

## Exploring the diversity of western Atlantic *Bathygobius* (Teleostei: Gobiidae) with cytochrome *c* oxidase-I, with descriptions of two new species

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### Abstract

*Bathygobius* is currently represented by three species in the western Atlantic (*B. soporator*, *B. curacao* and *B. mystacium*) based on diagnostic morphological features. Our combined genetic and morphological analyses indicate that there are at least six species of *Bathygobius* comprising eight genetic lineages in the western Atlantic. Two lineages are identified as *B. curacao* and *B. mystacium*. Four lineages possess characters that would previously have led to their identification as *B. soporator*. Two of those are morphologically indistinguishable and are recognized here tentatively as a single species, *B. soporator*. A third “*B. soporator*” lineage is distinct, and *Gobius lacertus* is resurrected here as *Bathygobius lacertus* for that lineage. The fourth “*B. soporator*” lineage is also distinct and is described as a new species. Two other closely related genetic lineages are morphologically indistinguishable and are treated as a single new species. Redescriptions of *B. soporator*, *B. mystacium* and *B. curacao* are provided. Comments are made on the identification of larval *Bathygobius* from Belize.

### Zusammenfassung

*Bathygobius* ist nach bisherigem Kenntnisstand nach morphologischen Kriterien im Westatlantik mit drei Arten vertreten (*B. soporator*, *B. curacao* und *B. mystacium*). Unsere kombinierte genetischen und morphologischen Untersuchungen belegen aber, dass es im Westatlantik mindestens sechs *Bathygobius*-Arten gibt, die aus acht genetischen Linien bestehen. Zwei Linien lassen sich mit *B. curacao* und *B. mystacium* in Übereinstimmung bringen. Vier der Linien zeigen Merkmale, die man bisher *B. soporator* zugeordnet hätte. Davon sind zwei morphologisch ununterscheidbar, sodass sie hier vorläufig zu einer einzigen Art, nämlich *B. soporator*, zusammengefasst werden. Eine dritte „*B. soporator*“-Linie unterscheidet sich, sodass für sie die Wieder-Einrichtung des alten Namens *Gobius lacertus* als *Bathygobius lacertus* vorgeschlagen wird. Auch die vierte „*B. soporator*“-Linie unterscheidet sich; sie wird hier als neue Art beschrieben. Zwei weitere nahe verwandte genetische Linien sind morphologisch ununter-

scheidbar und werden als eine einzige weitere neue Art zusammengefasst. Es folgen revidierte Beschreibungen von *B. soporator*, *B. mystacium* und *B. curacao* sowie Bemerkungen zur Bestimmung von *Bathygobius*-Larven von Belize.

### Résumé

Le genre *Bathygobius* est habituellement représenté par trois espèces dans l'ouest atlantique (*B. soporator*, *B. curacao* et *B. mystacium*) sur base de données morphologiques diagnostiques. Nos analyses à la fois génétiques et morphologiques montrent qu'il y a au moins six espèces de *Bathygobius* comprenant huit lignages dans l'ouest atlantique. Deux lignages sont identifiés comme *B. curacao* et *B. mystacium*. Quatre lignages ont des caractères qui auraient conduit jadis à leur identification comme *B. soporator*. Deux d'entre eux sont indifférenciables morphologiquement et sont proposés ici, hypothétiquement, comme une seule espèce, *B. soporator*. Un troisième lignage de “*B. soporator*” est distinct et *Gobius lacertus* est rebaptisé *Bathygobius lacertus* pour ce lignage. Le quatrième lignage “*B. soporator*” est aussi distinct et décrit comme espèce nouvelle. Deux autres lignages génétiques étroitement apparentés sont morphologiquement indifférenciables et sont traités comme nouvelle espèce unique. Des redescriptions de *B. soporator*, *B. mystacium* et *B. curacao* sont fournies. Des commentaires sur l'identification de *Bathygobius* larvaires de Belize sont présentés.

### Sommario

Sulla base di caratteristiche morfologiche il genere *Bathygobius* è attualmente rappresentato nell'Atlantico occidentale da tre specie (*B. soporator*, *B. curacao* e *B. mystacium*). La nostra analisi combinata genetica e morfologica indica che nell'area esistono almeno sei specie di *Bathygobius* suddivise in otto linee genetiche. Due linee sono identificate come *B. curacao* e *B. mystacium*. Quattro linee possiedono caratteristiche che dovrebbero portare tutte a identificarsi con *B. soporator*. Due di queste sono morfologicamente indistinguibili e sono qui tentativamente riconosciute come un'unica specie, *B. soporator*. Una terza linea di “*B.*

*soporator*” risulta distinta e coincidente con la specie nominale *Gobius lacertus* che è qui riassegnato come *Bathygobius lacertus*. La quarta linea di “*B. soporator*” è altresì distinta e descritta come nuova specie. Due altre discendenze genetiche molto vicine sono morfologicamente indistinguibili e sono trattate anch’esse come una nuova specie. Viene fornita una nuova descrizione di *B. soporator*, *B. mystacium* e *B. curacao*. Sono riportati commenti sull’identificazione delle larve di *Bathygobius* del Belize.

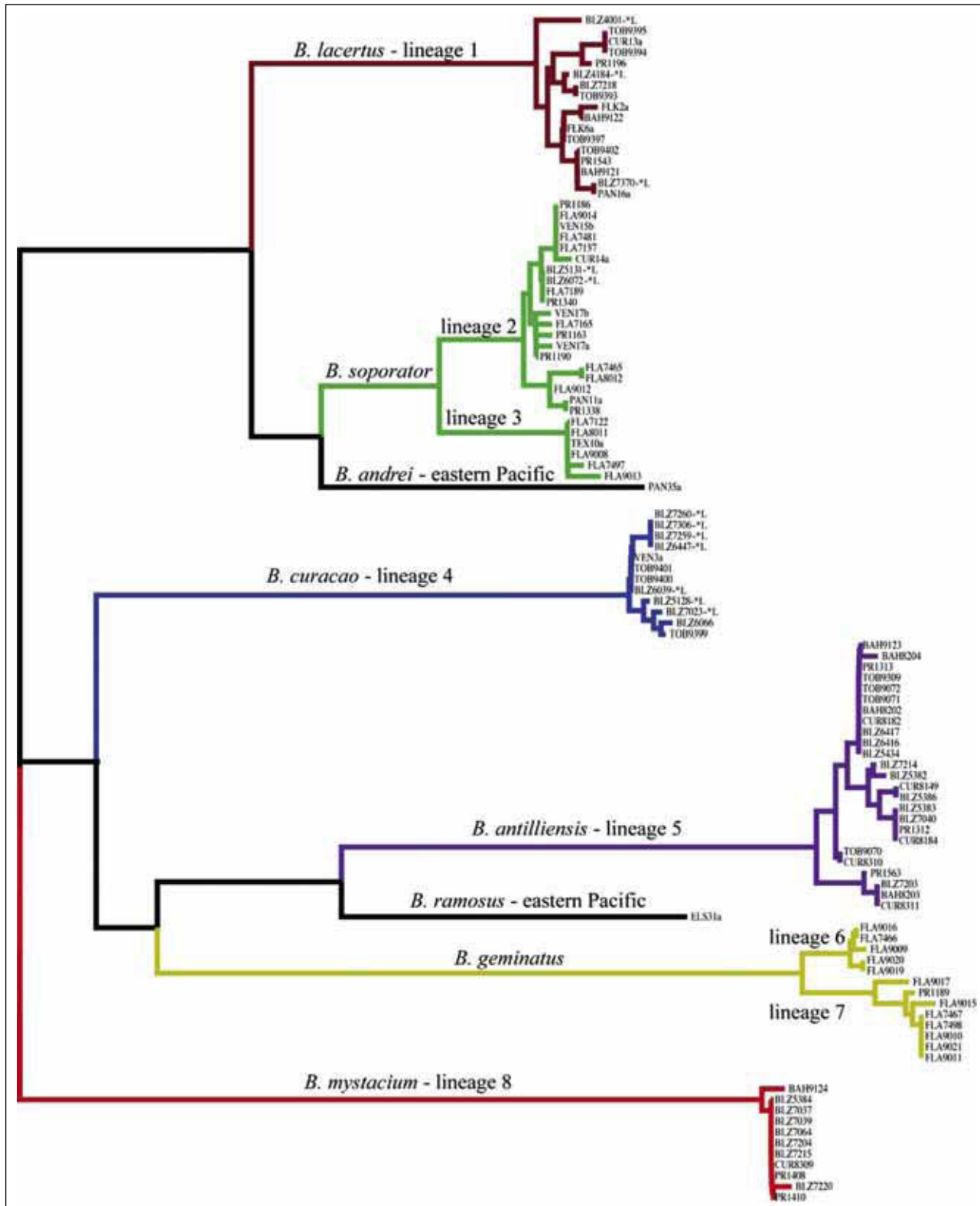
## INTRODUCTION

The genus *Bathygobius* Bleeker, 1878, currently comprises 26 nominal species (Eschmeyer 2010) with representatives in all tropical oceans. Although no formal review of the genus as a whole has been attempted thus far, there have been reviews of species in the western Atlantic (Ginsburg 1947), Colombia (Garzón-Ferreira & Acero 1992), Japan (Akihito & Meguro 1980; Akihito et al. 1988), the eastern Pacific (Ginsburg 1947; Miller & Stefanni 2001) and West Africa (Miller & Smith 1989). Three species of *Bathygobius* are currently recognized from the western Atlantic: *Bathygobius soporator* (Valenciennes, 1837), *B. curacao* (Metzelaar, 1919) and *B. mystacium* Ginsburg, 1947. Four subspecies of *B. soporator* and one subspecies of *B. curacao* were described primarily on the basis of minor differences in the number of modified free pectoral fin rays, modal differences in pectoral fin ray counts, subtle morphometric differences, and the presence or absence of a highly variable patch of scales on the operculum (Ginsburg 1947). Analyses of nuclear allozymes and mitochondrial cytochrome *b* sequence data on specimens from the Bahamas, coastal Brazil and Rocas Atoll suggested the presence of one or more undescribed species of *Bathygobius* from the western Atlantic (Lima et al. 2005). The western Atlantic species of *Bathygobius* have highly conserved morphology, making it difficult to determine the number of valid species using morphological characters alone. Furthermore, general coloration in these species is somewhat variable, and it has been suggested that populations of *B. soporator* exhibit two distinct patterns of pigmentation depending on whether they are living over sandy bottoms or rocky substrates (Tavolga 1950). The purpose of this study was to use cytochrome *c* oxidase-I (COI) sequence data and subsequent morphological investigation to clarify the status of the nominal species of *Bathygobius* in the western Atlantic and detect cryptic lineages that may exist in the region. Herein we redescribe the three cur-

rently recognized western Atlantic *Bathygobius* species, describe two new species, and resurrect and redescribe one previously synonymized species. We present a taxonomic key to the species that illuminates the subtle morphological and pigmentation characters useful in their identification, and we make comments on previous identifications of *Bathygobius* larvae from Belize in light of new genetic data.

## METHODS

Specimens used in this study were collected from Belize, the Bahamas, Curacao, Panama, Tobago, Venezuela, Florida, Puerto Rico and Texas, and are listed at the beginning of the appropriate species description below. Depending on the locality, fish specimens were collected using quinaldine sulfate, rotenone, plankton tow (for larvae), seine, or dipnets from various habitats including sheltered and exposed rocky shorelines, tidepools, mangroves, rock jetties and reef crests. In addition to the western Atlantic collections, specimens of *Bathygobius andrei* (Sauvage, 1880) (AMNH 251643, DNA #PAN35a, 32 mm SL, Punta Patilla, Panama, Panama, 31 July 2000, J. Van Tassell and D. R. Robertson; AMNH 251643, DNA #PAN35b, 39 mm SL, Punta Patilla, Panama, 31 July 2000, J. Van Tassell and D. R. Robertson) and *Bathygobius ramosus* Ginsburg, 1947 (AMNH 251645, DNA #ELS31a, 49 mm SL, Golfo de Fonseca El Salvador, 9 March 2001, D. R. Robertson, C. Baldwin, J. Van Tassell, E. Barraza, K. Kaiser and E. Ochoa) from the eastern Pacific were included in the analysis for comparison. Additional museum specimens were examined for each species and are listed in the appropriate section below. Most specimens were photographed using a digital camera to record color patterns prior to dissection and preservation. Voucher specimens from each recovered genetic lineage were subsequently analyzed for diagnostic patterns in pigmentation and morphology. To determine if the lineages represented novel species or taxa that had been previously described and subsequently synonymized, type specimens for all western Atlantic *Bathygobius* and their synonyms were examined. Larval *Bathygobius* were collected in Belize and included in our DNA analysis, and comments made on their identification. All measurements were taken with digital calipers and counts of procurrent caudal fin rays were made from digital radiographs of specimens. Descriptions of pigmentation are based on fresh



**Fig. 1.** Neighbor-joining tree of western Atlantic *Bathygobius* derived from COI sequences, with 61 sequences removed to reduce size. Larval specimens denoted with L\*. See Appendix for neighbor-joining tree of all 167 sequences. Scale bar units = substitutions/site.

and recently preserved specimens. The postorbital, temporal and shoulder spots described here for each species are the same markings shown by Miller & Stefanni (2001: Fig. 4) and occur at the following locations on the body: postorbital blotch – posterior to the eye, anterior to a vertical through posterior margin of preopercle; temporal marking – directly above posterodorsal corner of preopercle; and shoulder spot – directly above posterodorsal corner of operculum. Meristic counts and measurements follow Miller & Smith (1989). Digital photographs of most of the voucher specimens were taken at the time of collection and are housed at the Smithsonian Institution.

Molecular techniques follow those of Baldwin et al. (2009). Tissue sampling for molecular work involved removing a muscle biopsy, eye, fin clip, or caudal body portion then storage in saturated salt buffer (Seutin et al. 1990) or 95% ethanol. Genomic DNA was extracted from up to approximately 20 mg minced preserved tissue via an automated phenol:chloroform extraction on the Auto-genprep965 (Autogen, Holliston, Massachusetts) using the mouse tail tissue protocol with a final elution volume of 50  $\mu$ L. For polymerase chain reaction (PCR), 1  $\mu$ L of this genomic DNA was used in a 10  $\mu$ L reaction with 0.5 U Boline (Bio-Line USA, Boston, Massachusetts) Taq polymerase, 0.4  $\mu$ L 50 mM MgCl<sub>2</sub>, 1  $\mu$ L 10 $\times$  buffer, 0.5  $\mu$ L 10 mM deoxyribonucleotide triphosphate (dNTP), and 0.3  $\mu$ L 10  $\mu$ M each primer FISH-BCL (5'-TCAACYAATCAYAAAGATATYGGC AC) and FISH-BCH (5'-TAAACTTCAGGGTGACCAA AAATCA). The thermal cycler program for PCR was 1 cycle of 5 min at 95°C; 35 cycles of 30 s at 95°C, 30 s at 52°C, and 45 s at 72°C; 1 cycle of 5 min at 72°C; and a hold at 10°C. The PCR products were purified with Exosap-IT (USB, Cleveland, OH) using 2  $\mu$ L 0.2 $\times$  enzyme and incubated for 30 min at 37°C. The reaction was then inactivated for 20 min at 80°C. Sequencing reactions were performed using 1  $\mu$ L of this purified PCR product in a 10  $\mu$ L reaction containing 0.5  $\mu$ L primer, 1.75  $\mu$ L BigDye buffer, and 0.5  $\mu$ L BigDye (ABI, Foster City, California) and run in the thermal cycler for 30 cycles of 30 s at 95°C, 30 s at 50°C, 4 min at 60°C, and then held at 10°C. These sequencing reactions were purified using Millipore Sephadex plates (MAHVN-4550; Millipore, Billerica, Massachusetts) per manufacturer's instructions and stored dry until analyzed. Sequencing reactions were analyzed on an ABI

3730XL automated DNA sequencer, and sequence trace files were exported into Sequencher 4.7 (GeneCodes, Ann Arbor, MI). Using the Sequencher program, ends were trimmed from the raw sequences until the first and last 10 bases contained fewer than 5 base calls with a confidence score (phred score) lower than 30. After trimming, forward and reverse sequences for each specimen were assembled. Each assembled pair was examined and edited by hand, and each sequence was checked for stop codons. Finally the consensus sequence (655 bp) from each contig was aligned and exported in a nexus format (sensu Swofford 2002). Neighbor-joining trees (Saitou & Nei 1987) and distance matrices were generated using Paup\*4.1 (Swofford 2002) and Mega 4.0 (Tamura et al. 2007) on an analysis of Kimura two-parameter distances (Kimura 1980). A total of 168 sequences were analyzed in this study. Several to many redundant specimens (61 total) were removed from each lineage in the resulting neighbor-joining tree (Fig. 1) for easier viewing. The complete tree with all 167 sequences is included as Appendix I. COI sequences are deposited in Genbank (accession numbers HM748331-HM748428 and HM775883-HM775951).

## RESULTS

**Diversity of *Bathygobius* in the western Atlantic (Fig. 2):** The neighbor-joining tree constructed from the COI sequence data shows eight distinct genetic lineages from the western Atlantic (Fig. 1). In addition to these eight lineages, the eastern Pacific *B. ramosus* and *B. andrei* also formed distinct genetic lineages (Fig. 1). Lineage 4 is identified as *B. curacao* based primarily on the presence of 15-17 pectoral fin rays and 31-36 lateral scale rows (Ginsburg 1947) in the voucher specimens and the *B. curacao* type material. Lineage 8 is identified as *B. mystacium* based on the presence of 31-36 lateral scale rows, 18-21 pectoral fin rays and a short upper jaw (9.2-11.7 % SL) (Ginsburg 1947). Lineages 6 and 7 comprise individuals that are morphologically indistinguishable, and do not unequivocally match the descriptions of *B. soporator*, *B. curacao* or *B. mystacium*. We recognize this pair of lineages as a single new species, *B. geminatus*, but note that future studies may provide additional evidence warranting the separation of these lineages into distinct species.

Specimens from the remaining four lineages (1, 2, 3, 5) originally were identified as *B. soporator*

based on characters described by Ginsburg (1947), specifically a high number of lateral scale rows (37-42), a long upper jaw (11.5-16.5 %SL) and 17-22 pectoral fin rays. We found subtle differences in patterns of pigmentation and predorsal squamation that diagnose lineage 1, the combined lineage 2/3, and lineage 5. We have found no morphological characters or pigment patterns that separate

lineages 2 and 3. As with lineages 6 and 7, we treat lineages 2 and 3 as a single species pending further study.

To determine which of the three species represented by lineages 1, 2/3 and 5 is *B. saporator*, we examined the original description, images of the *Gobius saporator* syntypes, and type material of Ginsburg's (1947) four *B. saporator* subspecies (*B.*



**Fig. 2.** Digital images of freshly collected western Atlantic *Bathygobius* specimens, shown here arranged in rows by species to accentuate the differences in diagnostic pigment patterns among the species. From left to right by row: *B. lacertus* – USNM 397570, DNA sequence #BLZ 7218, 48 mm SL, Belize, photo by Julie Mounts (JM) and Amy Driskell (AD), Smithsonian Institution (SI); AMNH 251649, DNA #PR 1196, 33 mm SL, La Boca, Barceloneta, Puerto Rico, photo by R. Chabarria (RC); USNM 397577, DNA #TOB 9402, 25 mm SL, Tobago, photo by Carole Baldwin (CB) and Lee Weigt (LW), SI; AMNH 251656, DNA #PR 1546, 39 mm SL, beach near Hwy 3, Patillas, Puerto Rico, photo by RC; *B. saporator* – USNM 397587, DNA #FLA 7157, 24 mm SL, Florida, photo by JM and CB, SI; USNM 397598, DNA #FLA 9012, 57 mm SL, Florida, photo by CB, SI; USNM 397599, DNA #FLA 9013, 42 mm SL, Florida, photo by CB, SI; USNM 397597, DNA #FLA 9008, 53 mm SL, Florida, photo by CB, SI; *B. curacao* – USNM 397561, DNA #BLZ 6066, 32 mm SL, Belize, photo by CB and LW, SI; USNM 397562, DNA #TOB 9399, 29 mm SL, Tobago, photo by CB and LW; USNM 397564, DNA #TOB 9401, 29 mm SL, Tobago, photo by CB and LW, SI; USNM 397563, DNA #TOB 9400, 29 mm SL, Tobago, photo by CB and LW, SI; *B. antillensis* – USNM 398060, DNA #BLZ 7203, 68 mm SL, Belize, photo by JM and AD, SI; USNM 398064, DNA #BLZ 7214, 44 mm SL, Belize, photo by JM and AD, SI; USNM 398065, DNA #BLZ 7378, paratype, 76 mm SL, Belize, photo by CB and LW, SI; No voucher available, DNA #BLZ 7066, 33 mm SL, Belize, photo by JM and AD; *B. mystacium* – USNM 398086, DNA #BLZ 7037, 63 mm SL, Belize, photo by JM; no voucher available, DNA #BLZ 7065, 35 mm SL, Belize, photo by JM and AD; USNM 398085, DNA #BLZ 6419, 29 mm SL, Belize, photo by JM and AD, SI; USNM 398088, DNA #BLZ 7039, 37.5 mm SL, Belize, photo by JM, SI; *B. geminatus* – USNM 398101, DNA #FLA 7466, 38 mm SL, Florida, photo by CB and LW, SI; USNM 398104, DNA #FLA 9009, 33 mm SL, Florida, photo by CB, SI; USNM 38110, DNA #FLA 9019, 35 mm SL, Florida, photo by CB, SI; USNM 398106, DNA #FLA 9011, paratype, 24.5 mm SL, Florida, photo by C. B. SI. Image editing by C. B.



*soporator soporator*, *B. soporator sextaneus*, *B. soporator longiceps* and *B. soporator catulus*). Specimens from all four lineages are morphologically consistent with Valenciennes' (1837) original description of *G. soporator*. Ginsburg (1947) attempted to differentiate the subspecies by a series of overlapping body measurements, modal differences in pectoral fin-ray counts, and patterns of branching on the pectoral fin rays. We find that those characters are not diagnostic of any of the genetic lineages recovered in this study. The two morphologically indistinguishable sister lineages (2/3) appear to be *B. soporator* based on similarities between the *G. soporator* syntypes and vouchers from both lineages in predorsal squamation patterns and in pigmentation on the first dorsal fin. *Gobius lacertus* Poey, 1860, long considered a synonym of *B. soporator*, is resurrected here as *Bathygobius lacertus* for lineage 1, based on similarities in trunk pigmentation and predorsal squamation between the voucher specimens of this lineage and the *G. lacertus* holotype. The remaining lineage (5) has a combination of morphological and pigmentation characters that are not present in the holotypes or syntypes of *B. soporator* or any of its synonyms, and therefore we describe it as a new species, *B. antilliensis*.

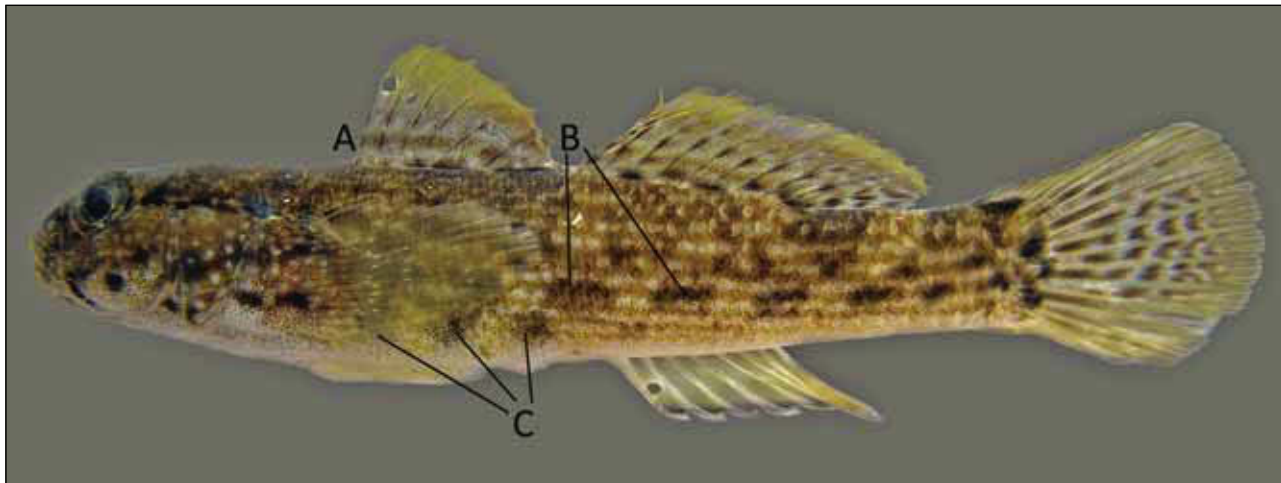
#### SYSTEMATICS

#### *Bathygobius antilliensis* n. sp. Tornabene, Baldwin & Pezold

Antilles frillfin (Figs 2-3)

**Holotype:** AMNH 251650, DNA #PR1313, 46 mm SL, female, Playa Magui, Hatillo, Puerto Rico, 18°29'26"N, 66°48'57"W, 27 May 2009, L. Tornabene and R. Chabarria.

**Paratypes:** AMNH 251658, DNA #PR1312, 45 mm SL, from holotype locality, Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria. USNM 397605, DNA #BAH8203, 41 mm SL, Sugar Beach Cave, Bahamas. USNM 397607, DNA #BAH9123, 41 mm SL, Sugar Beach Cave, Bahamas. USNM 398061, DNA #BLZ7207, 47 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounts and A. Driskell. USNM 398063, DNA #BLZ7213, 45 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounts and A. Driskell. USNM 398065, DNA #BLZ7378, 76 mm SL, Carrie Bow Cay, Belize, 25 January 2007, L. Weigt. USNM 398066, DNA #BLZ7379, 42 mm SL, Carrie Bow Cay, Belize, 25 January 2007, L. Weigt. USNM 398068, DNA #CUR8182, 61 mm SL, Boka Sami, Curacao, 13 March 2008, C. Baldwin, D. Smith and L. Weigt. USNM 398069, DNA #CUR8183, 51 mm SL, Boka Sami, Curacao, 13 March 2008, C. Baldwin, D. Smith and L. Weigt. USNM 398070, DNA #CUR8184, 39 mm SL, Boka Sami, Curacao, 13 March 2008, C. Baldwin, D. Smith and L. Weigt. USNM 398073, DNA #TOB9070, 56 mm SL, Arnos Vale Beach, Tobago, 15 March 2009, C. Baldwin, D. Smith and L. Weigt. USNM 398077, DNA #TOB9310, 39 mm SL, Culloden Bay Beach, Tobago, 18 March 2009, C. Baldwin, D.



**Fig. 3.** *Bathygobius antilliensis*, holotype, 46 mm SL, female, Hatillo, Puerto Rico, DNA #PR1313, AMNH 251650. A, longitudinal pattern of pigment on first dorsal fin; B, upper, complete row of 7-8 blotches, row terminating just anterior to basicaudal markings; C, lower, incomplete row of 3 (rarely 4) blotches row usually terminating anterior to origin of anal fin. Photo by R. Chabarria. Image editing by L. Tornabene.

Smith, L. Weigt, and Gonzales. AMNH 251658, 33.5 mm SL, from holotype locality, Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria. AMNH 251658, 31 mm SL, from holotype locality, Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria. 251658, 41 mm SL, from holotype locality Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria. AMNH 251658, 37.5 mm SL, from holotype locality, Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria. ANSP 191377, 42 mm SL, from holotype locality, Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria. ANSP 191378, 43 mm SL, from holotype locality, Puerto Rico, 27 May 2009, L. Tornabene and R. Chabarria.

**Additional material examined:** COI-sequenced specimens: AMNH 251657, DNA#PR1563, 21 mm SL, Guanica Beach, Puerto Rico, 8 June 2009, L. Tornabene and R. Chabarria. USNM 397604, DNA #BAH8202, 45 mm SL, Sugar Beach Cave, Bahamas, 18 June 2008, C. Baldwin and relatives. USNM 397606, DNA #BAH8204, 36 mm SL, Sugar Beach Cave, Bahamas, 18 June 2008, C. Baldwin and relatives. USNM 397608, DNA #BLZ5382, 62 mm SL, Carrie Bow Cay, Belize, 5 May 2005, C. Baldwin. USNM 397609, DNA #BLZ5383, 54 mm SL, Belize, 5 May 2005, C. Baldwin. USNM 397610, DNA #BLZ5386, 16 mm SL, Carrie Bow Cay, Belize, 5 May 2005, C. Baldwin. USNM 397611, DNA #BLZ5434, 17 mm SL, Carrie Bow Cay, Belize, 7 May 2005, C. Baldwin. USNM 397612, DNA #BLZ5436, 90mm SL, Carrie Bow Cay, Belize, 7 May 2005, C. Baldwin. USNM 397613, DNA #BLZ6416, 61 mm SL, Carrie Bow Cay, Belize, 17 April 2006, D. Smith, J. Mounts and A. Driskell. USNM 397614, DNA #BLZ6417, 55 mm SL, Carrie Bow Cay, Belize, 17 April 2006, D. Smith, J. Mounts and A. Driskell. USNM 398059, DNA #BLZ7040, 30 mm SL, Carrie Bow Cay, Belize, 12 January 2007, D. Smith, J. Mounts and A. Driskell. USNM 398060, DNA #BLZ7203, 68 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounts and A. Driskell. USNM 398062, DNA #BLZ7211, 45 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounts and A. Driskell. USNM 398064, DNA #BLZ7214, 44 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounts and A. Driskell. USNM 398067, DNA #CUR8149, 30 mm SL, Cas Abou, Curacao, 12 March 2008, C. Baldwin, D. Smith and L. Weigt. USNM 398071,

DNA #CUR8310, 26 mm SL, Blue Bay, Curacao, 14 March 2008, D. Smith. USNM 398072, DNA #CUR8311, 21 mm SL, Blue Bay, Curacao, 14 March 2008, D. Smith. USNM 398074, DNA #TOB9071, 49 mm SL, Arnos Vale Beach, Tobago, 15 March 2009, C. Baldwin, D. Smith and L. Weigt. USNM 398075, DNA #TOB9072, 39 mm SL, Arnos Vale Beach, Tobago, 15 March 2009, C. Baldwin, D. Smith and L. Weigt. USNM 398076, DNA #TOB9309, 49 mm SL, Culloden Bay Beach, Tobago, 18 March 2009, C. Baldwin, D. Smith, L. Weigt and Gonzales. USNM 398078, DNA #TOB9311, 36 mm SL, Culloden Bay Beach, Tobago, 18 March 2009, C. Baldwin, D. Smith, L. Weigt and Gonzales.

COI sequences without voucher specimens: BLZ7066, 33 mm SL, photographed, Carrie Bow Cay, Belize, 13 January 2007, D. Smith, J. Mounts and A. Driskell.

**Additional specimens:** MCZ 62340, 19, 15-53 mm SL, Bonaire. UF 16322, 5, 39-62 mm SL, Utila Island, Honduras. UF 16609, 43, 21-82 mm SL, Morant Cays, Jamaica. UF 19248, 10, 23-94 mm SL, Rocas Atoll, Brazil. USNM 178205, 6, 27-62 mm SL, Little Courland Bay, Tobago. USNM 178891, 4, 19-61 mm SL, Leeward I., Antigua. USNM 192183, 100, 14-80 mm SL, Marianao, Cuba. USNM 359412, 14, 12-57 mm SL, Navassa Island.

**Diagnosis:** Pectoral fin rays 18-21; lateral scale rows 38-42; upper jaw length 9.5-13 % SL, rarely less than 11% SL; predorsal squamation reaching anteriorly beyond vertical through posterior margin of preopercle, often reaching posterior edge of postorbital blotch; first dorsal fin either with 1-4 dark blotches on each element forming 1-4 stripes across fin, or with one broad, dark brown longitudinal stripe across middle of fin; ventral portion of trunk with two rows of markings, upper row consisting of 7-8 dark blotches along lateral midline from beneath pectoral fin to point just anterior to markings on caudal peduncle, lower row typically consisting of 3 conspicuous dark spots – occasionally with diffuse 4<sup>th</sup> spot beginning beneath ventral portion of pectoral fin and terminating just anterior to origin of anal fin.

**Description:** First dorsal fin VI; second dorsal fin I,9; anal fin I,8; total caudal rays, including procurrent rays, 17 in dorsal lobe, 15 in ventral lobe (rarely 17/16 or 16/15); predorsal scale rows 18-21; cheek and operculum without scales; snout length 4.5-8.5% SL, slightly less than or roughly

equal to eye diameter; eye diameter 6.5-9.0%; lower jaw extending to vertical through center of pupil and often beyond this point; interorbital region narrow; HL 27.2-32.1% SL; snout profile convex; body depth at origin of first dorsal fin roughly one-fourth to one-fifth of SL, 16.0-24.5% SL; caudal peduncle depth 11.0-16.7% SL; pectoral fin slightly longer than head, usually reaching vertical through posterior margin of first dorsal fin, and sometimes beyond this point; dorsalmost 4-5 rays free from membrane, extent of branching highly variable (see "Discussion"); pelvic fin disk oval-shaped or slightly elliptical, extending to or just falling short of anus.

**Pigmentation:** Ventral portion of trunk with two rows of markings, upper row consisting of 7-8 dark blotches along lateral midline from beneath pectoral fin to point just anterior to markings on caudal peduncle, lower row typically consisting of 3 conspicuous dark spots, occasionally with diffuse 4<sup>th</sup> spot, beginning beneath ventral portion of pectoral fin and terminating just anterior to origin of anal fin; markings on trunk typically more distinct and horizontally elongate in small specimens; dorsal portion of body with 3 very pale dorsal saddles, barely distinguishable near and below lateral midline; background color of body pale; in life, scales often with yellow fringes giving appearance of very narrow zigzag shapes along body, this pattern often less apparent in specimens collected from dark substrates; basicaudal markings typically a pair of vertically oriented spots; paired spots separate from small spot at origin of dorsal procurrent caudal rays; first dorsal fin either with 1-4 dark blotches on each element forming 1-4 distinct longitudinal stripes across fin, or with one broad, dark brown, longitudinal stripe across fin; second dorsal fin pigmentation similar to first, but stripes sometimes less distinct as those on first dorsal fin; branched caudal fin rays with dark blotches of varying length, giving appearance of complete or partially broken vertical bars in life; anal fin lightly pigmented medially, becoming more densely pigmented distally, but often with very narrow pale margin at the distal edge; proximal portion of anal fin and overall background color of dorsal, caudal, and pectoral fins, light brown; in life, this light brown pigment tinged with yellow; fin color may be darker depending on the substrate over which specimens were collected; pelvic fin ranging from uniformly dusky to lightly pigmented or pale; pectoral fin base densely pigmented, often with two

concentrations of melanophores forming two distinct blotches, one above the other, continuing onto pectoral fin rays, fading distally; operculum speckled with melanophores; cheek often with two distinct dark blotches, each blotch slightly smaller in diameter than the pupil, anterior cheek blotch typically occurring at posterior margin of lower jaw, second slightly more posterior; third spot of same size sometimes present just posterodorsal to second spot; small, dark, distinct spot present at posteroventral corner of orbit; jaws and snout with scattered melanophores, sometimes giving those areas mottled appearance; configuration of postorbital blotch highly variable among populations, typically either round or oval in shape, but may be divided by sensory canal into two blotches, one large and one much smaller; diameter of postorbital marking usually about 2/3 that of pupil; temporal marking very small, sometimes indiscernible, but typically present as pair of separate or loosely connected oblong spots; shoulder spot usually the same size as or slightly larger than postorbital blotch, variable in shape (sometimes dark iridescent shade of blue in life); gular, prepelvic, and branchiostegal regions dusky to lightly pigmented; abdomen very lightly pigmented or completely pale.

**GenBank accession number for COI sequence of holotype:** HM748393

**Habitat:** This species' habitat preference may be slightly more restricted than that of other species of *Bathygobius* in the region. *Bathygobius antillensis* has been collected primarily from reef crests and from shallow tidepools on exposed beaches, where it typically co-occurs with *B. mystacium* and *B. lacertus*. A single specimen was collected co-occurring with three species, *B. geminatus*, *B. lacertus*, and *B. saporator*, from a sheltered rocky shoreline near an irrigation canal in Puerto Rico.

**Distribution:** DNA voucher specimens for this study were collected from Belize, Tobago, Curaçao, Turks and Caicos, Puerto Rico, and the Bahamas. Museum specimens from Antigua, Grand Cayman, Jamaica, Cuba, Swan Island, Florida Keys, Great Corn Island off the coast of Nicaragua, Utila Island off the coast of Honduras, and Rocas Atoll appear to fit the description of this species as well, although it has been suggested that populations from the Rocas Atoll may represent an undescribed species or subspecies that is genetically distinct from populations in the Caribbean (Lima et al. 2005). *Bathygobius antillensis* is the most common



western Atlantic *Bathygobius* species collected from insular and continental islands in the Caribbean. The single record of this species in our study from the continental mainland is an 11 mm SL specimen from Venezuela. Specimens from Belize are not from the mainland, but rather from offshore islands. This species also may occur off continental Columbia, as the illustration of Colombian "*B. saporator*" in Garzon-Ferriera & Acero (1992) appears to be *B. antilliensis*.

**Discussion:** *Bathygobius antilliensis* is one of several genetic lineages in our study that fit Ginsburg's (1947) redescription of *B. saporator*. It is widespread in museum collections from throughout the Caribbean under the name *B. saporator*, often occurring in mixed lots with *B. lacertus* and *B. mystacium*. Despite its abundance in collections, the morphological characters that diagnose this lineage (trunk pigmentation, extent of predorsal squamation, pigment pattern on first dorsal fin) are not present or are indiscernible in the name-bearing types of the valid species of *Bathygobius* or their synonyms. We therefore have described this lineage as a new species.

**Comparisons:** *Bathygobius antilliensis* is morphologically similar to *B. lacertus* and *B. saporator* in having a high number of lateral scale rows and pectoral fin rays (18-21) and in having a long upper jaw (rarely less than 11% SL). It can be distinguished from *B. lacertus* in most cases in having more extensive predorsal squamation (usually extending anteriorly beyond a vertical through the posterior margin of the preopercle in *B. antilliensis* vs extending to and rarely beyond the vertical in *B. lacertus*). It is distinguished from all western Atlantic *Bathygobius* by the spotting pattern along the body: specifically the incomplete row of 3-4 spots ventral to a row of 7-8 spots along lateral midline. It further differs from *B. saporator* in having a longitudinal pigment pattern across the first dorsal fin (vs a broad vertical or slightly diagonal bar) and by the basicaudal spotting (a pair of separate or loosely connected spots one above the other in *B. antilliensis* vs a large irregularly shaped blotch often reaching dorsal midline in *B. saporator*).

This species exhibits a wide degree of variation in terms of branching of the free pectoral fin rays. Some specimens from Belize have the three uppermost rays branched once and the 4<sup>th</sup> ray branched more than once. In a population from Puerto Rico, nearly all of the samples have bifurcate or multifurcate 4<sup>th</sup> pectoral fin rays, with some of them of

them having bifurcate 2<sup>nd</sup> and 3<sup>rd</sup> pectoral rays. Samples from Jamaica, Cuba, Swan Island and the Bahamas contain some specimens with rays 1-3 branched more than once and others with rays 1-3 branched once. In addition to variation at the population level, many individuals of both sexes from each population have different branching patterns on the right pectoral fin versus the left. *Bathygobius ramosus* from the eastern Pacific, a species that is genetically similar to *B. antilliensis*, is also diagnosed from other eastern Pacific species in having more extensive pectoral fin branching (Miller & Stefanni 2001). The dorsalmost 3-4 pectoral fin rays typically branch once in eastern Pacific and western Atlantic *Bathygobius*. The more extensive branching pattern may be a synapomorphy uniting *B. ramosus* and *B. antilliensis* as sister taxa.

**Etymology:** The epithet *antilliensis*, an adjective formed from the proper noun "Antilles," is in reference to the islands of the Antilles, which constitute most of the known range of this species and the region where this species is most abundant. "Frillfin" is commonly used for *Bathygobius* gobies (Nelson et al. 2004) and is in reference to the free pectoral fin rays in the dorsal portion of the fin.

***Bathygobius curacao* (Metzelaar, 1919)**  
Notchtongue goby (Figs 2, 4)

*Gobius curacao* Metzelaar, in Metzelaar 1919: 136, Fig 38 (type locality Curacao and Bonaire Islands)

? *Bathygobius curacao lepidopoma* Ginsburg, in Ginsburg, 1947: 278 (type locality Newfound Bay, Florida)

**Material Examined:** DNA voucher specimens: AMNH 251644, DNA #VEN3a, 31 mm SL, Carabobo, Venezuela, 26 June 2007, J. Van Tassell, D.R. Robertson and J. Posada. AMNH 251644, DNA #VEN3b, 24 mm SL, Carabobo, Venezuela, 26 June 2007, J. Van Tassell, D. R. Robertson and J. Posada. USNM 397561, DNA #BLZ6066, 32 mm SL, Twin Cays, Belize, 1 April 2006, C. Baldwin, L. Weigt and R. Murphy. USNM 397562, DNA #TOB9399, 29 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397563, DNA #TOB9400, 29 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397564, DNA #TOB9401, 29 mm SL, Petit Trou, Tobago, 20

March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397565, DNA #TOB9403, 21 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton.

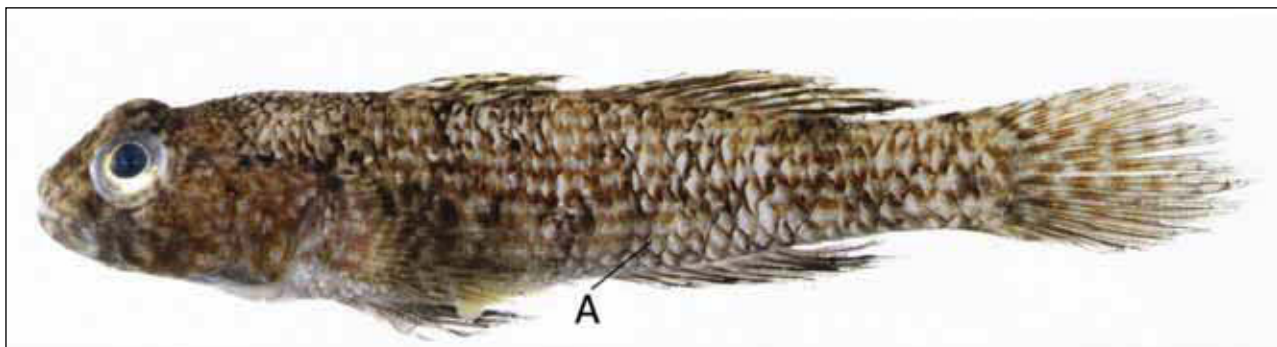
COI sequences with no voucher specimens: BLZ4052, larva, Carrie Bow Cay, Belize, 21 February 2004, C. Baldwin and J. Mounts. BLZ4074, larva, Carrie Bow Cay, Belize, 22 February 2004, C. Baldwin and J. Mounts. BLZ4154, 10.5 mm SL, photographed, Carrie Bow Cay, Belize, 26 February 2004, C. Baldwin and J. Mounts. BLZ5128, 5 mm SL, photographed, Carrie Bow Cay, Belize, 26 April 2005, C. Baldwin and J. Mounts. BLZ5505, 6 mm SL, photographed, Carrie Bow Cay, Belize, 10 May 2005, C. Baldwin, L. Weigt, and Murphy. BLZ6039, 6 mm SL, photographed, Carrie Bow Cay, Belize, 31 March 2006, C. Baldwin, L. Weigt and Murphy. BLZ6428, 6 mm SL, photographed, Carrie Bow Cay, Belize, 17 April 2006, D. Smith, J. Mounts and A. Driskell. BLZ6430, 6 mm SL, photographed, Carrie Bow Cay, Belize, 17 April 2006, D. Smith, J. Mounts and A. Driskell. BLZ6447, 11 mm SL, photographed, Carrie Bow Cay, Belize, 18 April 2006, D. Smith, J. Mounts and A. Driskell. BLZ7023, 6 mm SL, photographed, Carrie Bow Cay, Belize, 11 January 2007, D. Smith, J. Mounts and A. Driskell. BLZ7193, 6 mm SL, photographed, Carrie Bow Cay, Belize, 17 January 2007, C. Baldwin, D. Smith, L. Weigt and J. Mounts. BLZ7259, 6 mm SL, photographed, Carrie Bow Cay, Belize, 18 January 2007, C. Baldwin, D. Smith, L. Weigt and J. Mounts. BLZ7260, 6 mm SL, photographed, Carrie Bow Cay, Belize, 18 January 2007, C. Baldwin, D. Smith, L. Weigt and J. Mounts. BLZ7305, 5.5 mm SL, photographed, Carrie Bow Cay, Belize, 20 January 2007, C. Bald-

win, D. Smith, L. Weigt and J. Mounts. BLZ7306, 5.5 mm SL, photographed, Carrie Bow Cay, Belize, 20 January 2007, C. Baldwin, D. Smith, L. Weigt and J. Mounts. BLZ7307, 6 mm SL, photographed, Carrie Bow Cay, Belize, 20 January 2007, C. Baldwin, D. Smith, L. Weigt and J. Mounts.

**Additional specimens:** MCZ 44621, 5, 26-34 mm SL, Juan Chiquita, Panama. UF 18341, 22, 18-32 mm SL, Andros Islands, Bahamas. UF 201839, 30, 15-33 mm SL, Virginia Key, Florida. ZMA 111890, *Gobius curacao* syntypes, Curacao and Bonaire Islands. USNM 57452, *Bathygobius curacao lepidopoma* holotype, 55 mm SL, Newfound Bay, Florida.

**Diagnosis:** Pectoral fin rays 16-17 (rarely 15 or 18); lateral scale rows 31-36; upper jaw length 11.1-15.0 % SL; predorsal squamation extending anteriorly to vertical through posterior margin of preopercle, sometimes slightly beyond this point; body variously covered in dark blotches, sometimes loosely forming 6-7 diffuse dark blotches of varying size down body, but trunk typically with no apparent diagnostic pattern of pigment.

**Description:** First dorsal fin VI; second dorsal fin I,9; anal fin I,8; total caudal fin rays, including procurrent rays 16 in dorsal lobe, 15 in ventral lobe (rarely 17/15 or 16/16); predorsal scales 17-20; cheek and operculum typically without scales; snout length 4.5-7.0% SL, slightly less than eye diameter; eye diameter 7.5-11.0% SL; lower jaw typically extending to or slightly beyond vertical through center of pupil; HL 27.5-36.0% SL; slope of snout more or less convex; body depth at origin of first dorsal fin 21.4-24.8% SL; caudal peduncle depth 11.0-14.0% SL; pectoral fin reaching vertical through posterior margin of first dorsal fin; dorsalmost 3-4 pectoral rays free from membrane,



**Fig. 4.** *Bathygobius curacao*, 29 mm SL, Petit Trou, Tobago, DNA #TOB9399, USNM 397562. A. ventral portion of trunk with no distinct markings. Photo by C. Baldwin and L. Weigt. Image editing by L. Tornabene.

each free pectoral ray usually branching once; pelvic fin disk oval-shaped or slightly elliptical, extending to or just falling short of anus.

**Pigmentation:** Trunk variously covered in dark blotches, sometimes 6-7 diffuse dark blotches of varying size evident, but trunk typically with no apparent diagnostic pattern of pigment; dorsal half of trunk often with 3-4 dark saddles that may fade in preservation; background of body pale; first dorsal fin with 2-3 dark blotches on each element, giving appearance of 2-3 longitudinal stripes across fin; second dorsal fin with 3-4 dark blotches on each element typically forming 3-4 longitudinal stripes (often incomplete or broken) across fin; anal fin dusky to lightly pigmented; caudal fin variously pigmented, often possessing 1-4 blotches on each branched ray, forming 3-4 vertical bars; basicaudal pigment highly variable, ranging from inconspicuous irregular dark blotch to series of three connected spots arranged in triangular shape; pelvic fin pale to uniformly dusky; pectoral fin base covered with melanophores, sometimes forming dark blotches of varying shape and size; postorbital spot somewhat small, round or slightly oblong; temporal blotch present as two tiny distinctly separated or loosely joined spots; shoulder spot larger than postorbital or temporal spots, least defined, and most irregular in shape; operculum, and cheek uniformly pigmented or blotchy with no consistent patterns; gular, branchiostegal, and pre-pelvic regions sparsely or densely covered in melanophores; abdomen usually pale.

**Habitat:** In the Bahamas this species is reportedly taken in sheltered bay habitats with *B. saporator*, as opposed to exposed shorelines where *B. mystacium* typically occurs (Bohlke & Chaplin 1993). *Bathygobius curacao* specimens in this study were collected from shallow sheltered shorelines with rock and turtle grass, and around muddy substrate near mangrove roots. The only species in our study with which adult specimens of *B. curacao* have been collected is *B. lacertus*, both taken from mangroves in Tobago.

**Distribution:** Specimens in this study were collected from Belize, Tobago, and Venezuela. Museum records exist from the Florida Keys, the Bahamas, Panama, Nicaragua and the U.S. Virgin Islands.

**Discussion:** The subspecies *B. curacao curacao*, and *B. curacao lepidopoma* were described from the western Atlantic, the latter being distinguished from the former in most cases in having a patch of

1-8 scales on the anterodorsal corner of the opercle and a patch of scales on the cheek (Ginsburg 1947). The subspecies *B. curacao lepidopoma* was described from the holotype and 10 other individuals, all of which were collected from near Key West, Florida. Specimens of *B. curacao* used in our genetic analysis had no scales on the opercle or the cheek. Although we did not collect *B. curacao* from near the *B. curacao lepidopoma* type locality, we found no evidence of significant genetic divergence among populations of *B. curacao* from Belize, Tobago, and Venezuela. Further sampling from near Key West is needed to verify the presence of multiple subspecies of *B. curacao*.

**Comparisons:** *Bathygobius curacao* is quite different both morphologically and genetically from the other species of *Bathygobius* in the Western Atlantic. Typically it can be distinguished from all other species in the region by the absence of distinctive trunk pigmentation; from all except *B. mystacium* and *B. geminatus* in having a lower modal number of pectoral fin rays (15-17 in *B. curacao*, 18 or higher in *B. lacertus*, *B. saporator*, *B. antilliensis*); from *B. mystacium* in most cases in having less extensive predorsal squamation (predorsal squamation extending anteriorly to vertical through posterior margin of preopercle vs extending well anterior to the posterior margin of the preopercle); and from *B. lacertus*, *B. saporator*, *B. antilliensis*, and *B. geminatus* in having fewer lateral scale rows (31-36 in *B. curacao* vs more than 36 in other species).

### *Bathygobius geminatus* n. sp. Tornabene, Baldwin & Pezold

Twin-spotted frillfin (Figs 2, 5)

**Holotype:** USNM 398105, DNA # FLA 9010, female, 33 mm SL, north-east end of bridge on highway A1A, Indian River, Sewall's Point, Florida, United States, 30 October 2009, C. Baldwin and A. Vaslet.

**Paratypes:** AMNH 251648, DNA #PR1189, 20 mm SL, La Boca, Barceloneta, Puerto Rico, 25 May 2009, L. Tornabene and R. Chabarría. 398102, DNA #FLA7467, 28 mm SL, from holotype locality, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 398103, DNA #FLA7498, 20 mm SL, from holotype locality, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, Yanosh, Taylor and J. Bagley. USNM 398106, DNA #FLA9011,

24.5 mm SL, from holotype locality, Florida. USNM 398107, DNA #FLA9015, 36 mm SL, from holotype locality, Florida, 30 October 2009, C. Baldwin and A. Vaslet. USNM 398109, DNA #FLA9017, 28 mm SL, from holotype locality, Florida, 30 October 2009, C. Baldwin and A. Vaslet. USNM 398112, DNA #FLA9021, 26 mm SL, from holotype locality, Florida, 30 October 2009, C. Baldwin and A. Vaslet.

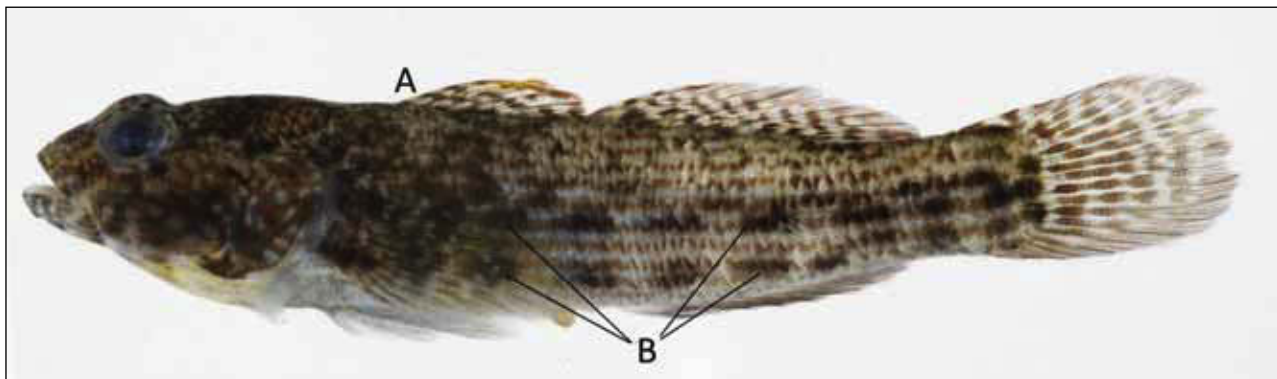
**Additional non-type specimens:** USNM 398101, DNA sequence #FLA7466, 38 mm SL, holotype locality, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 398104, DNA #FLA9009, 33 mm SL, holotype locality, Florida, 30 October 2009, C. Baldwin and A. Vaslet. USNM 398108, DNA #FLA9016, 34 mm SL, holotype locality, Florida, 30 October 2009, C. Baldwin and A. Vaslet. USNM 398110, DNA #FLA9019, 35 mm SL, holotype locality, Florida 30 October 2009, C. Baldwin and A. Vaslet. USNM 398111, DNA #FLA9020, 36.5 mm SL, holotype locality, Florida, 30 October 2009, C. Baldwin and A. Vaslet.

**Diagnosis:** Pectoral rays 17-18; lateral scale rows 36-38 (modally 37); upper jaw length 10.3-10.7% SL; anterior extent of predorsal squamation reaching anteriorly to vertical through posterior margin of preopercle, with a few scales sometimes extending slightly beyond this point; first dorsal fin elements with 2-3 dark blotches on each element giving appearance of 2-3 longitudinal stripes across fin; lower body with two rows of dark spots, spots in two rows directly above one another, beginning immediately behind pectoral fin base and terminating just anterior to dark blotch at base of caudal

fin; upper and lower spots more distinctly separate from one another anteriorly, becoming closer to one another and loosely connected posteriorly; arrangement of spots appearing as 6 to 7 sets of vertically paired spots often forming “=” shaped markings along ventral portion of trunk.

**Description:** First dorsal fin VI; second dorsal fin I,9; anal fin I,8; total caudal fin rays, including procurent rays 15-17 in dorsal lobe of fin, 14-15 in ventral lobe; predorsal scales 17-20; cheek and operculum without scales; snout length 6.0-7.5% SL, slightly less than eye diameter; eye diameter 8.1-9.9% SL; lower jaw typically extending to vertical through center of pupil, rarely beyond this point; interorbital region narrow; HL 28.8-32.1% SL; snout profile slightly convex; body depth at origin of first dorsal fin 19.0-22.5 % SL; caudal-peduncle depth 11.3-12.1 % SL; pectoral fin slightly longer than head, usually extending posteriorly beyond vertical through posterior margin of first dorsal fin, sometimes reaching below origin of second dorsal fin; dorsalmost 4 rays of pectoral fin free from membrane, with first 3-4 rays branching only once, the fourth sometimes branching more than once; pelvic fin disk oval-shaped or slightly elliptical, extending to or just falling short of anus.

**Pigmentation:** lower body with two rows of dark spots, spots in two rows directly above one another, beginning immediately behind pectoral fin base and terminating just anterior to dark blotch at base of caudal fin; upper and lower spots more distinctly separate from one another anteriorly, becoming closer to one another and loosely connected posteriorly; net effect of arrangement of spots is 6 to 7 sets of vertically paired spots often forming “=” shaped markings along ventral por-



**Fig. 5.** *Bathygobius geminatus*, holotype, 37 mm SL, female, Sewall's Point, Florida, DNA #FLA9010, USNM 398105; **A.** longitudinal pattern of pigment on first dorsal fin; **B.** two rows of 6-7 dark blotches along body, blotches one directly above the other. Photo by C. Baldwin. Image editing by L. Tornabene.



tion of trunk; body with three broad dorsal saddles, saddles not extending ventrally beyond lateral midline; each saddle sometimes possessing small, shallow, narrow pale band in center sometimes giving impression of 6 narrow dark bands when viewed from above; first dorsal fin elements with 2-3 dark blotches on each element giving appearance of 2-3 longitudinal stripes crossing fin; second dorsal fin with 2-4 dark blotches on each element forming 2-4 longitudinal stripes across fin; anal fin dusky with pigmentation becoming darker distally; branched caudal fin rays with 2-4 dark spots on each ray often producing vertical bands crossing caudal fin; pelvic fins uniformly covered with lightly scattered melanophores; pectoral fin base densely covered with melanophores; pectoral fin ray membranes with lightly scattered melanophores; postorbital blotch small and somewhat round, distinctly smaller in diameter than pupil; temporal blotch similar in size to postorbital blotch, though slightly more elongate; shoulder spot slightly larger than both temporal and postorbital spots, with irregular shape; operculum with pair of dark blotches one above the other, similar in appearance to diagnostic blotches on trunk; head with small dark spot on posteroventral margin of orbit and scattered dark blotches on cheek and jaws; abdomen and prepelvic region pale, (sometimes reflecting bluish pigment in fresh specimens); gular region usually lightly pigmented with scattered melanophores.

**GenBank accession number for COI sequence of holotype:** HM748368



**Fig. 6.** Type locality of *Bathygobius geminatus*, north-east end of bridge on highway A1A, Sewall's Point, Florida, United States. Photo by C. Baldwin.

**Habitat:** Specimens of this species were collected in Florida along rocky and sandy shorelines with seagrass in a sheltered bay, along with *B. saporator*. A single specimen was collected on a sheltered rock and pebble shoreline near the mouth of an irrigation canal in Puerto Rico, along with *B. saporator*, *B. lacertus* and a single specimen of *B. antilliensis*.

**Distribution:** This species is currently only known from the type locality and the surrounding region, as well as a single locality on the northern coast of Puerto Rico. A photograph of a *Bathygobius* specimen from Brazil on FishBase, (<http://www.fishbase.org>) (Froese & Pauly 2009) is labeled as *B. mystacium*, but possesses the distinct body markings that are diagnostic of *B. geminatus*. We have not examined these particular specimens and it remains unclear as to which *Bathygobius* species occur in Brazil.

**Discussion:** Scales in this species are fairly deciduous and for many specimens we were forced to rely on counting scale pockets. Thus the numbers of predorsal scales and lateral scale rows should be regarded primarily as approximate ranges. As noted previously, *B. geminatus* comprises two genetic lineages (Fig. 1); only specimens from the lineage containing the holotype were designated as paratypes to avoid confusion in the event that the two lineages are recognized as distinct species in the future.

**Comparisons:** *Bathygobius geminatus* can be distinguished from all other *Bathygobius* in the region by its distinctive ventral trunk pigmentation, though some specimens of *B. saporator* have a slightly similar spotting pattern anteriorly. It can be further distinguished from *B. saporator* in having a longitudinal pigmentation pattern on the first dorsal fin as opposed to a broad vertical or slightly diagonal pattern, and from all other species in the region except *B. mystacium* by its relatively short upper jaw (typically less than 10.7 % SL in *B. geminatus* vs. >10.9 % SL in *B. antilliensis*, *B. saporator*, *B. curacao*, *B. lacertus*). *Bathygobius geminatus* can be further distinguished from *B. mystacium* and *B. antilliensis* in most cases in having less extensive predorsal squamation and from *B. curacao* in having more lateral scale rows (36-38 in *B. geminatus* vs. 31-36 in *B. curacao*).

**Etymology:** The epithet *geminatus*, past-participle of the latin verb "geminare", meaning paired, doubled, or repeated, is in reference to the diagnostic pattern of vertically paired spots that are repeated 6-7 times laterally along the body of this



species. We give the new species the common name of “twin-spotted frillfin” in reference to the paired markings on the trunk.

***Bathygobius lacertus* (Poey, 1860)**

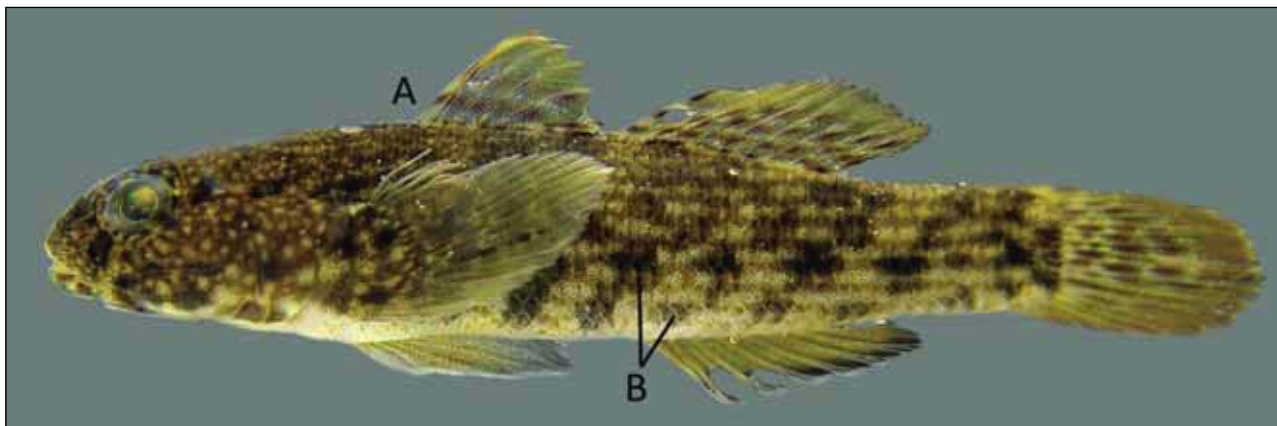
(Figs 2, 7)

*Gobius lacertus* Poey, in Poey, 1860: 278 (type locality Cuba).

? *Bathygobius saporator sextaneus* Ginsburg, in Ginsburg, 1947: 280 (type locality Bermuda)

**Specimens Examined:** DNA voucher specimens: AMNH 251634, DNA #PAN16a, 50 mm SL, Ensenada Indio, Panama, 28 May 2007, J. Van Tassell, D.R. Robertson, B. Victor, E. Pena and L. Tornabene. AMNH 251635, DNA #CUR13a, 29 mm SL, Piscadera Baai, Curacao, 9 February, 2005, J. Van Tassell et al. AMNH 251636, DNA #FLK6a, 62 mm SL, Fiesta Key, Florida, 17 June 2006, J. Van Tassell, C. Anderson and J. Holmes. AMNH 251637, DNA #FLK2a, 64 mm SL, Key West, Florida, 6 January 2004, J. Van Tassell and J. Maniscalco. AMNH 251649, DNA #PR1196, 33 mm SL, La Boca, Barceloneta, Puerto Rico, 25 May 2009, L. Tornabene and R. Chabarria. AMNH 251653, DNA #PR1416, 53 mm SL, shoreline north of airport, San Juan, Puerto Rico, 1 June 2009, L. Tornabene and R. Chabarria. AMNH 251656, DNA #PR1543, 68 mm SL, beach along Hwy 3, Patillas, Puerto Rico, 8 June 2009, L. Tornabene and R. Chabarria. AMNH 251656, DNA #PR1544, 36 mm SL, beach along Hwy 3, Patillas, Puerto Rico 8 June 2009, L. Torn-

abene and R. Chabarria. AMNH 251656, DNA #PR1546, 39 mm SL, beach near Hwy 3, Patillas, Puerto Rico, 8 June 2009, L. Tornabene and R. Chabarria. AMNH 251656, DNA# 1549, 27 mm SL, beach near Hwy 3, Patillas, Puerto Rico, 8 June 2009, L. Tornabene and R. Chabarria. USNM 397568, DNA #BAH9121, 47 mm SL, Hawk's Nest Island off Great Harbour Cay, Bahamas, 27 July 2009, C. Baldwin. USNM 397569, DNA #BAH9122, 42 m SL, Hawk's Nest Island off Great Harbour Cay, Bahamas, 27 July 2009, C. Baldwin. USNM 397570, DNA #BLZ7218, 48 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, A. Driskell and J. Mounts. USNM 397571, DNA #TOB9393, 42 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397572, DNA #TOB9394, 37 mm SL, Tobago. USNM 397573, DNA #TOB9395, 31 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397574, DNA #TOB9396, 35 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397575, DNA #TOB9397, 35 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397576, DNA #TOB9398, 32 mm SL, Petit Trou, Tobago. USNM 397577, DNA #TOB9402, 25 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton. USNM 397578, DNA #TOB9404, 24 mm SL, Petit Trou, Tobago, 20 March 2009, C. Baldwin, D. Smith, L. Weigt, D. Rousseau and Langton.



**Fig. 7.** *Bathygobius lacertus*, 39 mm SL, beach near Hwy 3, Patillas, Puerto Rico, DNA #PR1546, AMNH 251656; A. Longitudinal pattern of pigment on first dorsal fin; B. two rows of 6-7 blotches along body, blotches in upper and lower rows offset from one another forming a checker-board pattern; blotches extending posteriorly to caudal peduncle, those in lower row becoming diffuse posteriorly. Photo by R. Chabarria. Image editing by L. Tornabene.

COI sequences with no voucher specimens: BLZ4001, larva, photographed, Carrie Bow Cay, Belize, 18 February 2004, C. Baldwin and J. Mounts. BLZ7370, 6 mm SL, photographed, Carrie Bow Cay, Belize, 20 January 2007, C. Baldwin, D. Smith, L. Weigt and J. Mounts. BLZ4184, 68 mm SL, Carrie Bow Cay, Belize, 18 February 2004, C. Baldwin and J. Mounts.

**Additional specimens:** GCRL V70:5049, 8, 20-42 mm SL, Isla Mujeres, Mexico. USNM 360525, 39, 23-43 mm SL, Pelican Bay, Belize. USNM 120413, *Gobius lacertus* holotype, 74 mm SL, Cuba. USNM 21231, *Bathygobius soporator sextaneus* holotype, 103 mm SL, Bermuda.

**Diagnosis:** Pectoral fin rays 18-20 (modally 19); lateral scale rows 38-42; upper jaw length 12.5-15.9 % SL; first dorsal fin with 1-4 dark blotches on each spine, producing 1-4 distinct longitudinal stripes of pigment, stripes fading distally; predorsal squamation reaching anteriorly to vertical through posterior margin of preopercle, sometimes extending slightly beyond this point or falling short just short of it, rarely reaching postorbital spots; trunk with two offset rows of 6-7 dark blotches ventrally, often forming distinctive pattern resembling alternating dark squares on a checkerboard; first row positioned just below lateral midline and extending from beneath pectoral fin to caudal fin base; second row of spots offset from first, positioned just above ventral midline and extending from beneath pectoral fin to caudal fin base; spots in lower row typically more diffuse than spots in upper row, becoming more diffuse posteriorly.

**Description:** First dorsal fin VI; second dorsal fin I,9; anal fin I,8; total caudal fin rays, including procurrent rays, 17 in dorsal lobe, 15-16 in ventral lobe; predorsal scales 17-20; cheek and operculum without scales; snout length 6.2-9.1 % SL, slightly less than eye diameter; eye diameter 8.5-11.0 % SL; lower jaw typically extending past vertical through center of pupil and often to posterior margin of orbit; interorbital region narrow; HL 31.1-39.0 % SL; snout profile convex; body depth at origin of first dorsal fin 19.6-24.5 % SL; caudal peduncle depth 12.1-15.25 % SL; pectoral fin reaching or extending slightly beyond vertical through posterior margin of first dorsal fin; dorsalmost 4 (rarely 3 or 5) pectoral fin rays free from membrane, each free ray typically branching once until ray 5; pelvic fin disk oval-shaped or elliptical, extending to or just falling short of anus.

**Pigmentation:** Trunk with two offset rows of 6-7

dark blotches ventrally, both rows beginning beneath pectoral fin and terminating just before basicaudal markings; spots in two rows offset from one another, forming checkerboard pattern; spots in ventral row typically more diffuse than those in upper row and becoming more diffuse posteriorly; dorsal portion of body with 3 very faint dorsal saddles, rarely distinguishable near and below lateral midline; body background color pale; in life, scales often with yellow fringes, which may be less apparent in specimens collected from darker colored substrates; first dorsal fin with 1-4 dark blotches on each element, giving appearance of 1-4 distinct longitudinal stripes of pigment across fin, stripes fading somewhat distally; second dorsal fin with pigment pattern similar to that of first, with 2-4 dark blotches on each element forming 2-4 dark longitudinal stripes across fin; branched caudal fin rays with dark blotches of varying length, giving appearance of broken vertical bars across fin; anal fin with scattered melanophores, spots becoming more concentrated distally; proximal portion of anal fin and overall background color of dorsal, caudal and pectoral fins light brown; in life, this light-brown coloration tinged with yellow, but fins may be darker in specimens collected from dark substrates; pelvic fin ranging from uniformly dusky to lightly pigmented or pale; pectoral fin base densely pigmented, often with two concentrations of melanophores forming two distinct blotches, one above the other; pigment on pectoral fin base continuing onto pectoral rays, becoming scattered and pale distally; opercle and preopercle covered with melanophores, variously mottled, or with no discernable pattern; small, dark distinctive spot present at posteroventral corner of eye; jaws and snout with scattered melanophores, sometimes appearing distinctly mottled; postorbital blotch divided as pair of small dark blotches, dorsal marking round or bell-shaped and directly above sensory canal, ventral marking small, oval or horizontally elongate, positioned just below sensory canal; temporal blotch present as pair of small, separate or loosely connected, round to oblong spots, each roughly same size as ventral postorbital blotch; shoulder spot above pectoral fin base larger than both temporal and postorbital spots, with irregular shape and diffuse border; gular, pre-pelvic, and branchiostegal regions dusky to lightly pigmented; abdomen very lightly pigmented or completely pale.

**Habitat:** This species exhibits a diversity of habitat preferences, and has been taken from shallow

warm pools formed in limestone on exposed beaches with moderate wave action, from sheltered intertidal pools on rock and pebble shorelines of bays or coves, on reef crests, and over silt and mud around mangrove roots. It has been collected with *B. curacao*, *B. soporator*, *B. antilliensis*, *B. mystacium* and *B. geminatus*.

**Distribution:** The *B. lacertus* specimens investigated in our study were collected from Tobago, Belize, Panama, Curacao, Puerto Rico, the Bahamas, and the Florida Keys. Additional museum specimens of this species were examined from Mexico (Isla Mujeres) and Bermuda.

**Discussion:** *Bathygobius lacertus* is one of several *Bathygobius* lineages identified in this study that fits Ginsburg's (1947) redescription of *B. soporator* in having high numbers of pectoral fin rays and lateral scale rows and a long upper jaw. *Gobius lacertus* (Poey, 1860) was described from Cuba, and although the term "type" or "holotype" was never used in reference to a specific specimen, the description was said to be based on an "individu décrit" translated as a single "described individual" for which the total length was given (Poey 1860). Howell-Rivero (1938) recognized this specimen as the holotype for *G. lacertus*. Based on Article 73.1.1 of the International Code of Zoological Nomenclature (ICZN) (International Commission on Zoological Nomenclature 1999) we interpret Howell-Rivero's action as correct. The original description makes no reference to any other specimens, therefore the only specimen in the type series is the holotype. Though somewhat faded, the trunk pigmentation on the *G. lacertus* holotype closely resembles the diagnostic offset spotting pattern of the specimens in our lineage 1 (Fig. 1). Furthermore, the predorsal squamation in the *G. lacertus* holotype, which extends slightly anterior to the posterior margin of the preopercle but falls well short of the postorbital blotches, matches the anterior extent of predorsal squamation in our specimens of this lineage. Pigmentation on the first dorsal fin is completely faded in the holotype, so we cannot assess the presence or absence of the vertical or diagonal bar of pigment on that fin diagnostic of *B. soporator* (see *B. soporator* discussion); however, the two characters mentioned above leave little doubt that our voucher specimens from lineage 1 and the *G. lacertus* holotype are the same species.

The holotype of *B. soporator sextaneus* also possesses two parallel rows of spotting on the trunk

anteriorly, but the pattern is faded posteriorly, and we cannot determine if the lower row of trunk spots is complete (*B. lacertus*) or incomplete (as in *B. antilliensis*). Pigment on the first dorsal fin and the anterior extent of predorsal squamation in *B. soporator sextaneus* are similar to those of *B. lacertus*, and we consider *B. soporator sextaneus* a possible synonym of *B. lacertus*.

**Comparisons:** The two offset rows of 6-7 pigment spots on the lower portion of the trunk separates *B. lacertus* from all other western Atlantic species. The trunk pigment of *B. antilliensis* is most similar, but the lower row of spots in that species is abbreviated, rarely extending beyond the origin of the anal fin and rarely exceeding 3 spots in number. The anterior extent of predorsal squamation distinguishes *B. lacertus* from *B. antilliensis* and *B. soporator* in most cases, but this character is somewhat variable, and there is a small degree of overlap among the species. *Bathygobius lacertus* is easily distinguished from *B. soporator* by the longitudinal stripes of pigment on the first dorsal fin (vs. a broad vertical or diagonal bar); from *B. curacao* in having more pectoral fin rays (18-20 vs. 15-17) and lateral scale rows (38-42 vs. 31-36); and from *B. mystacium* in having more lateral scale rows (38-42 vs. 33-36), a longer upper jaw (12.5-15.9% SL vs. 9.2-11% SL), and in having a less steep snout profile. *Bathygobius lacertus* can be distinguished from *B. geminatus* in having a longer upper jaw (12.5-15.9% SL vs. 10.3-10.7% SL) and in the configuration of the body spots, as *B. lacertus* possesses two offset rows and *B. geminatus* possesses two rows one directly above the other.

### ***Bathygobius mystacium* Ginsburg, 1947** Island frillfin (Figs 2, 8)

*Bathygobius mystacium* Ginsburg, 1947: 275 (type locality Nassau, Bahamas)

**Materials examined:** DNA voucher specimens: AMNH 251652, DNA #PR1408, 33 mm SL, public beach in Old San Juan, Puerto Rico, 1 June 2009, L. Tornabene and R. Chabarria. AMNH 251652, DNA #PR1410, 21 mm SL, public beach in Old San Juan, Puerto Rico, 1 June 2009, L. Tornabene and R. Chabarria. AMNH 251654, DNA #PR1418, 38 mm SL, shoreline north of airport, San Juan, Puerto Rico, 1 June 2009, L. Tornabene and R. Chabarria. AMNH 251655, DNA #PR1508, 49 mm SL, public beach in Ponce,

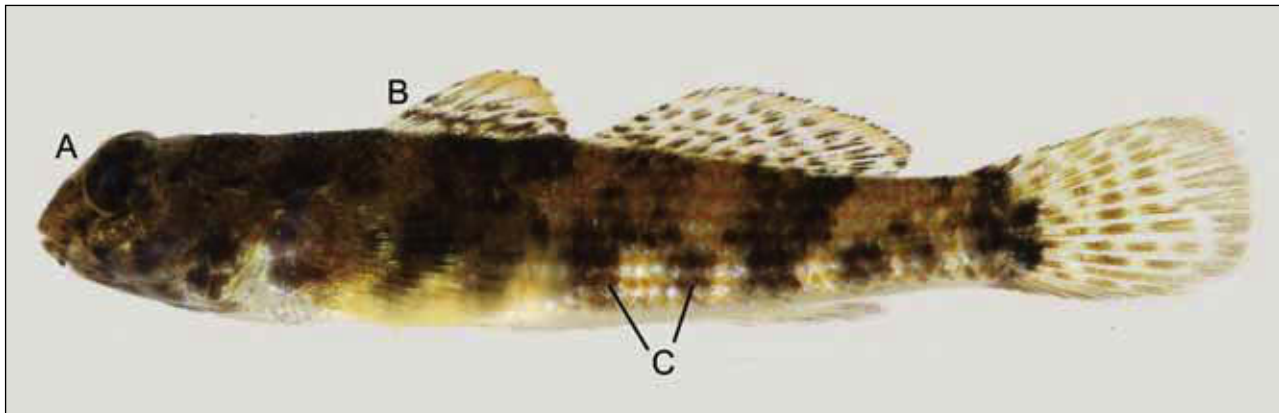
Puerto Rico, 6 June 2009, L. Tornabene and R. Chabarría. USNM 398079, DNA #BAH9124, 28 mm SL, Hawk's Nest Island off Great Harbour Cay, Bahamas, 27 July 2009, C. Baldwin. USNM 398080, DNA #BLZ4137, 47 mm SL, Carrie Bow Cay, Belize, 26 February 2004, C. Baldwin. USNM 398081, DNA #BLZ5384, 40 mm SL, Carrie Bow Cay, Belize, 5 May 2005, C. Baldwin. USNM 398082, DNA #BLZ5385, 16 mm SL, Carrie Bow Cay, Belize, 5 May 2005, C. Baldwin. USNM 398083, DNA #BLZ5433, 15 mm SL, Carrie Bow Cay, Belize, 7 May 2005, C. Baldwin. USNM 398084, DNA #BLZ5435, 21 mm SL, Carrie Bow Cay, Belize, 7 May 2005, C. Baldwin. USNM 398085, DNA #BLZ6419, 29 mm SL, Carrie Bow Cay, Belize, 17 April 2006, D. Smith, J. Mounds and A. Driskell. USNM 398086, DNA #BLZ7037, 63 mm SL, Carrie Bow Cay, Belize, 12 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398087, DNA #BLZ7038, 38 mm SL, Carrie Bow Cay, Belize, 12 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398088, DNA #BLZ7039, 37.5 mm SL, Carrie Bow Cay, Belize, 12 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398089, DNA #BLZ7041, 27 mm SL, Carrie Bow Cay, Belize, 12 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398090, DNA #BLZ7204, 56 mm SL, Carrie Bow Cay, Belize, collected 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398091, DNA #BLZ7208, 49 mm SL, Carrie Bow Cay, Belize, collected 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398092, DNA #BLZ7209, 48 mm SL, Carrie Bow Cay, Belize, collected 17 January 2007, D. Smith, J.

Mounds and A. Driskell. USNM, DNA #BLZ7210, 13.5 mm SL, Carrie Bow Cay, Belize, collected 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM, DNA #BLZ7215, 42 mm SL, Carrie Bow Cay, Belize, collected 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398095, DNA #BLZ7216, 29 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM, DNA #BLZ7219, 55 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398097, DNA #BLZ 7220, 47 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398098, DNA #BLZ7221, 44 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398099, DNA #BLZ7222, 44 mm SL, Carrie Bow Cay, Belize, 17 January 2007, D. Smith, J. Mounds and A. Driskell. USNM 398100, DNA #CUR8309, 26 mm SL, Blue Bay, Curacao, 14 March 2008, D. Smith.

COI sequences with no voucher specimens: BLZ7064, 43 mm SL, photographed, Carrie Bow Cay, Belize, 13 January 2007, D. Smith, J. Mounds, and A. Driskell. BLZ7065, 35 mm SL, photographed, Carrie Bow Cay, Belize, 13 January 2007, D. Smith, J. Mounds, and A. Driskell.

Additional specimens: UF 17675, 5, 29-36 mm SL, Grand Cayman, Cayman Isles. UF 18293, 17, 19-43 mm SL, Grand Cayman, Cayman Isles. USNM 119895, *B. mystacium* holotype, 57 mm SL, Nassau, Bahamas.

**Diagnosis:** Pectoral fin rays 17-20; lateral scale rows 33-36; upper jaw length typically 9.2-11.0%



**Fig. 8.** *Bathygobius mystacium*, 38mm SL, Carrie Bow Cay, Belize, DNA #BLZ7038, USNM 398087; A. head with short upper jaw and steeply sloped snout. B. longitudinal pigmentation pattern on first dorsal fin; C. large square to irregularly shaped blotches on ventral portion of trunk. Photo by J. Mounds and A. Driskell. Image editing by L. Tornabene.

SL (a single specimen with 11.7%); predorsal squamation reaching anteriorly well beyond vertical through posterior margin of preopercle; first dorsal fin pigmentation variable, typically 1-3 longitudinal stripes with pale distal border of varying width, but sometimes uniformly dusky in larger specimens; trunk with 3 dorsal saddles sometimes reaching lateral midline and row of 6 large square to irregularly shaped blotches beneath lateral midline ranging in size from slightly larger than pupil to as large as or larger than orbit.

**Description:** First dorsal fin VI; second dorsal fin I,9; anal fin I,8; total caudal fin rays, including procurent rays, 17 in dorsal lobe, 15 in ventral lobe (15/13 in one specimen); predorsal scales 17-20; cheek and operculum without scales; snout length 5.5-8.5% SL, slightly less than eye diameter; eye diameter 7.5-10.0% SL; lower jaw typically extending to vertical through center of pupil, rarely beyond this point; interorbital region narrow; HL 29-32.5% SL; slope of snout straight and steep; body depth at first dorsal fin 18.5-23.0% SL; caudal peduncle depth 11.9-14.9% SL; pectoral fin reaching vertical through posterior margin of first dorsal fin; dorsalmost 4 (rarely 3 or 5) pectoral fin rays free from membrane, each free pectoral ray branching once; pelvic fin disk oval-shaped or slightly elliptical, extending to or just falling short of anus.

**Pigmentation:** Trunk with 6 distinct, large, square to irregular-shaped blotches ranging in size from slightly larger than pupil to as large as or larger than orbit; central basicaudal blotch present, confluent with small blotch on dorsal margin of caudal peduncle at caudal fin origin; trunk with three broad dorsal saddles, sometimes only slightly darker than base color of body; saddles sometimes extending to lateral midline and connecting with series of 6 blotches along ventral portion of trunk; background of body pale; in life each lateral body scale often having yellow border, giving appearance of narrow yellow zigzag-shaped lines down the length of body; first dorsal fin pigmentation variable, ranging from 1-3 longitudinal stripes with light distal margin of varying width (yellow in life) to uniformly dusky; second dorsal fin pigmentation variable and similar to that of first dorsal fin; anal fin dusky to lightly pigmented; caudal fin often with 1-4 blotches on each branched ray, appearing as 3-4 vertical bars across entire fin; pelvic fins pale to uniformly dusky; pectoral fin base heavily pigmented, with pigmentation

extending onto interradiial membranes, becoming paler distally; operculum densely pigmented, sometimes with 1-2 distinct dark blotches; postorbital blotch highly variable, sometimes single, round and smaller than or as large as pupil, sometimes forming pair of small round spots separated by sensory canal; temporal blotch small and more horizontally elongate than postorbital blotch, sometimes appearing as two separate or loosely connected hyphen-shaped markings; shoulder spot slightly larger than both temporal and postorbital spots, with irregular shape and diffuse border; head with small dark spot on posteroventral margin of orbit and scattered dark blotches on cheek and jaws; abdomen and pre-pelvic region pale; gular region mottled with scattered melanophores or uniformly pale.

**Habitat:** Bohlke & Chaplin (1993) reported *B. mystacium* from more exposed shorelines than *B. curacao*, which is more frequently taken in sheltered bays. Specimens examined in this study were collected from warm-water pools formed in limestone on beaches with moderate wave action, from shallow rocky intertidal flats with turtle grass on exposed shorelines, and from reef crests. *Bathygobius mystacium* has been collected with *B. lacertus* and *B. antillensis*.

**Distribution:** Specimens in this study were collected from Belize, Curacao, the Bahamas and Puerto Rico. Additional localities from museum records for this species exist from the Cayman Islands, Cuba, Swan Island and the Tortugas. *Bathygobius mystacium* is also reported from Brazil (Moura et al. 1999), but no images or illustrations were included in that publication. One photograph of Brazilian *B. mystacium* from Fishbase (by Macieira, <http://www.fishbase.org>, Froese & Pauly 2009) more closely resembles *B. geminatus*, which morphologically is similar to *B. mystacium* (see comparisons). Brazilian specimens have not been examined, and we cannot confirm the presence of *B. mystacium* in Brazil.

**Comparisons:** In most cases *B. mystacium* is easily recognized by the large, square to irregular blotches of dark pigment along the ventral portion of the trunk. This species is morphologically distinct and can be distinguished from *B. curacao* in having a higher number of pectoral rays (17-20 in *B. mystacium* vs. 15-17 in *B. curacao*) and from *B. lacertus*, *B. antillensis* and *B. saporator* in having a shorter upper jaw (typically 11 % SL or less in *B. mystacium*), steeper snout profile, and fewer lateral



scale rows (31-36 vs. 37-42). *Bathygobius mystacium* overlaps to varying degrees with *B. geminatus* in pectoral fin rays (17-20 in *B. mystacium* vs. 17-18 in *B. geminatus*), lateral scale rows (33-36 vs. 36-38), and upper jaw length (9.2-11.0 % SL vs. 10.3-10.7 % SL), but *B. mystacium* never has the double row of spots on the trunk diagnostic of *B. geminatus*.

***Bathygobius soporator* (Valenciennes, 1837)**

Frillfin goby (Figs 2, 9, 10)

*Gobius soporator* Valenciennes, in Cuvier & Valenciennes, 1837: 344 Fig. 1; Plate I a-d (type locality Martinique)

*Gobius catulus* Girard, in Girard, 1858: 169 (type locality St. Joseph Island, Texas)

? *Gobius Mapo* Poey, in Poey, 1860: 277 (type locality Cuba)

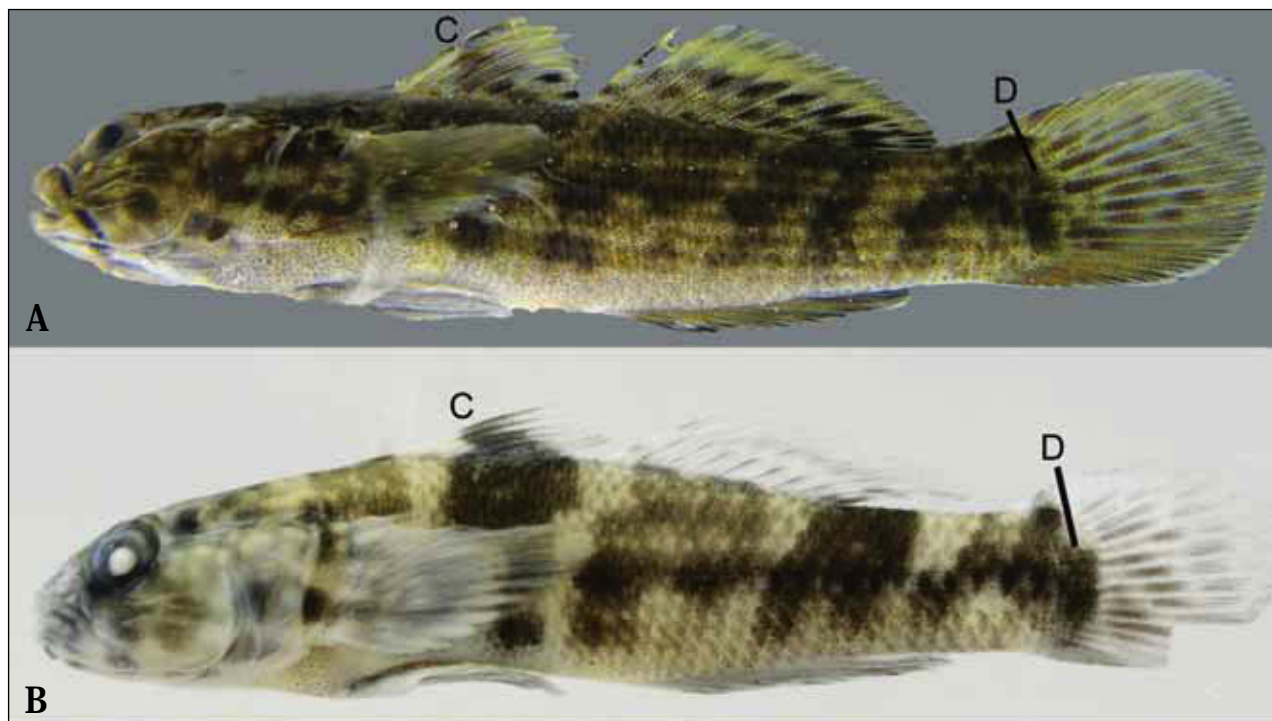
? *Gobius humeralis* Duméril, in Duméril, 1861: 248, Pl 21 (Figs. 2-2a) (type locality Gabon)

*Gobius caroliniensis* Gill, in Gill, 1863: 268 (type locality Charleston, South Carolina)

*Gobius brunneus* Poey, in Poey, 1868: 393 (type locality Havana, Cuba)

*Bathygobius soporator longiceps* Ginsburg, in Ginsburg, 1947: 280 (type locality Porto Bello, Panama)

**Materials Examined:** DNA voucher specimens: AMNH 251638, DNA #CUR14a, 50 mm SL, Piscadera Baai, Curacao, 9 February 2005, J. Van Tassell et al. AMNH 251639, DNA #VEN15b, 36 mm SL, Santa Cruz, Venezuela, 3 July 2007, J. Van Tassell, D.R. Robertson and J. Posada. AMNH 251640, DNA #VEN17b, 73 mm SL, Altagracia, Venezuela, 1 July 2007, J. Van Tassell, D.R. Robertson and J. Posada. AMNH 251641, DNA #PAN11a, 49 mm SL, Portobello, Panama, 28 May 2007, J. Van Tassell et al. AMNH 251646, DNA #PR1163, 34 mm SL, rock jetty at Punto Arecibo, Puerto Rico, 25 May 2009, L. Tornabene and R. Chabarria. AMNH 251646, DNA #PR1164, 24 mm SL, rock jetty at Punto Arecibo, Puerto Rico, 25 May 2009, L. Tornabene and R. Chabarria. AMNH 251647, DNA #PR1186, 36 mm SL, La Boca, Barceloneta, Puerto Rico, 25 May 2009, L. Tornabene and R. Chabarria. AMNH 251651, DNA #PR1338, 50 mm SL,

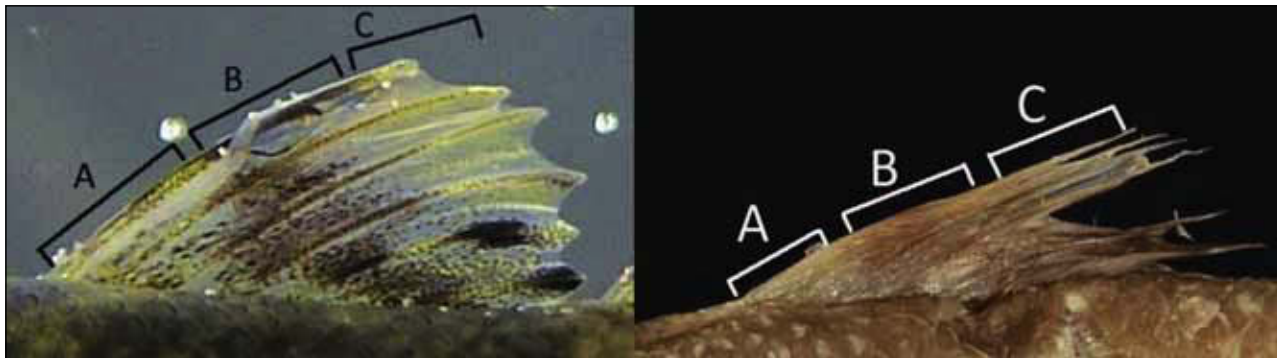


**Fig. 9. A-B. A.** *Bathygobius soporator* (lineage 2), 36 mm SL, Arecibo, Puerto Rico, DNA #PR1186, AMNH 251647; **B.** *Bathygobius soporator* (lineage 3), 33 mm SL, preserved, Port Aransas, Texas, DNA #TEX10a, AMNH 251642; **C.** vertical or slightly diagonal broad dark bar on first dorsal fin; **D.** large and irregularly shaped dark basicaudal blotch, either extending to dorsal midline or loosely connected to a separate dark spot near dorsal midline. Photos and image editing by L. Tornabene & R. Chabarria.

Arecibo, Puerto Rico, 28 May 2009, L. Tornabene and R. Chabarria. AMNH 251651, DNA #PR1340, 42 mm SL, Arecibo, Puerto Rico, 28 May 2009, L. Tornabene and R. Chabarria. AMNH 251642, DNA #TEX10a, 33 mm SL, rock jetty at Port Aransas, Texas, 15 November 2008, L. Tornabene and R. Chabarria. AMNH 251647, DNA #PR1190, 20 mm SL, La Boca, Barceloneta, Puerto Rico, 25 May 2009, L. Tornabene and R. Chabarria. USNM 397581, DNA #FLA7118, 24 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith and J. Mounts. USNM 397582, DNA #FLA7119, 18 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith, and J. Mounts. USNM 397583, DNA #FLA7120, 15 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith, and J. Mounts. USNM 397584, DNA #FLA7121, 15 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith, and J. Mounts. USNM 397585, DNA #FLA7122, 14 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith, and J. Mounts. USNM 397586, DNA #FLA7123, 13.5 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith, and J. Mounts. USNM 397587, DNA #FLA7157, 24 mm SL, St. Lucie County, Florida, 20 April 2007, C. Baldwin, D. Smith, and J. Mounts. USNM 397588, DNA #FLA7464, 75 mm SL, Sewall's Point, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 397589, DNA #FLA7465, 52 mm SL, Sewall's Point, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 397590, DNA

#FLA7468, 23 mm SL, Sewall's Point, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 397591, DNA #FLA7480, 85 mm SL, Stuart, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 397592, DNA #FLA7481, 50 mm SL, Stuart, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, S. Yanosh, S. Taylor and J. Bagley. USNM 397593, DNA #FLA8011, 37 mm SL, Port Canaveral, Florida, 21 November 2007, E. Reyier. USNM 397594, DNA #FLA8012, 32 mm SL, Port Canaveral, Florida, 21 November 2007, E. Reyier. USNM 397595, DNA #FLA8013, 28 mm SL, Port Canaveral, Florida, 21 November 2007, E. Reyier. USNM 397596, DNA #FLA8014, 21 mm SL, Port Canaveral, Florida, 21 November 2007, E. Reyier. USNM 397597, DNA #FLA9008, 53 mm SL, Sewall's Point, Florida, 30 October 2009, C. Baldwin and A. Vaslet. USNM 397598, DNA #FLA9012, 57 mm SL, Sewall's Point, Florida, 31 October 2009, C. Baldwin. USNM 397599, DNA #FLA9013, 42 mm SL, Sewall's Point, Florida, 31 October 2009, C. Baldwin. USNM 397600, DNA #FLA9014, 39 mm SL, Sewall's Point, Florida, 31 October 2009, C. Baldwin. USNM 397601, DNA #FLA9018, 34 mm SL, Sewall's Point, Florida, 31 October 2009, C. Baldwin.

COI sequences without voucher specimens: BLZ5131, 7.5 mm SL, photographed, Carrie Bow Cay, Belize, 26 April 2005, C. Baldwin and J. Mounts. BLZ6072, 6 mm SL, photographed, Carrie Bow Cay, Belize, 1 April 2006, C. Baldwin, L. Weigt and Murphy. FLA7165, 21 mm SL, photographed, Sewall's Point, Florida, 21 April 2007,



**Fig. 10.** Comparison of first dorsal fin pigmentation in (left) *Bathygobius soporator*, 36 mm SL, Arecibo, Puerto Rico, DNA #PR1186, AMNH 251647 and (right) *Gobius soporator*, syntype, 101 mm SL male, Martinique, MNHN A-1254. Note pale, lightly pigmented region on (A) the base and (C) distal portions of spines 1-3, with (B) a broad diagonal dark bar originating centrally on spines 1-3 and continues onto the proximal portions of spines 4-6. Photo of *Gobius soporator* by C. Ferrara. Photo of *B. soporator* and image editing by L. Tornabene.

C. Baldwin, D. Smith, and J. Mounts. FLA7189, 19 mm SL, photographed, Stuart, Florida, 23 April 2007, C. Baldwin, D. Smith, J. Mounts, L. Weigt, and Yanosh. FLA7291, 33 mm SL, photographed, St. Lucie County, Florida, 25 April 2007, D. Smith, Yanosh and Hoffman. FLA7495, 66 mm SL, photographed, Sewall's Point, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, Yanosh, Taylor and J. Bagley. FLA7496, 57 mm SL, photographed, Sewall's Point, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, Yanosh, Taylor and J. Bagley. FLA7497, 49 mm SL, photographed, Sewall's Point, Florida, 28 April 2007, C. Baldwin, D. Smith, L. Weigt, Yanosh, Taylor and J. Bagley.

**Additional specimens:** AMNH 248452, 1, 56 mm SL, Ocean Springs, Mississippi. AMNH 082697, 58 mm SL, Mobile Bay, Alabama. AMNH 52032, 9, 26-63 mm SL, Dauphin Island, Alabama. AMNH 76598, 2, 56-58 mm SL, Charleston, South Carolina. GCRL V67:2357, 13, 12-49 mm SL, Veracruz, Mexico. GCRL V68:2841, 23, 12-68 mm SL, Tamaulipas, Mexico; GCRL V70:4643, 9, 13-40 mm SL, Campeche, Mexico. GCRL V72:9608, 10, 50-79 mm SL, Isla Itaparica, Brazil. MCZ 26071, 2, 61-62 mm SL, Martinique. SLU 12668, 1, 31 mm SL, Palm Beach, Florida. TCWC 11203.17, 12, 38-55 mm SL, San Martin Lake, Texas. TCWC 11212.01, 6, 47-71 mm SL, Redfish Bay, Texas. TCWC 316.26, 4, 66-67 mm SL, Mustang Island, Texas. TCWC 422.06, 5, 48-65 mm SL, Port Isabel, Texas. TCWC 575.16, 31, 15-63 mm SL, Port Isabel, Texas. TCWC 624.06, 22, 25-61 mm SL, Escambia, Florida. TCWC 625.05, 4, 28-64 mm SL, Biloxi Bay, Mississippi. TCWC 670.02, 7, 46-67 mm SL, Pensacola, Florida. TCWC 8361.10, 7, 33-85 mm SL, Rio Grande, Texas. TCWC 871.05, 6, 31-75 mm SL, Port Aransas, Texas. TCWC 919.08, 7, 43-57 mm SL, Mustang Island, Texas. UF 115914, 42, 24-65 mm SL, Palm Beach, Florida. UF 230656, 2, 87-89 mm SL, Venado Beach, Panama. UF 36063, 41, 13-64 mm SL, Withlacoochee River, Florida. UF 60246, 10, 57-92 mm SL, Bayamon, Puerto Rico. USNM 087804, 7, 36-54 mm SL, Paranagua, Brazil. USNM 121543, 43, 39-72 mm SL, Maracaibo, Venezuela. USNM 81816, *Bathygobius saporator longiceps* paratypes, 15, 30-56 mm SL, Porto Bello, Panama. MNHN A-1254, *Gobius saporator* syntypes, 2, 90-110 mm SL, Martinique. USNM 6612, *Gobius catulus* syntypes, St. Joseph Island,

Texas. USNM 648, *Gobius catulus* syntype, St. Joseph Island, Texas. MCZ 13116, *Gobius mapo* holotype, 88 mm SL, Cuba. MNHN A-1193, *Gobius humeralis* holotype, 62 mm SL, Gabon. MCZ 13110, *Gobius brunneus* syntypes, 2, 70-94 mm SL, Cuba. USNM 119896, *Bathygobius saporator longiceps* holotype, 108 mm SL, Porto Bello, Panama.

**Diagnosis:** Pectoral fin rays 18-21 (modally 20); lateral scale rows 38-42 (44 in a single specimen); upper jaw length 11.9-13.7% SL; first dorsal fin with dark broad bar extending vertically or diagonally (anterodorsal to posteroventral) across fin; predorsal squamation reaching anteriorly beyond vertical through posterior margin of preopercle, often reaching posterior edge of postorbital blotches; trunk with 3 prominent dark saddles reaching ventrally to lateral midline, saddles sometimes dividing into two parts ventrally; side of body with 6-7 large dark irregular blotches along midline, some extending ventrally onto ventral portion of trunk; anteriorly ventral extensions sometimes present as separate entities, appearing to be loosely connected pairs of blotches; blotches along midline often connecting dorsally to ventral portions of dorsal saddles (or divided saddles).

**Description:** First dorsal fin VI; second dorsal fin I,9; anal fin I,8; total caudal fin rays, including procurrent rays 17 in dorsal lobe, 16 in ventral lobe (rarely 16/16 or 17/15); predorsal scales 19-22; snout length 6.5-9.0% SL, equal to or slightly less than eye diameter; eye diameter 6.5-10.5% SL; lower jaw typically extending to vertical through center of pupil and often beyond this point; interorbital region narrow; HL 27.5-34.0% SL; snout profile convex; body depth at origin of first dorsal fin 15.5-24.5% SL; caudal peduncle depth 10.9-14.6% SL; pectoral fin slightly longer than head, usually extending to or slightly beyond vertical through posterior margin of first dorsal fin; dorsalmost 4 rays (rarely 3 or 5) free from membrane, with rays 1-4 usually branching once; pelvic fin disk oval-shaped or slightly elliptical, extending to or just falling short of anus.

**Pigmentation:** Trunk with 3 prominent dark saddles reaching ventrally to lateral midline, saddles sometimes dividing into two parts ventrally; side of body with 6-7 large dark irregular blotches along midline, some extending onto ventral portion of trunk, ventral extensions sometimes present as separate entities anteriorly, appearing as loosely connected pairs of blotches; blotches along midline

often connecting dorsally to ventral portions of dorsal saddles (or divided saddles); first dorsal fin with dark, broad bar extending vertically or diagonally (anterodorsal to posteroventral) across fin, pigment less obvious in larger specimens and often fading completely shortly after death or preservation; shape and definition of bar on first dorsal fin slightly variable, but fin typically with pale region at anterior base, similarly pale region along distal margin posteriorly and more darkly pigmented region between those two pale regions constituting vertical/diagonal bar; second dorsal fin uniformly dusky or with 1-3 longitudinal stripes crossing fin (often with narrow pale, orange or yellow band distally in life); caudal fin with irregular blotches on branched rays giving appearance of irregular vertical bands across fin; large, irregularly shaped basicaudal blotch, often extending to dorsal margin of caudal peduncle or loosely connected to separate dark spot at that location; anal fin lightly pigmented proximally, becoming darker distally but often possessing very narrow pale stripe along the distal margin of fin; pelvic fins dusky, often with narrow pale band near distal margin; pectoral fin base either uniformly darkly pigmented or with two concentrated areas of pigment, one dorsally and one ventrally, separated by pale region; in both cases, pigment on ventral portion of pectoral fin base extending anteriorly underneath margin of operculum and posteriorly onto bases of pectoral rays, pigment on rays becoming lighter to nearly pale distally; opercle mottled, but often possessing narrow, triangular-shaped dark blotch, apex directed ventrally and reaching horizontal through angle of preopercle; cheek and jaw dusky with irregular dark blotches; postorbital blotch usually large, often equivalent in length to diameter of pupil, sometimes separate concentration of melanophores present below longitudinal sensory canal; postorbital blotch shape variable, but often somewhat triangular; temporal blotch small, horizontally elongate, hyphen-shaped marking, often indiscernible in small specimens; shoulder blotch as large as or larger than postorbital blotch, irregular in shape, and dark, but with diffuse margin; gular, prepelvic and branchiostegal regions light to dusky; abdomen pale.

**Habitat:** *Bathygobius soporator* has been taken from sheltered rock and sand beaches, mangroves, cobble shorelines with patches of seagrass, rock jetties, seawalls near the mouths of rivers and streams, near *Millepora* reefs and warm, shallow tidepools covered with soft algae on sheltered shores. This

species has been collected with *B. geminatus* and *B. lacertus*. At one site in Puerto Rico, it was taken with those species and a single specimen of *B. antilliensis* from a rocky shore near the mouth of an irrigation canal.

**Distribution:** *Bathygobius soporator* is widespread throughout the western Atlantic, and may also occur off western Africa (see "Discussion"). Specimens from lineage 2 (Fig. 1) were collected from the east coast of Florida (Jacksonville south to Florida Keys), Venezuela, Panama, Puerto Rico, Curacao, and Belize (larvae only). Specimens from lineage 3 were taken from Texas and the Atlantic coast of Florida. Additional localities of *B. soporator* tabulated from museum specimens examined in this study include Mexico, Brazil, Martinique, Alabama, Mississippi, and the west coast of Florida, but in the absence of genetic data for those specimens we do not know to which of the *B. soporator* lineages they belong.

**Discussion:** As noted (see "Results"), several genetic lineages illuminated in this study fit Ginsburg's (1947) redescription of *B. soporator*. Identifying the lineage in this study that represents the true *B. soporator* was difficult because the pigment in the *Gobius soporator* syntypes has largely faded, and patterns of pigmentation are important diagnostic characters in western Atlantic *Bathygobius*. Trunk pigmentation on the syntypes has completely faded; however, pigmentation on the first dorsal fin is evident in one of the syntypes (101 mm SL male; the first dorsal fin pigment on the other syntype is completely faded). On the 101 mm SL syntype, the basal and distal portions of dorsal spines I-II are pale (Fig. 10A, C) and a broad area between those pale regions is darkly pigmented (Fig. 10B). This dark pigment continues onto the proximal portions of the other dorsal spines, giving the appearance of a broad vertical or slightly diagonal dark bar across the fin. As noted above, the presence of this bar of pigment on the first dorsal fin is diagnostic of our lineages 2 and 3, but it is not characteristic of the other lineages initially confused with *B. soporator* (i.e., lineage 1, *B. lacertus*, and lineage 5, *B. antilliensis*). Predorsal squamation also is somewhat helpful in separating the species. Predorsal squamation on both of the *G. soporator* syntypes extends anteriorly well beyond the posterior margin of the preopercle, reaching the posterior margin of the postorbital spots. By contrast, the predorsal squamation in the lineage we recognize as *B. lacertus* rarely extends

anterior to the posterior margin of the preopercle. Based on the extent of predorsal squamation and the pattern of pigmentation on the first dorsal fin, it is most parsimonious to conclude that specimens in lineages 2 and 3 and the *G. saporator* syntypes represent the same species. We were unable to identify morphological features that separate lineages 2 and 3 and we assign both to *B. saporator* pending further investigation.

*Gobius catulus* Girard, 1858, was described from St. Joseph Island, Texas, and was resurrected as the subspecies *B. saporator catulus* by Ginsburg (1947). The characters he proposed to distinguish this subspecies (a smaller eye diameter, a shorter caudal fin and a lower average number of pectoral fin rays) do not diagnose any of the lineages identified in this study. The *G. catulus* syntypes have predorsal squamation that extends anteriorly to slightly beyond a vertical through the posterior margin of the preopercle, but falls short of the postorbital blotches, making it difficult to determine the identity of *G. catulus* based on this character. The pigmentation on the trunk and first dorsal fin of the syntypes is completely faded. *Bathygobius lacertus* and *B. antilleanus* are absent from the Gulf of Mexico in the material examined in this study and the only species occurring from that region in our material is *B. saporator*. More specifically, *B. saporator* is the only species in this study that we collected from Port Aransas, Texas, a locality less than 20 miles away from the type locality of *G. catulus* and part of the same major bay system. We therefore suggest that *G. catulus* remain a synonym of *B. saporator*.

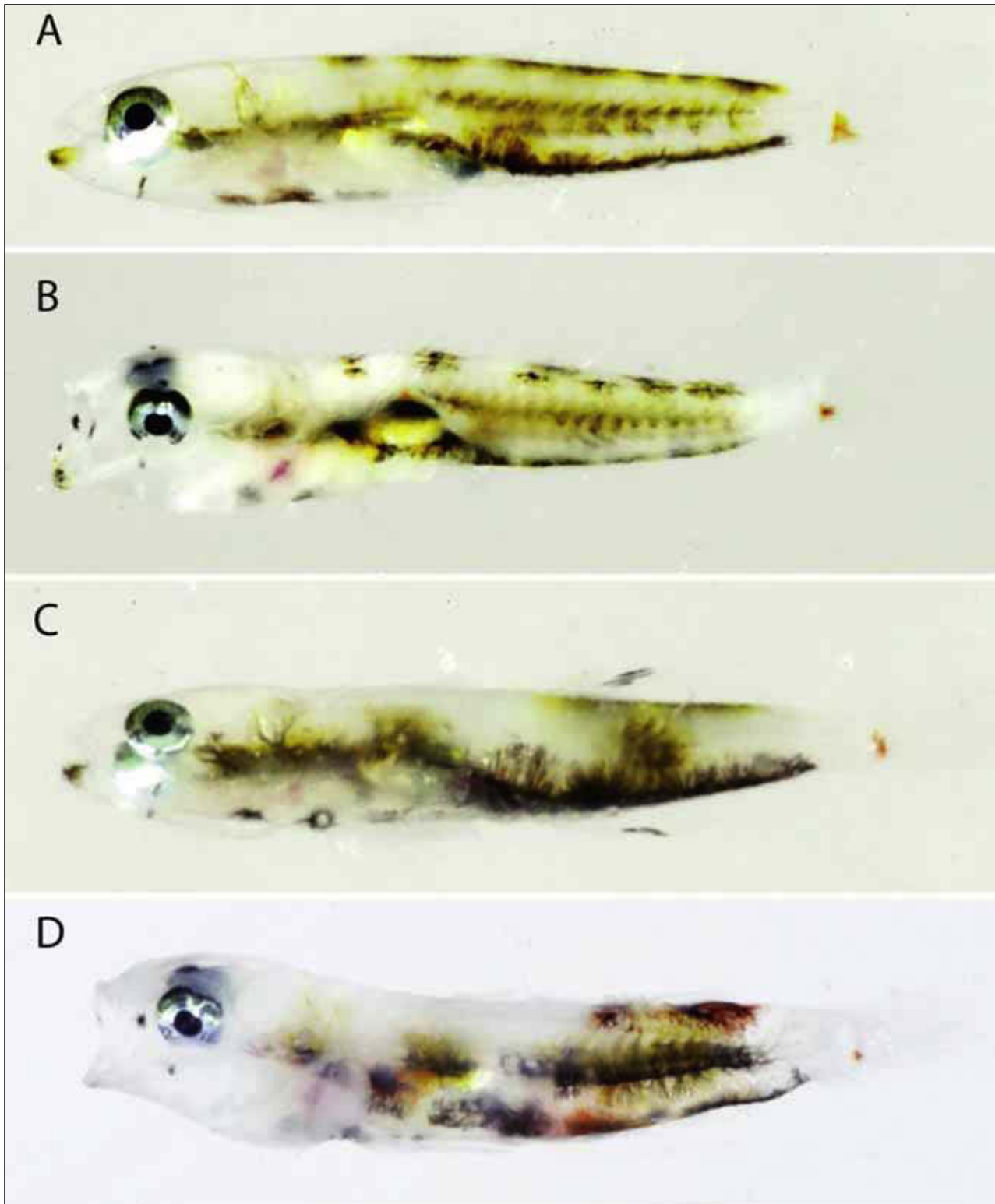
*Gobius brunneus* Poey, 1868, is another species that has long been recognized as a synonym of *B. saporator*. The anterior extent of predorsal squamation and first dorsal fin pigmentation of the *G. brunneus* syntypes both support this synonymy.

*Gobius mapo* Poey, 1960, another *B. saporator* synonym, was described from a single individual (110 mm total length) referred to as "l'individu décrit" which translates as "the described individual" (Poey 1860). Howell-Rivero (1938) later referred to that specimen as the holotype. Though Poey (1860) never used the term "holotype" or "type", we agree with Howell-Rivero's (1938) recognition of the holotype following Article 73.1.1 the ICZN (International Commission on Zoological Nomenclature 1999). Howell-Rivero (1938) reports five individuals (including the holotype) deposited at MCZ by Poey. The presence of two collection numbers (MCZ 13116-13117) in one jar for these

five specimens suggests that two lots were mixed at the museum or by subsequent investigators. Although the specimens were cataloged into the collection as syntypes, per Article 73.1.1 we regard the specimen referenced in the original description (110 mm total length, 88 mm SL) as the holotype and only type specimen of *G. mapo*, and the remaining four specimens in MCZ 13116-13117 as having no type status (this lot has now been separated into two, with the holotype as MCZ 13116 and the remaining specimens as MCZ 13117). The holotype of *G. mapo* and the holotype of *B. saporator longiceps* Ginsburg, 1947, both possess predorsal squamation that reaches the postorbital blotch. Pigmentation on the body and first dorsal fin of the holotype of both species has faded. Because these types cannot be unambiguously linked to any other species recognized in this study, we suggest that *G. mapo* and *B. saporator longiceps* remain in the synonymy of *B. saporator*. *Gobius carolinensis* Gill, 1863, previously considered a synonym of *B. saporator*, was described from Charleston, South Carolina. The holotype of this species is apparently lost, and the original description does not provide sufficient information to tie it to one of our genetic lineages. The specimens of *Bathygobius* from Charleston in our study (AMNH 76598) possess all of the diagnostic characters of *B. saporator*, and therefore we suggest that *G. carolinensis* also remains in the synonymy of *B. saporator*.

*Gobius humeralis* Duméril, 1861, from Gabon, Africa, is another species currently considered a synonym of *B. saporator*. The only diagnostic character evident from the *G. humeralis* holotype is the predorsal squamation, which extends anteriorly to the postorbital blotch. Though West African material is not included in this study, unpublished preliminary phylogenetic studies suggest that *Bathygobius* from Guinea that are morphologically indistinguishable from specimens of western Atlantic *B. saporator* form a third genetic lineage within this species based on mitochondrial DNA sequence data (Tornabene et al. unpublished). Thus, it is possible that *G. humeralis* and other morphologically similar West African *Bathygobius* belong to *B. saporator*, as suggested by Miller & Smith (1989), or perhaps form a distinct sister species to *B. saporator*. Miller & Smith (1989), however, described *B. saporator* as having a longitudinal pigmentation pattern on the first dorsal fin, which is contrary to our findings. It is possible that more than one species occurs in West Africa that fits Ginsburg's





**Fig. 11A-D.** *Bathygobius* larvae from Carrie Bow Cay, Belize; A. *B. curacao*, 5.5 mm SL, DNA sequence #BLZ7305, SI; B. *B. curacao*, 6.0 mm SL, DNA sequence #BLZ7260; C. *B. lacertus*, 6.0 mm SL, DNA sequence #BLZ7370; D. *B. saporator*, 6.0 mm SL, DNA sequence #BLZ6072. Photos A-C by J. Mounts, C. Baldwin, L. Weigt; photo D by C. Baldwin and L. Weigt. Image editing by J. Mounts.

(1947) and Miller & Smith's (1989) description of *B. saporator*. We retain *G. humeralis* as a synonym of *B. saporator* pending further analysis of West African material.

**Comparisons:** *Bathygobius saporator* can be distinguished from all other western Atlantic species of *Bathygobius* in having a broad vertical or slightly diagonal bar on the first dorsal fin. This character, as well as the overall body pigmentation of *B. saporator*, is similar to that observed in the genetically similar *B. andrei* from the eastern Pacific (Miller & Stefanni 2000). Although the bar of pigment on the first dorsal fin becomes less distinct in very large or poorly preserved specimens, it never approximates a striped or longitudinal pattern characteristic of other *Bathygobius*. *Bathygobius saporator* is morphologically similar to *B. antilliensis* and *B. lacertus* in having a high number of pectoral fin rays (18-21) and lateral scale rows (38-42), and in having a long upper jaw (typically greater than 11% SL). The high number of lateral scale rows further distinguishes this species from *B. mystacium* and *B. curacao* and trunk pigmentation further distinguishes it from *B. geminatus*. In some cases, the anteriormost trunk markings of *B. saporator* appear as a pair of loosely connected dark blotches, similar in appearance to the paired markings diagnostic of *B. geminatus*. In *B. geminatus* however, these markings are distinctly separate anteriorly and continue posteriorly to the caudal fin base, whereas in *B. saporator* they are less distinct and only evident anteriorly. In most cases, the shape and size of the dark basicaudal blotch distinguishes this species from *B. lacertus* and *B. antilliensis* (large and irregularly shaped, often reaching the dorsal midline of the caudal peduncle in *B. saporator* vs. a set of 2 small loosely connected or separate spots in *B. lacertus* and *B. antilliensis*). The anterior extent of predorsal squamation is also useful in distinguishing this species from *B. lacertus* (usually extending anteriorly to postorbital blotch in *B. saporator* vs. terminating near a vertical through posterior margin of preopercle in *B. lacertus*), although there is some variation in this character in the two species.

**Key to the western Atlantic species of *Bathygobius***

As noted previously, *Bathygobius* species are morphologically conserved, although most species can be easily distinguished based on pigmentation (Fig. 2). If pigment has faded, most *Bathygobius* species cannot be identified. The exception is *B. curacao*,

which typically has a longer upper jaw than *B. geminatus* and *B. mystacium* (11.1-15.0 % SL in *B. curacao* vs. 10.3-11.0 % SL in *B. geminatus* and *B. mystacium*), and fewer pectoral fin rays than *B. lacertus*, *B. antilliensis*, and *B. mystacium* (typically 16-17 in *B. curacao* vs. 18-21 in the other species). The extent of predorsal squamation can be useful in separating species, although there is some overlap among species. The intraspecific variation in this character does not appear to be directly correlated with the size of the individual or the locality in which the specimen was collected. Despite this apparent variation, there is still diagnostic utility in this character when used in combination with other characters. The diagnostic pigment and morphological characters described in detail above are summarized in the taxonomic key to the species of western Atlantic *Bathygobius*, below.

- 1a. First dorsal fin with a broad vertical or slightly diagonal 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 7-8 vertically paired blotches, one directly above the other; blotches beginning beneath pectoral fin and terminating just anterior to basicaudal blotch ..... *B. geminatus*
- 2b. Ventral portion of trunk variously pigmented, with or without blotches, but never with vertically paired markings as described above ..... 3
- 3a. 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; both rows complete, i.e., beginning beneath the pectoral fin and terminating just before caudal fin base, the lower row of spots more diffuse than top row and becoming more diffuse posteriorly; predorsal squamation reaching a vertical through the posterior margin of preopercle, rarely extending beyond this point; lateral scale rows 38-42 ..... *B. lacertus*
- 3b. Ventral portion of trunk variously pigmented, with or without blotches, but never with two offset rows of markings as described above; lateral scale rows 31-42 ..... 4
- 4a. 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 mark-

**Table I.** Distance matrix showing the mean Kimura 2-parameter genetic distances between the genetic lineages from the complete neighbor-joining tree. Shaded values are mean within-lineage genetic distances. Values between the lineages of *B. saporator* and *B. geminatus* are highlighted in bold.

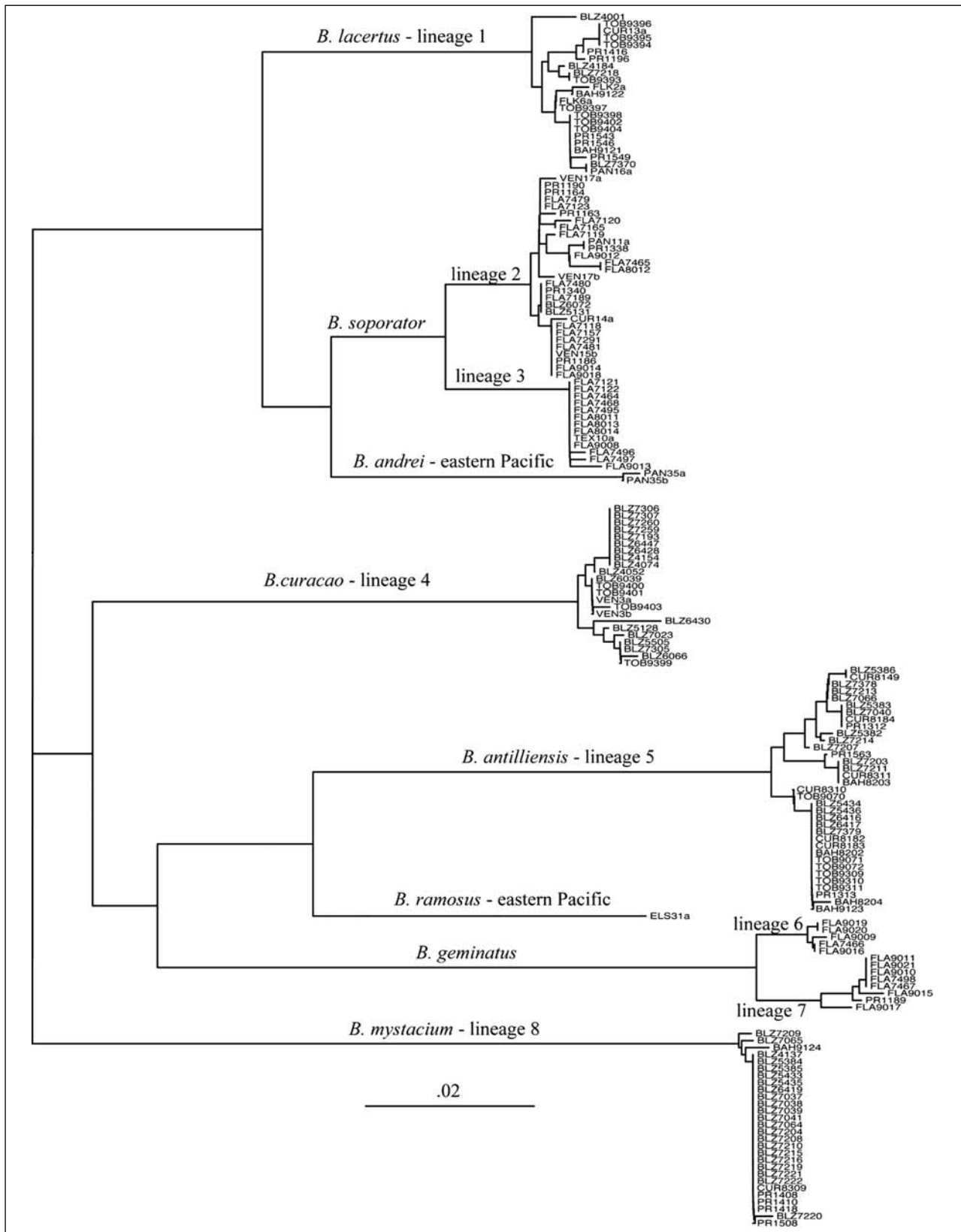
	<i>B. lacertus</i>	<i>B. andrei</i>	<i>B. saporator</i> (lineage 2)	<i>B. saporator</i> (lineage 3)	<i>B. mystacium</i>	<i>B. curacao</i>	<i>B. antillensis</i>	<i>B. ramosus</i>	<i>B. geminatus</i> (lineage 6)	<i>B. geminatus</i> (lineage 7)
<i>B. lacertus</i>	0.006									
<i>B. andrei</i>	0.083	0.002								
<i>B. saporator</i> (lineage 2)	0.072	0.063	0.005							
<i>B. saporator</i> (lineage 3)	0.076	0.063	<b>0.029</b>	0.001						
<i>B. mystacium</i>	0.148	0.165	0.149	0.153	0.001					
<i>B. curacao</i>	0.133	0.124	0.130	0.135	0.167	0.004				
<i>B. antillensis</i>	0.170	0.163	0.150	0.155	0.165	0.137	0.005			
<i>B. ramosus</i>	0.143	0.142	0.129	0.137	0.172	0.133	0.099	n/a		
<i>B. geminatus</i> (lineage 6)	0.158	0.157	0.156	0.156	0.161	0.149	0.136	0.158	0.002	
<i>B. geminatus</i> (lineage 7)	0.162	0.163	0.164	0.160	0.161	0.155	0.145	0.159	<b>0.021</b>	0.003

- ings; the lower row incomplete, comprising 3 (rarely 4) spots, and typically terminating anterior to origin of anal fin; predorsal squamation reaching anterior to a vertical through the posterior margin of preopercle, often to the posterior margin of postorbital blotches; lateral scale rows 38-42.....*B. antillensis*
- 4b. Ventral portion of trunk variously pigmented, with or without blotches, but never with one complete and one incomplete row of spots as described above; lateral scale rows 31-36 (rarely 37)..... 5
- 5a. Trunk typically with no apparent diagnostic pattern of pigment (sometimes 6-7 diffuse dark blotches of varying size along body); pectoral fin rays 15-17; upper jaw length 11.1-15 % SL .....*B. curacao*
- 5b. A row of 6 large square to irregularly shaped blotches beneath lateral midline ranging in size from slightly larger than the pupil to as large as or larger than the orbit; pectoral fin rays 18-21 (rarely 17); upper jaw length 9.2-11.0 % SL .. ..... *B. mystacium*

***Bathygobius* larvae (Fig. 11):** Baldwin & Smith (2003) described settlement-stage larvae of *B. curacao* and *B. saporator* from Belize, Central America, based on wild-caught specimens collected in a plankton net off the Smithsonian's Carrie Bow Cay marine station. Species identifications were made

by rearing selected specimens through transformation. Identification of reared *B. curacao* was based on low numbers of scales in a longitudinal series (32-33) and pectoral fin rays (16-17). Our DNA data include sequences from numerous Belizean larval *Bathygobius* (Fig. 1, indicated by "L\*"), some of which are in the *B. curacao* lineage (Fig. 1). Those larvae have all of the diagnostic characters of *B. curacao* larvae described by Baldwin & Smith (2003: 646, Figs 1, 17A), including the presence of approximately five large melanophores on the ventral midline along the posterior portion of the trunk, one large melanophore around the anus, six large melanophores along the dorsal midline and internal melanophores along the myosepta of the epaxial and hypaxial musculature. In terms of diagnostic color patterns, they have xanthophores associated with the trunk melanophores and a single erythrophore at the base of the caudal fin (Fig. 11A,B). The identification of Baldwin & Smith's (2003) *B. curacao* larvae is thus confirmed through DNA barcoding.

Baldwin & Smith's (2003: 648, Figs 2, 17B) larvae of *B. saporator* have three or four large, stellate melanophores on the ventral midline on the posterior half of the body, two large melanophores on the dorsal midline ventral to the posterior half of the second dorsal fin and a patch of partially internal pigment midlaterally. There is a melanophore on the membrane of each of the second through



Appendix I. Complete neighbor-joining tree of all167 COI sequences.

fifth elements of the second dorsal fin, and the anal fin has flags of pigment distally on approximately the third through fifth elements. Chromatophores include xanthophores associated with the melanophores on the dorsal and ventral midlines and a single erythrophore at the base of the caudal fin. Larvae with those diagnostic features are in the same genetic lineage as *B. lacertus* in our neighbor-joining tree (Fig. 1). Baldwin & Smith's (2003: 649) identification of larval *B. saporator* was based on a single specimen reared through transformation, and they noted that the 18 pectoral fin rays present in that specimen is within the extremes of, but not the typical count for, any of the three species considered valid at the time. Their identification was based on the presence of approximately 39 scales in a longitudinal series (37-41 in *B. saporator*, 31-34 in *B. curacao*, and 33-36 in *B. mystacium* (Böhlke & Chaplin 1993; Ginsburg 1947). Eighteen pectoral fin rays and 39 longitudinal scales have been observed in specimens of four lineages in this study, but they are most commonly seen in *B. lacertus*. We suggest that Baldwin & Smith's (2003) larval *B. saporator* (Fig. 11C) is *B. lacertus*.

Baldwin & Smith (2003) described one variant of their *B. saporator* that has orange vs. yellow chromatophores on the body, but they were not sure if the color difference represented variation within a single species or was indicative of a different species with similar meristic counts. Our material from Belize includes two larval specimens that also differ from *B. lacertus* larvae in having orange vs. yellow pigment on the trunk (Fig. 11D). In our analysis, those specimens belong to lineage 2 of *B. saporator* (Fig. 1) and thus it appears that Baldwin and Smith's (2003) variant of *B. saporator* is the true *B. saporator*. Additional intact larval specimens are needed to provide a full description of larvae of this species.

We have no larval specimens of *B. antillensis*, *B. mystacium*, *B. geminatus*, or lineage 3 of *B. saporator*. Peters (1983) described larvae and juveniles of *B. saporator* from Florida, which, as noted by Baldwin & Smith (2003) are different from their "*B. saporator*" (now *B. lacertus*) from Belize. Peters' (1983) larvae are part of a reared series, and illustrations of 41- and 49-day old specimens (his Fig. 2C-D) show a nearly vertical bar of dark pigment on the first dorsal fin. As that character is diagnostic of *B. saporator* and larvae of one lineage of that species (lineage 2, Fig. 1) have been identified, it

seems likely that Peters' larval *B. saporator* represents the other *B. saporator* lineage (lineage 3, Fig. 1). Fresh larval specimens are needed to confirm that identification genetically. Identification of larvae of all *Bathygobius* species could provide information useful, in combination with adult features and genetic data, in resolving interspecific phylogenetic relationships.

**The question of sympatric cryptic species:** It has been suggested that the species of *Bathygobius* in the western Atlantic are in an early stage of speciation, and that contrasting populations may be closer to subspecies than actual species (Ginsburg 1947). Our results show that although western Atlantic *Bathygobius* species are fairly conserved morphologically, many of the species show evidence of deep ancestral divergences (0.06-0.17 genetic distance between most lineages, Table I) with no obvious correlation between geographic distance and genetic variation. However, in two cases in this study, morphologically indistinguishable individuals form two closely related genetic lineages (Fig. 1. *B. saporator* lineages 2/3, *B. geminatus* lineages 6/7). In both of those instances, we provisionally treat the pairs of "lineages within lineages" as belonging to a single species. Within each pair of lineages, voucher specimens were indistinguishable with regards to every morphological and pigmentation character analyzed in this study. A more exhaustive morphological examination including a multivariate morphometric analysis might uncover subtle differences providing evidence that these lineages represent distinct species. In both instances, specimens from each of the sister lineages were collected from the same site on two different occasions from localities on the east coast of Florida, but further fine-scale investigation of specific local habitat is needed to determine whether or not the fishes of each of the sister lineages are truly syntopic in the strictest sense. The genetic distance between sister lineages in both cases (0.029 for *B. saporator*, 0.021 for *B. geminatus*, Table I) is less than the distance between the other congeners in the region, but is considerably larger than the intraspecific variation typical of the other species in this region ( $\leq 0.006$ ; Table I). Although both cases may be indicative of more recent speciation events, support from other independent lines of evidence such as nuclear markers is needed. Some authors caution the use of mitochondrial DNA alone in delimiting species boundaries and argue that the maternally inherited, non-



recombining nature of mitochondrial DNA will always result in gene lineages that show a phylogenetic pattern of transmission, even within populations of a single species (e.g. Davis 1996; Puerto et al. 2001). Thus the sympatric haplotypes that are present here may represent independently evolving gene lineages within single species. Until more critical testing of these hypotheses is done using other independent genetic markers and additional morphological data, we treat both pairs of sister lineages as single species.

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#### REFERENCES

- AKHITO, PRICE & MEGURO, K. 1980. On the six species of the genus *Bathygobius* found in Japan. *Japanese Journal of Ichthyology* 27: 215-236.
- AKHITO, P., HAYASHI, M. & YOSHINO, T. 1988. Suborder Gobioidi. In: *The Fishes of the Japanese Archipelago*. (Eds. K. Masuda, C. Amaoka, C. Araga, Y. Uyeno, T. Yoshino.): Tokai University Press, Tokyo.
- BALDWIN, C. C. & SMITH, D. G. 2003. Larval Gobiidae (Teleostei: Perciformes) of Carrie Bow Cay, Belize, Central America. *Bulletin of Marine Science* 72: 639-674.
- BALDWIN, C. C., WEIGT, L. A., SMITH, D. G. & MOUNTS, J. H. 2009. Reconciling genetic lineages with species in western Atlantic *Coryphopterus* (Teleostei: Gobiidae). *Smithsonian Contributions to the Marine Sciences*: 113-140.
- BLEEKER, P. 1878. Quatrième mémoire sur la faune ichthyologique de la Nouvelle-Guinée. *Archives Néerlandaises des Sciences Exactes et Naturelles* 14: 35-66.
- Bohlke, J. & CHAPLIN, C. 1993. *Fishes of the Bahamas and adjacent tropical waters*. University of Texas Press, Austin, 771 pp.
- CUVIER, G., & VALENCIENNES, A. 1837. Histoire naturelle des poissons. Tome douzième. Suite du livre quatorzième. Gobioides. Livre quinzième. Acanthoptérygiens à pectorales pédiculées. *Histoire Naturelle des Poissons* 12: 56
- DAVIS, J. 1996. Phylogenetics, molecular variation, and species concepts. *Bioscience* 46: 502-511.
- DUMÉRIL, A. H. A. 1861. Poissons de la côte occidentale d'Afrique. *Archives du Museum National d'Histoire Naturelle (Paris)* 10: 241-268.
- GILL, T. N. 1863. On the gobioids of the eastern coast of the United States. *Proceedings of the Academy of Natural Sciences of Philadelphia* 15: 267-271.
- GINSBURG, I. 1947. American species and subspecies of *Bathygobius*, with a demonstration of a suggested modified system of nomenclature. *Journal of the Washington Academy of Sciences* 37: 275-284.
- GIRARD, C. F. 1858. Notes upon various new genera and new species of fishes, in the museum of the Smithsonian Institution, and collected in connection with the United

- States and Mexican boundary survey: Major William Emory, Commissioner. *Proceedings of the Academy of Natural Sciences of Philadelphia* **10**: 167-171.
- INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. 1999. *International Code of Zoological Nomenclature*. 4th Ed. The International Trust for Zoological Nomenclature, London, 306 pp.
- ESCHMEYER, W. N. Catalog of Fishes electronic version (6 May 2010). <http://research.calacademy.org/ichthyology/catalog/fishcatmain.asp>
- FROESE, R. & PAULY, D. 2009. FishBase version (November, 2009). <http://fishbase.org>
- GARZÓN-FERREIRA, J. & ACERO, A. 1992. Los peces del genero *Bathygobius* (Perciformes: Gobiidae) del Caribe Colombiano. *Boletín de Investigaciones Marinas y Costeras - INVEMAR* **21**: 23-32.
- HOWELL-RIVERO, L. 1938. List of the fishes, types of Poey, in the Museum of Comparative Zoology. *Bulletin of the Museum of Comparative Zoology*: 169-227.
- KIMURA, M. 1980. A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. *Journal of molecular evolution* **16**: 111-120.
- LIMA, D., FREITAS, J. E. P., ARUAJO, M. E. & SOLÉCAVA, A. M. 2005. Genetic detection of cryptic species in the frillfin goby *Bathygobius soporator*. *Journal of Experimental Marine Biology and Ecology* **320**: 211-223.
- METZELAAR, J. 1919. *Over Tropisch Atlantische Visschen*. A. H. Kruyt, Amsterdam. 314 pp.
- MILLER, P. J. & SMITH, R. M. 1989. The West African species of *Bathygobius* (Teleostei: Gobiidae) and their affinities. *Journal of Zoology* **218**: 277-318.
- MILLER, P. J. & STEFANNI, S. 2001. The eastern Pacific species of *Bathygobius* (Perciformes: Gobiidae). *Revista de biologia tropical* **1**: 141-156.
- MOURA, R., GASPARINI, J. & SAZIMA, I. 1999. New records and range extensions of reef fishes in the western south Atlantic, with comments on reef fish distribution along the Brazilian coast. *Revista Brasileira de Zoologia* **16**: 513-530.
- NELSON, J. S., CROSSMAN, E. J., ESPINOSA-PÉREZ, H., FINDLEY, L. T., GILBERT, C. R., LEA, R. N. & WILLIAMS, J. D. 2004. *Common and Scientific Names of Fishes from the United States, Canada, and Mexico*. 6<sup>th</sup> Ed. American Fisheries Society, Bethesda, 386 pp.
- PETERS, K. M. 1983. Larval and early juvenile development of the frillfin goby, *Bathygobius soporator* (Perciformes; Gobiidae). *Northeast Gulf Science* **6**: 137-153.
- PUERTO, G., DA GRACA SALOMÃO, M., THEAKSTON, R., THORPE, R., WARRELL, D. & WÜSTER, W. 2001. Combining mitochondrial DNA sequences and morphological data to infer species boundaries: phylogeography of lanceheaded pitvipers in the Brazilian Atlantic forest, and the status of *Bothrops pradoi* (Squamata: Serpentes: Viperidae). *Journal of Evolutionary Biology* **14**: 527-538.
- POEY, F. 1860. *Memorias sobre la historia natural de la Isla de Cuba, acompañadas de sumarios Latinos y extractos en Francés (v.2)*. Imprenta de la Viuda de Barcina, Habana, 239 pp.
- POEY, F. 1898. Synopsis piscium cubensium. *Catalogo Razonado de los peces de la isla de Cuba., Repertorio Físico-Natural de la Isla de Cuba* **2**: 279-484.
- SAUVAGE, H. E. 1880. Description des Gobioides nouveaux ou peu connus de la collection du Muséum d'histoire naturelle. *Bulletin de la Société philomathique de Paris (7th Série)* **4**: 40-58.
- SAITOU, N. & NEI, M. 1987. The neighbor-joining method: a new method for reconstructing phylogenetic trees. *Molecular Biology and Evolution* **4**: 406-425.
- SEUTIN, G., BAGLEY, P. & WHITE, B. N. 1990. Preservation of avian blood and tissue samples for DNA analyses. *Canadian Journal of Zoology* **69**: 82-90.
- SWOFFORD, D. 2002. Phylogenetic analysis using parsimony (\*and other methods). Sunderland, Massachusetts: Sinauer Associates.
- TAMURA, K., DUDLEY, J., NEI, M., & KUMAR, S. 2007. MEGA4: Molecular Evolutionary Genetics Analysis (MEGA) software version 4.0. *Molecular Biology and Evolution* **24**:1596-1599.
- TAVOLGA, W. 1950. Pattern variability among populations of the gobiid fish, *Bathygobius soporator*. *Copeia* **1950** (3): 182-194.
- TORNABENE, L., CHABARRIA, R. & PEZOLD, F. Preliminary phylogeny of the Atlantic members of the goby genus *Bathygobius* (Teleostei: Gobiidae). *Presented at Joint Meeting of Ichthyologists and Herpetologists*, 23 July, 2009, Portland, Oregon.

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## ERRATA

Allen, G. R., Drew, J. A. & Fenner, D. (2010). *Amphiprion pacificus*, a new species of anemonefish (Pomacentridae) from Fiji, Tonga, Samoa, and Wallis Island. *aqua International Journal of Ichthyology* **16** (3): 129-138.

We erroneously stated in the Materials and Methods section that we used the mitochondrial 12s gene. Although this oversight was corrected throughout the rest of the manuscript, for clarity's sake the phrase "12s" on page 130 should read "Control Region".