et al. 2006; Outerbridge et al. 2007a). Mark and recapture studies produced the following estimates of population size: Mangrove Lake (11,325 ± 1,884 fish), Trott's Pond (7,926 ± 1,576), Lover's Lake (8,508 ± 1,347), Blue Hole Bird Pond (5,394 ± 480 introduced from West Walsingham), West Walsingham Ponds (2,202 ± 178), Bartram's Pond (1,793 ± 224, introduced from Lover's Lake), and Warwick Pond (436 ± 13). No estimates could be made for East Walsingham or Evan's Pond. In addition, the annual reproductive cycle was described for the population inhabiting Mangrove Lake indicating that males and females actively breed for more than half the year, beginning in February and ending in September (Outerbridge et al. 2007b).

Syngnathidae

Cosmocampus albirostris (Kaup 1856), Whitenose Pipefish. Since the only two records of *Cosmocampus albirostris* supposedly from Bermuda were without locality data, we (p. 189) decided that additional voucher material was needed to confidently include this pipefish in the known Bermuda ichthyofauna. Russell Whayman found a specimen (Fig. 22) near Northeast Breakers in August 2008 and on a subsequent dive at the same spot found two other individuals, confirming that this pipefish does occur at least occasionally in Bermuda.

Scorpaenidae

Pterois volitans (Linnaeus 1758), Red Lionfish. A species introduced from the Indo-West Pacific and now widespread along the Atlantic coast of North America (Whitfield et al. 2002; Meister et al. 2005; Morris et al. 2009), recently reported from several localities in the Bahamas (Snyder & Burgess 2007; Morris & Akins 2009), and other localities bordering on the Caribbean Sea (Schofield 2009, 2010). The first Bermuda record was based on a juvenile collected by Horace Landy in a Devonshire Bay tidepool, which was raised in his aquarium until it reached four inches long. This fish was entered in the 2001 Agricultural Exhibition and seized under suspicion of having been illegally

imported into Bermuda (Sterrer 2002b; Whitfield et al. 2002). Spawning along the coast of southeastern United States probably supplied juvenile lionfish to Bermuda (Whitfield et al. 2002). Lionfish may cause deleterious changes in coral-reef ecosystems by predation on native fishes and invertebrates (Albins & Hixon 2008; Morris & Akins 2009) so the fact that they are now abundant in Bermuda raises concerns about their potential threat there. Morris et al. (2009) state that lionfish are established along the southeast U.S. coast, Bermuda, and the Bahamas but presented no evidence that lionfish are reproducing in Bermuda. The Bermuda Ministry of the Environment offers education and training seminars on lionfish so that divers can apply for a license to net and spear lionfish (Morris et al. 2009; Dale 2009).

Brian Luckhurst had a very interesting session with Chris Flook at the Bermuda Aquarium Museum and Zoo regarding lionfish. 1) All Bermuda specimens examined so far are identified as *Pterois volitans* based on fin-ray counts. 2) 50% of females examined (N = 50) had ovaries with eggs, some apparently hydrated indicating imminent spawning. Several very small juveniles (6-7 cm) were collected suggesting a Bermuda origin. 3) Eggs in Chris' BAMZ tanks hatched in 4 days. He said that they grow very quickly and he believes males mature in 6-7 months. 4) Chris has sampled stomach contents and has good evidence that lionfish are voracious predators in keeping with similar findings elsewhere. 5) In an effort to control population growth, Bermuda has licensed divers to spear lionfish and bring the specimens in to the Aquarium. Currently about 130 divers are licensed. Eradication is probably not possible but this policy may help control population growth. 6) In October 2008, a lobster trap set on the edge (in 30 fathoms) reportedly had 27 lionfish in one haul! They may have entered the trap to eat other fishes caught in the trap. A fisherman reported another anecdote to Chris: a vertical longline set on Challenger Bank in 70 fathoms came up with 8 out of 10 hooks with a lionfish. The next day, same place, 10 hooks, 10 lionfish! The fisherman had to move to another area because he could not catch anything else there.

Polyprionidae

Polyprion americanus (Bloch & Schneider 1801), Wreckfish. A 134-cm TL individual weighing 45.5 kg was captured by commercial fishermen in Oct. 1995 at 650 m (Luckhurst & Dean 2009). Counts

of the opaque zones (interpreted as annuli) on transverse sections of the sagittal otolith gave an age estimate of 60 years.

Epinephelidae

Hyporthodus mystacinus (Poey 1852), Misty Grouper. We follow Craig & Hastings (2007) and Craig et al. (2011) in placing this grouper in the genus *Hyporthodus* Gill rather than its traditional placement in *Epinephelus* Bloch. Two large specimens (152 and 157 cm TL) were caught in 2000-2001 by commercial fishermen using vertical longline gear set in 220-270 m on the edge of the Bermuda platform (Luckhurst & Dean 2009). Counts of the opaque zones (interpreted as annuli) on transverse sections of the sagittal otolith gave age estimates of 135 years for the 152-cm specimens, 150 years for the 157-cm specimen. These appear to be the oldest groupers reported to date in the literature. Capture of these two groupers increased the documented maximum weight (74.5 and 75.5 kg, respectively) for the species by over 20 kg.

Hyporthodus niveatus (Valenciennes 1828), Snowy Grouper. We also follow Craig & Hastings (2007) and Craig et al. (2011) in placing this grouper in the genus *Hyporthodus* Gill rather than its traditional placement in *Epinephelus* Bloch.

Mycteroperca bonaci (Poey 1860), Black Grouper. A spawning aggregation was located on the northeast reef platform at a depth of about 30 m (Luckhurst 2010). Diving observations revealed many similarities to observations of this species described at multi-species spawning aggregation sites in Belize. The spawning aggregations were observed at the warmest time of the year in Bermuda, June-August.

Paranthias furcifer (Valenciennes 1828), Creole-fish or Barber. Hybridization of *Paranthias furcifer* and *Cephalopholis fulva* was noted by us and treated in detail by Bostrom et al. (2002). A recent molecular phylogeny of groupers (Craig & Hastings 2007) revealed that both species of *Paranthias* are nested within *Cephalopholis*, implying that this species should be known as *Cephalopholis furcifer*. This new classification has been adopted by Page et al. (2013). However, a major publication on groupers of the world (Craig et al. 2011), as well as the Catalog of Fishes (Eschmeyer 2013), reverted to the traditional classification maintaining *Paranthias* as valid, "pending additional study." Thus, the generic placement of this grouper is not fully resolved.

Serranidae

Choranthias tenuis (Nichols 1920), Threadnose

Bass. This species was moved from the genus *Anthias* to their new genus *Choranthias* by Anderson & Heemstra (2012). Their account includes a color description of a Bermuda specimen based on a color transparency provided by the first author of this paper.

Epinephelus guttatus (Linnaeus 1758), Red Hind. Luckhurst & Trott (2009) reported increases in size of Red Hind after protection by seasonally-closed spawning aggregation sites in Bermuda following years of declining catches.

Hypoplectrus puella (Cuvier 1828), Barred Hamlet. Only a single species of hamlet occurs in Bermuda. Victor (2012) recently described a new species, *Hypoplectrus floridae*, from Florida that strongly resembles *H. puella*, with which it had consistently been misidentified. The Florida species has a pair of vertically aligned small dark spots at the base of the caudal fin (absent in *H. puella*) and has a 3% mitochondrial DNA sequence-divergence from a large homogenous clade of other Caribbean species of *Hypoplectrus* including *H. puella*. Re-examination of specimens of the Bermuda hamlet reveals that they are the true *H. puella* and not *H. floridae* which possibly could have been carried to the island via the Gulf Stream.

Parasphyraenops atrimanus Bean 1912, Bank Bass. This poorly known species, redescribed by Johnson & Smith-Vaniz (1987) based on the holotype and then only extant specimen, was questionably treated by us (p. 216) as a Bermuda endemic. However, Heemstra et al. (2003: 1327) gave the distribution of *P. atrimanus* as Bermuda and Venezuela. A second species of small planktivorous serranid, originally described as *Serranus incisus* by Colin (1978), was transferred to *Parasphyraenops* by Johnson & Smith-Vaniz (1987). The reported Venezuelan distribution for *Parasphyraenops atrimanus* was based on Heemstra's conclusion (pers. comm., March, 1995) that Cervigón's (1991:403) description and figure of *Serranus incisus* actually apply to *P. atrimanus*, an opinion with which we agree.

Colin (1978) described *Serranus incisus* from material collected from Jamaica and Puerto Rico and observed but did not collect specimens off Curaçao that he believed to be this species. Subsequently, Quattrini et al. (2004) recorded it from deep reefs off North Carolina, reported it from the Bahamas and Turks and Caicos (R. G. Gilmore, pers. comm.), and documented the life colors (their Plate 1b) of a 55 mm SL specimen, the largest yet recorded of this diminutive planktivore.

Although we have been unable to examine his material (these specimens cannot be located in the institute's collection, D. R. Robertson, pers. comm., Sept. 2012), Cervigón's (1991) description and drawing (p. 403, Fig. 2) does not agree with the color photograph of Quattrini et al. (2004), especially the less vertical orientation of the dark oblique bar in the spinous dorsal fin, in contrast to that given in Bean's (1912) original description "large black blotch on *base* [our italics] of spinous dorsal extending upward a distance equal long diameter of eye" and ... "jet black spot behind base of pectoral fin." Johnson & Smith-Vaniz (1987:50) noted that the pigment described by Bean was still evident on the holotype, including the black "blotch in axil of pectoral fin." However, the two most important discrepancies between Cervigón's description (which agrees best with the holotype of *P. atrimanus*) and *P. incisus* concern the shape of the lacrimal (first infraorbital bone) and the relative sizes of the two species. The lacrimal of the holotype is relatively deep with a broadly rounded posteroventral margin versus the slender and tapered bone of *P. incisus* (see Johnson & Smith-Vaniz, 1987, Figs 3c-d). Bean (1912) described the large lacrimal of the type by stating "suborbital depth 1/2 diameter of eye." Cervigón's drawing clearly shows a fish with a similarly broad lacrimal in contrast to photographs of *P. incisus* (Colin 1978; Quattrini et al. 2004) which show fish with narrow suborbital depths. Cervigón's three specimens were reported to be 64-72.5 mm SL, all exceeding the largest known individual of *P. incisus* (see above).

Rypticus carpenteri Baldwin & Weigt 2012, Slope Soapfish. This new species has been confused with the Spotted Soapfish, *R. subbifrenatus*, with which it shares a very similar pattern of dark spots. Both species are broadly distributed throughout the Caribbean and occur sympatrically at many localities. We erroneously identified (p. 218) the only two collections of Bermuda soapfish that have conspicuous dark spots as *R. subbifrenatus*, however, re-examination of the two ANSP specimens by Baldwin & Weigt (2012) has shown them to actually be *R. carpenteri*. The two historical FMNH specimens are badly faded and, although probably *R. carpenteri*, cannot be positively identified.

Rypticus bistrispinus (Mitchill 1818), Freckled Soapfish. In our synonymy of *Rypticus saponaceus* (p. 218) we listed Bean's (1906:55) report of a single specimen (FMNH 5295) of *R. bistrispinus* from Nonsuch Island, Bermuda as a misidentification.

However, re-examination of the specimen by both us and Guimarães (1999) has confirmed the accuracy of the original identification. This is the only confirmed record of the species from Bermuda.

Malacanthidae

Caulolatilus bermudensis Dooley 1981, Bermuda Tilefish. The life colors of this Bermuda endemic (Fig. 23) were unknown when the species was originally described and this is the first photograph of a fresh specimen.

Caulolatilus dooleyi Berry 1978, Bahama Tilefish. This tilefish was originally described from a single specimen from the Bahamas (Berry 1978). Recently we received a photograph (Fig. 24) of what appears to be this species (Dooley, pers. com.) but because the specimen was not retained and no meristic or morphometric data were taken, the identification should be considered tentative until more specimens become available.

Rachycentridae

Rachycentron canadum (Linnaeus 1766), Cobia. A rare fish in Bermuda known from (p. 233) some early Bermuda records: a museum specimen caught in 1957, and a 124-cm TL specimen taken at Watford Bridge, Somerset in June 1985; thus, a recent capture is of interest. A three-foot cobia was caught and photographed by Denis Kerr off the South Shore in June 2010 (Arandjelovic 2010).

Carangidae

In the key to the jacks in our book (p. 235), there is an error in couplet 13. It should read gill rakers 10-14 **upper** and 25-28 **lower** versus gill rakers 6-9 **upper** and 16-21 **lower** instead of lower and total.

Caranx bartholomaei Cuvier 1833, Yellow Jack. In 1999 (p. 237), we believed that all the Bermuda specimens of this species were juveniles 62-82 mm FL, suggesting a non-resident waif occurrence. However, we overlooked a 350-mm FL specimen, ANSP 177887 taken off Kitchen buoy by P. C. Heemstra and J. Burnett-Herkes in June 1973 so adults do at least occasionally reach Bermuda.

Caranx hippos (Linnaeus 1766), Crevalle Jack. We reidentified the only specimens identified as *Caranx hippos* as *C. latus* and concluded, as did Smith-Vaniz & Carpenter (2007), that the Crevalle Jack is a continental species that does not occur in Bermuda. However, we have received an underwater photograph (Fig. 25) from Lisa Greene, taken at Aristo Wreck in 2009, that proves that Crevalle Jack do occur, at least occasionally, in Bermuda.

Chloroscombrus chrysurus (Linnaeus 1766),

Atlantic Bumper. Only three positively identified specimens of bumper from Bermuda existed when we wrote the book (p. 239) but recently there was an influx of small bumper into Bermudian waters where some were netted by Kevin Winter and Brian Lines on April 30, 2006 while hauling bait at Foot of the Lane. Brian Luckhurst thinks these may have arrived on a Gulf Stream eddy. Representative specimens have been preserved in the BAMZ collections as 2006-238-004.

Bramidae

Pteraclis carolinus (Valenciennes in Cuvier & Valenciennes 1833), Atlantic Fanfish. Two specimens (Fig. 26) were found in the stomach of a Yellowfin Tuna off the Banks in 2004 (communicated to us by Chris Flook, BAMZ). This record adds another species to the three bramids known from Bermuda.

Gerreidae

Gerres cinereus (Walbaum 1792), Yellowfin Mojarra. Because there was only one confirmed record of this species from Bermuda (p. 260), we considered it to be a non-established waif species. However, REEF volunteers have now recorded the species from Harrington Sound, Flatts Inlet, Walsingham Pond, Bailey's Bay, Evans Bay, Shelly Bay, Parsons Bay, Grotto Bay, Tom Woods Bay, Elys Harbour mangroves, Penhurst Park, etc. (Judie Clee, pers. com., 12 May 2013) indicating that the Yellowfin Mojarra (Fig. 27) is undoubtedly an established Bermuda species.

Haemulidae

Haemulon macrostomum Günther 1859, Spanish Grunt. Although there were historical reports of Spanish grunts frequently being brought into Hamilton by fishermen, who caught them in deep water near the outer reefs, we incorrectly concluded (p. 263) that these and other literature records were based on misidentifications because Bermuda fisheries workers were unfamiliar with the species and we were unable to locate any correctly identified museum voucher specimens. However, Drummond-Hay's unmistakable watercolor (Fig. 10) documents at least the historical presence of the species in Bermuda.

Inermiidae

Haemulon vittatum (Poey 1860), Boga. This family is now considered a synonym of Haemulidae and the species formerly known as *Inermia vittata* is a member of the genus *Haemulon*, based on mitochondrial and nuclear genetic data (Rocha et al. 2008; Sanciangco et al. 2011).



Fig. 3. *Holocentrus rufus*, Longspine Squirrelfish, Drummond-Hay no. 41, "Squirrel fish," natural size, original drawing about 163 mm TL, Bermuda, 21 October 1847. Courtesy of Smithsonian Institution, no. P12956.



Fig. 6. *Lutjanus synagris*, Lane Snapper, Drummond-Hay no. 12, "White water snapper," 2/3 natural size, original drawing 183 mm TL, Bermuda, 12 March 1849. Courtesy of Smithsonian Institution, no. P11884.

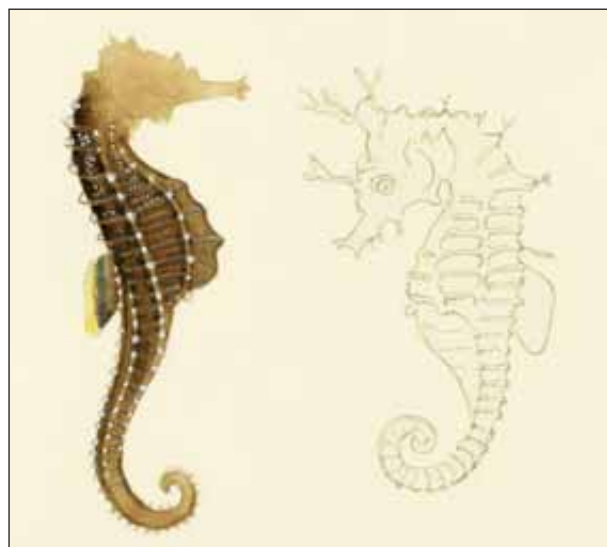


Fig. 4. *Hippocampus erectus*, Lined Seahorse, Drummond-Hay no. 89, "Sea horse," natural size, original of the larger drawing ca. 100 mm TL, Bermuda, October 1847. Courtesy of Smithsonian Institution, no. P15911.

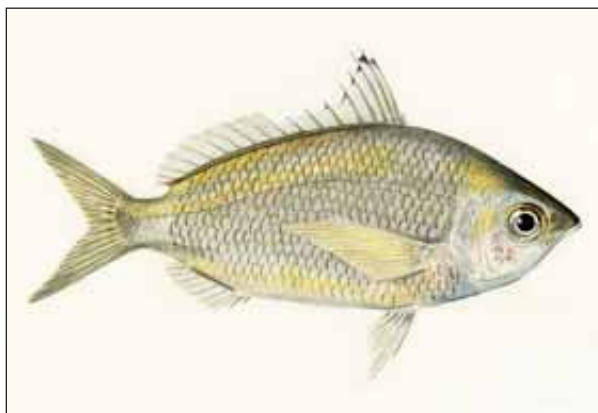


Fig. 7. *Eucinostomus gula*, Silver Jenny, Drummond-Hay no. 18, "Shad," natural size, 72 mm TL, Bermuda, September 1850. Courtesy of Smithsonian Institution, no. P10700.

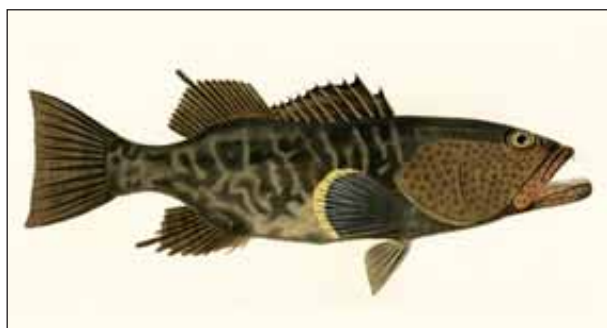


Fig. 5. *Mycteroperca tigris*, Tiger Grouper, Drummond-Hay no. 4, "Gag," 1/2 natural size, original drawing 270 mm TL, Bermuda, November 1849. Courtesy of Smithsonian Institution, no. P9679.

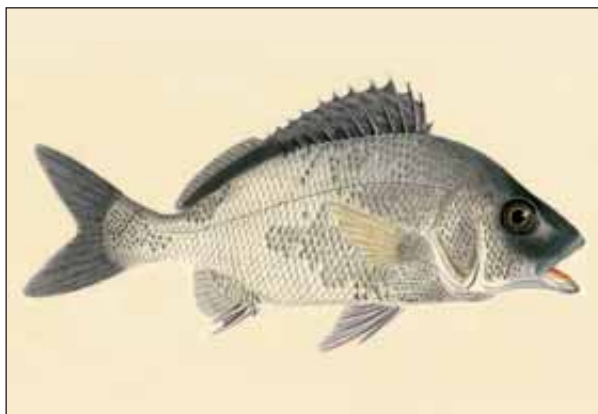


Fig. 8. *Haemulon album*, Margate, Drummond-Hay no. 24, "Margate fish," 1/2 natural size, original drawing 178 mm TL, Bermuda, 19 June 1847. Courtesy of Smithsonian Institution, no. P12039.

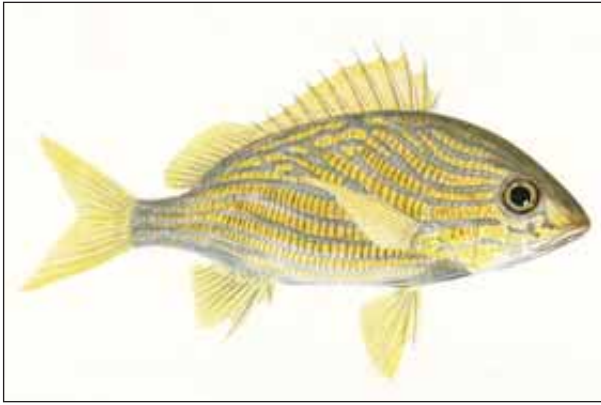


Fig. 9. *Haemulon flavolineatum*, French Grunt, Drummond-Hay no. 20, "Large scale yellow grunt," natural size, original drawing 176 mm TL, Bermuda, October 1850. Courtesy of Smithsonian Institution, no. P12038.



Fig. 12. *Kyphosus vaiigiensis*, Yellow Chub, Drummond-Hay no. 28, "Chub," natural size, original drawing 201 mm TL, Bermuda, 14 September 1850. Courtesy of Smithsonian Institution, no. P14490.

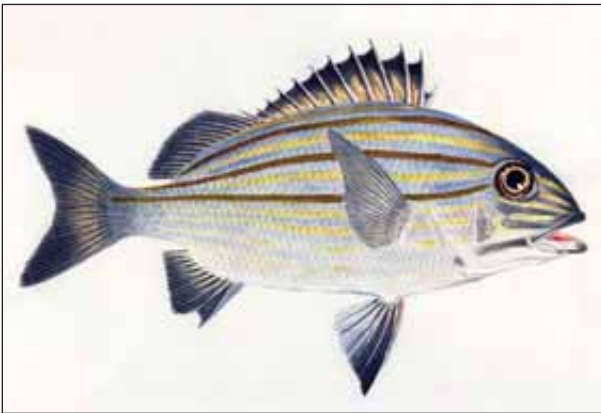


Fig. 10. *Haemulon macrostomum*, Spanish Grunt, Drummond-Hay no. 21, "Black grunt," 2/3 natural size, original drawing 186 mm TL, Bermuda, 20 May 1851. Courtesy of Smithsonian Institution, no. P12036.

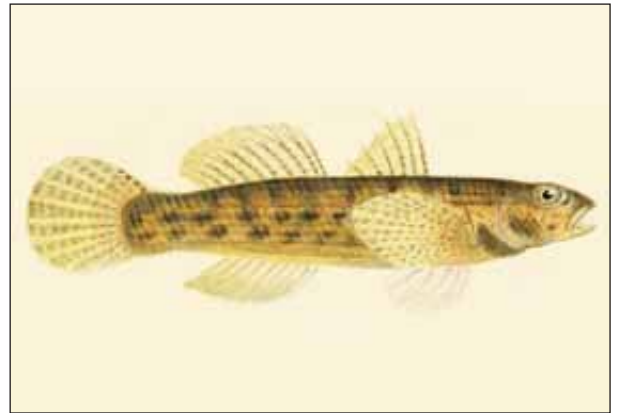


Fig. 13. *Bathygobius lacertus*, Spotted Frillfin, Drummond-Hay no. 60, "Goby," natural size, original drawing 102 mm TL, Bermuda, 15 March 1851. Courtesy of Smithsonian Institution, no. P10723.

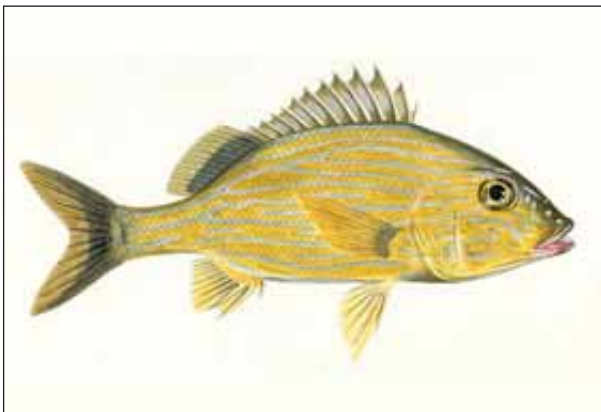


Fig. 11. *Haemulon sciurus*, Bluestripe Grunt, Drummond-Hay no. 19, "Small scaled yellow grunt," common size, original drawing 188 mm TL, Bermuda, July 1849. Courtesy of Smithsonian Institution, no. P12037.

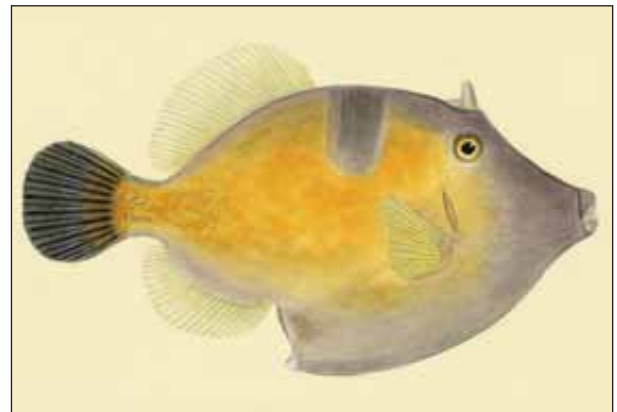


Fig. 14. *Cantherines macrocerus*, Whitespotted Filefish, Drummond-Hay no. 96, "Ocean turbot," 1/2 natural size, original drawing 224 mm TL, Bermuda, February 1851. Courtesy of Smithsonian Institution, no. P2285.

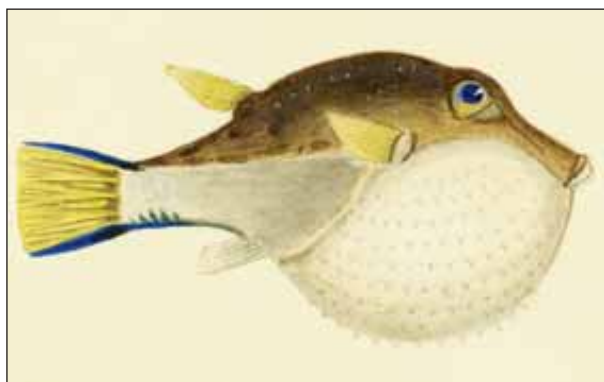


Fig. 15. *Canthigaster rostrata*, Sharpnose Puffer, Drummond-Hay no. 93, "Puff fish," natural size, original drawing 57 mm TL, Bermuda, no date. Courtesy of Smithsonian Institution, no. P2285.



Fig. 17. *Dasyatis centroura*, Rough-tail Stingray, Bermuda. Photo by G. Mayer.

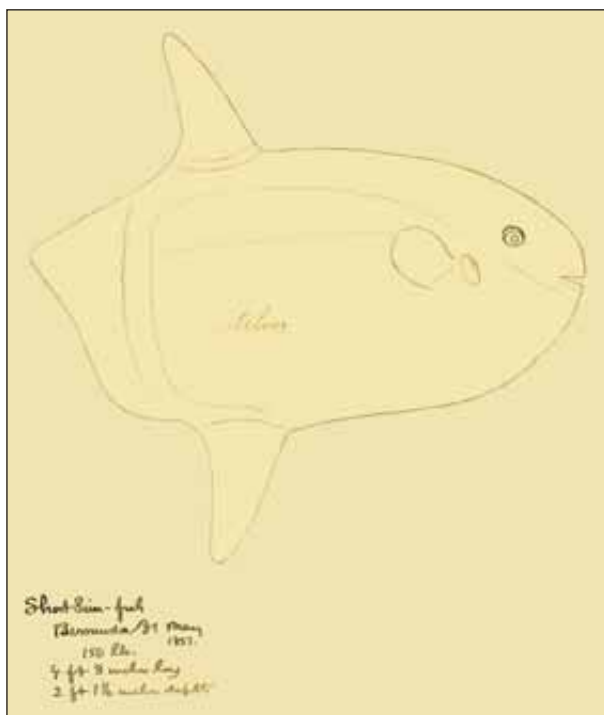


Fig. 16. *Masturus lanceolatus*, Sharptail Mola, Drummond-Hay unnumbered, "Short sun-fish," 4 ft. 3 inches long, Bermuda, 31 May 1851. Courtesy of Smithsonian Institution, no. P11073.



Fig. 18. *Ophichthus ophis*, Spotted Snake Eel, Clearwater Beach, Bermuda. Photo by S. R. Smith.

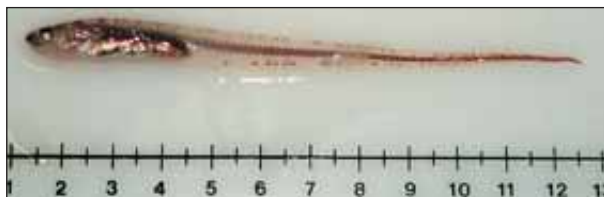


Fig. 20. *Carapus bermudensis*, Pearlfish, Bermuda. Photo by W. Sterrer.



Fig. 19. *Lampris guttatus*, Opah, Bermuda. Photo from D. Soares.



Fig. 21. *Antennarius scaber*, Splitfin Frogfish, Bermuda. Photo by K. Holzer.



Fig. 22. *Cosmocampus albirostris*, Whitenose Pipefish, Bermuda. Photo by R. Lucas.



Fig. 23. *Caulolatilus bermudensis*, Bermuda Tilefish, Bermuda. Photo courtesy of Bermuda Department of Environmental Conservation.



Fig. 24. *Caulolatilus dooleyi*, Bahama Tilefish, Bermuda. Photo courtesy of Bermuda Department of Environmental Conservation.



Fig. 25. *Caranx hippos*, Crevalle Jack, Astro Reef, Bermuda. Photo courtesy Lisa Greene, Bermuda Natural History Museum.



Fig. 26. *Pteraclis carolinus*, Atlantic Fanfish, from the stomach of a Yellowfin Tuna off the Banks, Bermuda in 2004. Photo by S. Cabral, Jr.



Fig. 27. *Gerres cinereus*, Yellowfish Mojarra, Bermuda. Photo by L. Franks.



Fig. 28. *Cynoscion regalis*, Weakfish, Bermuda. Photo by T. Adderly.



Fig. 29. *Pomacanthus paru*, French Angletfish, Bermuda. Photo by J. Burville.



Fig. 30. *Chromis bermudae*, Yellowfin Chromis, Bermuda. Photo by A. Marquart.



Fig. 31. *Chromis flavicauda*, Cobalt Chromis, Brazil. Photo by A. de Luca, Jr.



Fig. 32. *Clepticus* sp., Bermuda Creole Wrasse, Bermuda. Photo by R. Lucas.



Fig. 33. *Halichoeres garnoti*, Yellowhead Wrasse, with typical "decoratus" colour pattern (see text discussion). Photo by R. Lucas.



Fig. 34. *Halichoeres poeyi*, Blackear Wrasse, Bermuda. Photo by L. Franks.



Fig. 35. *Masturus lanceolatus*, Sharptail Mola, Horseshoe Beach, Bermuda. Photo by A. Davis.



Fig. 36. *Ranzania laevis*, Slender Mola. Photo by D. Skinner.

Sciaenidae

Cynoscion regalis (Bloch & Schneider 1801), Weakfish. A Weakfish (Fig. 28) was caught on Oct. 16, 2001 by Thomas Adderly on the North Shore inside the shipping channel off of Bailey's Bay in 40-60 feet of water. This is a new record for Bermuda. The specimen has been catalogued as BAMZ 2001-197-024.

Pomacanthidae

Pomacanthus paru (Bloch 1787), French Angelfish. We reported this angelfish as historically introduced to Bermuda with the most recent recorded sighting in October 1968. However, Russell Whayman sent us photographs of a pair of adults he observed in Bermuda on August 17 2006. They have been periodically seen by several divers off East End and one of the pair was photographed (Fig. 29) by John Burville. Whether the species is reproducing in Bermuda is uncertain.

Kyphosidae

Species of *Kyphosus* are difficult to identify and a recent family revision by Knudsen & Clements (2013) has revealed that in addition to the Bermuda Chub, *Kyphosus sectatrix*, two other chubs occur in Bermuda, both with unfamiliar names.

Kyphosus vaigiensis (Quoy & Gaimard 1825), Yellow Chub. We recorded this chub (p. 278) as *K. incisor* (Cuvier 1831), a species then considered to be restricted to the Atlantic Ocean. Knudsen & Clements (2013) have determined that it actually occurs in both the Atlantic and Indo-Pacific regions and was first described by Quoy & Gaimard (1825) from Indonesia.

Kyphosus bigibbus Lacepède 1801, Brown Chub. Previously confused with *K. sectatrix*, Knudsen & Clements (2013) recorded this species from both sides of the Atlantic and the Indo-Pacific region, and listed the following three specimens from Bermuda: ZMB 7866 (100 mm SL), ZMB 7997 (186 mm SL) and ZMUC journ. 256 (150 mm SL).

Pomacentridae

Chromis bermudae Nichols 1920, Bermuda Chromis. We treated (p. 284) this colorful damselfish as a junior synonym of *C. flavicauda* (Günther 1880), described from northeastern Brazil, following Smith-Vaniz & Emery (1980) who had only the badly faded Brazilian holotype for comparison. Although recognizing these two nominal species as conspecific, Moura (1995) noted that Brazilian specimens have less yellow coloration on the caudal peduncle, dorsal and anal fins. Observations and photographs provided by L. A. Rocha, J.

L. Gasparini and others, based on a large series of fresh *C. flavicauda* obtained during recent surveys of deep reefs off northeastern Brazil, reveal that they consistently differ from the Bermuda *Chromis* in having the caudal peduncle and spinous dorsal almost entirely blue versus a broad diagonal band of yellow on the caudal peduncle extending anterodorsally to the rear of the dorsal fin and at least the distal third of the spinous dorsal fin bright yellow. Bermuda fish also have a more extensive area of yellow in the anal fin.

Considering the color pattern differences between the Bermuda and Brazilian *Chromis* (Figs. 30-31), their widely disjunct distributions, and recent publications indicating that the level of endemism of the Brazilian reef fishes is much greater than previously thought (Menezes et al. 2003; Moura & Sazima 2003; Rocha 2003), we now recognize *Chromis bermudae* as a valid Bermudian endemic.

Labridae

Clepticus sp., Bermuda Creole Wrasse. We recently became aware of two color photographs, one of a school and the other of a single individual (the latter here reproduced as Fig. 32), of wrasses from Bermuda (Lucas 2012) identified as *Clepticus parrae*. Terminal phase adults are distinctive in having very elongate outer caudal-fin rays, mostly solid blue body and fins and a bright yellow snout. We predict that subsequent research will show these fish to be another Bermuda endemic. All records of *Clepticus parrae* from Bermuda apparently are based on misidentifications of this undescribed *Clepticus*. Heiser et al. (2000) provide the most recent review of *Clepticus* species.

Halichoeres garnoti (Valenciennes 1839), Yellow-head Wrasse, Fig. 33. We noted (p. 293) that terminal males of *H. garnoti* from Bermuda (our colour Pl. 12, Figs 78-79) "typically differ from non-Bermuda individuals in having a dorsum that is bright orange to vermilion instead of being yellowish or greenish posterior to a diagonal cross-band at the origin of the first segmented dorsal-fin ray," and that should subsequent studies reveal additional differences, the name *H. decoratus* (Bean) is available for the Bermuda form.

In a study of mitochondrial DNA variation in western Atlantic *Halichoeres*, Rocha (2004) determined that *H. garnoti* had no significant population structure across its entire range from Bermuda to Venezuela; the Bermuda population shares 12 of its 20 haplotypes with fish at one or more Caribbean locations, and haplotypes restricted to

Bermuda were nested within the Caribbean lineage. Rocha reported that *Halichoeres garnoti* does not occur in the northern Gulf of Mexico (although there are records from deep reefs in the northwest Gulf of Mexico) or in any coastal location north of Florida and presumably is a strictly tropical species. During the last glacial maximum (25,000-15,000 yr B.P.) temperatures at Bermuda were much lower than present (Sachs & Lehman 1999), thus it is probable that the Bermuda population is relatively young and although the color differences likely have a genetic basis, they are not detectable in neutral genes, such as cytochrome *b*, because of insufficient time for lineage sorting.

Halichoeres poeyi (Steindachner 1867), Blackear Wrasse. The first record of this wrasse from Bermuda was based on a solitary, initial phase, individual observed at Baileys Bay on 25 September 2002. While volunteering with a biodiversity team conducting seagrass transects, Judie Clee (pers. com.) sighted it amongst a school of Slippery Dicks, *Halichoeres bivittatus* (Bloch) and kept an eye on it for an extended period of time. She was very familiar with the Blackear Wrasse having seen them many times in the Caribbean and was absolutely positive of the identification, based on its very pea-green colour and distinctive ear mark. Lydia Franks observed and photographed (Fig. 34) a second initial phase individual between Flatts and Gibbet Island on September 4, 2012. Because these are the only records of this wrasse in Bermuda, we consider the two observations of single individuals to be examples of non-established waif occurrences.

Three species of parrotfishes were observed in a multispecies spawning aggregation at the same time and location just outside the breaking reef line along the southwest coast of Bermuda about 500 m from the shoreline in June and July 2003 (Luckhurst 2011). The species were the Redfin Parrotfish *Sparisoma rubripinne* (46 spawning events observed), Queen Parrotfish *Scarus vetula* (11), and Stoplight Parrotfish, *Sparisoma viride* (3).

Uranoscopidae

Xenocephalus egregius (Jordan & Thompson 1905), Freckled Stargazer. We follow Springer & Bauchot (1994) and Eschmeyer (2013) in assigning this stargazer to the genus *Xenocephalus* Kaup 1858 instead of its traditional classification in *Gnathagnus* Gill 1861, a junior synonym.

Eleotridae

Eleotris perniger (Cope 1871), Spinycheek Sleeper.

The species that we recorded (p. 312) as *Eleotris pisonis* is actually *Eleotris perniger* (Cope 1871). Pezold & Cage (2002) have determined that *E. pisonis* is a continental South American species while the insular Caribbean basin species is *E. perniger*.

Gobiidae

In our book we reported only two *Bathygobius* species from Bermuda. A recent review of western Atlantic *Bathygobius* by Tornabene et al. (2010) requires two additions to the species composition of the genus in Bermuda. The color pattern consisting of a double row of diagonal, dark blotches on the flanks clearly identifies Drummond-Hay's "Goby" watercolor (Fig. 13) as that of *Bathygobius lacertus* (Poey 1860). Apparently, at least four species of *Bathygobius* occur in Bermuda (L. Tornabene and C. Baldwin, pers. com.): *B. saporator*, *B. curacao*, *B. lacertus*, and *B. antillensis* Tornabene, Baldwin, & Pezold 2010. Tornabene et al. (2010) re-identified the holotype of *Bathygobius saporator sextaneus* Ginsburg 1947 as probably a specimen of *B. lacertus* and reported that additional museum specimens (without catalog numbers) of this species were examined from Bermuda (see also Tornabene et al. 2010, Fig. 13). The specimens (ANSP, UMMZ) that we previously identified as *B. curacao* are apparently correctly identified. However, material that we identified as *B. saporator* contains all four species. One lot (USNM 178014) collected by William Beebe in 1929 contains a few *B. saporator* and multiple specimens of *B. curacao* (L. Tornabene, pers. com.). ANSP 32677 is re-identified as *B. lacertus* and ANSP 14287 as probably *B. antillensis* (C. Baldwin, pers. com.). UMMZ material originally identified as *B. saporator* was reidentified (C. Baldwin, pers. com.) as either *B. antillensis* (UMMZ 172393) or *B. curacao* (UMMZ 176373, 1764562).

Key to Bermuda *Bathygobius* (based on Tornabene et al. 2010)

- 1a. First dorsal fin with a broad vertical or slightly diagonal dark bar..... *B. saporator*
- 1b. First dorsal fin with a longitudinal pattern of pigment, either a single broad stripe or 1-4 narrow stripes 2
- 2a. Ventral portion of trunk with two rows of 6-7 dark blotches, the blotches in the two rows offset and reminiscent of the dark squares on a checker-board; lateral scale rows 38-42
.....*B. lacertus*

- 2b. Ventral portion of trunk variously pigmented, with or without blotches, but never with two offset rows of blotches; lateral scale rows 31-42 3
- 3a. Ventral portion of trunk with two rows of markings, the uppermost with 7-8 dark blotches beginning beneath the pectoral fin and terminating just before basicaudal marking; lower row with 3 (rarely 4) spots and terminating anterior to anal fin origin; lateral scale rows 38-42; pectoral fin rays 18-21 *B. antilliensis*
- 3b. Trunk typically with no diagnostic pigment pattern (sometimes 6-7 diffuse dark blotches of varying size along body); lateral scale rows 31-36; pectoral fin rays 15-17..... *B. curacao*

Coryphopterus tortugae (Jordan 1904), Sand Goby. Although Garzón & Acero (1990) resurrected this species from synonymy with *C. glaucofraenum* Gill 1863 based on color pattern (basicaudal marking a bar instead of two colon-like spots) and relative body depth, we (p. 315) felt that the color pattern difference was not sufficient to recognize two distinct species in Bermuda. However, Victor (2008) and Baldwin et al. (2009) used morphological and molecular characters to successfully differentiate the species. Re-examination of most of our material showed both species to be common but usually not occurring together. Of 41 stations shown on the map in Fig. 128, only five stations (81-4, 81-5, 81-6, 81-10 and 81-32) contained specimens of both species. Half of the other stations (18) contained only *C. glaucofraenum*, and half (18) contained only *C. tortugae*. One specimen from Three Hills Shoals that was originally identified as *C. glaucofraenum* has been reidentified by B. Victor, based on genetic evidence, as *C. bol* Victor 2008 (A. Bentley, pers. comm.). However, Baldwin et al. (2009: 129) consider *C. bol* to be a synonym of *C. venezuelae* Cervigón 1966. Additional research is needed to resolve this issue.

We do not list the stations where each of these two species of *Coryphopterus* were collected separately but for those who want that information it can be obtained by accessing the ANSP ichthyology collection database at http://data.acnatsci.org/biodiversity_databases/fish.php. *Coryphopterus glaucofraenum* and *C. venezuelae* Cervigón 1966 (originally described as a subspecies of *C. glaucofraenum*) co-occur throughout much of their respective ranges and have very similar color pat-

terns, but there are no confirmed Bermuda collections of the latter species. Presence of a third species, *C. bol*, is based mostly on genetic characters making identification of it difficult. We present the following revised key to Bermuda *Coryphopterus*.

Key to Bermuda *Coryphopterus* (modified, in part, from Baldwin et al. 2009)

- 1a. Pelvic fins broadly united 2
- 1b. Pelvic fins completely separate or united basally by narrow membrane 4
- 2a. Body usually pale, pigment primarily comprising three rows of markings on side of body; lower row comprising small, mostly vertically elongate markings, some of which may be crescent shaped or some part of an X-shape but rarely well defined X's; if X-shaped markings present, their height is considerably shorter than eye diameter; pigment marking above opercle usually a triangle, and basicaudal pigment usually a central bar..... *C. tortugae*
- 2b. Body heavily pigmented or pale but without vertically elongate or crescent-shaped markings in ventral row of pigment on side of body; height of X-shaped markings, if present, three-quarters of or equal to diameter of eye; pigment marking above opercle triangular, rounded, or with two well-defined peaks; basicaudal pigment comprising two separate spots, two spots connected by a line of pigment and resembling a dumbbell, a central bar, or a C-shaped..... 3
- 3a. Pigment on pectoral-fin base variable but always with dark spot or rectangular-shaped blotch ventrally (may be associated with bright yellow pigment in life); one or two additional bars, blotches, or concentrations of pigment sometimes present dorsally; three rows of dark markings on side of body, some in lower row large, X-shaped markings in heavily pigmented specimens, small, circular blotches in paler specimens; pigment markings above the opercle triangular or round *C. venezuelae*
- 3b. Pectoral-fin base rarely with prominent dark marking ventrally, although melanophores may form one to three light to moderate concentrations on base; body with three rows of dark markings, most of those in the lower row large, distinctive X-shaped markings; pigment marking above opercle usually with two well-defined peaks *C. glaucofraenum*

- 4a. Anus situated at or near center of black ring; anterior interorbital region of head with one median pore *C. personatus*
 4b. Anus not situated at center of black area but nearer posterior margin; anterior interorbital region of head with two pores, each nearer orbital rim than fellow pore *C. hyalinus*

Gnatholepis cauerensis (Bleeker 1853), Goldspot Goby. We recorded (p. 316) this common and widely distributed Caribbean goby as *Gnatholepis thompsoni* Jordan 1904 because, as the only Atlantic representative of the genus *Gnatholepis*, application of the scientific name had not been questioned. In a study of mitochondrial DNA variation in populations of *Gnatholepis*, Rocha et al. (2005) presented data indicating that a single species had colonized the Atlantic from the Indian Ocean during the late Pleistocene. Subsequently, Randall & Greenfield (2007) redescribed *Gobius cauerensis* Bleeker, 1853, discussed why the name used by Rocha et al. (op. cit.) was incorrect and concluded that *Gnatholepis cauerensis* (Bleeker) is a senior synonym of *G. thompsoni*.

In their recent revision of the genus *Gnatholepis*, Larson & Buckle (2012) treat *Gnatholepis thompsoni* and *G. cauerensis* as allopatric sister-species. However, they stated that fish from South Africa, which they identify as *G. cauerensis*, “look almost identical in colour pattern to *G. thompsoni*” as do certain others from Indonesia and Malaysia, and fish from Atol das Rocas, Brazil “resemble *G. cauerensis* in colouring,” as do ... photographs of fish from San Salvador which “show similar-coloured fish.” We acknowledge the thoroughness of their revision, but note that all the meristic and other morphological characters purported to separate these two “species” have broadly over-lapping values. We therefore disagree with their choice of nomenclature, which seems to have been strongly biased by geography.

Acanthuridae

Based on color pattern and genetic differences, Bernal & Rocha (2011) showed that the Bermuda and northwestern Atlantic population of the Ocean Surgeon that we referred to (p. 321) as *Acanthurus bahianus* Castelnau 1855 is actually a distinct species, *Acanthurus tractus* Poey 1860. The South Atlantic species retains the name *A. bahianus*.

Scombridae

Thunnus thynnus (Linnaeus 1758), Atlantic Bluefin Tuna. Alan Card caught the Bluefin Tuna

in 1980 that we recorded in our book and Andrew Card recently caught another one off Argus Bank on 1 Feb. 2012, which weighted 920 lbs even with part of its caudal peduncle eaten by sharks (Bernews 2012).

Istiophoridae

Collette et al. (2006) revised the family and recommended several changes in nomenclature of billfishes affecting one species reported from Bermuda. The White Marlin *Tetrapturus albidus* (p. 336), along with the Indo-Pacific Striped Marlin, have been moved to the genus *Kajikia* Hirasaka and Nakamura 1947 so its name is now *Kajikia albida* (Poey 1860).

Makaira nigricans Lacepède 1802, Blue Marlin. While fishing offshore in July 2006, Ian Card was speared in the chest and knocked overboard by a blue marlin estimated to be about 363 kg and 4.3 m long. The marlin had just been hooked when it suddenly leaped out of the water and impaled Mr. Card just below his collar bone. The bill just missed one of his main arteries so the wound easily could have been fatal.

Based on gonad histology, 70% of 11 female Blue Marlin caught in July in Bermuda waters were actively spawning or in spawning condition (Luckhurst et al. 2006). These observations confirm that active spawning of Blue Marlin occurs in Bermuda waters in July extending the known spawning range of the species in the western North Atlantic. Also, a juvenile (256 mm lower jaw fork length), estimated to be 42 days old, was dipnetted on Challenger Bank on Sept. 2, 1994.

Molidae

We recorded (p. 358) two species of Molidae from Bermuda, *Mola mola* and *Ranzania laevis*. However, the first report (Goode 1877) of *Mola mola* (as *M. rotunda*) from Bermuda was actually based on misidentification of a third species, the Sharptail Mola, *Masturus lanceolatus* (Liénard 1840). This became obvious when a recently discovered Drummond-Hay sketch (Fig. 16) included collection data identical to that reported by Goode. This circum-global species differs from other molas in having a protruding pseudocaudal fin (clavicle) and a horizontal mouth. Andrew Davis found a second specimen of the Sharptail Mola floating, alive, in shallow water at Horseshoe Beach, Southampton on May 27, 2001. The 407-mm SL specimen (Fig. 35) is catalogued as BAMZ 2001-194-001.

Ranzania laevis (Pennant 1776), Slender Mola. The only previous Bermuda specimen of this

moloid was one obtained from the stomach of a Wahoo caught on Argus Bank in 1995. Recently two additional specimens of this rarely seen species (Fig. 36) were discovered on the East End: Judie Clee found one on the South Shore of Coopers Island in St. David's and Chris Smith found another one the same day (April 7, 2002) at Clearwater Beach. The two specimens have been catalogued as BAMZ 2002-203-001 (445 mm TL) and BAMZ 2002-203-002 (430 mm TL).

Endemism and Phylogeography: The description of the Bermuda population of *Hyporhamphus* as a new species, recognition of *Chromis bermudae* (Pomacentridae) as a valid species, and removal of *Parasphyraenops atrimanus* (Serranidae) from the list of Bermuda endemics, changes the total number of Bermuda endemic fishes to seven species (eight if the Bermuda *Clepticus* proves to be another endemic, as we believe), excluding from consideration several land-locked species of *Fundulus*. It is difficult to determine if some species (including several discussed above) are established in Bermuda but with very low population numbers or they represent rare waif occurrences. Regardless of how these species are categorized or the definition used to determine which families (or species) should be treated as "shorefishes," the percentage of nearshore Bermuda endemic fishes is less than 3 percent.

Sequence analysis of the mitochondrial control region and the nuclear ITS1 region was performed to investigate some questions about Bermudian phylogeography (Johnson 2003). Seven species of common shorefishes were analyzed, eight individuals from Bermuda and eight others from the southeastern United States. Haplotype diversities of the control region and gene diversities of ITS1 in Bermudian populations were relatively high, while mean nucleotide sequence diversities of the control region and ITS1 were relatively low. This is indicative of rapid population growth following a period of low effective population size or a founder event. Four species, *Haemulon flavolineatum*, *Holocentrus adscensionis*, *Lagodon rhomboides*, and *Lutjanus griseus*, have mitochondrial control region and ITS1 divergence values corresponding to mean divergence times of 2,000 to 21,500 years which suggests colonization following the last glacial period 18,000 years ago. Three species, *Haemulon aurolineatum*, *H. sciurus*, and *Holocentrus rufus* have mitochondrial control region and ITS1 divergence values corresponding to mean divergence times of 38,000 to 214,500 years. These species

may have colonized Bermuda during a previous interglacial warming period 120,000-130,000 years ago.

Grady et al. (2001) also found molecular evidence of multiple colonization events in killifishes of the genus *Fundulus*. However, we reported (p. 179) that age estimates based on radiometric dating of peat deposits for Mangrove Lake and other isolated Bermuda inland marshes, range from 4-8+ thousand years. Prior to the rapid rise in sea levels beginning about 7,000 years BP *Fundulus* species would have been unable to surmount the steep flanks of the Bermuda platform.

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